THE NEUTRINO® SERIES
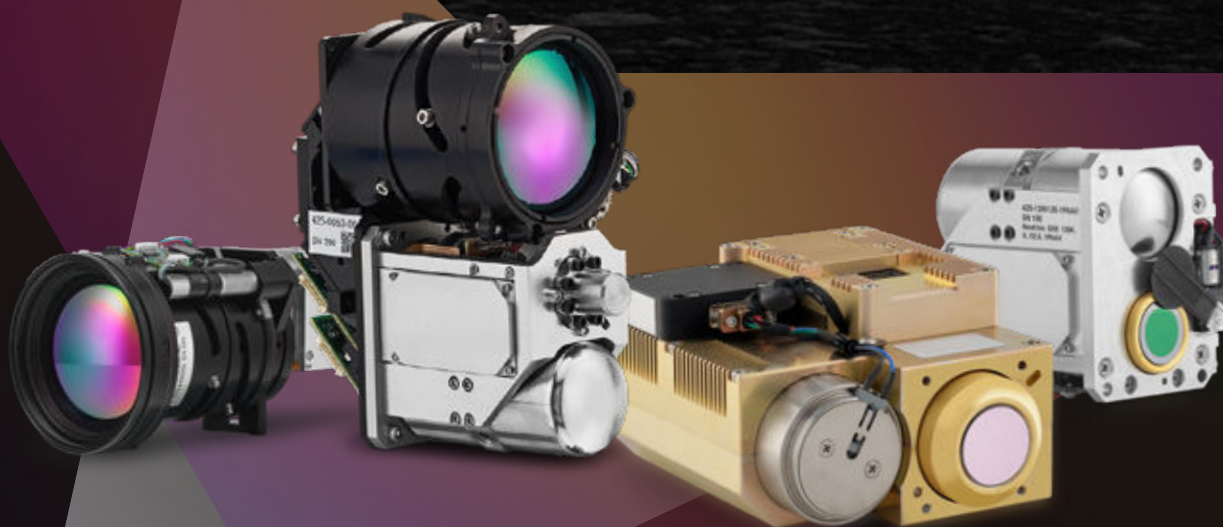
High Performance and SWaP MWIR Camera & Continuous Zoom Lens Solutions

www.flir.com/**neutrino**

TELEDYNE
FLIR

A **COOLED MWIR** SOLUTION FOR YOUR APPLICATION

The Neutrino high-performance and SWaP+C cooled mid-wavelength infrared (MWIR) OEM camera modules and continuous zoom (CZ) lenses provide an optimized imaging solution for missions demanding performance and reliability.

Offering size, weight, power, and cost optimized VGA, SXGA, and QXGA resolution camera modules with long-life and low-vibration linear coolers, common camera interfaces, and various continuous zoom lens combinations, Teledyne FLIR's Neutrino portfolio provides the best technical solution available. And with near off-the-shelf delivery, real price competitiveness and best-in-class product development support and reliability, the Neutrino portfolio is also the lowest risk solution. Teledyne FLIR also offers the industry-leading two-year warranty for Neutrino SWaP and IS series.
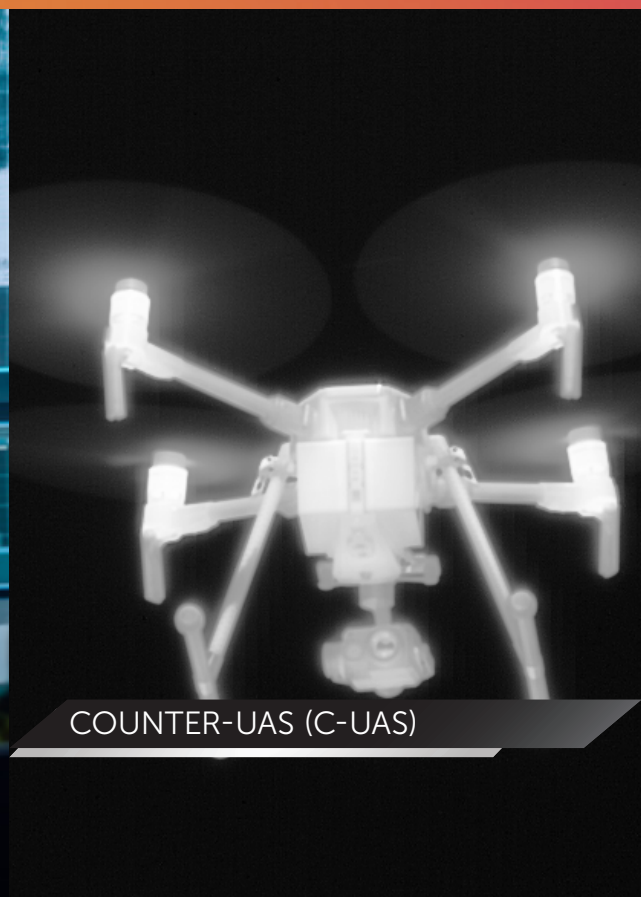
See what solution is best for you

UNMANNED AERIAL SYSTEMS (UAS)

MILITARY DISMOUNT SYSTEMS

AIRBORNE ISR

COUNTER-UAS (C-UAS)

GROUND ISR & SECURITY

MEET THE
NEUTRINO FAMILY

Neutrino SWaP Series

HOT FPA SWAP+C Optimized MWIR Camera Modules

The Neutrino LC and newly-released Neutrino SX8 provide best-in-class MWIR imagery and data in a small, lightweight package. Based on Teledyne FLIR's High Operating Temperature (HOT) FPA technology, they are designed for ruggedized products requiring long life, low-power consumption, and quiet, low-vibration operation. Both are ideal for small gimbals and airframes, handheld devices, security cameras, targeting devices, and asset monitoring applications.

- VGA and SXGA formats in a SWaP envelope
- ITAR free
- Low-power linear micro-cooler provides quick cool-down time
- Industry-leading two-year warranty

Neutrino Performance Series

High Definition Resolution MWIR Camera Modules
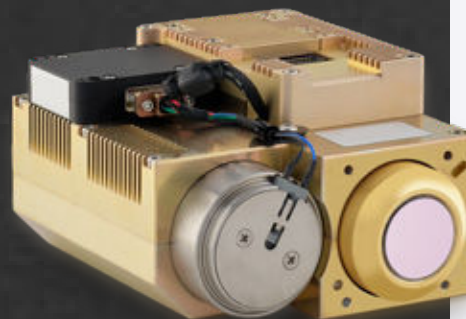
With high resolution and fast frame rates, the Neutrino QX and SX12 are ideal for ground or airborne ISR, targeting, C-UAS, and wide area motion imagery (WAMI) applications. The Neutrino Performance series offers a range of FPA types and optical interface options.

- Flexible detector type, FPA window size, frame rate, and interface
- ITAR free
- Mature infrared image processing architecture and robust SDK

Neutrino IS Series

HOT MWIR Camera Modules + Continuous Zoom (CZ) Lenses

Multiple affordable mid-wavelength infrared (MWIR) camera resolution and continuous zoom lens combinations can shave months and thousands of development dollars from camera lens integration projects. Not only does the Neutrino IS lower development risk and improve time-to-market, since each camera and lens are designed for each other, users also gain optimal performance not achievable when integrating cameras and lenses from multiple sources.

- VGA and SXGA formats in a SWaP envelope
- ITAR free
- Factory-integrated Teledyne FLIR MWIR camera and CZ lens
- Industry-leading two-year warranty

Neutrino Ground ISR Series

MWIR Camera Module + Continuous Zoom (CZ) Lens

The Neutrino Ground ISR series provides turnkey solutions for integrators developing intelligence, surveillance, and reconnaissance (ISR) systems. The cameras combine Teledyne FLIR's world-class mid-wavelength infrared (MWIR) camera modules and continuous zoom (CZ) lenses with market-leading image processing and control electronics from InVeo Designs LLC. Each camera offers high-performance imaging, a reliable long-life linear cooler, and a low switching cost to upgrade existing systems. The factory-integrated and optimized MWIR imaging systems from a single source provide market-leading performance while reducing development risk, cost, and time to market.

- MWIR VGA (640x512) or SXGA (1280x1024) resolution
- ITAR free
- Factory-integrated Teledyne FLIR MWIR camera and CZ lens

CORE TO INNOVATION

Neutrino SWaP Series

	Neutrino SX8	Neutrino LC
Sensor Technology	HOT MWIR	
Sensor Size & Pixel Pitch	1280 x 1024, 8 μm pitch	640 x 512, 15 μm pitch
Spectral Band	3.4 to $\geq$ 5.1 μm Standard	3.4 to $\geq$ 5.0 μm Standard
Senstivity (NEdT)	<38mK,f/4, 50% well	<25 mK, f/4, 50% well
Frame Rate Options	1 - 60 Hz, configurable	
Time to Image	<5 min 23°C ambient (goal)	<4 min 23 °C ambient (goal)
PHYSICAL ATTRIBUTES		
Size (L x W x H)	7.9 x 5.3 x 6.1 cm (3.1 x 2.1 x 2.4")	7.4 x 4.6 x 6.1 cm (2.9 x 1.8 x 2.4")
f/number	f/4, f/3, and f/2.5	f/5.5 Standard, f/4, & f/2.5 options
Cold Aperture Height	19.4 mm from FPA	19.4 mm from FPA (f/2.5, f/4) 19.7 mm from FPA (f/5.5)
Weight	< 420 grams (<15 oz)	<380 grams (<13.4 oz)
FPA CONTROL		
ROIC	ISC1601	ISC0403
Direct Injections, Snapshot, Progressive	Yes	
Programmable Integration Time	Yes (.01ms - 16ms) at 60 Hz	
Well Capacity	2.6 x 10^6 electrons	7 x 10^6 electrons
ROIC Modes	Free Run, Readout Priority, & Integration Priority	
External Sync	Master or Slave	
IMAGE PROCESSING & DISPLAY CONTROLS		
NTSC/PAL	N/A	Yes (accessory board required)
Image Optimization/AGC	Linear, Histogram Equalization, DDE	
Invert/Revert	Yes	
Color Palettes/LUTs	Yes, RGB888 mode	
Symbology	Yes, RGB888 mode	
Continuous Zoom	Yes, up to 8x	
DIGITAL VIDEO		
Parallel (24-bit/16-bit/8-bit)	Yes	
Camera Link	Yes	Yes (accessory board required)
USB	Yes	
INTERFACING		
Primary Electrical Connector	80-pin SAMTEC, ST4-40-2.50-L-D-P-TR	80-pin Hirose, DF40C-80DS
Input Power	+5.0 VDC Camera, +12 VDC Cryocooler	+3.3 VDC Camera, +12 VDC Cryocooler
Power Dissipation	<12 W cooldown, <8 W steady state @ 23 °C	<8 W cooldown, <4 W steady state @ 23 °C
Communication	UART (115.2K baud)	USB or UART (921.6k baud)
Discrete I/O Control	Yes, Three available	One Discrete, custom configurable at factory
User Configurability via SDK & GUI	Yes	Yes
ENVIRONMENTAL		
Operating Temperature Range	-40 °C to +71 °C (-40 °F to +160 °F)	
Non-Operating Temperature Range	-57 °C to +80 °C (-70.6 °F to +176 °F)	-54 °C to +80 °C (-65 °F to +176 °F)
Operational Altitude	~12 km (40,000 ft)	
Humidity	Non-condensing between 5% – 95%	
Vibration	5.8 grms, 3-axis, 1 hr each	
Shock (goal)	Lateral 190 grams @ .55 ms Vertical 320 grams @ .55 ms Axial 550 grams @ .8 ms	

Neutrino Performance Series

	Neutrino QX	Neutrino SX12
Sensor Technology	MWIR	MWIR
Sensor Size & Pixel Pitch	2048 x 1536, 10 μm pitch	1280 x 1024, 12 μm pitch
Spectral Band	3.4 to $\geq$ 5.0 μm Standard	3.4 to $\geq$ 5.0 μm Standard, CO2 notch available
Senstivity (NEdT)	<30 mk, f/4, 50% well	<25 mk, f/4, 50% well
Frame Rate Options	60 Hz (1080P), >30 Hz (QXGA)	120 Hz (720P), >60 Hz (SXGA)
Time to Image	<7 min @ 22°C ambient	
PHYSICAL ATTRIBUTES		
Size (L x W x H)	13.4 x 7.0 x 10.3 cm (5.26 x 2.76 x 4.05")	12.0 x 7.0 x 10.3 cm (4.732x 2.76 x 4.05")
f/number	f/2, custom available	f/2.5, f/4, and f/5
Cold Aperture Height	38.1 mm from FPA	25.0 mm from FPA
Weight	1.97 kg (4.34 lb)	
FPA CONTROL		
ROIC	ISC1901	ISC1308
Direct Injections, Snapshot, Progressive	Direct Injection, Snapshot	Direct Injection, Snapshot, Integrate While Read
Programmable Integration Time	Yes (.01-16 ms)	
Well Capacity	3 x 10^6 electrons	>11 x 10^6 electrons
ROIC Modes	Free Run, Readout Priority, & Integration Priority	
External Sync	Free run, external sync with readout or integration priority	
IMAGE PROCESSING & DISPLAY CONTROLS		
NTSC/PAL	N/A	
Image Optimization/AGC	Yes	
Invert/Revert	Yes	
Color Palettes/LUTs	N/A	
Symbology	N/A	
Continuous Zoom	N/A	
DIGITAL VIDEO		
Parallel (24-bit/16-bit/8-bit)	No	
Camera Link	Yes (basic or medium)	
USB	No	
INTERFACING		
Primary Electrical Connector	40-pin Samtec	
Input Power	5 VDC Camera, 28 VDC Cryocooler	
Power Dissipation	<20 W Steady State	
Communication	RS-422, selectable BAUD rate	
Discrete I/O Control	No	
User Configurability via SDK & GUI	Yes	
ENVIRONMENTAL		
Operating Temperature Range	-40 °C to +71 °C (-40 °F to +160 °F)	
Non-Operating Temperature Range	-54 °C to +80 °C (-65 °F to +176 °F)	
Operational Altitude	12,190 m (40,000 ft)	
Humidity	Non-condensing between 5% – 95%	
Vibration	3.4 grms, 3-axis, 1 hr each	
Shock (goal)	20 G Shock Pulse W/11 ms Half Sine	

CHALLENGES WITH MWIR INTEGRATION

TIME TO MARKET

The typical project timeline for a system integrator to develop a MWIR imaging platform averages 12 to 28 months when buying and integrating third party commercial-off-the-shelf (COTS) components. It can require even longer for programs where developers need to design to specific customer requirements, such as with traditional government contract programs.

MULTIPLE COMPLEX SUBSYSTEMS

An MWIR imaging system consists of multiple subsystems. The optics collect and focus the MWIR energy onto the detector. Zoom optics provide the field of view or optical magnification to the camera. The detector includes a focal plane array (FPA), readout integrated circuit (ROIC), and integrated detector cooler assembly (IDCA). Imaging electronics control the FPA, cooler and create an image. A development team has to consider multiple variables, including pixel size, frame rate, vacuum packaging, and much more.

MULTIPLE COMPONENT PROVIDERS

Development teams are challenged when acquiring and integrating subsystems from two or more providers. Reduced system performance and reliability are likely when integrating "stand-alone" components due to compatibility tradeoffs. This can also lead to efficiency loss and added complexity in the system development process, procurement, manufacturing, and eventual system support.

BOLD PERFORMANCE AND INTEGRATION SUPPORT

SWAP+C OPTIMIZED SENSOR ENGINE

SWaP+C optimized design saves space, weight, and power, resulting in operational and cost benefits and the ability to integrate into smaller spaces.

- T2SL HOT FPA provides superb MWIR imagery
- Tight optics-to-camera tolerances minimize optics size and mass
- Best-in-class power consumption

RELIABLE LINEAR COOLER

Designed from the ground up for optimum performance and reliability minimize cost of ownership and maximize operational uptime.
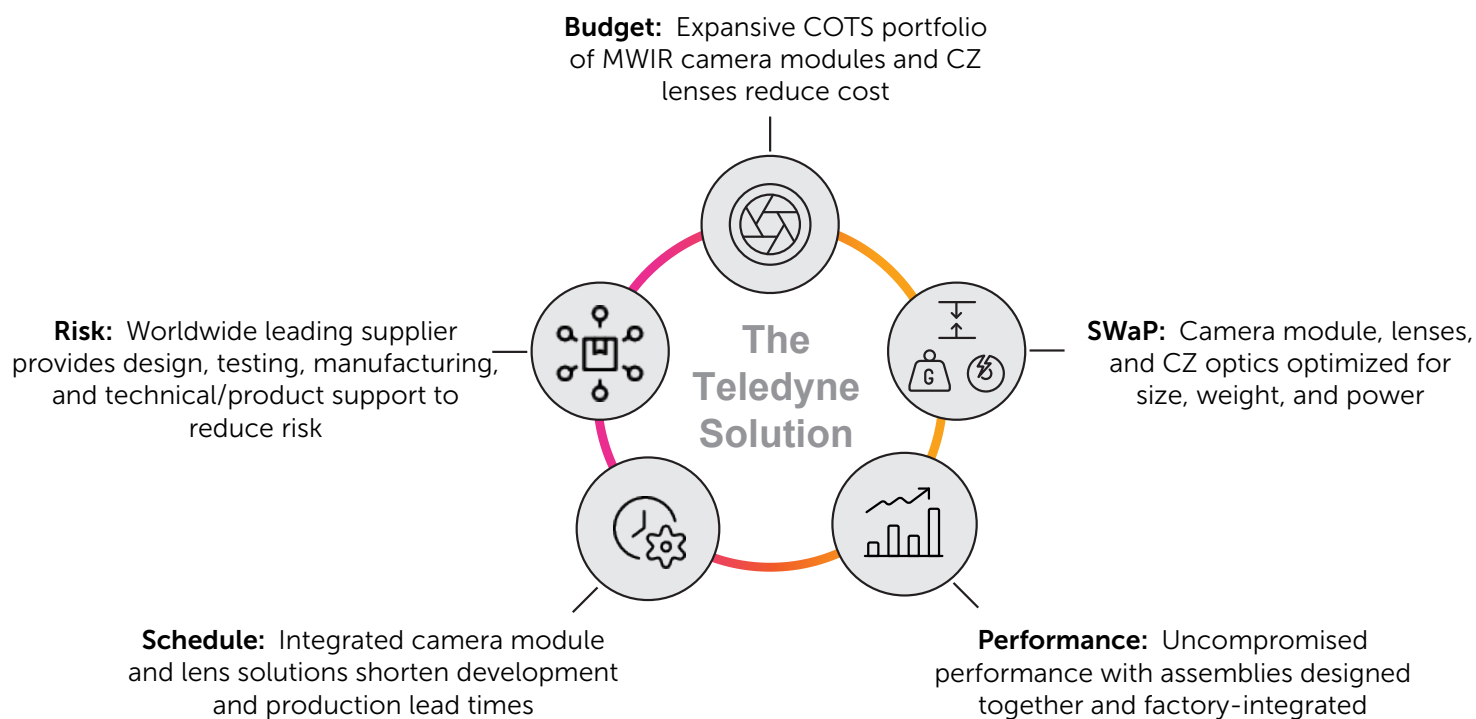
- Increased reliability and low-vibration
- 2x faster time to image
- Reduce user fatigue and operate for longer periods
- Comprehensive product documentation

MARKET LEADING THERMAL OPTICS

Integrated SWaP optimized lens provides instant clear imaging able to withstand every rugged environment.

- Smooth continuous zoom
- Precision aligned camera and lens with a collimator and sophisticated test equipment
- Highly qualified Teledyne FLIR Technical Services team available to support integration

ADVANTAGES OF MWIR INTEGRATION WITH TELEDYNE FLIR

Budget: Expansive COTS portfolio of MWIR camera modules and CZ lenses reduce cost

Risk: Worldwide leading supplier provides design, testing, manufacturing, and technical/product support to reduce risk

The Teledyne Solution

SWaP: Camera module, lenses, and CZ optics optimized for size, weight, and power

Schedule: Integrated camera module and lens solutions shorten development and production lead times

Performance: Uncompromised performance with assemblies designed together and factory-integrated

THE AFFORDABLE TOTAL PACKAGE REVOLUTIONIZING MWIR IMAGING

Teledyne FLIR is the first integrated solutions provider capable of supplying high-performance MWIR camera modules and continuous zoom optic assemblies. Teledyne FLIR accelerates time to market for MWIR imaging platform developers with vertically integrated, size-weight-and-power (SWaP)-optimized camera modules and zoom optics. When developers can work with a single solutions provider to produce all of the subsystems necessary for a complete platform—including the IR detector, zoom optics, electronics and packaging—the results are shorter design cycles, streamlined procurement, increased reliability, and reduced end-item lead time.

BOUNDLESS VERSATILITY
WITH INTEGRATED SOLUTIONS

	Neutrino LC CZ 19-290	Neutrino LC CZF 25-250	Neutrino LC CZF 30-600	Neutrino LC CZF 25-375
Resolution	640 x 512, (15 µm pitch) HOT MWIR			
f/number	f/5.5	f/5.5	f/5.5	f/5.5
Description	Straight	Folded	Folded	Folded
HFOV	1.9° to 27.4°	2.2° to 21.7°	0.9° to 18.2°	1.5° to 21.9°
Size	15.6 x 7.88 x 10.0 cm (6.20 x 3.09 x 3.94 in)	11.4 x 7.1 x 12.1 cm (4.5 x 2.8 x 4.7 in)	16.89 x 13.21 x 14.99 cm (6.65 x 5.20 x 5.90 in)	15.42 x 8.53 x 12.65 cm (6.07 x 3.36 x 4.98 in)
Weight	749 grams (1.65 lb)	741 grams (1.63 lb)	1980 grams (4.37 lb)	1140 grams (2.51 lb)
Volume	1237 cm^3 (76 in^3)	920 cm^3 (56 in^3)	3344 cm^3 (204 in^3)	1663 cm^3 (102 in^3)

	Neutrino LC CZ 15-300	Neutrino SX8 CZF 30-300	Neutrino SX8 CZ 15-300
Resolution	640 x 512, (15 µm pitch) HOT MWIR	1280 x 1024, (8 µm pitch) HOT MWIR	
f/number	f/4.0	f/3.0	f/4.0
Description	Straight	Folded	Straight
HFOV	1.8° to 35.5°	1.96° to 19.37°	1.9° to 37.6°
Size	19.25 x 9.91 x 10.59 cm (7.58 x 3.90 x 4.17 in)	17 x 13.5 x 19 cm (6.69 x 5.31 x 7.48 in)	19.25 x 9.91 x 9.96 cm (7.58 x 3.90 3.92 in)
Weight	1324 grams (2.92 lb)	1770 grams (3.90 lb)	1337 grams (2.95 lb)
Volume	2020 cm^3 (123 in^3)	4361 cm^3 (266 in^3)	1900 cm^3 (116 in^3)

Save time and money wtith Teledyne FLIR's integrated MWIR cooled camera module and continuous zoom lens solutions. The Neutrino IS models are cost-effective, swap-optimized, reliable, and can erase weeks of precision engineering getting you to market faster than ever. FLIR engineered specific zoom lens and camera combinations to guarantee simplified opto-mechanical integration and user interface while providing smooth continuous zoom with a common and simplified user interface in a variety of FOV options. These solutions are fully athermalized over a wide operating temperature range and are autofocus capable.

- Optimized SWaP, usability, and image performance in demanding environments

- Tight optics-to-camera tolerances minimize optics size and mass

- Simplified and common electrical interface and software controls

- Fewer connectors, cables, and software SDKs to manage

- Precision aligned camera and lens for optimized co-boresight performance

MORE GROUND COVERAGE THAN EVER BEFORE

Neutrino LC - ISR 20-420

Neutrino SX12 — ISR 1200

Neutrino SX8 — ISR 15-300

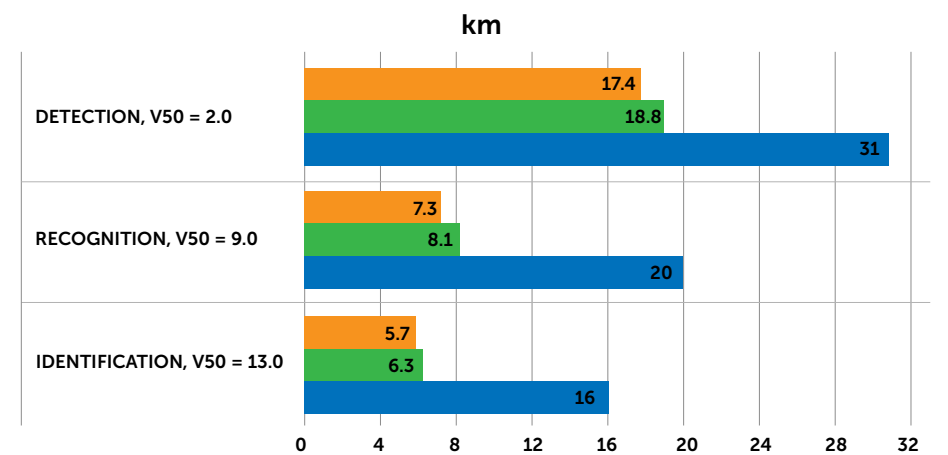| Overview	Neutrino LC - ISR 20-420	Neutrino SX8 – ISR 15-300	Neutrino SX12 - ISR1200
Size (L x W x H)	Length: 20.3 cm (8") Lens Diameter: 8.9cm (3.5")	Length: 20.3 cm (8") Lens Diameter: 9.65 cm (3.8")	Length: 63.75 cm (25.1") Lens Diameter: 29 cm (11.4")
Weight	1.2 kg (2.65 lb)	1.5 kg (3.31 lb)	14.51 kg (32 lb)
Spectral Band	3.4 to 5.1 μm Standard	3.4 to 5.1 μm Standard	3.4 to 5.0 μm
Thermal Imager	640 x 512 Pixels	1280 x 1024 Pixels	1280 x 1024 Pixels (ISC1308)
Lens Specifications			
Lens Type	21x Continuous Zoom Maintain Focus Through Zoom	20x Continuous Zoom Maintain Focus Through Zoom	10x Continuous Zoom Maintain Focus Through Zoom
Focal Length	20-420 mm, HFOV 27.50° to 1.30°	15-300 mm, HFOV 39.1° to 2.0°	120-1200 mm, HFOV 7.2° to 0.72°
Zoom and Focus Controls	Motorized, Zoom to Specified Angle, Preset FOV (Infinity Focus)		
F-number	f/5.5	f/4.0	f/5.0
Focus	Motorized, Focus to Specified Distance, Focus to Infinity, Commanded / Continuous Autofocus		
Shutter	Integrated Shutter for 1-Point Flat Field Correction (FFC)		
Connections & Communications			
Communication	RS-422 UART COM, up to 921,600 Baud		
Dual Simultaneous Outputs	Camera Link (Base) Output (14-bit NUC Corrected at Full Frame Format): • 30 Hz • Optional Gigabit Ethernet	Display Output Options (10-bit (14 optional) fully processed video) • 720p60 HD-SDI (SMPTE) • 1080p30 HD-SDI (SMPTE) • NTSC • PAL	
Electrical & Mechanical			
Input Power	24 VDC & 2.2 A Peak@ Cooldown, 23 °C		
Environmental & Approvals			
Operating Temperature Range	-40 °C to +71 °C (-40 °F to 160 °F)		-30 °C to +70 °C (-22 °F to 158 °F)
Storage Temperature Range	-57 °C to +80 °C (-65 °F to 176 °F)		-50 °C to +85 °C (-58 °F to 185 °F)
Imaging & Optical			
Pixel Pitch	15 μm	8 μm	12 μm
Sensor Material	HOT MWIR		InSb
Cooler	Teledyne FLIR FL-100 Linear Cryocooler		Cobham Carleton LC1062 Linear Stirling
Cooler MTTF	Up to 27,000 Hours		Up to 25,000 Hours
FPA Full Frame Rate	30 Hz		
Boresight Drift Through Zoom	<0.15 mm		9 Pixels (0.10 mm) + plus alignment tolerance of 10 Pixels
Min to Max Zoom Time	<2 Seconds		4 Seconds
Non Uniformity Correction [NUC]	Factory Calibrations: • Two point (gain/offset) • One-point update (optimizes offset) • Defective / noisy pixel detection • 8 Op Modes with 2 NUC tables each Operational (Run-Time) Calibrations: One-point refresh		

The Neutrino Ground ISR series provides turnkey solutions for integrators developing intelligence, surveillance, and reconnaissance (ISR) systems. The cameras combine Teledyne FLIR's world-class mid-wavelength infrared (MWIR) camera modules and continuous zoom (CZ) lenses with market-leading image processing and control electronics from InVeo Designs LLC. Each camera offers high-performance imaging, a reliable long-life linear cooler, and a low switching cost to upgrade existing systems. The factory-integrated and optimized MWIR imaging systems from a single source provide market-leading performance while reducing development risk, cost, and time to market.

They incorporate multiple focal plane array (FPA) resolutions and CZ lens options, all with the same industry standard image processing and interface electronics, allowing for differing detection recognition and identification (DRI) requirements and affordability. With three configurations today and several more coming soon, the ITAR-free cameras provide the imaging performance required for short-, mid-, and long-range ISR, perimeter surveillance, border surveillance, and counter-UAS (CUAS) applications.

All Neutrino Ground ISR cameras are upgradable in 2024 to run Teledyne FLIR's AI detection, tracking, and classification models and image signal processing (ISP) libraries for super-resolution, turbulence mitigation, contrast enhancement, and more.

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- 🟠 Neutrino SX8 - ISR 15-300
- 🟢 Neutrino LC - ISR 20-420
- 🔵 Neutrino SX12 - ISR1200

The detection, recognition, and identification (DRI) probabilities are modeled using the industry-standard NV-IPM passive sensor modeling tool. The NV-IPM model results are for the NFOV zoom position with a target dimension of 3.1 m and temperature of 4.0K. V50 is the range at which there is a 50% probability of achieving the task.

DETECTION, V50 = 2.0
- 17.4
- 18.8
- 31

RECOGNITION, V50 = 9.0
- 7.3
- 8.1
- 20

IDENTIFICATION, V50 = 13.0
- 5.7
- 6.3
- 16

0 4 8 12 16 20 24 28 32

ACCESSORIES

Neutrino LC USB VPC Kit (421-0061-01)
The USB Video Power Connector (VPC) kit turns the Neutrino LC camera into a webcam. Power, digital video, and comm are all via USB2. The kit includes a USB-A to USB-C cable.

Neutrino LC USB/Analog VPC Kit (421-0062-01)
The USB VPC kit with an additional custom 6-foot cable with a BNC pigtail provides an additional analog video signal (NTSC-compliant).

Neutrino LC Camera Link Accessory (250-0609-00)
The Camera Link accessory converts CMOS video signal into a Camera-Link-compliant output via SDR-26 receptacle. Communication and power are provided via a standard USB-3 micro-B.

Neutrino LC Utility Kit (421-0074-00)
Provides all output options on a single PCB. Includes a wire harness to the cooler interface. The accessory board converts video signal into a Camera-Link-compliant output via a SDR-26 receptacle.

Neutrino LC Development Kit (421-0071-00)
Provides all output options on a single PCB and easy access to the full 80-pin camera interface for development. Includes a flex cable between the board and the camera and a wire harness to the cooler interface.

Neutrino LC Demonstration Lens (322-0487-00)
A 22 mm fixed focal length, f/5.5 lens provides a 25° horizontal field of view (HFOV). Includes a mechanical housing for the lens and allows for focus capability via keyed lens barrel and threaded barrel/housing.

Neutrino SX8 Accessory Board (421-0085-00)
The Utility Kit provides Camera link and HDMI video output to a single development electronics board. The kit includes a wire harness for camera and cooler power. Communication and power to the Neutrino SX8 camera electronics is provided via a USB driver to a virtual COM port. External sync input/output signals are provided with standard MCX connectors. A header connector is provided for RS-422 lens control.

Neutrino SX8 Demonstration Lens (2402-300)
A 30 mm fixed focal length, f/2.5 lens provides a 32° HFOV. Includes a mechanical housing for the lens and allows for focus capability via keyed lens barrel and threaded barrel/housing.

NEUTRINO SOFTWARE GUI

The Neutrino Demo Application or graphical user interface (GUI) allows developers to quickly start streaming video from the Neutrino LC or the Neutrino SX8. The GUI provides access to functions available within the SDK and uses a x64 Windows 10 program. It connects to the camera module via an accessory board and provides access to a number of image appearance, NUC calibration, and system settings to help with development. Example interfaces include and are not limited to CMOS and HDMI video mode, LVDS/Camera Link, NUC threshold, NUC gain, image stats controls, and FFC controls.

The interface also provides access to a wide range of diagnostic features such as diagnostic control and the status panel useful for quick troubleshooting. It can load and save configuration files to and from the Neutrino camera module.
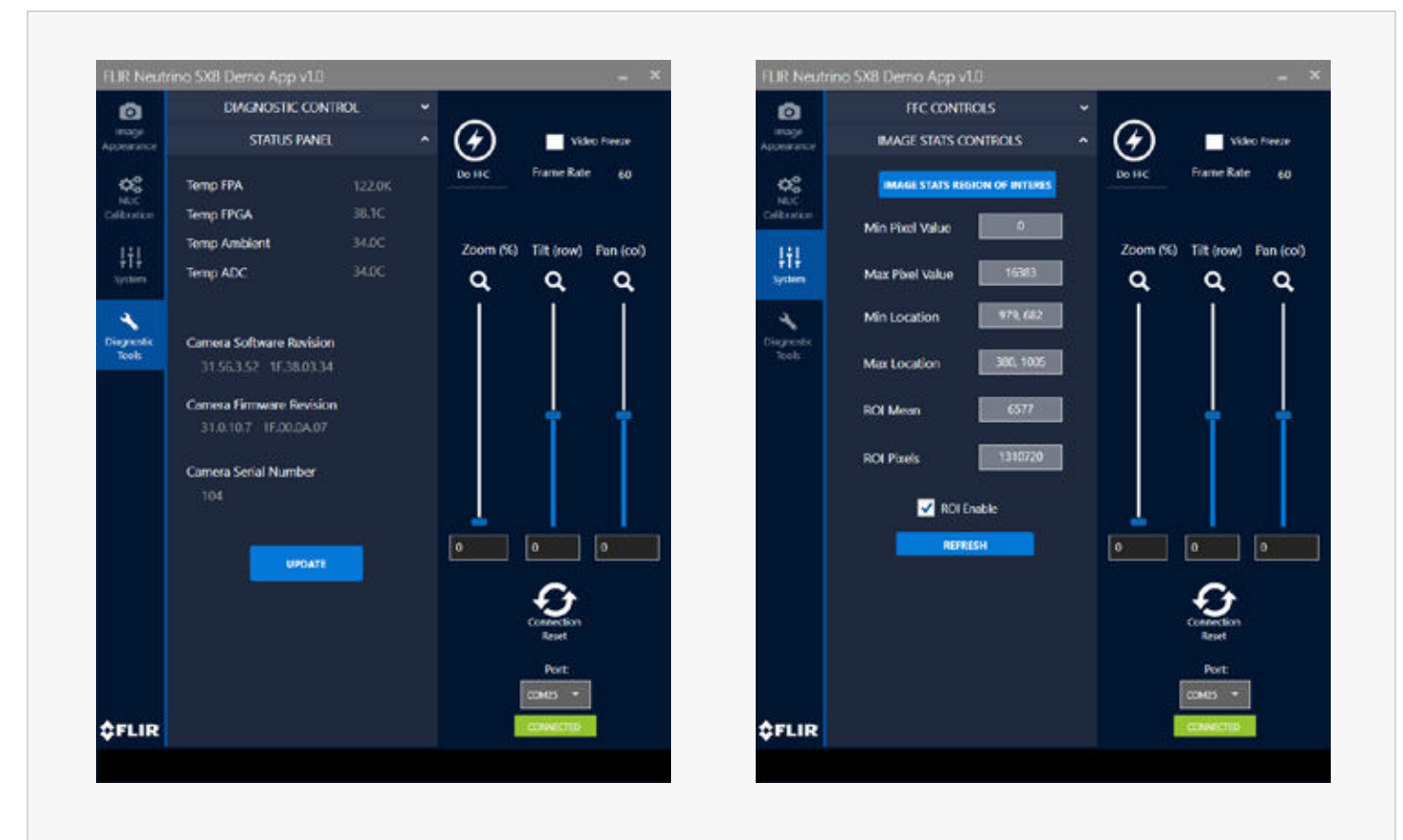
INTEGRATION SUPPORT

Highly qualified Teledyne FLIR Technical Services team is available to support integration. Various schematic and BOM references are available upon request.

Please visit **www.flir.com/neutrino** to connect with a representative.

About Teledyne FLIR

Teledyne FLIR designs, develops, manufactures, markets, and distributes technologies that enhance perception and awareness. We bring innovative sensing solutions into daily life through our thermal imaging, visible-light imaging, video analytics, measurement and diagnostic, and advanced threat detection systems.

Teledyne FLIR offers a diversified portfolio that serves a number of applications in government & defense, industrial, and commercial markets. Our products help first responders and military personnel protect and save lives, promote efficiency within the trades, and innovate consumer-facing technologies. Teledyne FLIR strives to strengthen public safety and well-being, increase energy and time efficiency, and contribute to healthy and intelligent communities.

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