

## FEATURED ARTICLE

# FA002 | Challenges and advantages of high-bandwidth uncompressed video connectivity for medical diagnostic equipment



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in cooperation with



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The technological overhaul taking place in hospitals and medical centers is undoubtedly improving medical procedures. Doctors and health professionals benefit from operating with the highest possible video image quality for the most accurate representation of patients' conditions. With the advent of medical-grade visualization systems, procedural workflows improve, and high-quality, zero latency uncompressed video images are transmitted over long-distances for better collaboration, education and monitoring. This paper introduces high-bandwidth uncompressed video connectivity for medical diagnostic equipment based on Valens' chipset VS3000 HDBaseT reference design solution, developed in collaboration with Würth Elektronik passive components.

### 01. BASIC REQUIREMENTS FOR A VISUAL MEDICAL DIAGNOSTIC SYSTEM

The advanced medical imaging systems demand high-bandwidth connectivity and increased video performance, thus introducing new requirements in the operating room, including:

- Color accuracy with high-dynamic range (HDR)
- High-quality imaging - uncompressed video
- Real-time, zero latency video distribution

- Long-distance transmission
- Flexible and efficient infrastructure
- Range of supported interfaces
- Cross-vendor interoperability

HDBaseT enables high-bandwidth, long-distance, high-quality video images to be transmitted in real time over a single cable, while supporting interoperability between different devices, thus enabling a visual medical diagnostic system connected inside and outside the operating room.

### 02. WHAT IS HDBASET?

HDBaseT is a global standard that allows for the convergence and distribution of the 5Play feature set –audio, video, Ethernet, controls, USB 2.0 and up to 100 W of power– over a single LAN cable (Cat 6 or above), for up to 100 m and even up to 1000 m over optical fiber.

### 03. WHAT ARE THE BENEFITS OF HDBASET FOR MEDICAL APPLICATIONS?

#### Real-time transmission

During surgical procedures, accurate and real-time video images are critical, and HDBaseT delivers uncompressed UHD video, enabling the best possible quality image with virtually no latency since it does not compress the data.

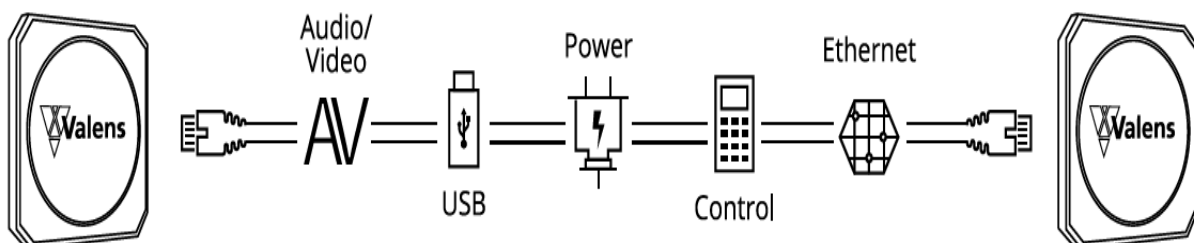


Figure 1: Diagram of the HDBaseT scheme

# FEATURED ARTICLE

## FA002 | Challenges and advantages of high-bandwidth uncompressed video connectivity for medical diagnostic equipment

### Superior performance

When using diagnostic imaging systems such as MRIs, displaying X-rays, or conducting endoscopic procedures, medical professionals depend on high-resolution and color accuracy, with no loss of visual information. HDBaseT provides an advanced connectivity solution that meets the high demands of medical visualization systems and enables bit exact transmission of high bandwidth data.

### One Cable Solution

With the proliferation of advanced digital video imaging, more devices and cabling must fit into small and crowded procedure rooms. HDBaseT can improve workflow efficiency by reducing cables and connectors, facilitating sterilization methods and increasing flexibility of equipment location.

## 04. EVALUATION KIT OF HDBASET IC FOR MEDICAL GRADE APPLICATIONS

The Valens Semiconductor's VS3000 integrated circuit leverages the HDBaseT Spec 3.0 standard technology and it

features HDBaseT port duality, where the same chipset can be configured to operate as either a TX (transmitter) device on the video source side, or an RX (receiver) device on the video receive side. The same design of TX and RX devices brings considerable cost savings for manufacturers.

In order to evaluate the characteristics of the VS3000 chip family, Valens Semiconductor has realized an evaluation kit that demonstrates the implementation of the devices' feature set over a single CAT6a cable. The data transfer between the HDBaseT TX or RX and the peripheral device is shown in Figure 3.

To achieve a connection with a network cable that satisfies both the high speed signal output and the electrical isolation between the source and the receiver, a signal transformer is required.

The design of the above mentioned transformer can be challenging because of the requirements given from the medical applications. First of all, to ensure long-distance signal transmission, CAT6 and above are recommended for the network cables.

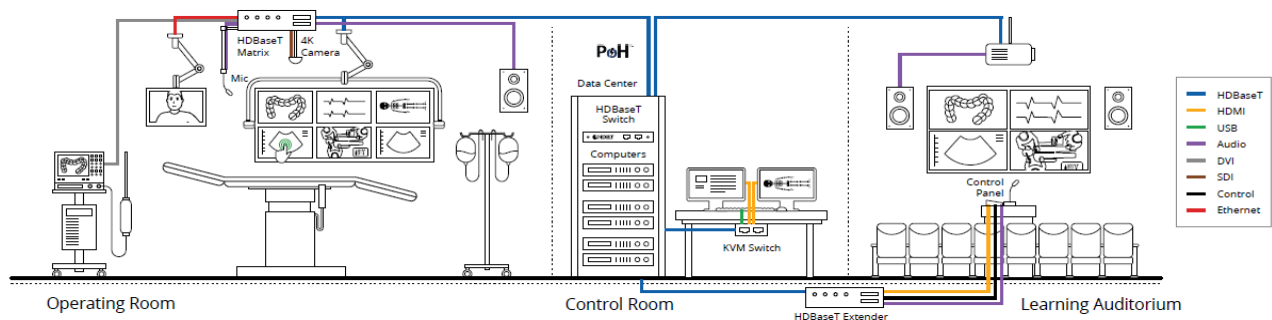


Figure 2: Schematic diagram of the medical visualization and diagnosis system

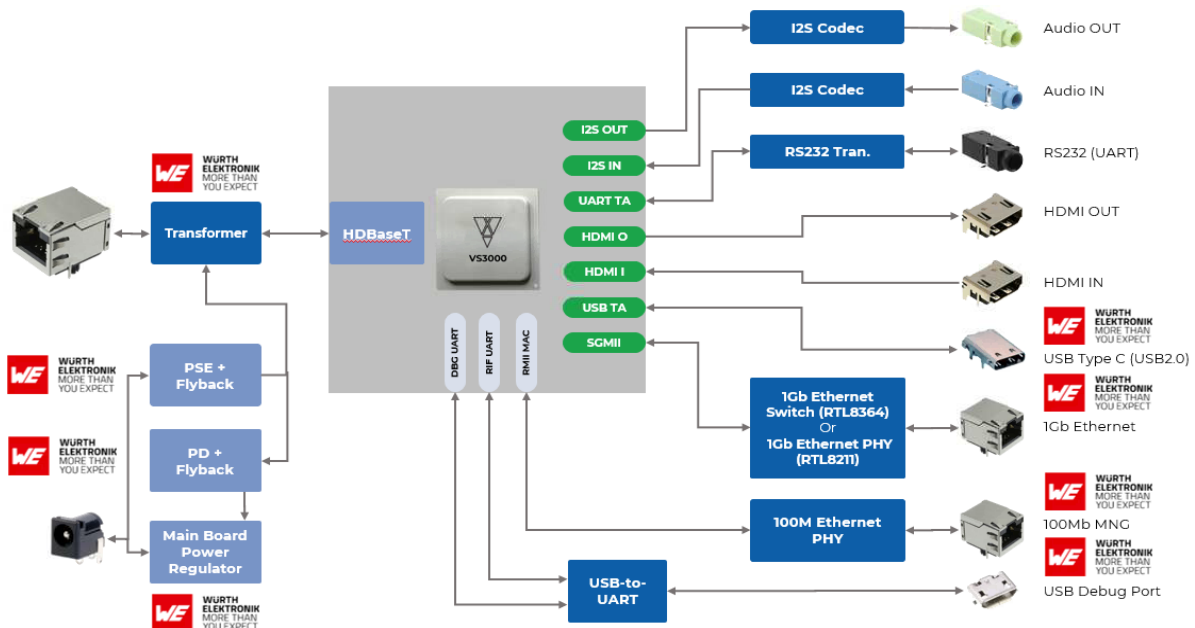


Figure 3: HDBaseT and peripheral interface communication schematic

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### FA002 | Challenges and advantages of high-bandwidth uncompressed video connectivity for medical diagnostic equipment

A withstand voltage of 4000 Vrms / 1 min is required to meet IEC 60601, technical standard for the safety and essential performance of medical electrical equipment.

Thus, the HDBaseT connection is made with a 4-channel HDBaseT front-end, routed to a CAT6A RJ45 connector through the Würth Elektronik WE-LAN HDBaseT Transformer—[749054010](#); a 10 G Base-T PoE transformer with 4 pairs, up to 150 W power capability and 4 kV isolation voltage, specifically verified for the VS3000 interface.

The isolation requirements, as well as the normal operating voltage requirements of 250 Vrms, are met with specific design of the electrical spacing: the creepage distance is 8 mm and the electrical clearance is 5 mm. Furthermore, the transformer windings are realized with reinforced insulation (Figure 4).

The VS3-EVK implements the HDBaseT Power over HDBaseT (PoH). Per PoH, one side is the power supplier PSE (Power Source Element) and the other side (Remote side) accepts the

power delivered, also called PD (Powered Device). On the able side of the HDBaseT transformer, the center taps are connected to the PoH PD Controller.

Long distance, high speed transmission, PoH power supply may bring EMC issues. It can be shown how the signal transformer addresses isolation, insertion loss and return loss requirements of HDBaseT applications without decreasing the system performance.

Circuit considerations in an HDBaseT application

Since the data rate is 16 Gbps and the connection is PoH, the power path has to go through the center tap of the signal transformer, creating common mode noise propagation in the data transmission. Typically, the clock source of the IC also generates noise at its frequency and its multipliers (Figure 5). To overcome these issues, common mode chokes are integrated in the signal transformer, as shown in Figure 6, with different common mode rejection ratios at the different frequencies.

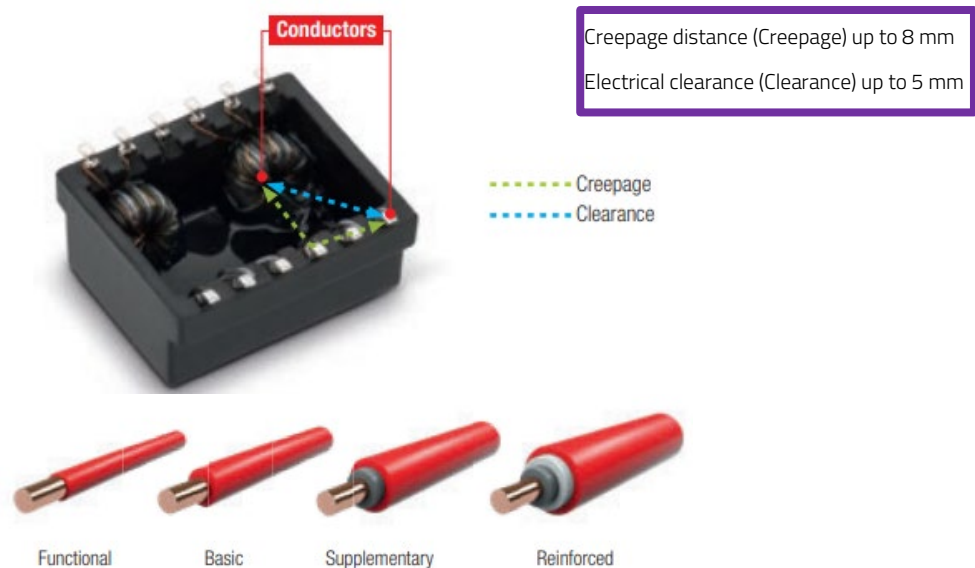


Figure 4: Details of insulation strengthening measures

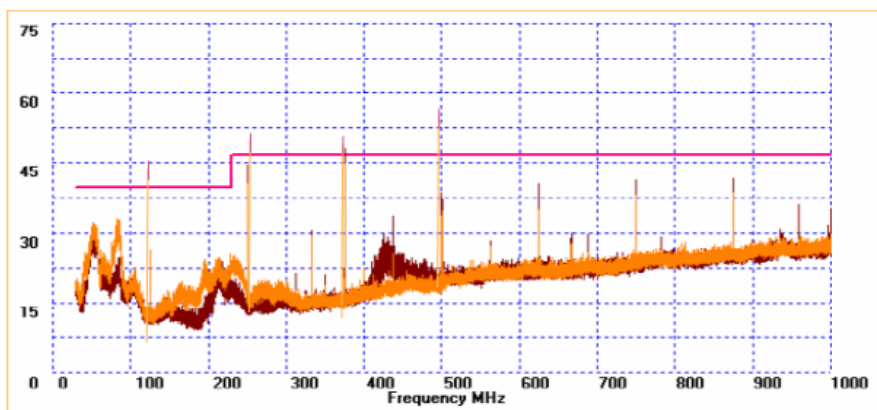


Figure 5: Typical network line radiation problem caused by 125 M clock and multiplier

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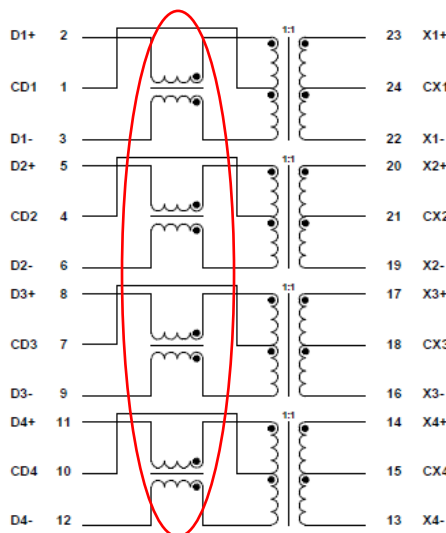
Improved rejection of common mode noise by adding built-in common mode chokes on the PHY side of the network transformer can be seen in Figure 7.

By adding common mode chokes to the transformer, the network cable radiation is effectively suppressed.

Noise problems can arise also from PoH transmission. A flyback transformer, MID-FLYTI-750312791 is used to provide power to the PD, capable of stepping up the input voltage to 56 V. Noise generated by isolated power supplies, which may cause conduction and radiation problems, require additional common mode chokes (Figure 8) close to the power supply to filter this type of noise. Chokes like the WE-SL5 and SL5 HC series for PoE power supply filtering achieve high common mode impedance over a wide frequency band (in this evaluation kit, WE-SL5 HC – 744273102 have been selected).

The transformers do not provide protection against ESD or surge impulses. Since these voltages are associated with rapid current increases, they can couple onto the transformer from the cable side to the VS3000 chip and damage it. It is therefore recommended to connect each signal line between the transformer and PHY chip to a TVS diode, as highlighted in Figure 9.

The TVS needs to be placed between the VS3000 and the network transformer, as close to the network transformer as possible, to provide the first protection in case ESD noise enters the system. The TVS is connected between the signal line and ground, to the reference ground of the VS3000 and the original side of the network transformer, not to earth PE. The board from the reference design EVS3-EVK2-KT-3000-MD is shown in Figure 10.



Common Mode Rejection Ratio	CMRR	1-100 MHz	-30	dB	min.
Common Mode Rejection Ratio	CMRR	100-250 MHz	-25	dB	min.
Common Mode Rejection Ratio	CMRR	250-500 MHz	-20	dB	min.

Figure 6: Schematic of adding common mode inductor on the PHY side

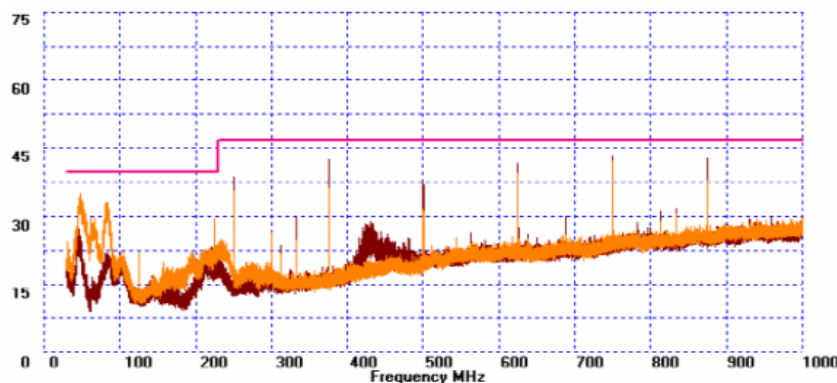


Figure 7: Diagram of the effect after adding common mode inductor

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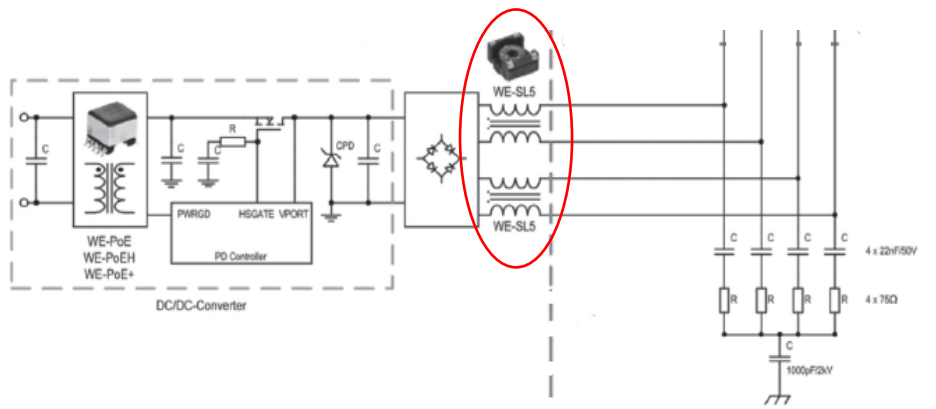


Figure 8: Schematic of adding common mode chokes at PoH power supply output

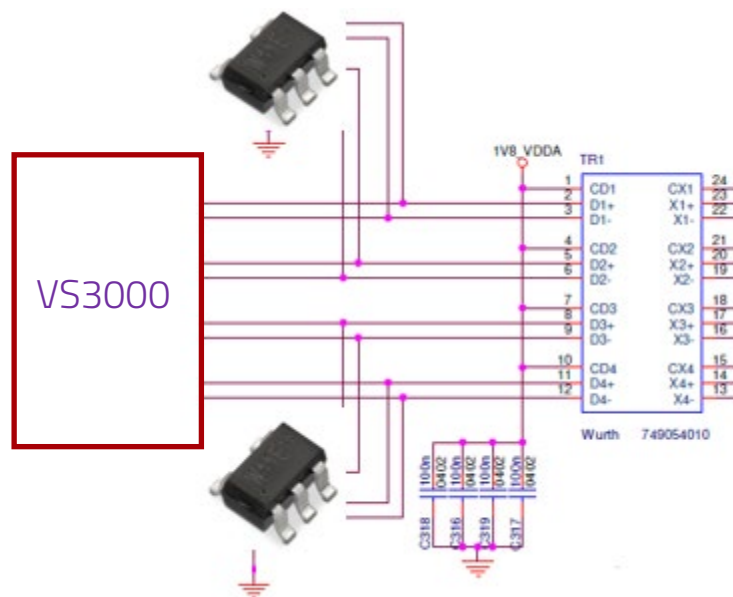


Figure 9: Schematic of adding TVS on the PHY side of the network transformer

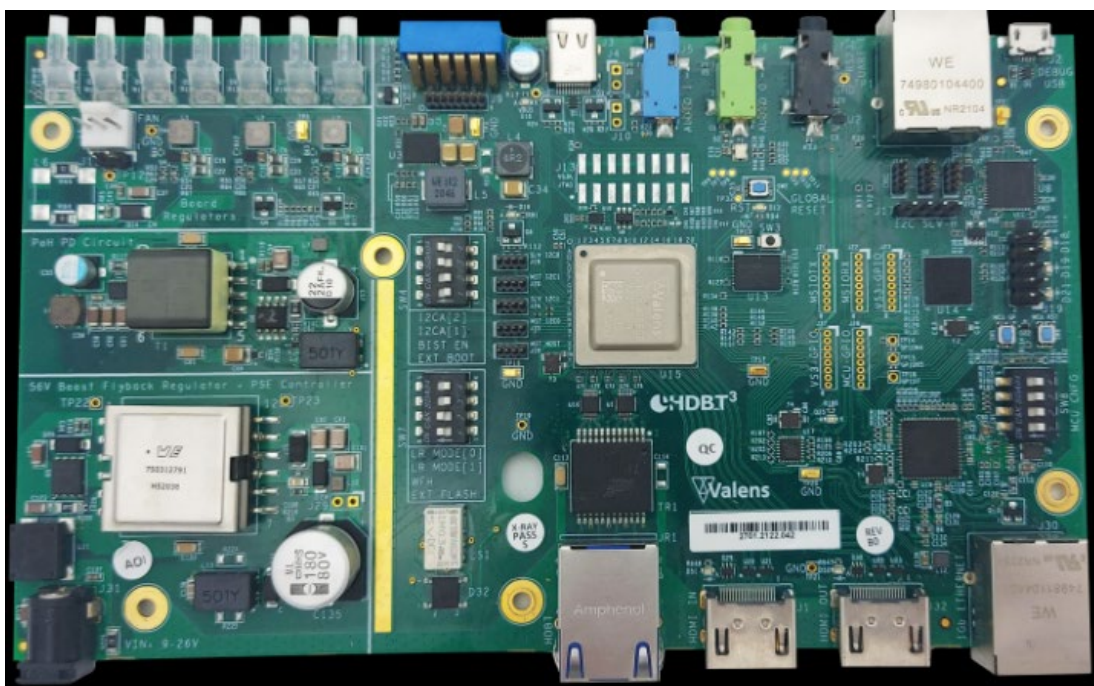


Figure 10: Valens EVS3-EVK2-KT-3000-MD Evaluation Kit for Medical application

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### **05. CONCLUSION**

HDBaseT provides an elegant solution to several requirements in the medical sector and it has the ability to converge multiple peripheral interfaces into one interface and achieve long-distance bit exact, zero latency transmission of high bandwidth signals through a single network cable, saving cabling space in the operating room and outside, while ensuring compatibility between different devices.

The Valens VS3000 chip represents an ideal device to optimize connectivity for audio/video transmission. To ensure the connections high level of performance according to the HDBaseT specification it is recommended to follow the chip manufactures reference design that uses high quality electronic and electromechanical companion components that support the Valens chipset on the board.

For this purpose, the HDBaseT signal transformer is designed from Würth Elektronik to meet medical grade voltage withstand requirements, ensuring high quality signal transmission in terms of EMC performance, as well as the filter components that provide the finest solution to meet the requirements of the medical applications.



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