IMAGO TECHNOLOGIES

Hardware Manual

Vision Box AGE-X^6

Version 1.0 – 2025

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 the heat sinks, may have sharp edges and pose 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 installing expansion cards, make sure that the Vision Box AGE-X is disconnected from power.
Use appropriate ESD protection when changing components.

Only open if advised by IMAGO!
Warranty void if warranty seal is removed or broken.

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 Vision Box 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 Vision Box AGE-X6. To get the most out of your purchase, please take some time to read all the information given here thoroughly.

This Vision Box AGE-X6 is optimized for cameras using the GigE Vision interface. For multi-camera systems, not only several camera ports but also several integrated LED Controllers and digital I/Os allow a compact setup without additional electronics. If you need more connectivity or a specific PCIe board, kindly consult the other Vision Box alternatives.

The integrated Real-Time Communication Controller ensures proper timing between all devices, even when using Windows or Linux operating systems. To avoid complex cabling, the cameras can be connected through standard Ethernet cables. A single cable provides trigger, image data and power for each GigE camera.

Thanks to its small size, powered by $24V_{DC}$ and without a fan, the AGE-X 6 can be mounted into nearly every machine. For applications requiring additional cooling, the system can optionally be equipped with a Fan Assembly.

All components are available for several years to provide continuous delivery without changes. The AGE-X-SDK can be used in C++ and .NET as well as with some third-party machine vision libraries to enable easy integration with your products and projects.

For series production, IMAGO delivers the AGE-X ready-to-run, including customer-specific SSD image, qualified 3rd-party components and acceptance tests.

2.1 Concept

The philosophy of the Vision Box AGE-X6 series is about a real-time communication controller with vision- & automation-specific interfaces combined with an embedded Intel processor:

- **14th generation Intel x86 processor**
- **Real-Time Communication Controller *RTCC***:
  - Controls vision- & automation-specific interfaces:
    - Digital I/Os
    - Encoder
    - Camera trigger
    - LED Strobe Controller
  - 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 x86 processor
  - Easy-to-use high-level API for C++, .NET and support by 3rd-party software tools
- **Operating System**:
  - Windows 11 IoT Enterprise
  - Debian GNU/Linux, optionally with *PREEMPT_RT* patch
- **Housing**:
  - Passive cooling
  - All interfaces on front panel
  - 24 VDC power input
  - No moving parts
  - Service hatch for access to USB for dongle and M.2 SSD slots.
- **Vision & automation interfaces:**
  - **Ethernet**: Available with PoE and ToE.
  - **Digital I/O**: Galvanically isolated, with status LEDs, high-frequency input support and adjustable debouncing, communication to x86 via interrupt or polling
  - **Camera Trigger**: Integrated trigger interfaces
  - **LED Controller:** Strobe and continuous current modes
  - **Encoder:** RS-422 inputs / outputs
- **Extensions**:
  - Fan Assembly for applications requiring active cooling

2.2 Configurations

The following table shows available features and interfaces for the different models of the Vision Box AGE-X6:

Model	4 × 2.5GigE	4 x 1GigE
RAM	up to 96 GB	up to 96 GB
Storage / Expansion	M.2 2230 M-key M.2 3042/2280 M-key	M.2 2230 M-key M.2 3042/2280 M-key
USB	2× USB 3.2 2 x USB 2.0 internal 2x USB 4 Type C (with Alternate DP-Mode)	2× USB 3.2 2 x USB 2.0 internal 2x USB 4 Type C (with Alternate DP-Mode)
Display	DP++ (max. resolution 4096x2304 @ 60Hz)	DP++ (max. resolution 4096x2304 @ 60Hz)
Ethernet Mainboard	2× 2.5 Gbit	2× 2.5 Gbit
Camera Interface	4x 2.5GigE	4x 1GigE
Additional Options	-	4× PoE / ToE
Dig. I/Os	8× IN / 8× OUT optionally 16× IN / 16× OUT	8× IN / 8× OUT optionally 16× IN / 16× OUT
LED Controller	2×, optionally 4×	2×, optionally 4×
Camera Trigger	2×, optionally 4×	2×, optionally 4×
Encoder / RS-422	Optionally 4× IN	Optionally 4× IN

Table 1: Feature overview

Please also ask for special OEM configurations.

2.3 Block Diagrams

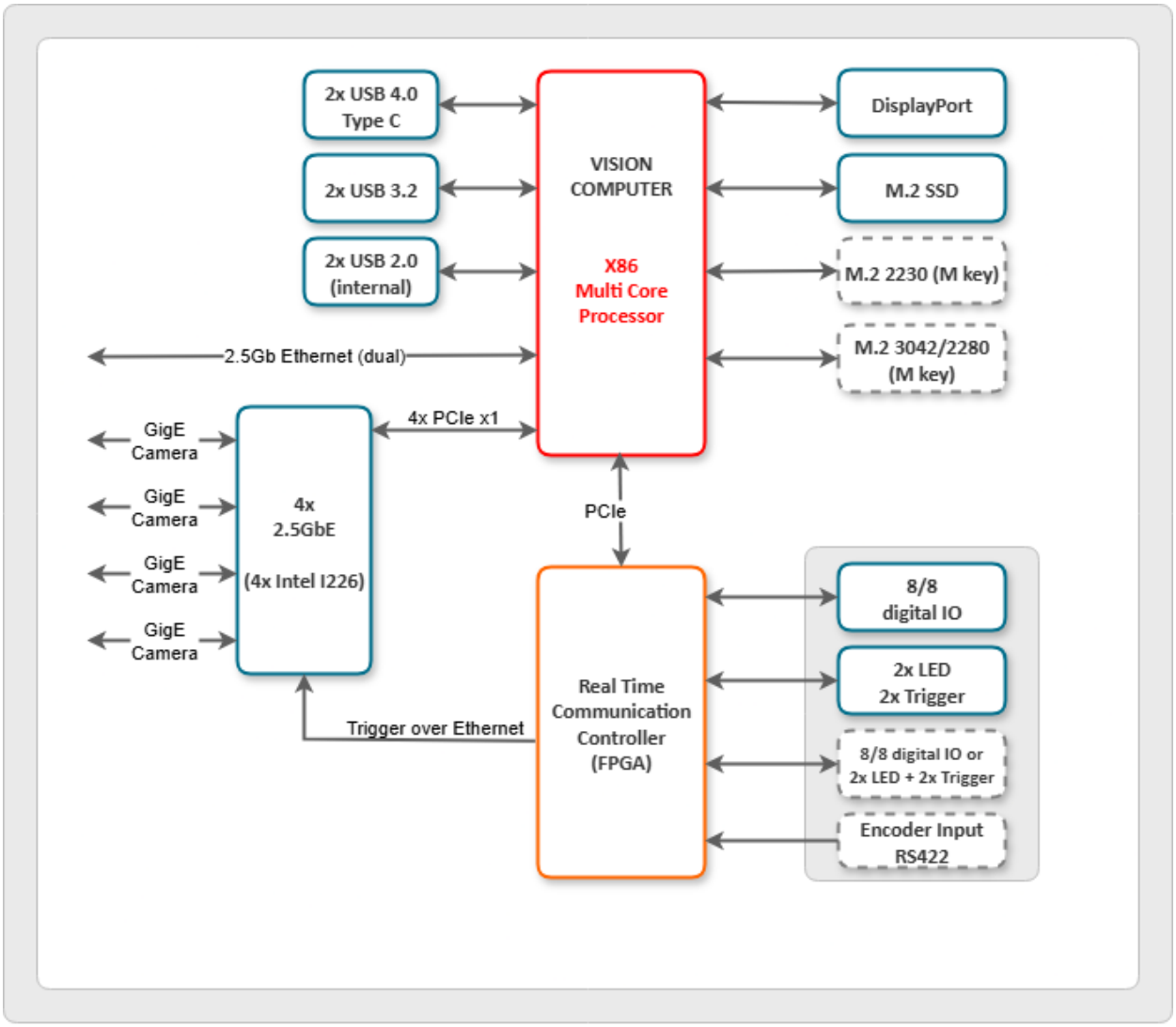

Figure 1: Block diagram Vision Box AGE-X6 4x 2.5GigE

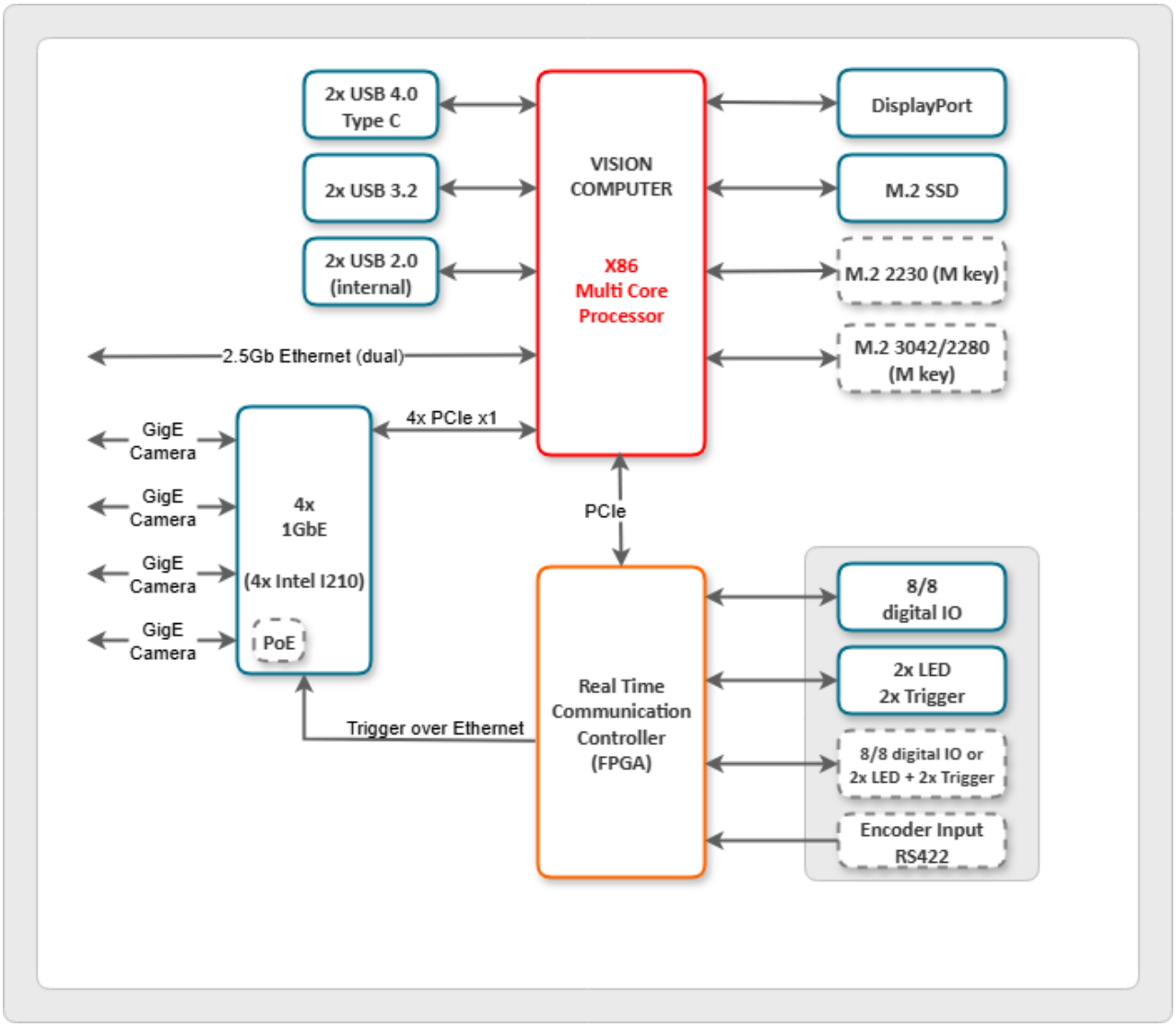

Figure 2: Block diagram Vision Box AGE-X6 4x 1GigE

3 Technical Data

3.1 Processors

The following processors of 14th generation are currently supported:

	i5-14500		i5-14500T		i5-14501TE	
	Efficient core	**Performance core**	**Efficient core**	**Performance core**	**Efficient core**	**Performance core**
Nominal Frequency	1.9 GHz	2.6 GHz	1.2 GHz	1.7 GHz	-	2.2 GHz
Turbo Frequency	3.7 GHz	5.0 GHz	3.4 GHz	4.8 GHz	-	5.1 GHz
Max. Turbo Frequency	5.0 GHz		4.8 GHz		5.1 GHz	
Cores	8	6	8	6	-	6
Threads	20		20		12	
TDP / Max. power in turbo	65 W / 154 W		35 W / 92 W		35 W / -	

Table 2: Processor overview 14th generation (1)

	i7-14700		i7-14700T		i7-14701TE	
	Efficient core	**Performance core**	**Efficient core**	**Performance core**	**Efficient core**	**Performance core**
Nominal Frequency	1.5 GHz	2.1 GHz	0.9 GHz	1.3 GHz	-	2.1 GHz
Turbo Frequency	4.2 GHz	5.3 GHz	3.7 GHz	5.0 GHz	-	5.2 GHz
Max. Turbo Frequency	5.4 GHz		5.2 GHz		5.2 GHz	
Cores	12	8	12	8	-	8
Threads	28		28		16	
TDP / Max. power in turbo	65 W / 219 W		35 W / 106 W		45 W / -	

Table 3: Processor overview 14th generation (2)

i9-14901TE						
	Efficient core	**Performance core**				
Nominal Frequency	-	2.3 GHz				
Turbo Frequency	-	5.5 GHz				
Max. Turbo Frequency	5.5 GHz					
Cores	-	8				
Threads	16					
TDP / Max. power in turbo	45 W / -					

Table 4: Processor overview 14th generation (3)

3.2 Operating Conditions

Power supply:

Parameter | CPU	i5-14500T	i7-14700T	i7-14700	Unit
Power supply	24	24	24	V
Power Supply Current with Turbo (Peak) Max. CPU and internal GPU Workload[1]	8.35	12.6	16.21	A
Power Supply Current without Turbo (Peak) Max. CPU and internal GPU Workload[2]	3.7	4.7	6.1	A
Power Consumption with Turbo	205	302	389	W
Power Consumption without Turbo	89	112	145	W
Continuous Supply Current Limit[3]	8			A

Environment:

Parameter	Value	Unit
Operating Temperature for Intel CPU 14th generation	+5 … +45	°C
Operating Humidity, relative, non-condensing	5 … 85	%
Storage Temperature	-10 … +70	°C
Storage Humidity, relative, non-condensing	5 … 95	%
Device Weight	≈2.66	kg

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.

[1] Measured with CPU at TDP workload and without external devices except 1× Ethernet and DP.
[2] Measured with CPU at TDP workload and without external devices except 1× Ethernet and DP.
[3] Certain possible usage combinations like simultaneous PoE / USB device supply and active LED output can lead to continuous excess of this value, which must be avoided by the user.

Note: Due to the lifetime of electronic components, we recommend not operating the device permanently under the maximum possible temperature and instead use a lower than max temperature. Laws of physics say: if the average operating temperature is increased by 7°C, the lifespan of an electronic component will be divided in half! Following are common scenarios in industrial applications:

- Multiple devices are mounted inside an electrical cabinet
  ➔ The cabinet itself is equipped with an air conditioner.
- In a large electrical cabinet, a single device is mounted with other (low heat-producing) devices
  ➔ It is enough when a fan provides air circulation inside the cabinet.
- It is recommended that the application software regularly checks internal temperatures.

Digital Input:

Parameter		Min.	Typ.	Max.	Unit
Input voltage range		0		30	V
Input current range (limited by internal circuit)		0		21	mA
Threshold Voltage	Standard	6		11	V
	TLL-compatible (option)[4]	1.8		2.4	
Threshold current			1	5	mA
Input delay				250	ns

Digital Output:

Parameter	Min.	Typ.	Max.	Unit
Common VCC Supply Voltage (V_{CC} - V_{OUT})	0		30	V
Output Current, Saturated Operation (V_{CC} - V_{OUT}) < 1 V			10	mA
Turn-On Time (24 V Common VCC, 10 mA)		5		µs
Turn-Off Time (24 V Common VCC, 10 mA)		15		µs

[4] TTL-compatible option is only available for the second I/O module

RS-422[5] (Encoder):

Parameter	Min.	Typ.	Max.	Unit
Receiver Input Hysteresis		45		mV
Receiver Input Offset			3.3	V
Receiver Data Rate			10	Mbps

LED Controller:

Parameter[6]	Min.	Typ.	Max.	Unit
Strobe Current Range	0.05		6	A
Strobe Current Step Size		30		mA
Maximum Continuous Current (V_{Supply}=28 V, V_{Load}=24 V)		0.5		A
Minimum Flash Duration 2 A		10		µs
Flash Duration Step Size		1		µs
Turn-on delay (6 A)		3		µs
Turn-on delay (100 mA)		80		µs
Turn-off Delay (6 A)		2		µs
Turn-off Delay (100 mA)		50		µs

Camera Trigger:

Parameter	Min.	Typ.	Max.	Unit
ACQ TRG High Voltage		24		V
ACQ TRG Low Voltage		0.5		V
ACQ TRG High Side Current		20		mA
ACQ TRG Maximum Low Side Sink Current		100		mA

Ethernet with 4× PoE Option (IEEE 802.3af/at):

Parameter	Min.	Typ.	Max.	Unit
PoE Output Voltage		53		V
PoE Class Support	0		4	
Total PoE Supply Power for all Four Ports[7]			55	W

[5] A “Fail-Safe” circuit is used for the input signals to put unconnected terminals into a defined state.
[6] The maximum current and strobe timing limits are calculated by the software, depending on the used parameters.
[7] For example, two class 4 devices or four class 3 devices can be powered simultaneously.

3.3 Dimensions

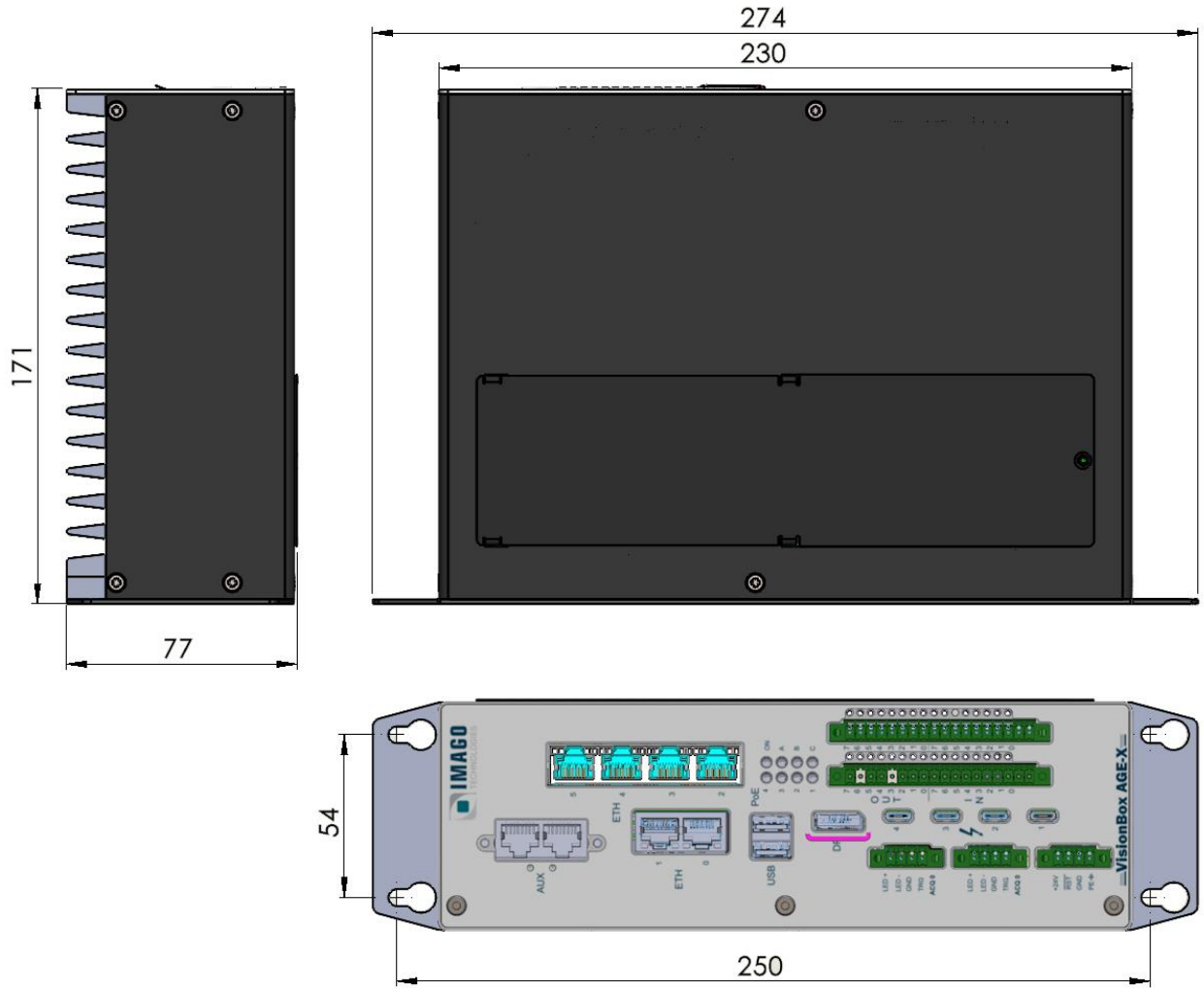

Figure 3: Housing dimensions (in mm)

4 Power Connector and LEDs

4.1 Power Connector

Figure 4: Power plug

Pin	Function
+24V	24 V power supply
RST	Reset input, low active
GND	Ground
PE	Shield / housing connection

Table 5: Power connector

The $\overline{\text{RST}}$ terminal can be pulled to GND to reset the Vision Box during operation. A falling edge will trigger the reset. Leaving the signal floating is the default mode for normal operation.

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

4.2 System LEDs

The computer has four main system LEDs. These LEDs are dual color (bicolor) types. The functionality of the LED A, B and C can be changed by software.

Figure 5: Status LEDs

LED	Color	Function (green)
On	Green	Power On
	Red	FPGA configuration error
	Orange blinking	Backup firmware is loaded
	Orange	System shutdown or reset
A	Green	User LED 0
	Red	User LED 1
B	Green	User LED 2
	Red	User LED 3
C	Green	User LED 4 (default: SATA/CFAST activity)
	Red	User LED 5

Table 6: System LED values

5 Interfaces

This chapter describes the interfaces for the Vision Box AGE-X6.

5.1 Ethernet Interface (dual)

The dual Ethernet interface is present for all hardware configurations.

- 14th generation CPU: 2.5GbE (2.5GBASE-T)

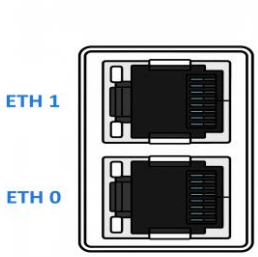

Figure 6: Ethernet connector (dual)

Assignment of the status LEDs:

Link state	Upper LED
Link down	Off
Link up, no traffic	On
Link up, traffic	Blinking

Table 7: Upper LED

Link speed	Lower LED
10 Mbit/s	Off
100 Mbit/s	Off
1000 Mbit/s	Green
2500 Mbit/s	Red

Table 8: Lower LED

5.2 Ethernet Interface (Quad)

The Vision Box AGE-X5 with Quad GigE is available in the following configurations:

- 4× 2.5GigE (2.5GBASE-T)
- 4x 1GigE (1000BASE-T)

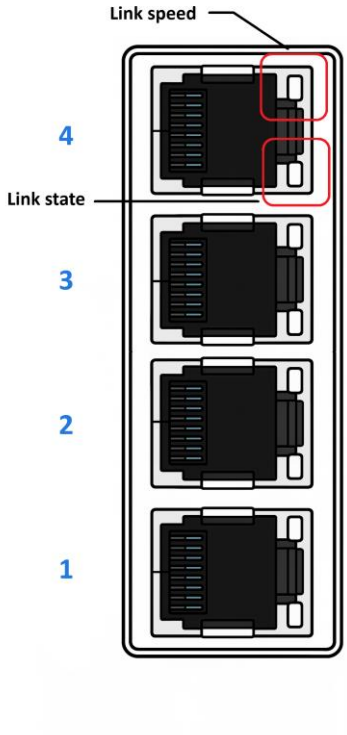

Figure 7: Ethernet connector

Link Speed	Port configuration	
	4x 2.5GigE	*4x 1GigE*
10 Mbit/s	Off	Off
100 Mbit/s	Off	Off
1000 Mbit/s	On	On
2500 Mbit/s	On	
5000 Mbit/s	-	

Table 9: Upper LEDs

Link Speed	Port configuration	
	4x 2.5GigE	*4x 1GigE*
Link down	Off	Off
Link up, no traffic	On	Off
Link up, traffic	Blinking	Blinking

Table 10: Lower LEDs

5.2.1 Power-over-Ethernet

The optional PoE feature for the Vision Box AGE-X6 with 4× 1GigE provides power to PoE enabled devices.

Four additional status LEDs signaling the power state are associated with the four ports:

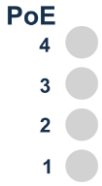

Figure 8: Ethernet PoE LEDs

LED State	Description
Green blinking	Searching for PoE device
Green on	PoE device found and powered
Red blinking all LEDs	Error code
Red flash single LED	See ToE section below

Table 11: PoE LED state

5.2.2 Trigger-over-Ethernet

The optional Trigger-over-Ethernet (ToE) feature for 4× 1GigE adds support for the GigE Vision Action Command. 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:

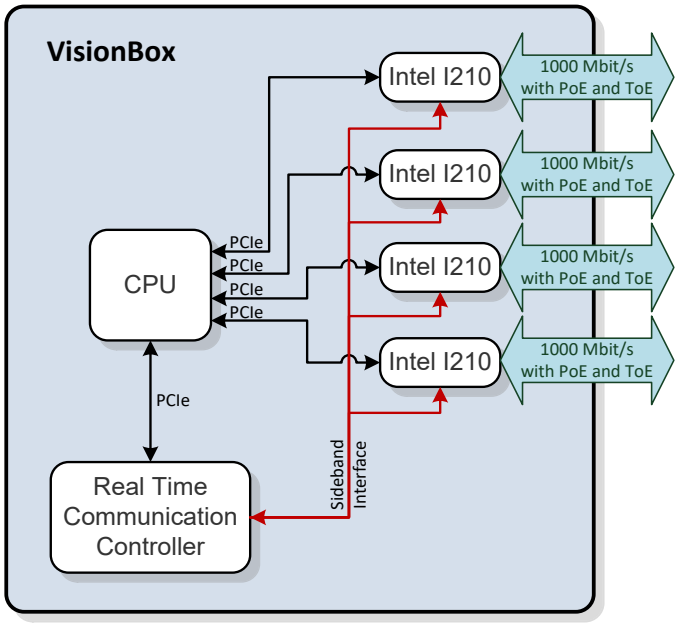

Figure 9: GigE real-time trigger diagram

Up to four different Action Commands can be defined by the application.

The PoE state LEDs described previously are also used for Action Commands: each LED is associated with one of these Action Commands. When an Action Command packet is transmitted, the respective LED will flash red very shortly. The PoE state will still be shown for each port by the green LED.

Please note that Action Commands don’t belong to any port. All Action Commands are broadcast on all four ports.

5.3 DisplayPort Monitor

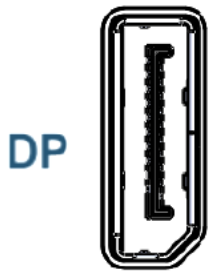

Figure 10: DP connector

The DisplayPort interface a maximum resolution of 4096 × 2304 pixels with framerate of 60/s.

5.4 USB 4

The Vision Box AGE-X6 provides high speed connectivity via USB-C ports compliant with USB4 and Thunderbolt 4 standards. Two USB4 ports are available in the base configuration, while a version with four USB4 ports is also available.

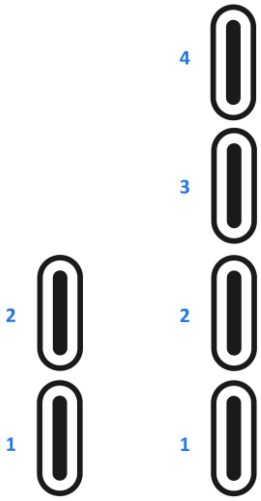

Figure 11: USB4 connector (dual and quad configuration)

Supported features:

- Up to 40 Gbit/s per port
- Thunderbolt 4 compatible
- DisplayPort Alternate Mode (port 1 and 2)
- USB Power Delivery for device charging
- Backward compatible with USB 3.2 and USB 2.0

5.5 Digital I/O

The digital I/O interface provides an input group and an output group. Each group has eight signals, and all groups are electrically isolated from each other, as well as from other Vision Box circuits and interfaces.

The following illustration shows the corresponding electrical equivalent circuit for one input and one output group:

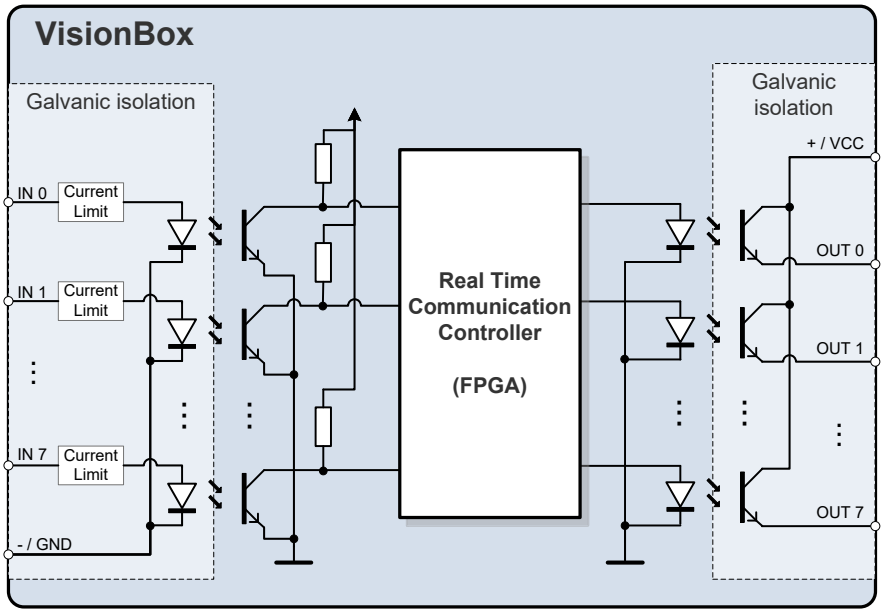

Figure 12: Simplified digital I/O circuit

The input group requires 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 each channel.

The connector arrangement is shown below:

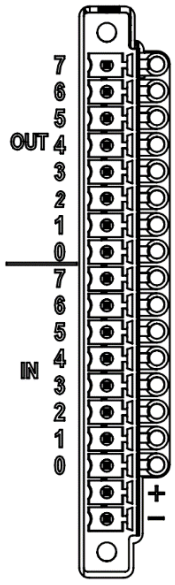

Figure 13: Digital I/O connectors

Pin	Function
+	Common VCC of outputs
-	Common GND of inputs
IN 0…7	Input 0…7
OUT 0…7	Output 0…7

Table 12: Pin assignment I/O connector

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

The standard version of the digital output interface allows high-speed signaling, but with limited current ability. The output current can be increased by connecting multiple output terminals with each other. Software must configure the Real-Time Communication Controller to use the same signal source for these outputs.

Example 1: Connecting multiple cameras to a single output with high-current option.

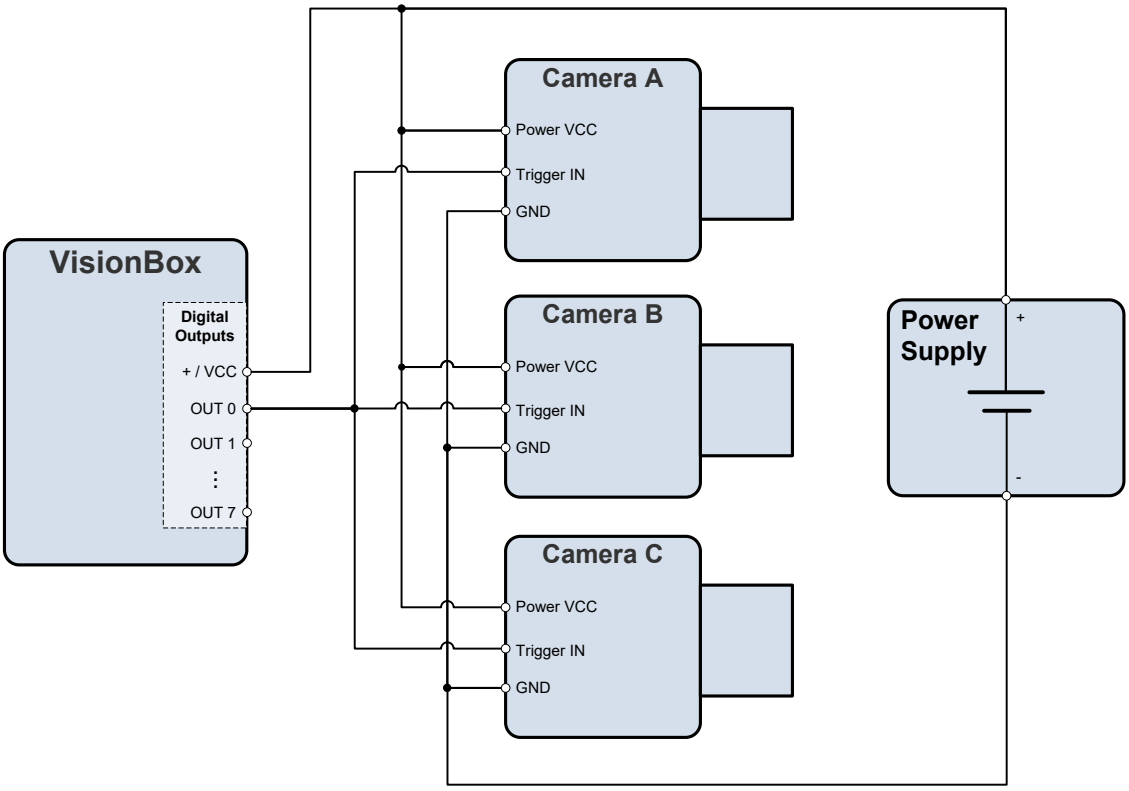

Figure 14: Digital I/O example 1

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

Example 2: Connecting a relay to an output with high-current option.

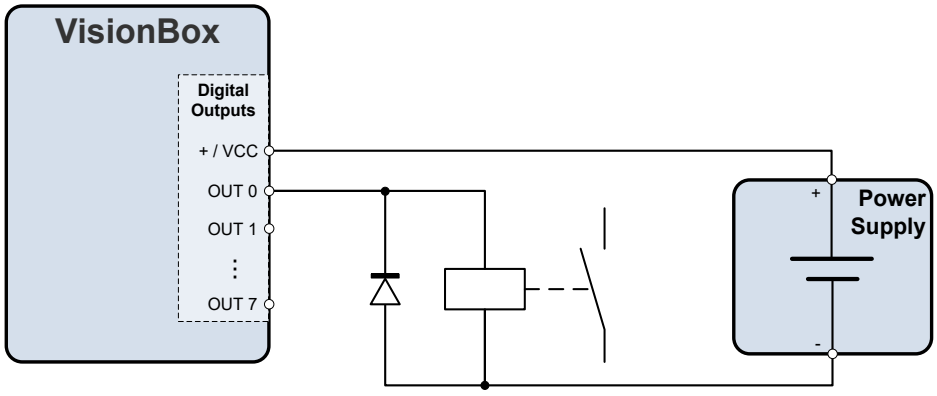

Figure 15: Digital I/O example 2

Please note that a flyback diode as shown in the drawing should be used to protect the output circuit from voltage spikes at deactivation.

5.6 RS-422 Interface

The RS-422 interface can be used to connect additional devices like encoders, sensors and cameras. The behavior is controlled by the Real-Time Communication Controller.

Figure 16: Encoder connector (D-Sub 15HD)

The optional RS-422 connector is available for all configurations, and it provides four input signals:

Pin	Function
1	In1-
2	In2-
3	In3-
4	N/C
5	+5 V
6	GND
7	In1+
8	In2+

Pin	Function
9	In3+
10	N/C
11	In0+
12	In0-
13	N/C
14	N/C
15	+12 V

Table 13: RS-422 pin assignment for GigE versions

The Camera Link version always provides an RS-422 connector with three input and three output signals:

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 14: RS-422 pin assignment for Camera Link version

Pins #5 and #15 provide a 5 V / 12 V power supply for RS-422 encoders. They are protected internally by a 2 A fuse.

Do not insert a plug while the device is powered. There is a risk of making a short circuit on the supply output pins with the connector shield.

5.7 LED Controller and Camera Trigger

The Vision Box provides two LED Controller channels and two Camera Trigger channels. Each connector shares one LED Controller and one Camera Trigger channel.

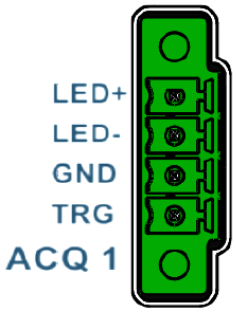

Figure 17: LED / Camera Trigger connector

Name	Function
LED+	Positive output / current source
LED-	Negative output / current sink
GND	Ground reference
TRG	Trigger output

Table 15: Pin assignment LED / Camera Trigger

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

5.7.1 LED Controller

The LED Flash Controller is designed as a current source. Output current, flash duration and other parameters can be set via software.

The following diagram shows the internal structure for the LED Controller:

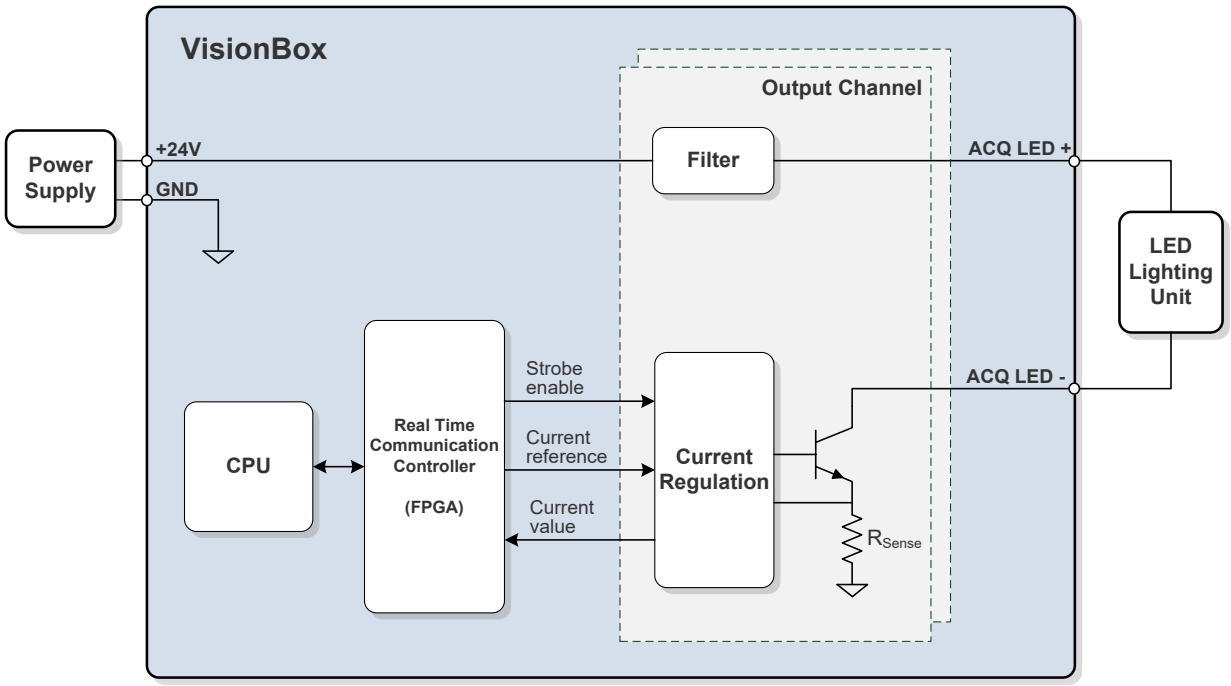

Figure 18: LED Controller structure

5.7.2 Camera Trigger

The electrical behavior of the camera trigger output can be controlled via software. Each output has two transistors, one for the positive and one for the negative side. Both transistors can be programmed independently. Therefore, the output can be configured in push-pull, open-collector or emitter-follower configuration:

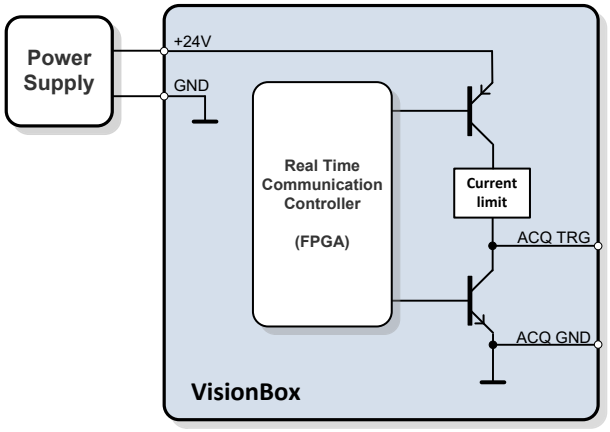

Figure 19: Simplified camera trigger diagram

The high-side switch is connected to the power supply voltage of the Vision Box and has a current-limiting circuit.

6 Internal Connectors

A service hatch enables access to the internal USB2 ports.

When opening the service hatch, make sure that the Vision Box has been completely disconnected (power, interfaces) and your environment is protected against ESD.

Figure 20: Service hatch (option)

6.1 USB 2.0

There are two USB 2.0 type A sockets inside the Vision Box. Please note that no current-limiting circuit is provided on these ports.

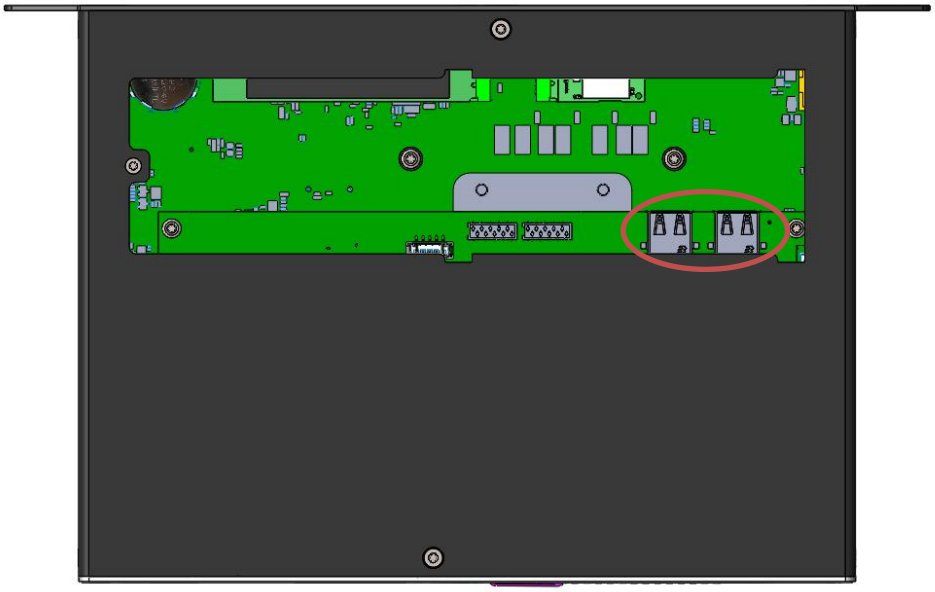

Figure 21: USB 2.0 connectors

6.2 M.2 Slot

Through the service hatch, two M.2 slots are accessible:

- M.2 2230 M-key
- M.2 3042/2280 M-key

These can be used for storage or expansion modules.

Figure 22: M.2 slots

6.3 CMOS Battery

The CMOS battery (type CR2032) is not accessible via the service hatch. If necessary, the battery can be replaced by carefully removing the housing cover, taking out the old battery and inserting a new one.

Figure 23 : Location of the battery holder

7 Accessories

This list shows some compatible connectors, shells and plugs to support the device interfaces. Typically, the plugs are not included in the device package.

7.1 Third-party Components

Vendor:	Type:	Part Number:	Usage:
Phoenix	MC 1,5 / 4-STF-3,5	1847071	Power connector / camera trigger & LED interface
Phoenix	MC 1,5 / 18-STF-3,5	1847288	Digital In / Out

There is also a connector set with plugs available. Please refer to the following table or ask for more details.

7.2 IMAGO Accessories

Order Number	Description
10100071	Connector set: 1x 4 Pin power connector, 2x 18 Pin I/O
10005154	Connector set: 1x 4 Pin power connector, 1x 18 Pin I/O
10100069	Connector set: 2x 4 Pin LED/Trigger
10101537	AGE-X6 Fan Assembly

More accessories and upgrades are available upon request.

8 History

Revision	Date	Changes	Initials
1.0	09.2025	First version	md