What is Visible Light Communication (VLC)?

What is Visible Light Communication (VLC)?

Introduction

First established in the 1790s, visible light communication (VLC) is ready again for prime time. As the name suggests, VLC uses light instead of radiofrequency (RF) to communicate. The data is converted into modulated light and transmitted to a receiver. The modulated light is captured by an image sensor or a photodiode on the receiver end and converted into a digital signal, which the system microcontroller then processes.

Recent advancement in LED technology has revived the applicability and efficiency of VLC. New LED technology has made it easier to illuminate and communicate using the same LEDs, eliminating the need for a separate communication infrastructure. Rather than install and deploy separate communication nodes, access points or beacons, VLC can be integrated into existing luminaries.

VLC Spectrum

Using visible light as data carrier has the significant advantage that the information access or broadcast points can be integrated into existing luminaire infrastructure, saving on installation costs and complexity. Employing modulation techniques that do not require deep modulation depths in the amplitude, and keep a steady average luminance level, will maintain lighting levels where they are expected by the users. And by working from a modulation frequency of several kHz upwards, the data stream will remain completely invisible to the human eye.

Figure 1 shows the frequency spectrum of the visible light spectrum – within the 380 nm to 750 nm spectrum (430 THz to 790 THz). Other light communication schemes are sometimes using infrared wavelengths, mainly Near InfraRed at 780 nm to 1.4 μm (where the IR spectrum runs to Far InfraRed, or up to the 1 mm wavelength range).

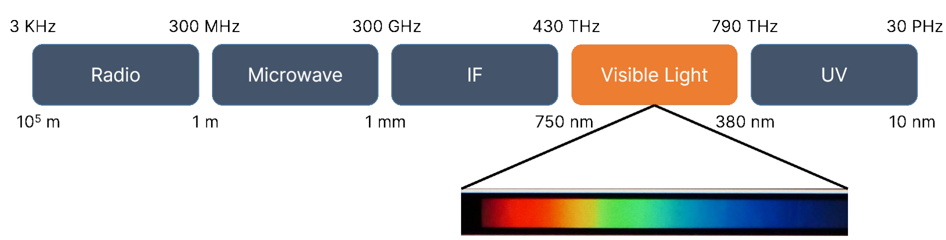

Figure 1. Visible Light Spectrum

Light Communication Taxonomy

It is important not to confuse the various technologies that are being used in light communication. Light communication can happen inside the visible spectrum, or outside of it. As usual in developing technology, there are pros and cons to be balanced, largely dependent on the type of light source used. In the visible spectrum, communication speeds are for example curtailed by the various phosphorous layers employed in LEDs, which introduce a delaying factor. On the other hand, utilizing more focused laser LEDs will significantly increase the achievable range. The major differentiators in light communication are high−speed bidirectional techniques versus lower speed broadcast technologies.

Visible Light Communication (VLC)	Optical Camera Communication (OCC)	Light Fidelity (LiFi)	Free Space Optics (FSO)
• Low to Mid-Speed • Broadcast • Short Range	• Low Speed • Broadcast • Short Range	• High Speed • Bi-Directional	• High Speed • Bi-Directional • Long Distance • Stationary
• Indoor Location • M2M Communication • Information Point • Advertising	• Indoor Location • Information Point • Advertising	• Mobile Communications • User Information	• Backhaul Communications

Figure 2. Light Communication Taxonomy

- Higher immunity
  - Less sensitive to reflections (ideal for metallic environments)
  - No influence by RF sources nearby
  - No influence on other systems
  - Better suited for EM sensitive area’s: aircrafts, hospitals, explosion risk areas
- Scalability
  - No saturation of the comms channel with large numbers of assets
- Higher security
  - Inherently limited to line−of−sight communication (does not travel through walls)
  - Localized to the light source
- Less complexity
  - No additional power amplifier and signal chain needed (saves power & design complexity)

VLC Applications

Light communication will of course never replace RF communication. It is a complementary technology that, in many use−cases, will co−exist or even cooperate to achieve the most optimal results in the application.

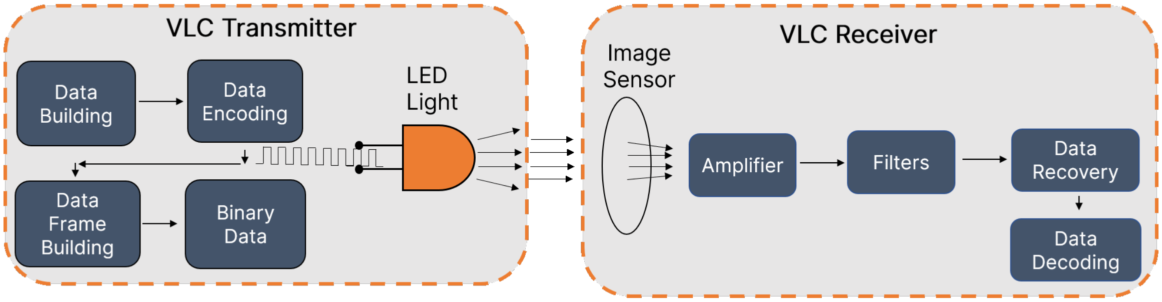

Figure 3. Example VLC Implementation

Indoor Positioning

One of the main applications of VLC is indoor positioning systems in an industrial environment using the technology to identify a location of a package or an asset such as a forklift.

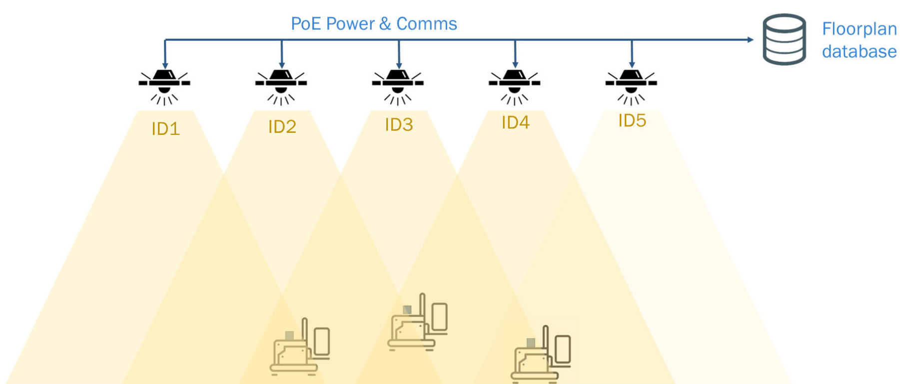

Figure 4. LED Ballast with Unique ID

As shown in Figure 4, each LED ballast has a unique identifier that indicates the position within a building − the LED ballast signals through visible light to a receiver. The receiver detects the code and calculates the position. The receiver can be a sensor camera module or a photodiode.

In its simplest form, the mobile units can have a pre−programmed floorplan. The floorplan database contains unique IDs and luminaire positions − the luminaire transmits it's unique ID continuously. The robot optical sensor or camera module captures IDs while the robot application triangulates position. Accuracies down to 10~15 cm, in three dimensions, are achievable in the field.

Conclusion

Light communication is opening the door to many new applications, overcoming some of the limitations of RF implementations today. With highly integrated and efficient LED drivers from **onsemi**, VLC is emerging as valuable additional technology for expanding information and location services.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Email Requests to: orderlit@onsemi.com

onsemi Website: www.onsemi.com

TECHNICAL SUPPORT
North American Technical Support:
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

Europe, Middle East and Africa Technical Support:
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative