

ANNOUNCEMENT

LEDs Used in Night Vision Imaging Systems Compatible Lighting

U.S.A. Military – Market Forecast 2017-2024

Study Release May 28, 2018



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Published: May 28, 2018
Text Pages: 94 pages – PDF
Excel File: Market Forecast Database (2017-2024)
Fee: USD 2,900 Files sent by E-mail

Analyst Inquiry Services are included in the fee.

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This is the ElectroniCast forecast of global market consumption of packaged light emitting diodes (LEDs), used in Night Vision Imaging System (NVIS) compatible lighting, by the US Military – worldwide.

A night vision device (NVD) comprises of an Infrared (IR) image intensifier tube in a rigid casing, commonly used by US military forces. Infrared light is electromagnetic radiation with a wavelength between 0.7 and 300 micrometers, which equates to a frequency range between approximately 1 and 430 terahertz (THz).

Night vision goggles (NVG) combined with magnification lenses constitutes night vision binoculars. Other types include monocular night vision devices with only one eyepiece, which may be mounted to firearms as night sights. NVG and enhanced vision systems (EVS) technologies are becoming standard operating products for US military operations to improve safety. Light emitting diodes used in Night Vision Imaging Systems must provide an environment that will not have near infrared (NIR) noise, which would interfere with the nighttime sensitivity of the NVGs. It is important to note that night vision compatibility (NVC) is only achieved when the design of the lighting equipment allows for proper use with and without the NVIS, at night or during the day.

In this study report, we provide detailed 2017-2024 estimates and market forecasts for packaged LEDs that have night vision compatibility in relationship to night vision imaging systems (NVIS) – used by the US Military

NVIS are passive systems, which have a very high sensitivity to radiation in the approximate region of 600nm to 930nm (orange to near infrared). The NVIS work by converting photons from the outside night scene onto a micro-displayed visible image. The NVIS will amplify the nighttime scene approximately 2000 times. To protect the image intensifier assembly, the systems are equipped with an automatic gain control (AGC), which will aperture down the NVIS when exposed to bright lights in the region of approximately 600nm to 930nm. If displays or light sources are not NVIS compatible, the automatic gain control will activate and the NVIS will become proportionally less sensitive to nighttime objects outside of the cockpit.

The Department of Defense (United States) published the MIL-STD-3009 Standard for lighting, aircraft, night vision imaging system compatibility, which specifies the interface and performance requirements for aircraft lighting and display equipment that is intended to be used along with NVIS. This specification defines aircraft interior lighting standards for sources such as cockpit displays and caution / warning lights, for both day and nighttime operating conditions. NVIS filters designed for avionic applications must incorporate NIR attenuation properties, chromaticity, contrast for daylight readability and often EMI/RFI shielding. The MIL-STD-3009 superseded MIL-L-85762A standard. This standard also includes provisions for white light sources and for “leaky green” requirements.

The light emitting diodes in a display heavily influence its color, contrast, and NVIS radiance (NR) properties. White, green, and red light emitting diodes with certain spectral emission can be adjusted with filters to produce displays that comply with various NVIS color coordinates and NVIS Radiance (NR) specifications described in MIL-STD-3009. Meeting both color and Night Vision Imaging System (NVIS) Radiance limits can be challenging. Each application is unique and always involves certain constraints, such as space limitations or production methods, that may require a specific approach in order meet compliance.

Market Forecast and Analysis by Application The Night Vision Imaging System
LED market is segmented into the following application categories:

- **United States of America - Military**
 - Aircraft
 - Cockpit / Display Panel / Instrument Lighting
 - Other Interior Night Vision Compatible (NVC) Lighting
 - Exterior Aircraft NVC Lighting
 - Ships/Watercraft
 - Bridge Display Panel / Instrument Lighting
 - Other Interior Night Vision Compatible (NVC) Lighting
 - Exterior NVC Lighting
 - Ground Vehicle
 - Display Panel / Instrument Lighting
 - Other Interior Night Vision Compatible (NVC) Lighting
 - Exterior NVC Lighting
 - Ground Field Command / Man-Portable Devices / Other
 - Display Panel / Instrument Lighting
 - Other Interior Night Vision Compatible (NVC) Lighting
 - Exterior NVC Lighting

LED Level Quantified in the ElectroniCast Study A Light Emitting Diode (LED) is a solid-state semiconductor device that converts electrical energy directly into light. On its most basic level, the semiconductor is comprised of two regions. The p-region contains positive electrical charges while the n-region contains negative electrical charges. When voltage is applied and current begins to flow, the electrons move across the n region into the p region. The process of an electron moving through the p-n junction releases energy. The dispersion of this energy produces photons with visible wavelengths. Below, are four levels (or “food chain”) of LEDs. For the purposes of THIS ElectroniCast study, we quantify and provide a market forecast for “Level 2”

Level 1 - The chip or die

Level 2 – Packaged LED - single or multiple-die packaged LED

Level 3 - LED array; may include optics, heat sink and/or power supply

Level 4 - LED luminaire

Quantitative Analysis LEDs face the challenge of creating definitive positions in the NVIS illumination market, as competing lighting solutions (technologies) are readily available and accepted. While this does not limit the potential success of LEDs, it does create some challenges. This report provides an independent examination and analysis of the changing market dynamics for LEDs used in selected end-use applications. The LED market forecast data are segmented by the following functions:

- Consumption Value (US\$, million)
- Quantity (number/units)
- Average Selling Prices (ASP \$, each)

Ship/Watercraft Leads in Consumption The use of LEDs in Night Vision Imaging System compatible lighting will continue to be dominated by the Military market sector. The market forecast, by ElectroniCast Consultants, provides second-level (or sub-level) applications under the US Military application sectors. The next-level of detailed is provided in the report text, as well as in the Microsoft Excel database worksheet found in the addendum of the study report.

During the forecast period, as the luminous efficacy techniques improve (Lumens per Watt: lm/W), the LED is being considered for more than (just) indicator lighting. The conversion of interior lights in aircraft cockpits and cabins to meet MIL-Spec (specifications) and standards can involve the following conversion techniques, based on cost effectiveness and operational requirement:

- Replacement of instrument panel glass with filter material
- Installation of filter material to warning, caution and annunciator indicators
- Replacement of existing lamps with LED based modular lamps
- Installation of NVIS compatible bridge and bezel lighting
- NVG compatible floodlights

These same techniques are also used for the conversion of vehicle driving instruments, ships' bridge, navigational and control lighting and communication equipment.

Exterior lighting for ships, aircraft and vehicles can be made Night Vision Goggles (NVG) friendly or dual mode Convert/NVG friendly through:

- Replacement of bulbs with form and fit compatible LEDs
- Installation of solid state LED based navigation and anti-collision lights
- Fitting filters to existing light fittings
- Addition of Infra Red LEDs for covert navigation and formation lights only visible through NVIS

This study is based on analysis of information obtained continually over the past several years, but updated through the middle of May 2018. During this period, ElectroniCast analysts performed interviews with authoritative and representative individuals in the LED manufacturing (materials, chips, packaging, devices, associated parts/pieces, fittings/fixtures, NVIS filters) and military/aerospace, communication, vehicles, R&D, and government regulating authorities. The interviews were conducted principally with:

- Engineers, marketing personnel and management at manufacturers of LEDs as well as other technologies.
- Design group leaders, engineers, marketing personnel and market planners at major users and potential users of LEDs used in Night Vision Compatible Lighting applications.
- Other industry/sector experts, including those focused on standards activities, trade associations, and investments.

The interviews covered issues of technology, R&D support, pricing, contract size, reliability, documentation, installation/maintenance crafts, standards, supplier competition and other topics.

In analyzing and forecasting the complexities of the US Military use of light emitting diode products, it is essential that the market research team have a good and a deep understanding of the technology and of the industry. ElectroniCast members who participated in this report were qualified.

Bottom-up Methodology ElectroniCast forecasts, as illustrated in the forecast data structure, are developed initially at the lowest detail level, then summed to successively higher levels. The background market research focuses on the amount of each type of product used in each application in the base year (2017), and the prices paid at the first transaction from the manufacturer. This forms the base year data.

ElectroniCast analysts then forecast the growth rates in component quantity use in each application, along with price trends, based on competitive, economic and technology forecast trends, and apply these to derive long term forecasts at the lowest application levels. The usage growth rate forecasts depend heavily on analysis of overall end user trends toward equipment usage and economic payback.

About ElectroniCast

ElectroniCast, founded in 1981, specializes in forecasting technology and global market trends in fiber optics communication components and devices, as well providing market data on light emitting diodes used in lighting.

As an independent consultancy we offer multi-client and custom market research studies to the world's leading companies based on comprehensive, in- depth analysis of quantitative and qualitative factors. This includes technology forecasting, markets and applications forecasting, strategic planning, competitive analysis, customer-satisfaction surveys and marketing/sales consultation. ElectroniCast, founded as a technology-based independent consulting firm, meets the information needs of the investment community, industry planners and related suppliers.

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ADDENDUM – Microsoft Excel File (US Military Market Forecast)