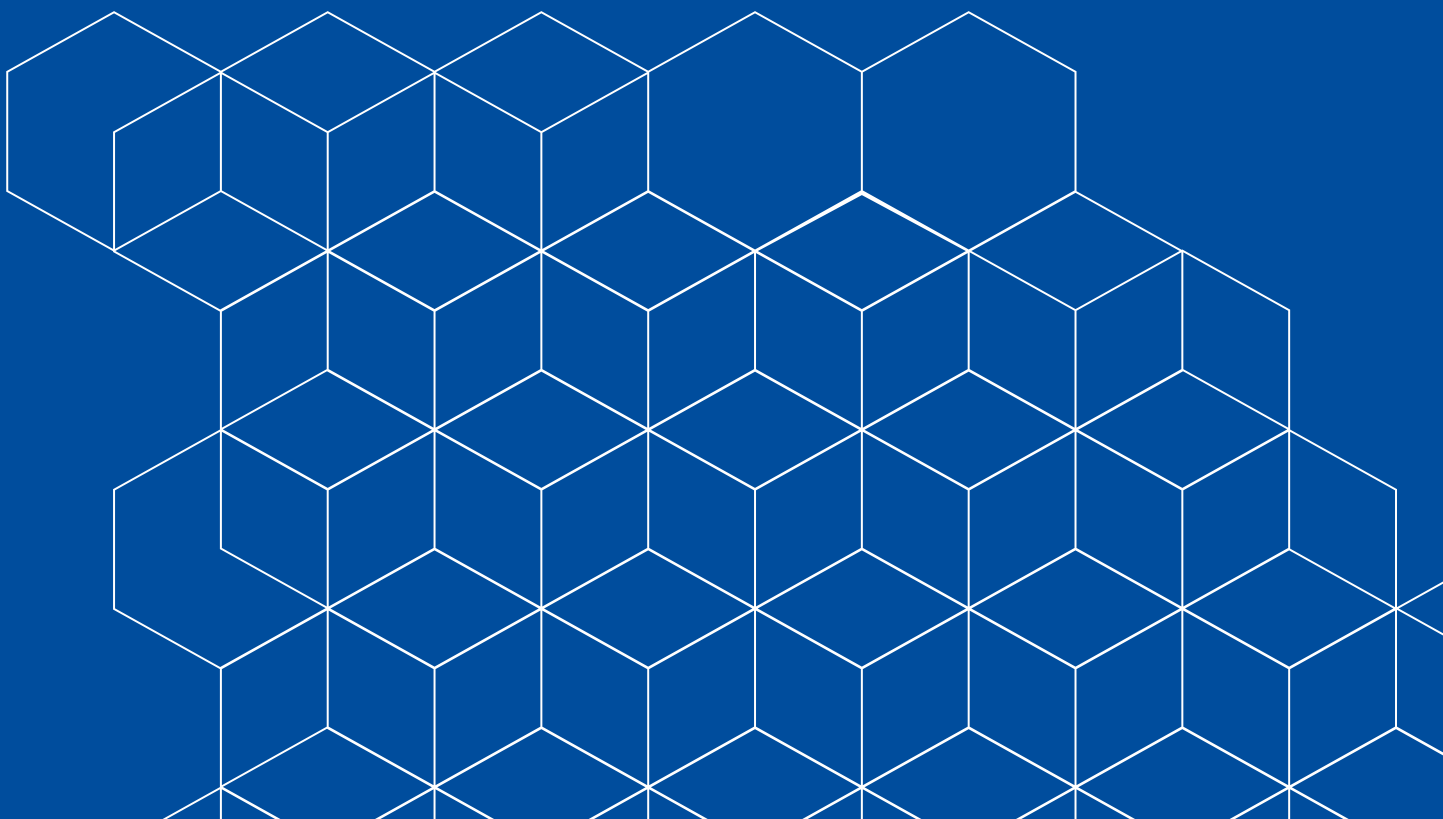




INFRARED DETECTORS
FOR SECURITY AND DEFENSE
APPLICATIONS



INFRARED DETECTORS FOR SECURITY AND DEFENSE APPLICATIONS

VIGO System has developed a unique technology of manufacturing instruments for a quick and convenient detection of a 1 – 16 μm infrared radiation. The instruments operate at an ambient temperature or are cooled with thermoelectric coolers. Our detectors can withstand harsh environments, for example hot temperatures in the deserts or high acceleration on most advanced fighter aircrafts.

Infrared detectors in security and defense applications must meet a number of standards and requirements. Undoubtedly, the increased exposure to mechanical and environmental conditions is of great importance. Factors such as temperature, pressure and shock have a direct impact on the sensitivity and accuracy of the detector. VIGO System, as a leader in the production of uncooled standard and custom infrared detectors, with over 30 years of experience, meets the stringent standards listed below.

MIL standard requirements:

- Strict mechanical tolerances: $\pm 0.005 \text{ mm}$
- Strict spectral specifications: wavelength tolerance $\pm 0.1 \mu\text{m}$
- Short start up / reaction times: 6 s / 8 μs
- Long lifetime: 15 years @ $+20^\circ\text{C}$

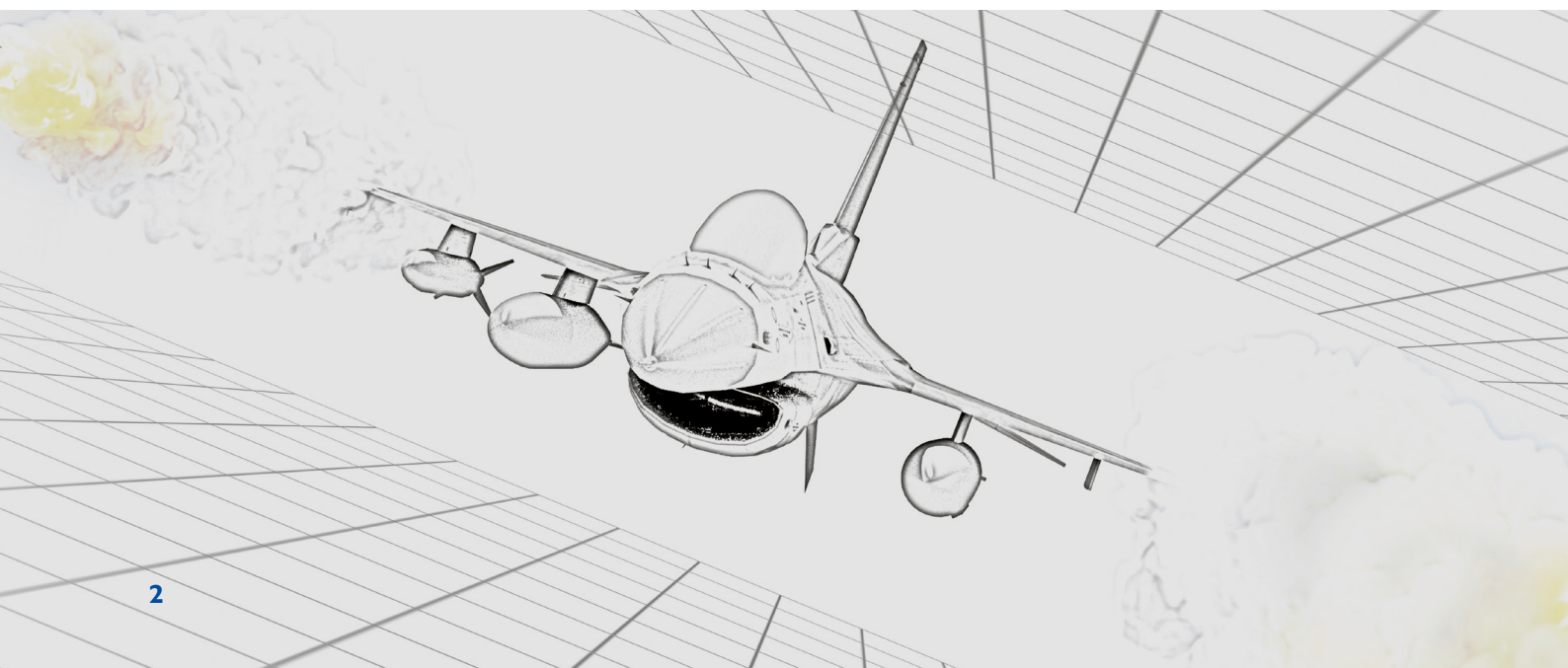
Increased exposures to environmental conditions:

- Low / high temperatures: -50°C / $+80^\circ\text{C}$
- Temperature shocks: -40°C / $+50^\circ\text{C}$

Increased exposures to mechanical conditions:

- Vibrations: 20 – 500 Hz @ 0.0225 g^2 / Hz
- Shocks: up to 20 000 g / 10 ms
- Constant acceleration: up to 40 000 g

VIGO System photon infrared detectors can be used in various security and defense applications. Components carefully adapted to the environmental and mechanical conditions are used in the production of munitions, anti-missile systems or stand-off detection solutions. The detectors high sensitivity allows for a precise detection of the enemy (smart munitions) or threats (gas attacks, terrorist attacks). Below we present military applications paired with the suggested standard infrared detectors.



SMART MUNITIONS

Tanks and other military vehicles emit particularly large amounts of heat (mid infrared radiation) as a result of the engine and equipment operation. For this application we usually advise to use the LWIR region as in the ground combat there are often some smoke or burning vehicles for example. LWIR detectors enable detecting such objects and distinguishing them from the surroundings. Thanks to advanced detection, VIGO System detectors may be used for a precise and efficient homing on moving vehicles directly before the attack.

The use of a smart munitions system requires only minimum participation from the user. First, a carrier missile is fired which delivers explosive material to the target area. Next, the main charge with a homing system is separated from the missile and falls freely towards the ground. After the IR sensors are activated and a ground target is detected, the objects identified by means of comparing its parameters with patterns stored in the database. Finally, the proper attack is carried out and the target is effectively neutralized. VIGO System offers very well working LWIR detectors for this application:

Name of the detector	Spectral range* [μm]	Detectivity [cm ² Hz ^{1/2} /W]	Time constant [ns]
PVMI-4TE-10.6-1×1- TO8-wZnSeAR-36	2 - 12	$\geq 3 \times 10^9$	≤ 3
PCI-3TE-12-1×1- TO8-wZnSeAR-36	2 - 14	$\geq 1.6 \times 10^9$	≤ 5
PEM-10.6-2×2-PEM- SMA-wZnSeAR-48	2 - 12	$\geq 2.0 \times 10^7$	≤ 1.2

*Lambda cut-on & lambda cut-off at 10% of the lambda peak.

DIRCM & CIRCM

Directional Infrared Counter Measures (DIRCM) and Common Infrared Countermeasure (CIRCM) are anti-missile systems. The MWIR region of the IR spectrum is optimal for detecting missiles. For this we offer a linear detector which can be manufactured based on our photodiodes PV-5. These are matured structures which will perform better than lead based detectors. The Long-Wave Infrared (LWIR) region is better for degraded environments. Whenever there are dust in the war field or other blocking clouds we propose our most advanced detectors PVM-10.6. Those highly sensitive infrared detectors manufactured by VIGO System enable deceiving heat searching missiles. That is achieved by means of cooperation between detectors and active countermeasure systems equipped with their own laser sources disturbing the missiles operation. A laser installed on the protected object remains off till a threat is detected, so as not to reveal the location of the object. It is the job of an accurate infrared detector from VIGO System to detect the threat. A detector records infrared radiation emitted by the missile, and immediately passes the information on the threat to the missile countermeasure system and to the aircraft/helicopter crew. Next,

an active countermeasure system aims its own laser beam at the missile, so that it interprets the beam as the radiation incoming from the target. By means of a suitable modulation of the laser signal, the missile is diverted from the target and neutralized in a safe area. VIGO System recommends multielement detectors, consisting of 8-32 elements, for the DIRCM&CIRCM method. Multielement components eliminate the need of a rotary system and increase the field of view of the device. Additionally, the specialists at VIGO System are able to design multi-element detectors consisting of various structures. Such solutions allow to combine the advantages of MWIR and LWIR. Typical parameters for MWIR and LWIR detectors are presented in the table below:

Parameter	MWIR – PV-2TE-5	LWIR – PVM-2TE-10.6
Active element material	Epitaxial HgCdTe heterostructure	Epitaxial HgCdTe heterostructure
Optimal wavelength λ_{opt} , μm	5.0	10.6
Detectivity $D^*(\lambda_{peak})$, $\text{cm}^2\text{Hz}^{1/2}/\text{W}$	$\geq 2.0 \times 10^9$	$\geq 2.0 \times 10^8$
Time constant τ , ns	≤ 120	≤ 4
Optical area, mm X mm	0.1 x 0.1	1 x 1



STAND-OFF DETECTION

Stand-off detection is anti-threat solution which could replace soldiers in dangerous areas. This device will be capable of remote control. The long-range device will be designed to search places where an explosion, a gas or terrorist attack may occur. Next, the detection system will notify the operator of the device about possible risks or threats.

In those applications we offer detectors with the highest detectivity in the LWIR region - PC-3TE-12-1x1. The present stand-off detection systems are large installations with complicated optical systems, intricate spectroscopes and analyzers. Thanks to the ongoing progress in miniaturization, they may soon become compact systems, easy to transport and convenient to use. Because of their small dimensions and no need for cooling with liquid nitrogen, the infrared detectors from VIGO System can be used directly for a construction of handy systems for poisonous or flammable gases detection. Such systems are characterized by easy operation and small power consumption enabling their use in difficult conditions.



PROTECTION OF AN AREA AGAINST ACTS OF TERRORISM

The production of illegal substances creates distinguishable and unique production waste. This chemical waste in gaseous, liquid or solid form can be analysed by VIGO System detectors.

VIGO System infrared detectors provide a possibility to scan air over large areas with the use of drones or aircrafts, and to monitor sewage systems and solid wastes with the use of other measuring devices. In different environments, there are various elements (gas clouds, dust particles, etc.) that may interfere with the measured signal. With this type of interference, detectors operating at high frequencies and with high detection are needed. The projects implemented so far with the use of VIGO System detectors were focused on building a system for detecting explosives from large distances (100-400 m) or their substrates in the liquid phase and in the air. The device involved in that project had a wide optical ($3-11\text{ }\mu\text{m}$) and electrical ($\sim 1\text{ GHz}$) band along with a high sensitivity ($D^* \sim 10^{10}\text{ cm}^2\text{Hz}^{1/2}/\text{W}$ for a $>8\text{ }\mu\text{m}$ wavelength). It was the PVI-4TE-10.6 detector adjusted to customer needs. The development and use of such devices would mean a significant progress in operations conducted in the countries engulfed by conflicts, or in the territories controlled by terrorist organizations. Infrared guided missiles are an example of the newest generation of weapons which, thanks to their resilience to common and widely used thermal countermeasures, represent a real threat to aircraft and helicopters.

The security and defense applications described above include only the suggested standard mid-infrared and far-infrared detectors. VIGO System is open to all inquiries as well as research and development cooperation. As an innovator and a world-leading manufacturer of standard and custom, cooled and uncooled photodetectors, we have our own complete production line for semiconductors and photonic devices, from near to far infrared.



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