IMAGO TECHNOLOGIES

Hardware Manual

VisionBox DAYTONA

Version 1.0 – May 2019

Contents

1 Handling and Safety Instructions

Depending on the operating conditions, the housing temperature can exceed 60 °C. There is a risk of injury!

Handle with care! The housing, especially heat sinks, can have sharp edges. There is a risk of injury!

EMC conformity according to EN/IEC 61000-6-2:2005 is qualified for cable lengths ≤ 30 m.
Electrostatic discharge at unshielded I/O connectors can lead to unexpected events or data errors for the corresponding interface.

Electrical installation should be executed without power applied to the device and connected devices.

Before opening the housing, make sure that the VisionBox is disconnected from power.
Use appropriate ESD protection when changing components.

Please take special note of **the voltage range** which may be applied to the device. Otherwise, permanent damage to the device may result!

Air Circulation
When mounting the device within an enclosure, adequate space for air circulation is required. The space above, below and at both sides should be at least 5 cm.

Avoid extreme environmental conditions and protect the VisionBox from dust, humidity and heat.

Due to the characteristics and physical principles inside flash memory, **SSDs have a finite lifetime** dictated by the number of write operations.
Therefore, take care of the regular write operations to prevent an early SSD damage. Ask for the technical data of the used SSD and, if necessary, for support to calculate the lifetime.
Inform the user of the system that SSDs are wear parts which must be renewed regularly.

2 Introduction

Thank you very much for your interest in our VisionBox DAYTONA. To get the most out of your purchase, please take some time to read all the information given here thoroughly.

The VisionBox provides three Gigabit Ethernet ports and two USB 3.0 ports. To avoid complex cabling, two Ethernet ports have support for PoE and the GigE Action Command. This allows transferring data, power and trigger signal using a single Ethernet cable.

The integrated Real-Time Communication Controller (RTCC) ensures proper timing for trigger signals, even without any real-time operating system. The IMAGO SDK provides a consistent C++ programming interface for controlling the RTCC.

Due to its small size, powered by $24V_{DC}$ and without fan, the VisionBox can be mounted into nearly every machine. All components are available for several years, for continuous delivery without changes. For series production, IMAGO delivers the VisionBox ready-to-run, including a customer-specific root filesystem, qualified 3rd-party components and acceptance test.

2.1 Concept

A Real-Time Communication Controller with vision- & automation-specific interfaces combined with an embedded ARM processor and integrated GPU, this is the philosophy of the VisionBox DAYTONA:

- NVIDIA Tegra TX2 SoC
  - Quad-core ARM Cortex-A57 @ 2 GHz
  - Dual-core Denver 2 @ 2 GHz
  - GPU: NVIDIA Pascal™ architecture with 256 CUDA cores
  - 8 GB DDR4 RAM
  - 32 GB eMMC
- Real-Time Communication Controller – RTCC
  - Controls vision- & automation-specific interfaces:
    - Digital I/Os
    - Encoder
    - Camera Trigger
  - Contains functional units for controlling I/Os in real time:
    - Trigger unit: creation of trigger signals, derived from other inputs (e.g. encoder)
    - I/O Scheduler: applies values stored in a FIFO to outputs in real time (based on trigger event, encoder position or timer value)
    - Multiplexer: Flexible connection of functional units
  - Operates independently from the OS & the processor
  - Easy-to-use high-level API for C++
- Camera Interfacing:
  - Power-over-Ethernet: two independent Ethernet ports with PoE support
  - Trigger-over-Ethernet: Real-time trigger from RTCC with a µs-jitter
- Digital I/Os:
  - Opto-isolated
  - Status LEDs
  - Inputs up to 5 MHz with debouncing in RTCC. Communicated to CPU via interrupt or polling
  - Outputs up to 50 kHz
- Housing
  - Passive cooling
  - 24 VDC power input
  - No moving parts
- Wireless communication
  - WIFI and Bluetooth integrated
  - LTE / 4G modem option

2.2 Configurations

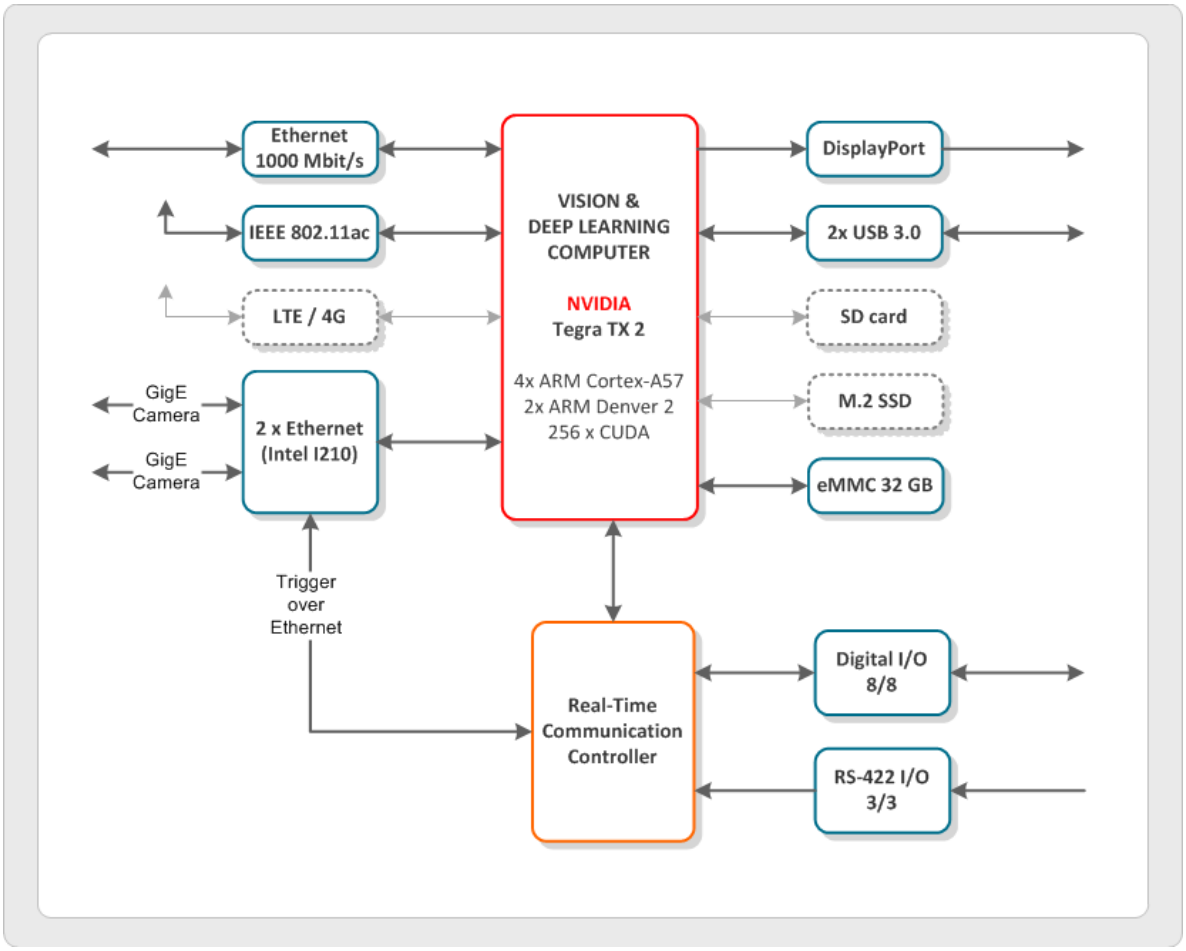
The following table shows available features and interfaces for the VisionBox DAYTONA:

	Jetson TX2
Main Storage	32 GB eMMC, SD card slot
Ethernet	3× 1000 Mbit/s
USB	2× USB 3.0 1x micro USB service port
Dig. I/Os	8× IN / 8× OUT
RS-422	3× IN, 3× OUT (option)
Display	1× DisplayPort
Wireless	Wi-Fi, Bluetooth
Additional Options	M.2 SATA SSD, M.2 LTE / 4G

Table 1: Feature overview

Please also ask for special OEM configurations.

2.3 Block Diagram



3 Technical Data

3.1 Operating Conditions

Power Supply:

Parameter	Min.	Typ.	Max.	Unit
Supply Voltage	20	24	28	V
Typical Power Consumption[1]	7		24	W
Continuous Supply Current Limit			3	A
Real-Time-Clock Backup Supply Duration (Ultracapacitor)		2		days

Environment:

Parameter	Value
Operating Temperature Range [°C]	+5 … +50
Operating Humidity [%, relative, non-condensing]	5 … 85
Storage Temperature [°C]	-10 … +70
Storage Humidity [%, relative, non-condensing]	5 … 95
Device Weight [g]	1300

Note: The maximum allowed temperature is influenced by the actual hardware configuration, the system workload and the mounting situation. The temperature range should be verified for each application.

Note: The heat sink can transfer more heat in upright mounting position.

Note: Due to the lifetime of electronic components (laws of physics say: if the average operating temperature is increased by 7°C, the lifespan of an electronic component will be cut in half), we recommend not to operate the device permanently under the maximum possible temperature and instead use a lower than max temperature. It is recommended that the application software regularly checks internal temperatures.

[1]The listed range applies to different CPU / GPU workloads while using DisplayPort and a single Gigabit Ethernet connection. The use of additional interfaces and supply of connected USB and PoE devices is not accounted for.

RS-422:

Parameter	Min.	Typ.	Max.	Unit
Receiver Input Hysteresis		45		mV
Receiver Input Offset			3.3	V
Receiver Data Rate			10	Mbps
Differential Driver Output, R_L = 100 Ω	2			V
Differential Driver Output, Open			3.3	V
Differential Driver Data Rate			2	Mbps

Digital Input:

Parameter	Min.	Typ.	Max.	Unit
Input Voltage		24	30	V
High Level Current Threshold		1	5	mA
Maximum Current Internal Limited	6		21	mA
Threshold Voltage	6		11	V
Signal Frequency			5	MHz

Digital Output:

Parameter	Min.	Typ.	Max.	Unit
Common VCC Supply Voltage			30	V
Output Current, Saturated Operation (V_{CE} < 1 V)	10		20	mA
Turn-On Time (24 V Common VCC, 10 mA)		5		µs
Turn-Off Time (24 V Common VCC, 10 mA)		15		µs

Ethernet with 2× PoE (IEEE 802.3af/at):

Parameter	Min.	Typ.	Max.	Unit
PoE Output Voltage		54		V
PoE Class Support	0		4	
Total PoE Supply Power for all Four Ports[2]			31	W

[2]For example, two class 3 devices or one class 4 device can be powered simultaneously.

3.2 Dimensions

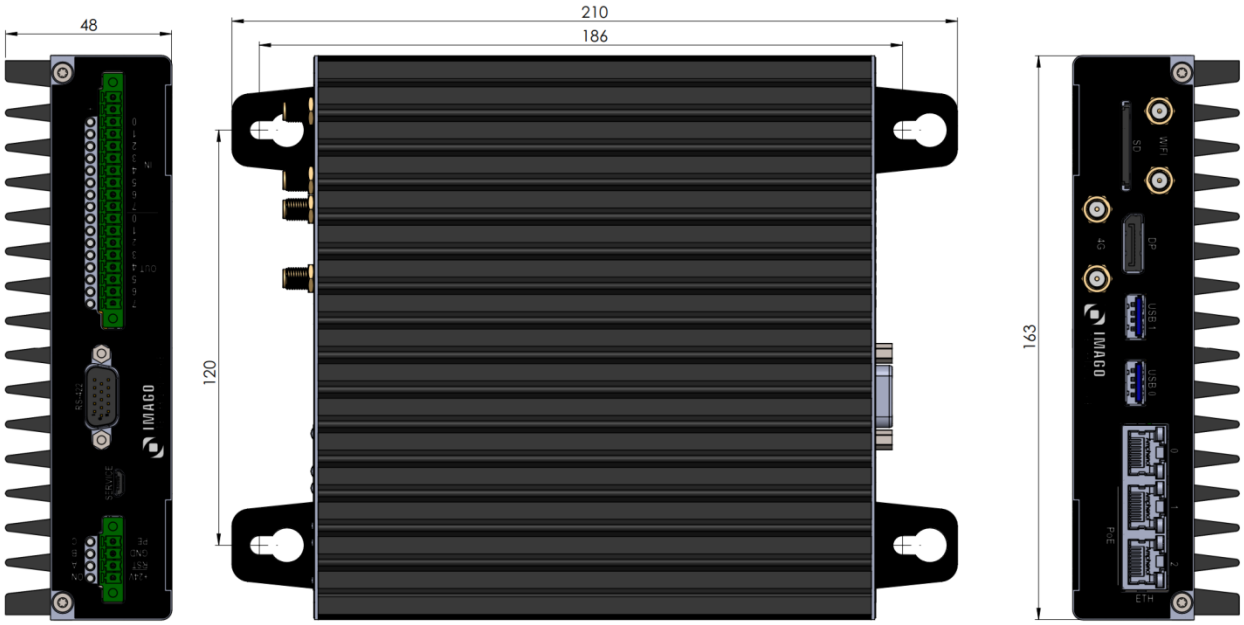


Figure 1: Housing dimensions (in mm)

4 Power Connector and LEDs

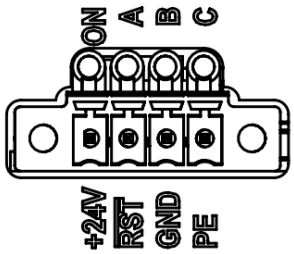


Figure 2: Power connector with system LEDs

4.1 Power Connector

Pin	Function
1	24 V power supply
2	Reset input
3	GND
4	Shield / housing connection

Table 2: Power connector

The $\overline{\text{RST}}$ terminal can be used to reset the VisionBox during operation. While the signal is pulled to GND, the VisionBox is held in reset state. Leaving the signal floating is the default mode for normal operation.

Mating external plug component: Phoenix Contact **MC 1,5/4-STF-3,5** (order no. 1847071)

4.2 System LEDs

The VisionBox has four main system LEDs. These LEDs are dual color (bicolor) types. The behavior of LEDs A, B and C can be controlled by software.

LED	Color	Function (green)
On	Green	Power on
	Green blinking	USB recovery mode
	Orange	System reset or power down
	Red	FPGA configuration error
A	Green	User LED 0
	Red	User LED 1
B	Green	User LED 2
	Red	User LED 3
C	Green	User LED 4
	Red	User LED 5

Table 3: LED values

5 Interfaces

5.1 Ethernet

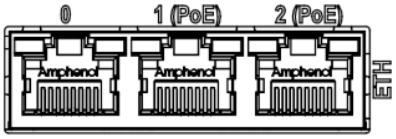


Figure 3: Ethernet connector

Left LED	State
Blinking	Traffic (only with 100 or 1000 Mbit/s link)
Off	No traffic

Right LED	Link Speed
Green	1000 Mbit/s
Orange	100 Mbit/s
Off	10 Mbit/s

5.1.1 Power-over-Ethernet

Ethernet ports 1 and 2 can provide power to PoE devices using the IEEE 802.3af/at standard.

5.1.2 Trigger-over-Ethernet

The ToE feature adds support for the GigE Vision Action Command on Ethernet ports 1 and 2. It can be used to trigger cameras over Ethernet in real time. The GigE specification allows sending these messages by a different device, distinct from the primary application, which normally runs on the main CPU. A sideband interface allows the Real-Time Communication Controller to introduce packets into the network:

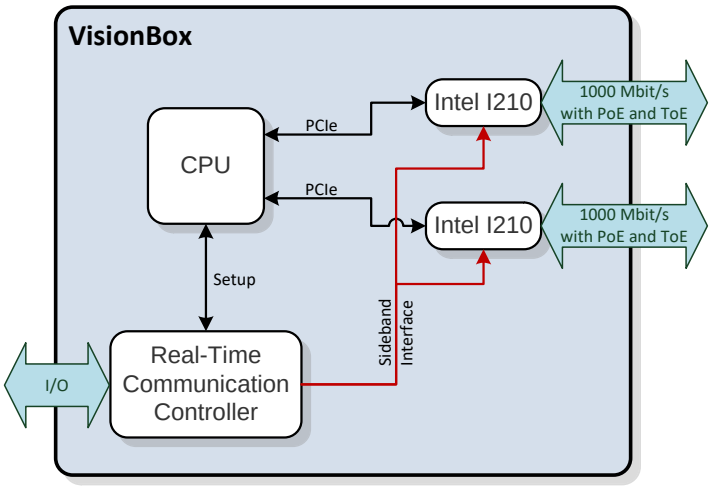


Figure 4: GigE real-time trigger diagram

Two different Action Commands can be defined by the application. Please note that Action Commands don’t belong to any port. All Action Commands are broadcast on all four ports.

5.2 USB 3.0

Figure 5: USB 3.0 port

The VisionBox provides two USB 3.0 type A ports. The supported maximum speed is 5 Gb/s. Based on the USB specification, each port can deliver 900 mA.

5.3 Micro USB Service Port

Figure 6: Micro USB service port

The micro USB service port only supports device mode operation. There are two use cases:

- If a PC is connected to the micro USB port during power on, the VisionBox enters USB recovery mode. This is indicated by a green blinking ON LED. Only use this mode if advised by IMAGO. Do not try to flash the Jetson OS image provided by NVIDIA!
- If a PC is connected after the VisionBox has already booted, the following USB device functions are supported by the Linux OS:
  - *Ethernet*: Provides SSH access, used by NVIDIA SDK manager for installation of SDK components.
  - *UART/Serial interface*
  - *USB Mass Storage device*

Important note:
The micro USB signals are shared with the first USB 3.0 port. The USB signals are internally switched to the micro USB port if a host is connected and providing the 5V USB supply voltage. Therefore, any devices connected to the USB 3.0 port 0 should be removed before plugging or unplugging the micro USB host cable during runtime. Otherwise, the integrated USB host controller may fail to operate.

5.4 DisplayPort

The DisplayPort 1.2a interface supports a link speed of up to 5.4 Gbps with 1, 2 or 4 lanes. The maximum supported resolution is 3840 × 2160 at 60 Hz. To connect the DP Port with a DVI, HDMI or VGA monitor, an active adapter is needed.

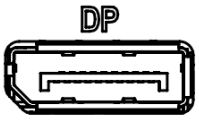


Figure 7: DP connector

5.5 SD Card

The SD card socket supports SDHC and SDXC memory cards with a maximum interface speed of 104 MB/s (UHS-I).

Figure 8: SD card socket

5.6 Wi-Fi and Bluetooth

Two SMA connectors are shared between Wi-Fi and Bluetooth. Two antennas are used for IEEE802.11n/ac Wi-Fi modes. The connectors are of type female RP-SMA.

Figure 9: Wi-Fi SMA connectors

5.7 4G / LTE Modem

The VisionBox can optionally be equipped with a 4G / LTE modem. One or two female SMA connectors are then available.

Figure 10: 4G / LTE connectors

5.8 Digital I/O

The digital I/O interface provides an input and an output group, each containing eight signals. The input group is electrically isolated from the output group. Both groups are also isolated from other VisionBox circuits and interfaces.
The following illustration shows the corresponding electrical equivalent circuit:

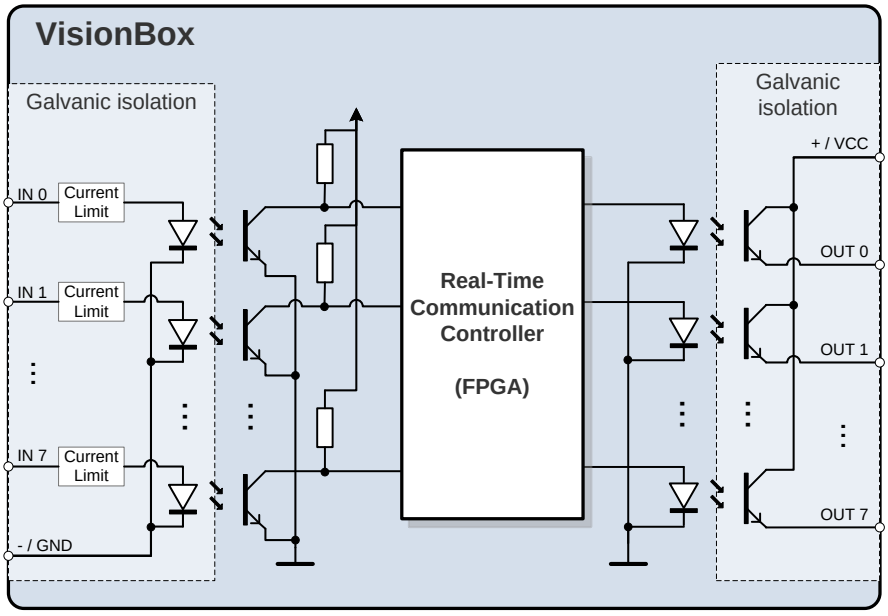


Figure 11: Simplified digital I/O circuit

The input group requires an external connection of a shared GND reference. For the output group, the user must provide a supply voltage to the VCC pin which is used by all output signals. Every input and output have an LED to show the current state of the channel.
The connector arrangement is shown below:

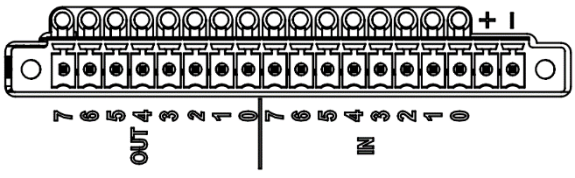


Figure 12: Digital I/O connector

Pin	Function	Pin	Function
1	OUT 7	9	IN 7
2	OUT 6	10	IN 6
3	OUT 5	11	IN 5
4	OUT 4	12	IN 4
5	OUT 3	13	IN 3
6	OUT 2	14	IN 2
7	OUT 1	15	IN 1
8	OUT 0	16	IN 0
17	+ / Common VCC of outputs	18	- / Common GND of inputs

Table 4: Pin assignment dig. I/O

Mating external plug component: Phoenix Contact **MC 1,5/18-STF-3,5** (order no. 1847288)

Example 1: Connecting a camera to a digital output

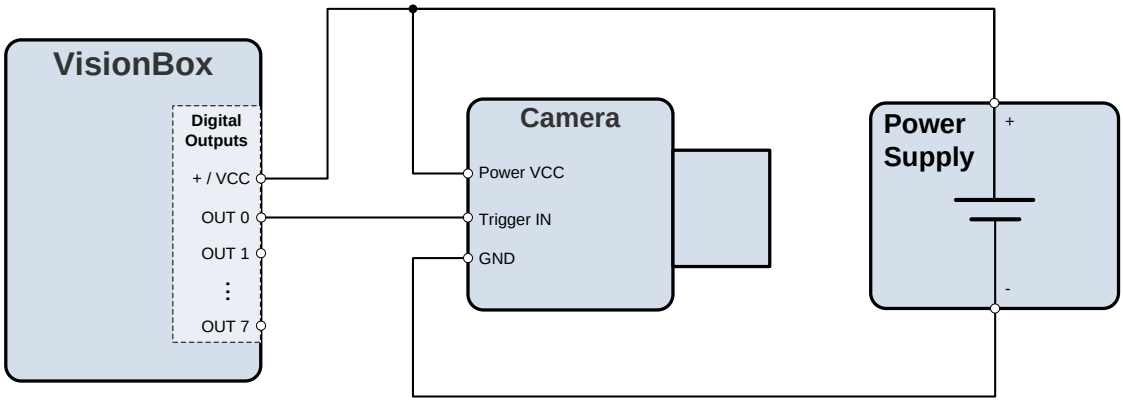


Figure 13: Digital output example 1

Depending on the voltage and isolation requirements of the application, the VisionBox can be powered from the same or from a different power supply.

Example 2: Connecting an external transistor for higher current capability

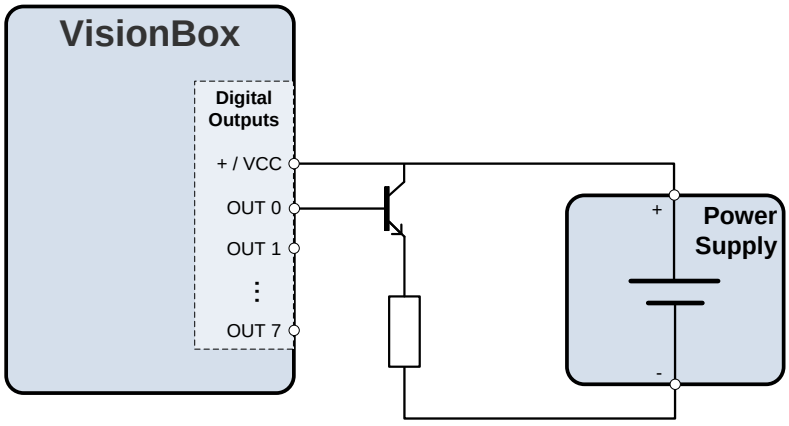


Figure 14: Digital output example 2

5.9 RS-422

The RS-422 connector can be used to trigger cameras by using external sensors or incremental encoders. Logical trigger conditions can be implemented within the FPGA.

Figure 15: D-Sub 15-HD connector

For example, the AMPHENOL connector **L77HDE15SOL2** can be used to make a connection to the VisionBox.
Pins #5 and #15 provide a 5 V / 12 V power supply for RS-422 encoders.

Three RS-422 input signals and three RS-422 output signals are available:

Pin	Function
1	In1-
2	In2-
3	Out2-
4	Out1-
5	+5 V
6	GND
7	In1+
8	In2+

Pin	Function
9	Out2+
10	Out1+
11	In0+
12	In0-
13	Out0+
14	Out0-
15	+12 V

Table 5: RS-422 pin assignment

A “Fail-Safe” circuit is used for the input signals to put unconnected terminals into a defined state (logic high).

6 Internal Connectors

The removable cover allows access to the following internal components:

- M.2 socket for SATA SSD
- M.2 socket for LTE / 4G modem
- Nano SIM socket

Before removing the housing cover, the VisionBox must be completely disconnected and the environment must be protected against ESD.

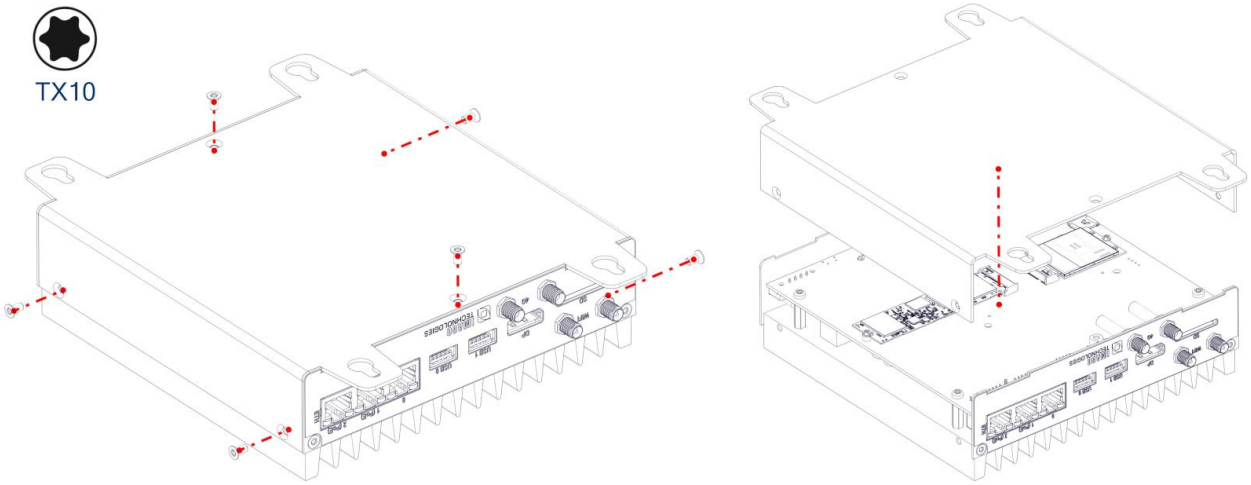


Figure 16: Removing the housing cover

6.1 M.2 SSD

The M.2 connector with type M keying notches can be used for adding an SSD to the VisionBox. It supports 80 mm modules and 3 Gbit/s SATA signaling. PCI Express signaling is not supported.

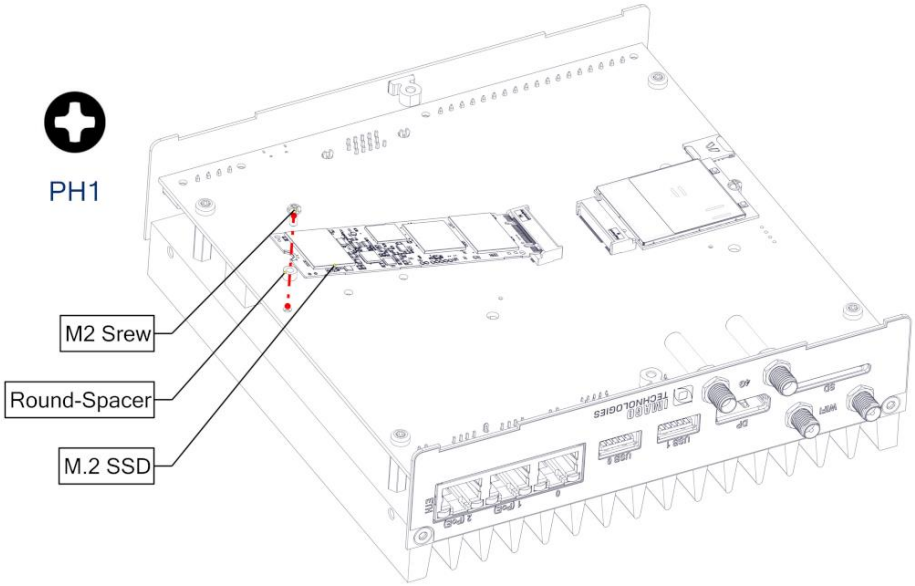


Figure 17: M.2 SSD

6.2 M.2 LTE Modem

The M.2 connector with type B keying notches allows the use of 4G / LTE modems with a USB 2.0 interface. A module length of 42 mm is supported.

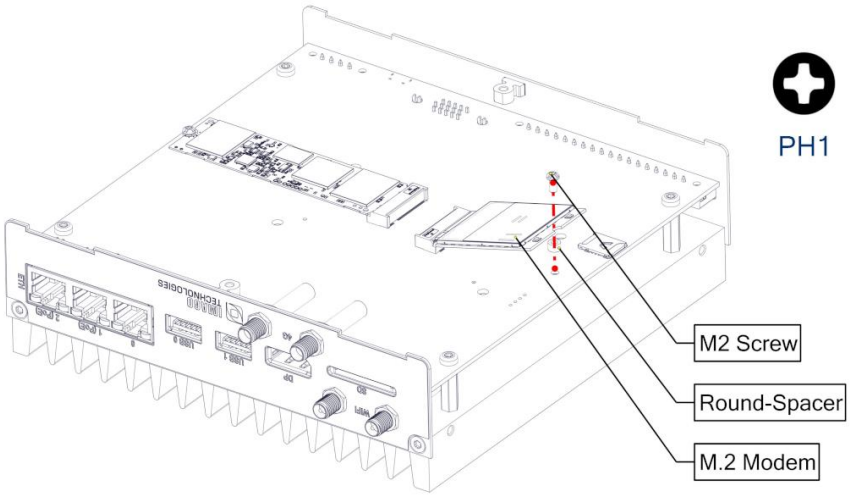


Figure 18: M.2 LTE modem

6.3 Nano SIM

The Nano SIM socket is connected to the M.2 connector for direct use by the LTE modem.

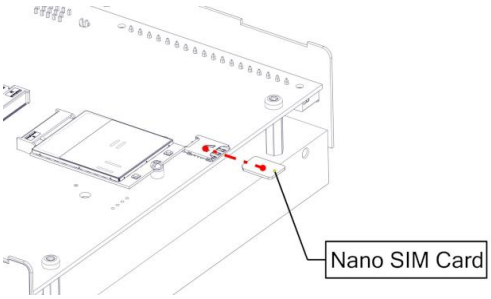


Figure 19: Nano SIM card

7 Support

Finally, if you have any open questions, the IMAGO support team is happy to assist you in any way. For direct contact to the support, please use our ticket system: https://imago.freshdesk.com

Visit the IMAGO Download Portal to get the latest SDK, documentation and firmware: https://www.imago-technologies.com/support

8 History

Revision	Date	Changes	Initials
1.0	May-2019	First version	rg, dm, vm