SIONYX

NIGHT VISION 101

AN INSIDER'S GUIDE

NIGHT VISION OVERVIEW

Using current night vision technology is an eye-opening experience that must be seen to be believed; a whole new world awaits your exploration after the sun has set. Game watching, boating, urban and rural observation, hiking and other outdoor activities can be an exciting experience after dark – especially with the right technology.

Choosing the ideal night vision device for your needs can be a complicated process without the proper guidance. Before narrowing your choices, a basic understanding of how these devices work, differences in technology by generation and their features and benefits should all be understood to truly appreciate the device, and to make an educated purchasing decision.

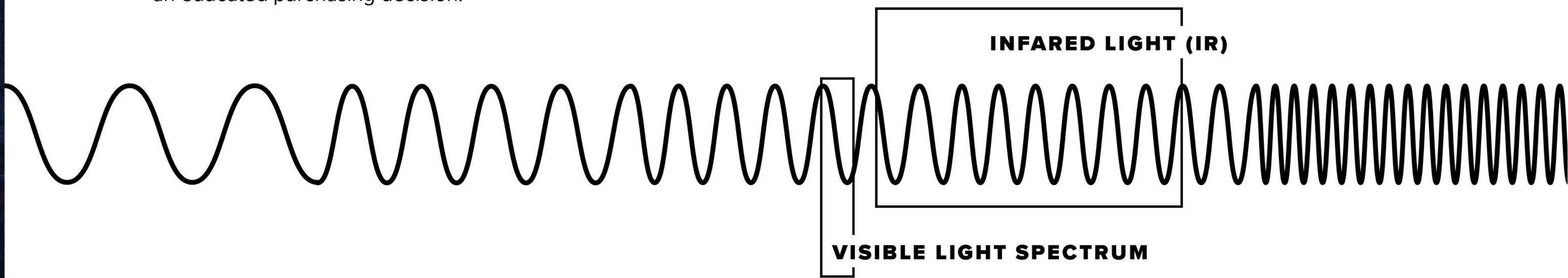


TABLE OF CONTENTS

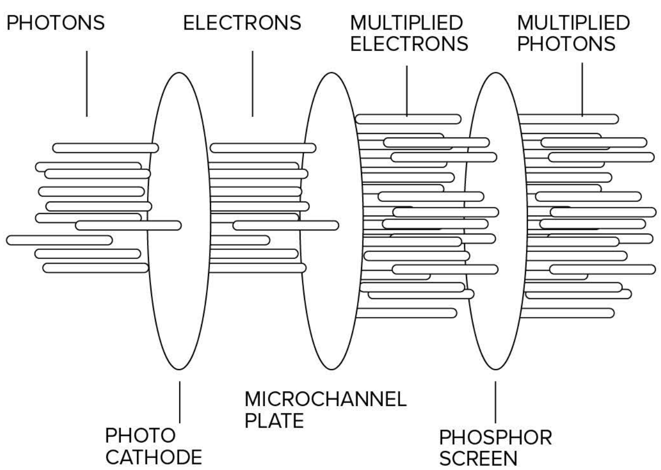
Essentially four types of night vision technology exist today:

ANALOG NIGHT VISION

All analog night vision devices share several main components that consist of an objective lens, an eye piece, a power supply, an image-boosting photocathode and photomultiplier. The latter two combined are commonly referred to as an image intensifier tube.

Intensifying the Image

Undoubtedly, the real magic lies within the image intensifier tube – which put into very basic terms – absorbs photons (light energy) and releases electrons (electric energy) before converting into light again in the form of an image. With that understanding in-mind, let's dive a little deeper into how it all actually works. At the front of any night vision device is an objective lens, whose job is to gather all available ambient and artificial infrared energy before funneling it to an electronically powered image intensifier tube. These photons pass through a photocathode, which converts them into electrons.
These electrons move on to a micro channel plate (MCP) where they are amplified by a factor of thousands through



an electrical and chemical chain reaction created when they impact the micro channel walls. These effectively supercharged electrons then slam into a screen coated in phosphors where they reach an excited state, releasing photons, or visible light, which can be viewed through an eye piece. The image will appear as a clear and crisp amplified recreation of the scene you are observing, but in a combination of greens and black tones.
Why green? The phosphor screen most commonly used produces an image that is green in color for a simple reason; the human eye is very sensitive to green tones and can distinguish more shades of green than any other color in the spectrum, thus providing a greater level of image detail to viewer. It's science!

DIGITAL NIGHT VISION

Digital night vision devices operate differently than analog devices, in that light entering the objective lens is transformed into a digital signal by an image sensor of either the Complementary Metal Oxide Semiconductor sensor (CMOS), or Charge Coupled Device (CCD) variety. These are the same technologies used in all digital cameras.
The digital image is enhanced several times before being viewable on the devices display. The larger the CMOS or CCD sensor pixel size, the better it will perform in reduced light. SiOnyx, as an example, has patented technology that enhances sensitivity to near infrared (NIR) wavelengths and therefore provides greater low light performance. Its CMOS sensors produce extremely good low light performance thanks to a combination of its patented technology and a much larger pixel. Currently, the company's most sensitive sensor is the XQE-1310, producing an impressive 1.3 mega pixels to collect incoming light. The sensor then registers a value for each pixel before converting it into a picture typically viewable on an LCD screen, or in the case of the SiOnyx Aurora, a very high-quality OLED display. While the OLED display produces an impressive image, it's still not quite on par with the actual image, as seen through analog devices.

Just like digital cameras, each generation of CMOS and CCD sensors produce higher quality images at a lower cost than the previous generation. At present, the SiOnyx Aurora's huge CMOS sensor brings its night vision capability on par with the top performing 2nd Generation analog night vision devices, except the Aurora is capable of producing color night vision imagery, while analog is not.

Another benefit of digital night vision worth mentioning is its ability to overlay imagery such as icons, indicators and other valuable information.
Since the optical image is being converted into a digital signal anyway, the device has the ability to record video, still imagery and sound, which can easily be stored onboard, on a memory card, or wirelessly transferred via WiFi to a device such as a phone or tablet.

One thing is for certain, digital night vision technology is just getting started and is destined for tremendous increases in performance, while analog night vision is already operating at the ragged edge of its capability. What GPS did to the compass, so too will digital night vision do to analog.

ARTIFICIAL LIGHT

Without a doubt, night vision devices are packed with an impressive level of tech that can open a world that is otherwise blanketed in darkness 50% of the time. But, they can't always do it alone. In completely blackout conditions, the device is no more useful than your unaided eye. Enter the infrared illuminator.

All night vision devices, regardless of generation, must have some light to amplify. Situations exist when there is simply not enough light for your image intensifier to boost. Think of a subterranean structure, an overcast moonless night or within a cave, as examples. In these environments, an infrared illuminator is an enabler.

Think of an infrared illuminator as an invisible flashlight that can only be seen through a night vision device. IR illuminators provide artificial illumination of an appropriate wave length in the near infrared spectrum that allow the user to illuminate specific areas of interest, while also enhancing image contrast.

IR ILLUMINATOR WITH LASER

IR ILLUMINATOR

NO IR ILLUMINATOR

GENERATIONS BY THE NUMBERS

Night vision devices are commonly broken down into three generations by the United States Military to simplify the segmentation of the technology.

1st Generation

Believe it or not, the first night vision system was created by the United States Army and used during the Second World War. This system relied entirely on an artificial infrared illumination source to work. The technology lead to what are referred to as Starlight Scopes popularized in the 1960’s and used during the Vietnam War.

For a 1st generation night vision device to provide a useable image in all but cloudless, full moon conditions, an external IR illumination source is required. Even then, first generation devices are plagued by an excessive, random sparkling effect throughout the image, known as electronic noise; similar to the static seen on an old television set. This noise greatly obscures the image, as the system is simply not capable of efficiently amplifying light to be useable.

2nd Generation

Aside from the cost, optics, and clarity of the unit, the primary difference between 1st and second generation night vision devices is the addition of a micro channel plate (MCP) to the image intensifier tube.

An MCP is a metal coated glass disk that multiplies electrons produced by the image intensifier and eliminates distortion. Additionally, the number of holes, or channels, in an MCP is a major contributor in determining resolution.

An MCP acts like an electron supercharger and is located behind the photocathode. The MCP is where the magic begins and consists of millions of parallel glass tubes. As electrons pass through these tubes, thousands of additional electrons are released, allowing the light to be amplified many more times than 1st generation devices. This translates into a brighter, clearer, more crisp image.

An enhanced version of second-generation night vision is available today, sharing many components with its third-generation sibling – minus the further advanced image intensifier. These devices are known as Gen2+, or Gen2 HP, that, in certain conditions, are capable of producing image quality that is comparable to Gen 3 devices, but available at a significant savings.

3rd Generation

3rd Generation devices benefit from the addition of a semiconductor material known as gallium arsenide (GaAs) added to the manufacturing of the photocathode within the image intensifier tube. The addition of GaAs aides in achieving an even brighter, sharper image, thanks to its high level of efficiency in converting photons into electrons; enabling detection of objects at greater distances – under much darker conditions. An ion barrier film is also added that increases the practical life of the image intensifier tube and protects it from harsh ambient light sources. Typical 3rd Gen night vision devices see resolution of approximately 64- to 72 line pairs per millimeter (lp/mm) and benefit from a high-voltage power supply. Most current 3rd gen devices also utilize a gated power supply, commonly referred to as autogating. This power supply provides increased performance in urban environments where excessive ambient lighting conditions exist – typically emitted by dwellings, street lights or vehicle lights passing by. All of which can create what is commonly referred to as blooming, or halo. This halo effect is the loss of portions of, or the full image, due to overloading by a bright light source, effectively whiting out the image. Autogating technology minimizes interference from these bright lights by turning itself on and off at such a rapid rate that it is undetectable by the user. This coupled with a filmed ion barrier attached to the micro channel plate greatly reduces the blooming/halo effect, thereby increasing the effectiveness of these devices in urban environments.

Photo Credit: TNVC.COM

Unfilmed White Phosphor

At present, true 4th Generation night vision devices do not exist, as the United States military has given no such designation. That said, unfilmed, or filmless 3rd Generation white phosphor units are the current pinnacle of analog night vision technology. These devices feature a filmless micro channel plate that can provide a much higher signal-to-noise ratio than typical filmed or thin-filmed 3rd gen devices, thereby reducing static or electronic noise in very dark conditions.

These white phosphor units offer an increased level of detail, overall contrast and range of shades. The black and white image (more of a warm light blue hue) also provides more discriminating shades of intensity, resulting in greater contrast and depth perception as compared to traditional green phosphor units. During prolonged use, some users observed a reduction of headaches and eye strain as compared to green phosphor models.

Unfilmed white phosphor units produced by L3Harris are currently being issued to U.S. Special Operations Forces by the United States Special Operations Command (USSOCOM).

Photo Credit: threecurl.com

Thermal Imaging

An alternative to night vision is a thermal imager. Instead of searching for light to magnify, a thermal imager detects infrared radiation by way of microbolometers that change resistance based on their temperature. This change in resistance can be measured and converted into a viewable image by thousands of microbolometer pixels. All objects emit some level of thermal infrared light; the hotter an object is, the more radiation it emits and the more that light will change the resistance of each bolometer.

Resolution is typically far behind current night vision devices, yet target detection ranges are typically greater. The rule of thumb is the higher the resolution, the more capable the unit is and the more it is going to cost. Because the resolution is lower than analog or digital night vision devices, thermal imagers are more difficult to interpret and recognize object detail, and the landscape. Furthermore, if all objects in a given scene are at the same temperature, there is very little contrast between them.

That said, thermal imagers are particularly good at showing living creates. If you're curious about what's roaming the woods during the day or night, how long a car has been parked on the street corner or where the dog went – through smoke, haze, rain or fog – the applications of a thermal are many.

Novelty Devices

At the very bottom of the night vision market are toys advertised as night vision devices to the unassuming. These units are typically cheap, come from Asia and claim to allow the user to see in the dark. A nice quality flashlight is far more effective at the task.

At their best, these devices can offer similar performance to inexpensive indoor home security cameras equipped with a night mode. To produce a quasi-visible image in a low-light environment, an external infrared illuminator, or a filtered light source is required. Even then, the image is only discernable at very close distances, and typically most effective within the confines of a small room with light colored, reflective walls.

In low/no light conditions, even with the aid of an artificial light source, these devices offer extremely limited range and suffer from excessive, image obscuring electronic noise. Anything beyond the distance of its flood illuminator will be unrecognizable. While these novelty devices use a digital sensor, they should not be confused with high-quality, CMOS-equipped digital night vision devices.

THE FUTURE

Imagine wrap around ski goggles that allow full color night vision fused with thermal technology. Integrated within the lens of the goggle is a heads-up display with an information overlay displaying speed, direction, navigational routes, mapping software, communications, your friends and foes, targeting, aiming integration and more.

The future is very clear for digital night vision devices and that future is awe inspiring.