THERMAL IMAGING OPTICS FOR DEFENSE APPLICATIONS

YOUR OPTICS PARTNER FOR MISSION SUCCESS

BROAD SOLUTIONS FOR ALL DEFENSE APPLICATIONS

Unmanned Aerial Systems

C-UAS Platforms

Security & Surveillance

Driver Vision Enhancement (DVE) & Situational Awareness

Armored Vehicles

Hand Held Thermal Imager

DECADES OF PARTNERSHIP WITH LEADING DEFENSE OEMs

Leading Provider of Defense Thermal Imaging with NATO Country-Based Production Site

MKS Ophir brand is at the forefront of innovation in the field of advanced defense thermal imaging, with state-of-the-art manufacturing facilities in Romania, a NATO member country, as well as Israel. Our commitment to excellence is evident in our high-performance IR optical elements and assemblies, meticulously crafted to meet the rigorous demands of defense and security applications.

Decades of Experience and Unmatched Partnerships

With more than 40 years of experience in the field of electro-optics, shaped by extensive collaborations and strategic partnerships with leading defense OEMs, we are a trusted partner for our customers, providing innovative solutions based on unrivalled capabilities and expertise that support major defense platforms worldwide.

One-Stop-Shop Solutions Provider

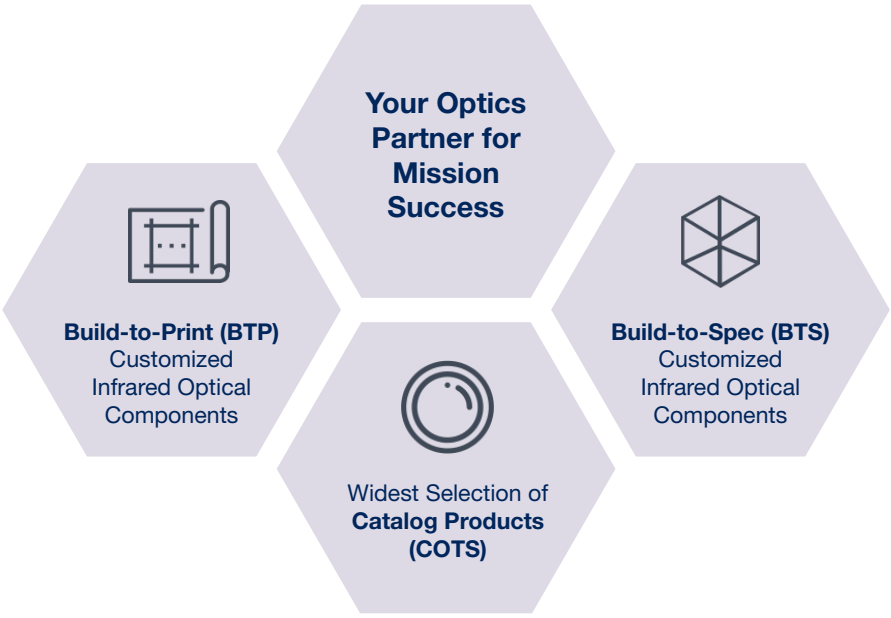
With a track record of designing and supplying thousands of thermal imaging optics for various defense applications, we have earned recognition as one of the world's leading one-stop-shop providers of infrared thermal imaging components for defense OEMs.

Collaborative R&D Approach

Our dedicated R&D engineering team collaborates closely with defense customers, leveraging their extensive experience to develop, design, and deliver high-performance optics tailored to meet the stringent requirements of high precision and environmentally challenging defense applications. This collaborative approach ensures that Ophir IR Optics product lines align perfectly with the evolving needs of defense customers, facilitating the deployment of today's most advanced aerospace and defense solutions.

Applications served

- **Ground-based:** Anti-drone IR systems (C-UAS), Enhanced Vision Systems (EVS), Driver Vision Enhancement (DVE), Situation Awareness Systems (SAS), Remote Controlled Weapon Stations (RCWS), Tank Gunner/Commander Sight, Thermal Goggles, Thermal Weapon Sight (TWS), Hand-Held Thermal Imagers (HHTI)
- **Airborne:** Unmanned Aerial Vehicles (UAV), Payloads and Forward-Looking IR Cameras (FLIR)
- **Naval:** Surveillance, Targeting
- **Missiles:** Optical build-to-print components for IR guided missiles, including domes, mirrors and Cassegrain telescopes



Build-To-Spec (BTS) & Build-to-Print (BTP) Expertise

Advanced optical design technologies and innovative engineering are applied to our build-to-specification (BTS) development processes, allowing us to reach efficient design results with fewer elements, lighter components, and reduced-cost.

These same advanced capabilities and expertise are combined with cutting-edge manufacturing technologies such as MRF technology, diamond-turning machines, CNC generators and polishers, automated coating chambers, and advanced metrology and test equipment, to create our build-to-print components and assemblies, including aspheric, diffractive and spherical lenses, mirrors, domes, windows and prisms.

Widest IR Assemblies Product Range

Our range of long-lasting products includes IR complex lens assemblies with various focus mechanisms:

- Fixed
- Manual
- Motorized focus
- Continuous zoom

From LWIR, MWIR to SWIR, we excel in production of the following product configurations:

- Single Field-of-View (FOV)
- Multiple FOV
- Zoom

Our knowledge and experience in motorized continuous zoom lens systems is recognized by customers around the world.

Meeting Strict Defense Market Demands

We harness innovative designs to provide the largest portfolio of products with field-proven performance, answering the strict demands of global defense customers for:

- Lightweight, compact designs answering the strict SWaP restraints
- Rugged design for durability in harshest environmental conditions
- Outstanding detection, recognition, and identification (DRI) ranges >28km
- Accurate Line on Sight (LOS)
- High precision optics with MTF close to the diffraction limit
- Focal length ranges from 1.8mm to 1350mm

STRICT QUALITY ASSURANCE (QA) PROCESSES

With rigorous QA testing throughout the production process, we ensure that any finished product is optimized for defense market requirements with the highest performance requested.

From design to delivery, our material control, in-process testing, operator inspections and final inspections all ensure that Ophir products meet the highest specifications and quality standards.

LWIR

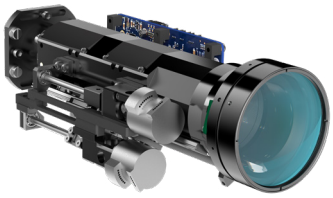
SupIR 40-300mm f/1.5
> 13km detection range
For 12 µm pixel pitch LWIR uncooled detector

MWIR

SupIR 50-1350mm f/5.5
> 26.5km detection range
For 15µm pixel pitch MWIR uncooled detector

MWIR

SupIR 60-1200mm f/4
> 28km detection range
For 10µm pixel pitch MWIR cooled detector



SWIR

SWIR & NIR 25-250mm f/5.5 (NFOV) f/4 (WFOV)
> 26km detection range
For 5µm & 10µm pixel pitch SWIR detector

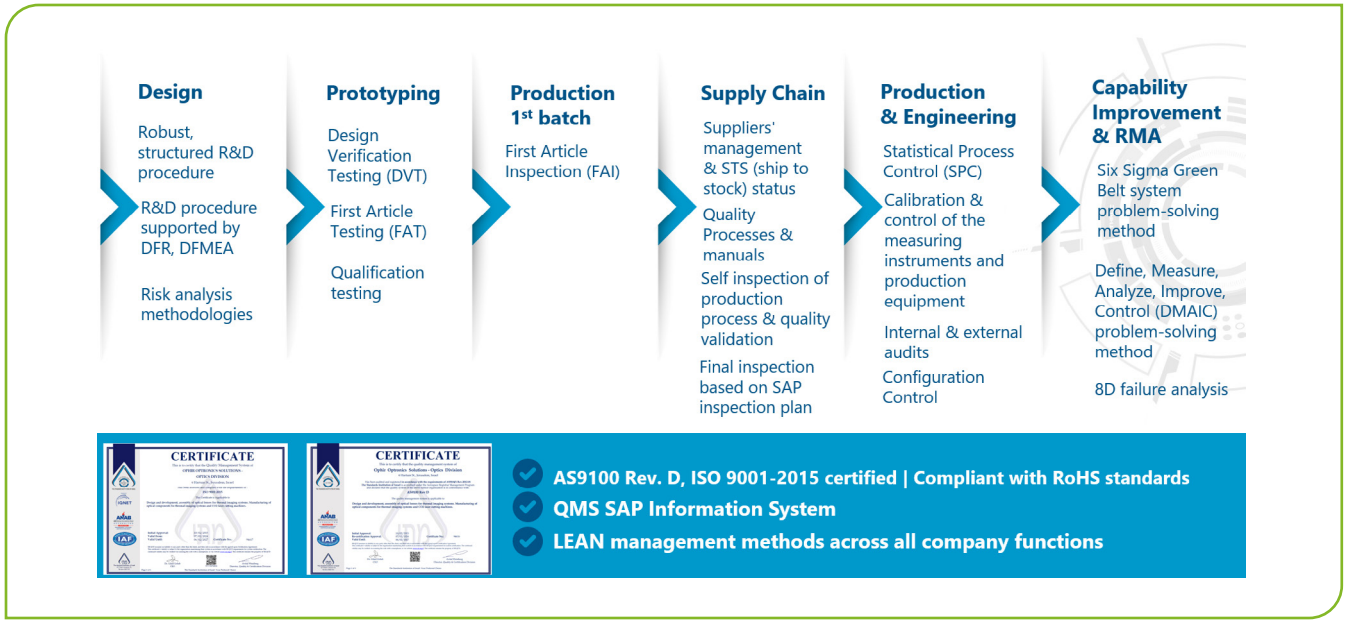


Figure 1: QA process throughout product manufacturing cycle

Our in-house testing tools encompass all required specifications and include the following:

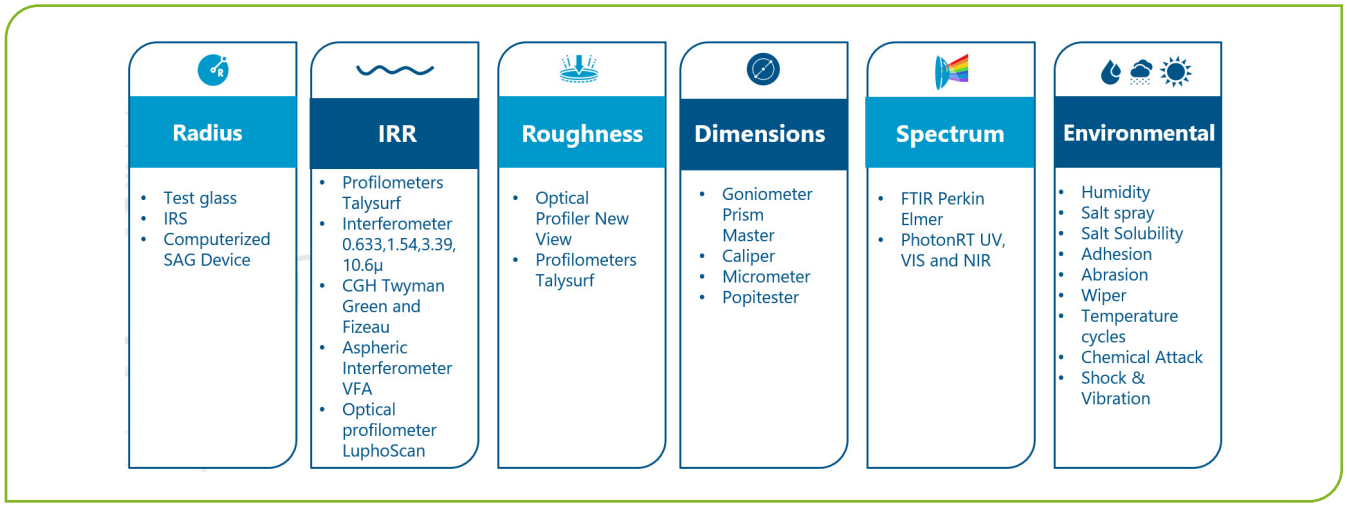
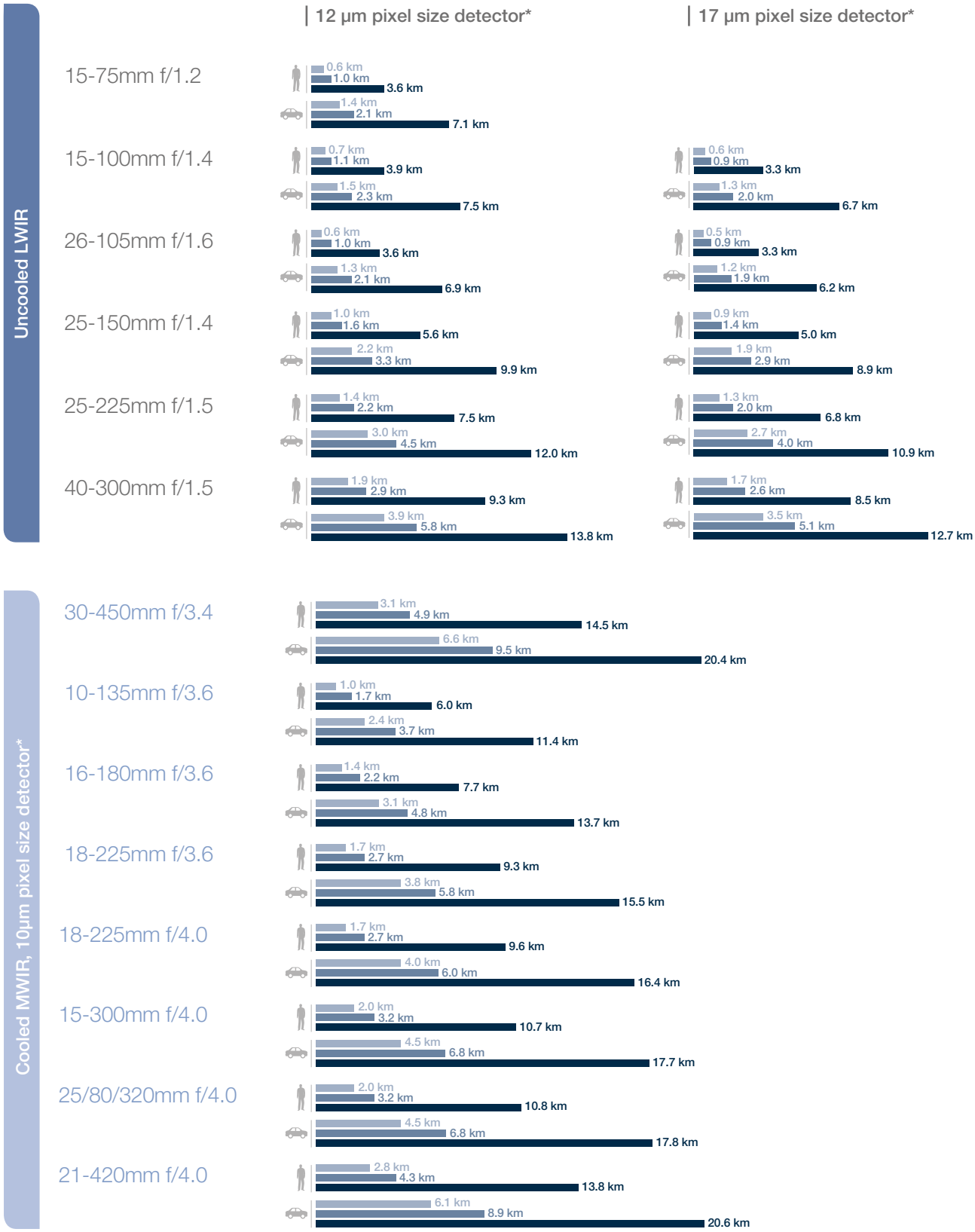


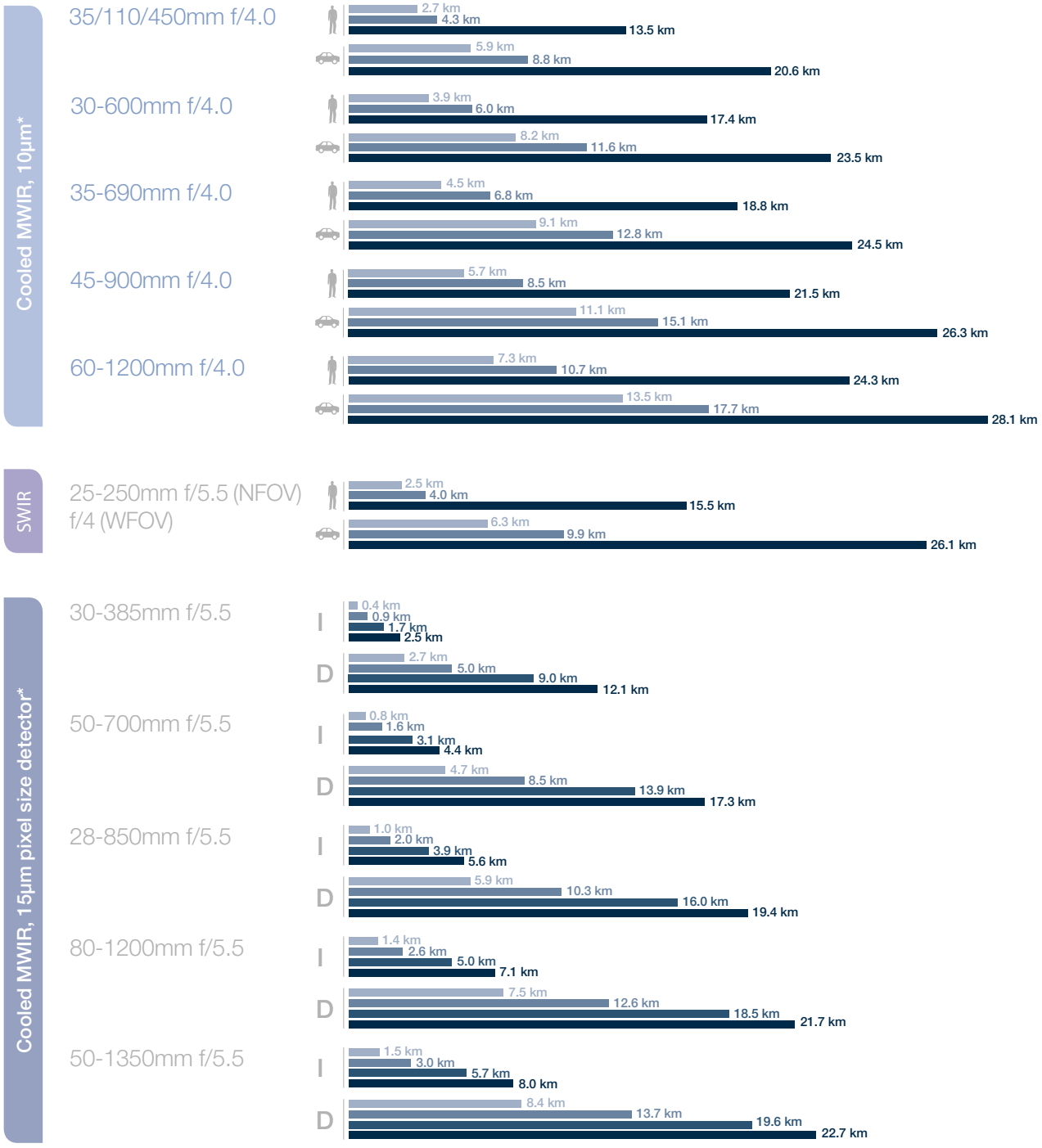
Figure 2: QA testing tools per specification requirements

Standard Compliance

- AS9100 Rev. E and ISO 9001:2015 certified
- US and European military standards compliant with:
  - DIN 3140
  - IPC 620
  - MIL-PRF 13830
  - MIL-PRF 85285
  - MIL STD 810
  - MIL-C-48497
  - MIL-C-48616
  - ISO 10110 sections 1-19, ANSI\ASQ Z1.4

ZOOM LENSES DETECTION, IDENTIFICATION OF NATO TARGETS





Identification
Recognition
Detection

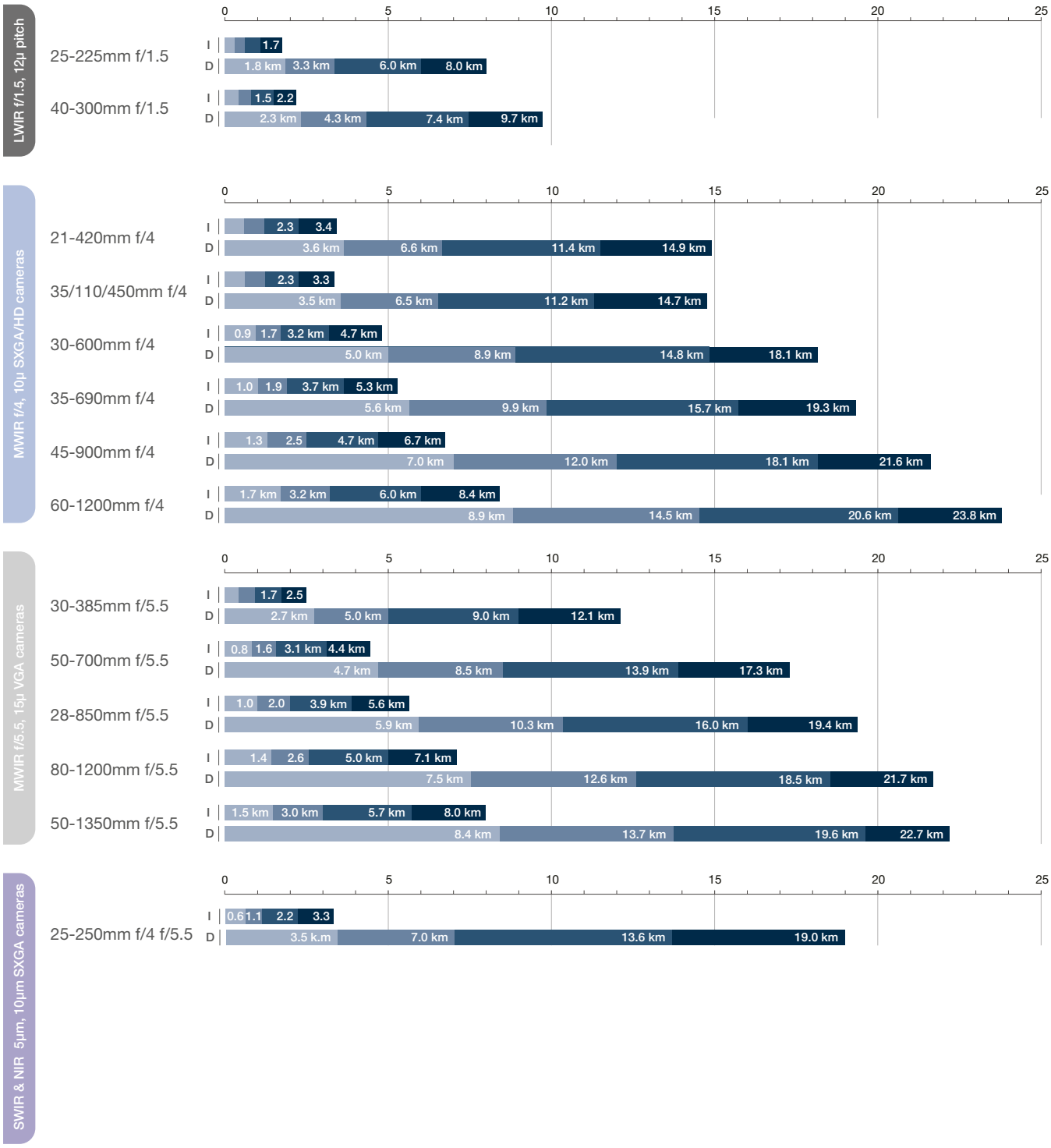
Vehicle size 2.3m x 2.3m

Human size 1.7m x 0.5m

Note: Calculations used are based on “Johnson Criteria” | Real world performance may vary depending on the weather conditions

Assumptions: 23mK NETD (f/4 & f/5.5) for MWIR cooled detectors | 35.5mK NETD (f/3.4) | 32mK NETD (f/3.6) | 50mK NETD (f/1.0) for LWIR uncooled detectors | 30Hz frame rate | 50% detection probability | 0.2km^{-1} atmospheric attenuation coefficient | Human ΔT = 5°C | vehicle ΔT = 2°C; SWIR assumptions: 1280 detector | TRM4 model | Day mode | 0.7µm to 1.7µm spectral range | 25Hz frame rate | Overcast daylight irradiance | 0.2 path radiance factor | 0.2km^{-1} atmospheric attenuation coefficient | 50% detection probability | Human and vehicle target 50% reflectivity | 15% background reflectivity

ZOOM LENSES IDENTIFICATION AND DETECTION RANGES FOR COUNTER-DRONE SYSTEMS



I = Identification
D = Detection

Micro Quadcopter 20x20cm

Quadcopter 40x40cm

Hexacopter 80x80cm

Octocopter 120x120cm

Assumptions: NETD LWIR f/1.5 50mK | NETD MWIR (f/4, f/5.5) 23mK | 2°C target ΔT | 30Hz frame rate LWIR MWIR | 25Hz frame rate SWIR at 0.7µm to 1.7µm spectral range, day mode TRM4 model, 10µm pitch Cardinal 1280 detector, overcast daylight irradiance | 0.2km-1 atmospheric attenuation coefficient | 50% detection probability | 0.2 path radiance factor | 250m drone altitude (above ground) | 50% drone reflectivity | 15% background reflectivity

CUSTOM OEM COMPONENT MANUFACTURING PER ANY SPECIFICATION

Vast Versatility

- Manufacturing large size mirrors, lenses, mirrors, domes, windows, and prisms, supporting multispectral optics and emerging applications
- VIS to LWIR wavelengths
- Spherical, aspherical, diffractive, flat, and free-form shapes
- Doublets and triplets
- Substrates: Germanium, Silicon, Zinc selenide, Zinc sulfide (IR & multispectral), Calcium fluoride, Chalcogenide materials such as IG materials

Core Capabilities

- In-house, cutting-edge manufacturing technologies:
  - MRF
  - Lupho Scan Profilometers
  - Diamond turning
  - CNC polishing
  - Coating
  - Metrology
- Highest development standards including Design for Manufacturability and Assembly (DFMA) as well as highest production standards including risk analysis.
- Complete control of production processes
- Statistical Process Control (SPC) over full production cycle
- Innovative engineering
- Large volume high-end production capabilities
- Manufacturing sites in Israel and Europe (Romania) with a clean room the coating, inspection and packing processes

Superior Components Manufacturing

- MRF strict irregularity
- Large optics up to 400mm dia
- Dual A-spherical elements
- Freeform (non-radial or matrix)
- Off axis parabolas
- Special truncated shapes
- Doublets and triplets
- Prisms of all types
- Mass production of low-cost IR small lenses

Figure 3: Ophir components: mirrors, domes, truncated shapes, prisms

Tolerances (typical | high-end):

	Windows	Lenses		Mirrors
Dimensional	± 0.05mm | ± 0.01mm	± 0.05mm | ± 0.01mm		± 0.05mm | ± 0.01mm
Surface Figure (P-V)	Flatness 0.5 | 0.2Fr Irregularity 0.2 | 0.1Fr	**Spherical** Power 2Fr | 1Fr Irregularity 0.5Fr | 0.2Fr	**Aspherical** Radius tolerance 0.1% | 0.05% Irregularity 1Fr | 0.5Fr	Flatness 0.5Fr | 0.2Fr
Parallelism	3 | 5 arc sec.	3 | 5 arc sec.		3 | 5 arc sec.
Surface Quality (S-D)	80-50 | 10-5	80-50 | 10-5		80-50 | 10-5
Roughness nm, RMS	2 | 0.5	2 | 0.5		2 | 0.5

Advanced Optical Coatings

Coating Types:

- Anti-reflective (AR), mirrors and filters
- UV, VIS, NIR, SWIR, MWIR, LWIR
- Multispectral coatings
- High efficiency and high durability coatings
- DLC (HC) coatings and Low Reflectance HC (LRHC)
- Laser coatings YAG and CO2

Coating Performance:

- Broadband AR:
  - Ref<0.5% to 0.2%
  - Tra >98% to 99%
- Broadband mirror: Ref>98% to 99%
- Windscreen Wiper Test TS1888 / P 5.4.3 – DLC coatings

New! AquaShieldIR Lens Coating: Long-lasting Protection, Enhanced IR Lens Capability for Maritime Environments

AquaShieldIR

Knowing firsthand the unique challenges posed by wet, humid, and salty coastal environments, we have meticulously crafted the new AuqaShieldIR lens coating to tackle the challenges of maritime environments head-on.

With its advanced hydrophobic properties, the AquaShieldIR lens coating provides unparalleled protection and boosts the performance of your IR imaging system for the long run.

Key Capabilities & Benefits:

- Exceeds MIL-STD 810 for durability testing in salt fog and salt solution
- Creates a water-repellent surface on IR imaging lenses
- Enables high performance in wet conditions, including rain and fog
- Provides clear imaging and reliable performance in maritime environments

AquaShieldIR Front Element Coating Specifications

	MWIR Si Coatings					
Specifications	**Standard**			**AquaShieldIR**		
Durability Type	**HD**	**LRHC**	**HC**	**HD.H**	**LRHC.H**	**HC.H**
	1178	1221	1039	1558	1564	1566
	High Durability	Low Reflectance Hard Carbon	Hard Carbon	High Durability Hydrophobic	Low Reflectance Hard Carbon Hydrophobic	Hard Carbon Hydrophobic
Abrasion	Severe	Severe	Severe	Severe	Severe	Severe
Adhesion	V	V	V	V	V	V
Humidity	1 day	1 day	1 day	1 day	1 day	1 day
Salt Fog	1+1 day	1+1 day	14 day	14 day	14 day	21 days
Salt Solution	1 day	1 day	1 day	1 day	1 day	1 day
Wiper	-	V	V	-	V	V
Acid Attack	-	V	V	-	V	V
Transmittance 3.4-5µm	97%	96%	93%	97%	96%	93%

	LWIR Ge Coatings (8-12µm)				MWIR+LWIR Chalcogenide Coatings			
Specifications	**Standard**		**Hydrophobic**		**MWIR (3.4-5µm)**		**LWIR (8-12µm)**	
Durability Type	**HD**	**HC**	**HD.H**	**HC.H**	**HD**	**HD.H**	**HD**	**HD.H**
	1006	1007	1557	1561	1455	1604	1405	1489
	High Durability	Hard Carbon	High Durability Hydrophobic	Hard Carbon Hydrophobic	High Durability	High Durability Hydrophobic	High Durability	High Durability Hydrophobic
Abrasion	Severe	Severe	Severe	Severe	Severe	Severe	Severe	Severe
Adhesion	V	V	V	V	V	V	V	V
Humidity	1 day	1 day	1 day	1 day	1 day	1 day	1 day	1 day
Salt Fog	1+1 day	7 day	14 day	14 day	1+1 day	14 day	1+1 day	14 day
Salt Solution	1 day	1 day	1 day	1 day	1 day	1 day	1 day	1 day
Wiper	-	V	-	V	-	-	-	-
Acid Attack	-	V	-	V	-	-	-	-
Transmittance	96%	88%	95%	88%	97%	96%	94%	93%

* Wetting Angle > 110deg.
** Standard compliance: MIL STD 675 & MIL STD 810

LARGE REFLECTIVE OPTICS FOR MULTISPECTRAL IMAGING SYSTEMS

Large reflective optics are essential for high-performance multispectral imaging systems in defense, surveillance and aerospace applications.

Our expertise lies in producing and assembling precise, large reflective optics available in spherical, aspherical, parabolic, and freeform shapes, fabricated from materials such as aluminum, silicon, germanium, and copper.

With strict accuracy and surface quality standards, Ophir's reflective optics meet the rigorous demands of multispectral imaging applications across visible, UV, and IR wavelengths.

High-end Specifications

- Diameter up to 700 mm
- On or off-axis mirrors
- Radius tolerance of 0.05%
- Irregularities less than 0.5 Fr P-V, 0.1 Fr RMS at 0.633µ
- Roughness less than 40 Å RMS

Advanced Optical Coatings

Coating types:

- Anti-reflective (AR), Mirrors and
- Filters
- UV, VIS, NIR, SWIR, MWIR,
- LWIR
- Multispectral coatings
- High efficiency and high durability coatings
- DLC (HC) coatings and Low Reflectance HC (LRHC)
- Laser coatings YAG and CO2
- EUV coatings

Coating performance:

- Broadband AR: Ref<0.5% to 0.2% Tra>98% to 99%
- Broadband mirror: Ref>98% to 99%
- Windscreen Wiper Test TS1888 / P 5.4.3 – DLC coatings

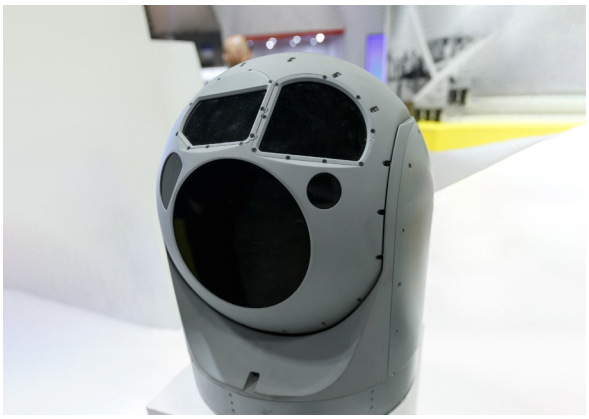


Figure 5: Multi-spectral electro-optical/infrared (EO/IR) system. Image credit: Alamy.

mks | Ophir

About Ophir IR Optics

Ophir is a brand within the MKS Instruments Photonics Solutions Division. The Ophir IR Optics product portfolio consists of world-leading high performance thermal IR lenses and optical elements for SWIR, MWIR and LWIR imaging. Based on decades of experience in the design and manufacture of IR components and complex lens assemblies with fixed or motorized zoom lenses, the Ophir IR Optics products line enhance the capabilities and productivity of our customers in homeland security, surveillance, commercial and defense markets.

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