PHYTEC

Components and Solutions
for Your Individual Products.

Embedded Imaging

ENGLISH

phyCAM®

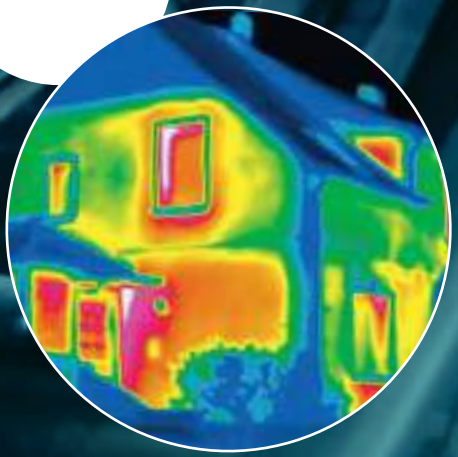
Smarter. Faster. Easier.

Content

Transport Security

Environmental Energy Technology

Quality Assurance Metrology



Laboratory Automation

Embedded Imaging

We integrate professional image processing into your device

Embedded Imaging is the key to the perfect integration of image processing into your serial device – efficient, cost-effective and optimized for production in quantities. Powerful microcontrollers with integrated camera interface make the implementation of camera sensors easy and cost-effective. At PHYTEC, digital image processing is embedded in a wide range of microcontroller modules and development services.

The special requirements of image processing tasks are taken into account by our own "Digital Imaging" product division. Here, experts develop ready-to-use, scalable concepts that can be directly incorporated into our customers' end products.

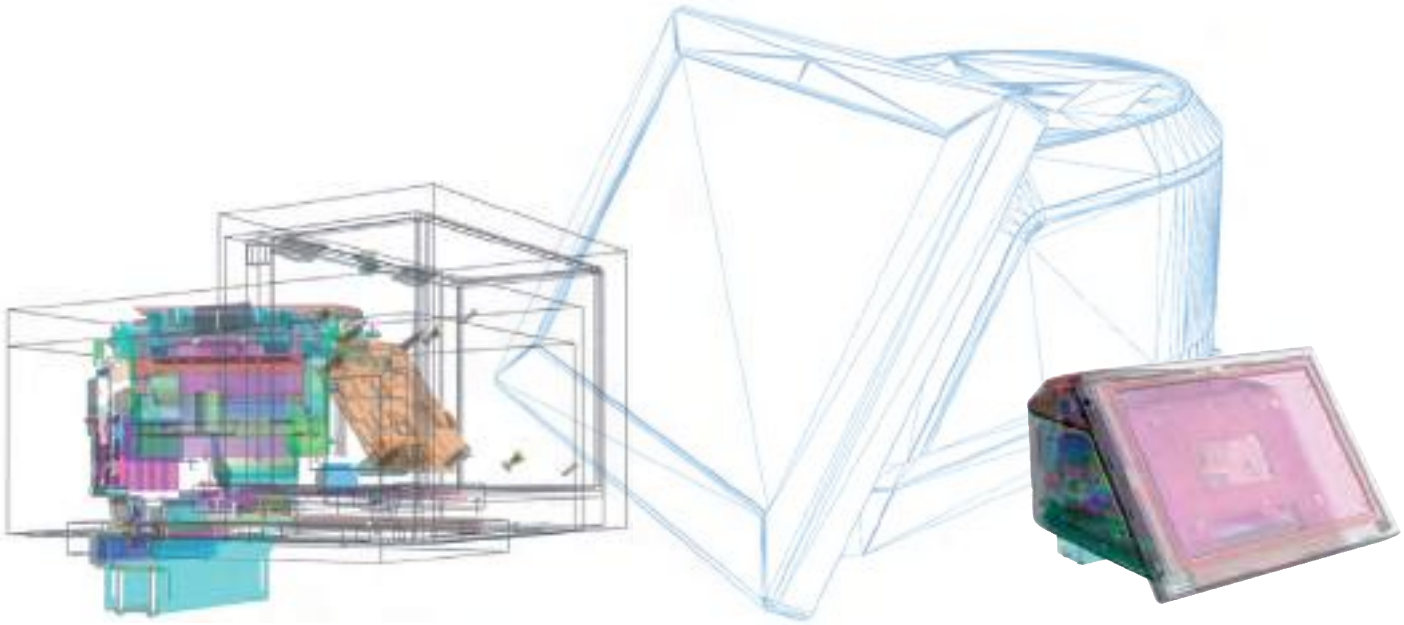
Efficient Solutions

The optimal integration of image processing into a series product always requires an individual approach. The planning covers the entire system to be developed. Optics and illumination, image resolution and computing power must be harmonized with other parameters such as other functions, device size, power consumption and last but not least, economic factors. The composition of the right components has a decisive influence on the expenditure required to implement the overall solution.

Our experts will advise you individually on your project and develop adapted or customized solutions for you.

"Our goal is to increase the benefits of image processing in serial products. Take advantage of the many investments we have made for you."

Martin Klahr
Head of Image Processing Division



The Embedded Imaging Concept

Advance performance optimally tailored to your application

Embedded Imaging – Optimized for Series Production
With our preliminary work, you can integrate cameras as easily as sensors. This "add-in" instead of "add-on" significantly increases the synergies within the application and, therefore, the cost efficiency of series products. Simplify solutions and add new functionality to your application.

Taking into account series costs and long-term availability, embedded systems offer convincing advantages.

PHYTEC System Solutions – a Perfect Fit to your Application
With PHYTEC's phyCAM concept, the requirements of a compact, tailor-made system solution can be easily met. The standardized phyCAM interfaces enable the assembly of scalable microcontroller modules with coordinated image processing components. The result is a complete system that is optimally adapted to the application.

Individualization – The Key to the Series
In addition to image acquisition, other functions (motor control, GPS, audio, CAN or I/O lines, etc.) are required. Furthermore, the hardware must be adapted to given mechanical dimensions. The application-specific base board covers these requirements perfectly. This individualization option is a very important part of our concept and distinguishes it from conventional, prefabricated components.

Interface to Software
In the phyCAM concept, software representation of the hardware is already prepared at operating system level. The required drivers for the camera sensor and controller's camera interface are integrated in our BSPs. Under Embedded Linux, the V4L2 interface is the preferred interface to the application software.

Develop Application Software Easily
The phyCAM interface makes image data available to the application software in a simple way. Further processing of the data can be implemented quickly and efficiently by using various ready-to-use image processing libraries.

Lifecycle Management
Our Lifecycle Strategies enable product maintenance and ensure the ability to deliver throughout the product life cycle. This includes obsolescence management as well as update- and security concepts.

NEXTSENSE

Customer Testimonial

Nextsense develops hand-held measuring devices for non-contact profile measurement. For example, railway accidents can be avoided by highly accurate wheel profile evaluations. Based on PHYTEC standard components, Nextsense was able to quickly and effectively develop the high-end product CALIPRI.

APPLICATION

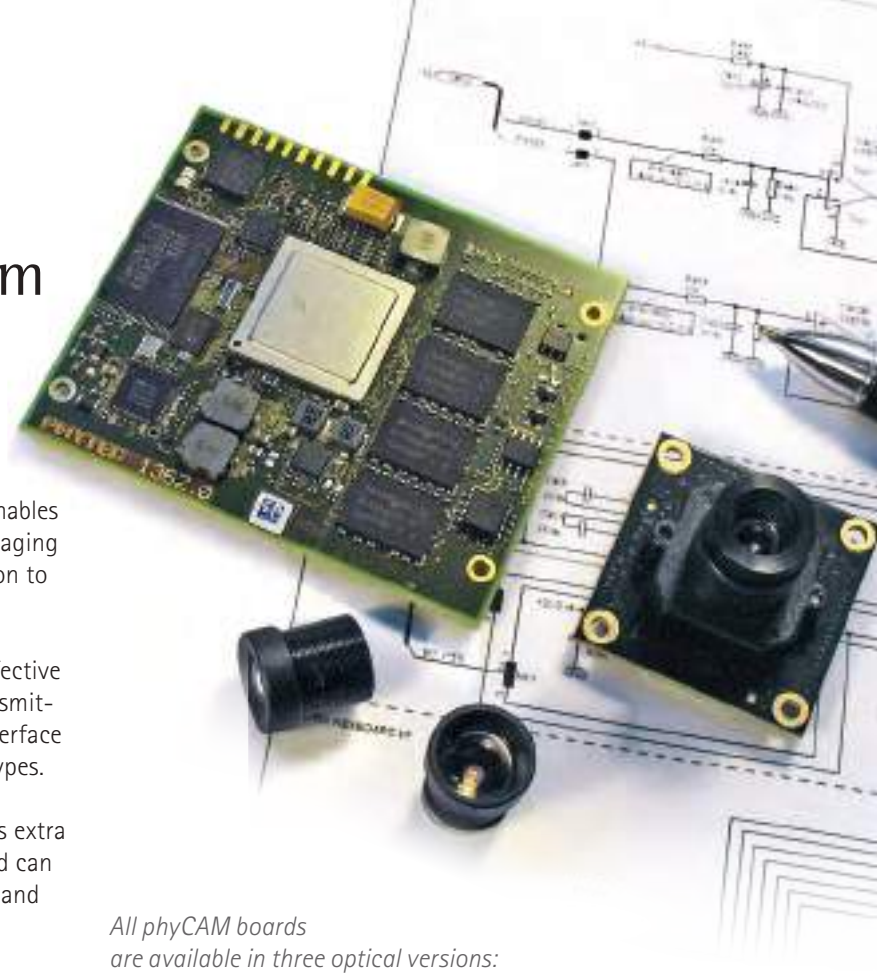
- Optical acquisition of 2D geometries using laser light-section technology
- Evaluation of object contours and comparison with user-specific limit values
- Output of measured values and deviations on the sensor display

PHYTEC PRODUCTS AND SERVICES

- Use of standard camera module VM-010-BW-LVDS
- Use of the controller module phyCORE-i.MX 6 Quad Core
- Consulting and support by PHYTEC in the development and series production phase

phyCAM-Imaging System

The flexible modular solution for Digital Image Products



phyCAM – Imaging with System – The phyCAM concept enables the simple integration of camera sensors into embedded imaging systems. Three interface systems allow an optimal adaptation to specific conditions:

phyCAM-P – The parallel phyCAM variant offers a cost-effective way to integrate cameras. Data and control signals are transmitted in parallel via a 33-pin FFC cable. This minimizes the interface effort while still allowing compatibility of various camera types.

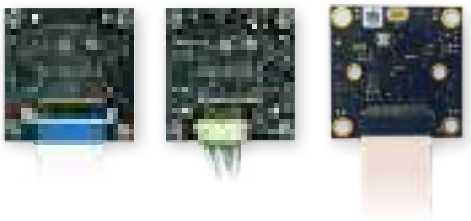
phyCAM-S – The LVDS-based phyCAM-S interface provides extra flexibility: The phyCAM-S cable requires only eight leads and can be up to five meters long. This also allows the camera head and main unit to be separated.

phyCAM-M – The phyCAM-M interface is based on the MIPI CSI-2 standard and in addition defines a connector for professional applications. This makes various camera modules compatible. The internal cable routing can be up to 15 cm long and can be planned flexibly. The phyCAM-M connector takes different supply voltages and additional control lines into account.

All phyCAM boards are available in three optical versions:

Lens Options

Plain sensor *M12 lens* *C/CS-Mount lens*



phyCAM-Systems

The table below shows the most important features:

Properties	phyCAM-P	phyCAM-S+	phyCAM-M
Transmission Method	parallel	LVDS	MIPI CSI-2
Max. Cable Length	30 cm	5 m	15 cm
Max. Data Rate	n/a [2]	640 Mb/s	>10 Gb/s
Data Word Width per Clock Cycle	10 up to 12 [1]	8	6 up to 24
Special Functions	+		+
Cost-optimized Design	+		+
Remote Camera Head		+	
Interchangable Camera Model	+	++	++
Flexible Cable Connection		+	

1) 12 Bit Configuration Options 2) not limited by system

phyCAM-M

MIPI CSI-2 for Industrial Applications

For the device-internal connection of camera modules, the CSI-2 standard of the MIPI-Alliance is an interesting solution. It enables a high data throughput by means of multiple, bundled LVDS lanes.

Originally coming from the consumer sector, the use in the industrial and professional products was difficult for two reasons: First, camera sensors were practically only available for the consumer market. However, with the establishment of the CSI-2 standard in the automotive sector, the first sensors that meet professional requirements – also in terms of long-term availability – are now coming onto the market.

Second, the CSI-2 standard does not contain a definition for the physical connector, so there was no modularity or interchangeability.

PHYTEC has developed the phyCAM-M interface as a solution to this problem. It takes into account industrial design criteria such as interchangeability and flexibility in cable routing. With the optional, switchable supply voltages of 3.3 V / 5 V, the interface is platform open and can be easily adapted if required.

With the VM-016-M and VM-017-M, two camera modules with phyCAM-M interface are already available. They cover the common resolution range from 1 to 5 MPixles. The BSPs of our qualified processor modules include the appropriate Video 4 Linux drivers, ready for use.

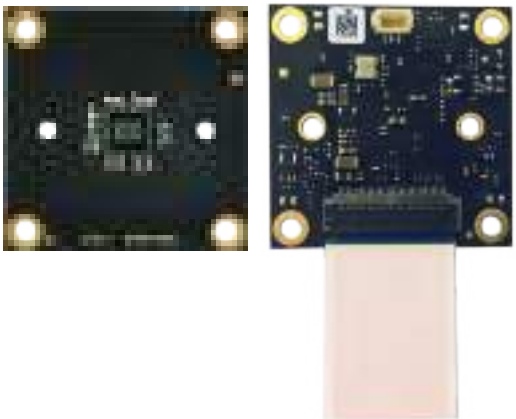
phyCAM-M – Electrical Interface

Pin	Dir.	Name	Function
1			
2	PWR	Vcam	Power Supply (3.3V or 5V; set by VCC_SELECT)
3			
4	-	GND	Ground
5	O	VCC_SELECT	Sets voltage on VCC Pins
6	I	nRESET	Reset Signal for camera
7	I	I2C_ADDR	I²C Address Select
8	I/O	I2C_SDA	SDA, I²C-Interface
9	I/O	I2C_SCL	SCL, I²C-Interface
10	-	GND	Ground
11	I/O	CTRL1	Multipurpose Pin 1 / Default = Strobe (OUT)
12	I/O	CTRL2	Multipurpose Pin 2 / Default = TRIGGER (IN)
13	I/O	CTRL3	Multipurpose Pin 3
14	I/O	CTRL4	Multipurpose Pin 4
15	-	GND	Ground
16	O	CSI_D3N	MIPI CSI-2 Data Lane 3 N
17	O	CSI_D3P	MIPI CSI-2 Data Lane 3 P
18	-	GND	Ground
19	O	CSI_D2N	MIPI CSI-2 Data Lane 2 N
20	O	CSI_D2P	MIPI CSI-2 Data Lane 2 P
21	-	GND	Ground
22	O	CSI_CLK0N	MIPI CSI-2 Clock Lane N
23	O	CSI_CLK0P	MIPI CSI-2 Clock Lane P
24	-	GND	Ground
25	O	CSI_D1N	MIPI CSI-2 Data Lane 1 N
26	O	CSI_D1P	MIPI CSI-2 Data Lane 1 P
27	-	GND	Ground
28	O	CSI_D0N	MIPI CSI-2 Data Lane 0 N
29	O	CSI_D0P	MIPI CSI-2 Data Lane 0 P
30	-	GND	Ground

Signal direction as seen from the Camera

The advantages for you:

- MIPI CSI-2 – Standard with industrial connectors
- Data rate >10 Gb/s with variable data width of 6 to 24 bits
- Suitable for internal use with cable length up to approx. 15 cm
- Exchangeable, long-term available camera modules
- Adaptable to other makes



PHYTEC Design Service

Hardware as individual as your project

The advantages for you:

- Space and cost efficient solution
- Interfaces and functions adapted exactly to your needs
- Protection of intellectual property rights
- Hardware from a single source – no need to manage and plug together many parts of different origin
- Future-proof through professional product maintenance and upgrade options

Embedded hardware shows its advantages in series production, especially when it is perfectly adapted to the target system. The efficient means for this is the project-specific base board, which can be fully adapted to the requirements of your project.

Describe your task to us in a free project workshop or send us your specification. We will sketch your individual solution together with you and subsequently work out the specification.

By using the pre-developed components such as camera and processor module, our circuit diagram library and the experience our engineers have gained from hundreds of projects, the development of an individual hardware is more cost-effective than you might think.

Additionally, the PHYTEC project manager will accompany you from the specification to the start of production.

Your specific solution, just like our standard products, is manufactured in our factory in Mainz. This enables short reaction times and the flexible fulfillment of individual requirements, including assembly and rollout service.

SSB Wind Systems

Customer Testimonial

SSB Wind Systems offers technologies and know-how for on- and offshore wind turbines.

The BladeVision system, used to measure the area of wind in the rotor blade, detects wind not only at specific points but also over the surface of the rotor blades. The embedded vision system rotates in the hub of wind turbines and determines a multitude of measurement data by measuring the bending of the rotor blade to improve the efficiency and management of wind farms.

APPLICATION

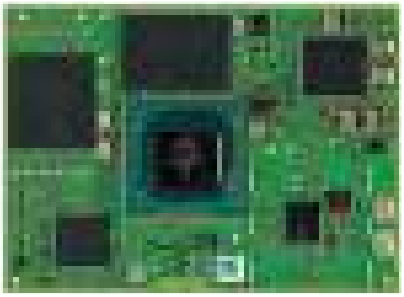
- Measurement of complex data in the rotor blade of a wind turbine
- Calculation of a multitude of wind and plant data
- Extremely robust, durable device design

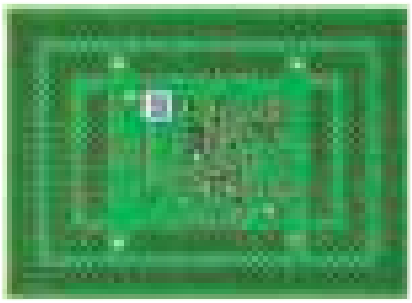
PHYTEC PRODUCTS AND SERVICES

- Development of the entire device electronics in close cooperation with SSB Wind Systems
- Use of the standard components phyFLEX-i.MX 6 and VM-010
- Manufacturing of the series hardware

Processor Modules for Embedded Imaging

Ready to use for Individual Series Solutions





The DSC technology enables high connectivity and a low-cost connection of SOM and base board.

Our microprocessor modules represent complete computer systems (SOM – System on Module) on a ready-to-use, compact board. They are equipped with the interfaces for the digital camera modules of the phyCAM series. This allows the camera modules to be connected to the computer board easily and cost- effectively. The processor-specific camera interfaces also allow direct access to internal pre-processing units for image data.

The modules offer a variety of data interfaces: Ethernet, HDMI, CAN, I²C, TFT display and RS-485 to name but a few. They can, therefore, be easily integrated into many applications. The adaptation to the respective task is done by the individual base board, onto which the module is plugged or – in our DSC solutions – directly soldered. The base board can also contain additional function groups and sensors.

Processor functions, interfaces and phyCAM camera modules are supported by the corresponding Linux operating system (BSP) which is maintained by PHYTEC. Our development kits enable software and design verification even before the individual base board is available.

Benefit from our many years of experience: PHYTEC development engineers advise customers who wish to develop their baseboards themselves and are available for design reviews. We would also be happy to take over the entire electronic development of the base board for you.

You can find even more detailed information on our modules at: **www.phytec.eu**

and the extensive SOM catalogue – simply request it at: **contact@phytec.de**

NEW






Module	phyCORE-i.MX 6	phyCORE-i.MX 6UL	phyCORE-AM57xx	phyCORE-i.MX 8QM	phyCORE-i.MX 8M	phyCORE-i.MX 8M Mini
Appropriate Camera Interface	2x phyCAM-P	phyCAM-P	phyCAM-P	2x phyCAM-M phyCAM-P	2x phyCAM-M MIPI CSI-2	phyCAM-M MIPI CSI-2
Operating System	Linux 4.x	Linux 4.x	Linux 4.x	Linux 4.x	Linux 4.x	Linux 4.x
Processor Family	Quad Cortex-A9 4x 1 GHz	Quad Cortex-A7 792 MHz	Dual Cortex-A15 2x 1.5 GHz	Dual Cortex-A72 2x 1.6 GHz, Quad Cortex-A53 4x 1.26 GHz	Quad Cortex-A53 4x 1.5 GHz	Quad Cortex-A53 4x 1.8 GHz
Hardware Codecs	H.264 Dec (1080p30) H.264 Enc (1080p30)	–	H.264 Dec (1080p60) H.264 Enc (1080p60)	H.265 Dec (4k60) H.264 Enc (1080p30)	H.265 Dec (4k60)	H.265 Dec (1080p60) H.264 Enc (1080p60)

i.MX 8 Processor Modules

NEW

Processing Power for Embedded Imaging

With the i.MX 8 families, NXP has developed three processor lines that are particularly well suited for embedded imaging applications.

Up to two phyCAM camera modules can be connected directly to the processor. Numerous integrated functional units support the processor cores in image processing applications. Performance and hardware accelerators vary between the various derivatives of the i.MX 8 families, so that the platform can be optimally adapted to each application.

PHYTEC supports you in selecting the appropriate platform and camera modules.

With our Embedded Imaging Kits (i.e. the Embedded Imaging Kit i.MX 8M), you get a quick start into the respective platform.

The phyCORE-i.MX 8M Embedded Imaging Kit for a quick start into your own product development

Baseboard with i.MX 8M and MIPI CSI-2 Camera Module

Comparison of selected i.MX 8M performance data for imaging applications

Features	i.MX 8 Quad X Plus	i.MX 8 M Mini Quad	i.MX 8 M Quad	i.MX 8 Quad Max
Cortex A72	-	-	-	2x 1.6 GHz
Cortex A53	-	4x 1.8 GHz	4x 1.5 GHz	4x 1.2 GHz
Cortex A35	4x 1.2 GHz	-	-	-
Cortex M4	1x 266 MHz	1x 400 MHz	1x 266 MHz	2x 266 MHz
3D GPU	1x GC7000 Lite	GC Nano Ultra	1x GC7000 Lite	2x GC7000 XSVX [2]
3D GFLOPS [1]	51.2 / 25.6	6.4	51.2 / 25.6	128 / 64 each
OpenCV/VX [3]	OpenCV 3.4.2	OpenCV 4.0.1	OpenCV 3.4.2	OpenCV 3.4.2/VX
OpenCL	1.2 EP	N/A	1.2	2.0
NEON SMID	4	4	4	6
VPU max. Resolution [4]	1080p30	1080p60	1080p30 Decoder	1080p60
VPU Encoder / Decoder	E / D	E / D	- / D	E / D
Image Acquisition Units	ISI (8 Pipelines)	1x CSI	2x CSI	ISI (8 Pipelines)
Parallel Camera-I/F	1	-	-	-
MIPI CSI-2 Camera-I/F	1	1	2	2
PLATFORM	**KIT**	**POLIS**	**POLARIS**	**ALPHA-KIT**
phyCAM-P – Interface	1	-	-	1 [5]
phyCAM-M – Interface	1	1	2	2

1) theor. Value MP/HP 2) supports EVIS Extended Vision Instruction Set 3) Status Q3/2019 4) H264 Hardware encode / decode
5) Interface 1 optionally P or M – all data is preliminary information

BSP and Middleware

Best Ecosystem for your Application

The advantages for you:

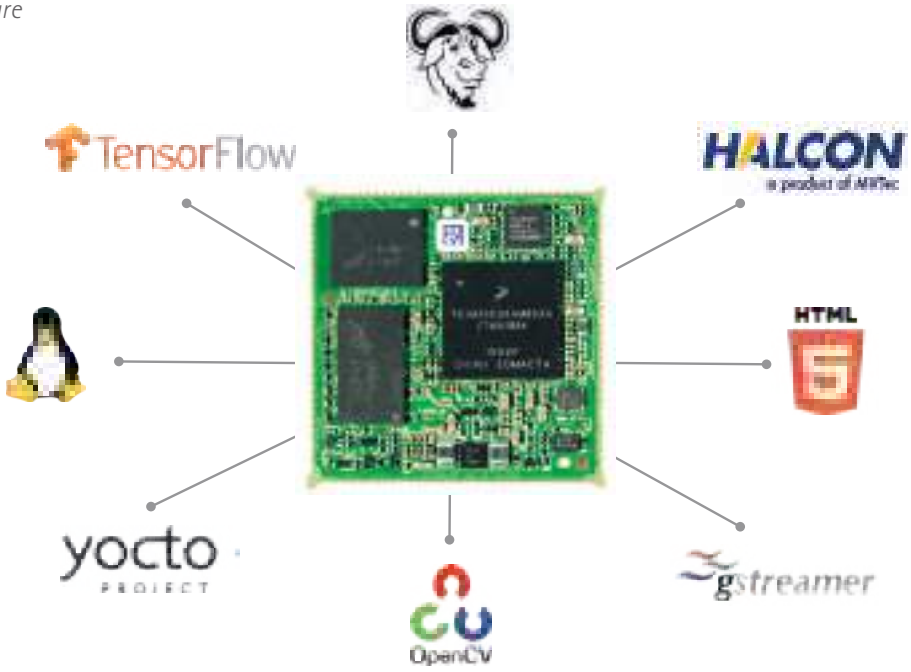
- Professionally maintained Linux BSP
- Linux is open source and royalty-free
- Ready to use BSPs, adapted to our hardware, save you considerable time and costs
- Test and develop your application with our imaging kits before the target hardware is available
- Individual hardware adaptations by the PHYTEC development team are possible

The application software is often the heart of your product. Our preliminary software services are the enablers for the efficient development of individual solutions across a wide range of industries and applications.

With our "Embedded Imaging" development kits, you receive free, well-maintained board support packages with Embedded Linux distributions. They contain the software drivers for our V4L2-based phyCAM camera modules.

Middleware, in the form of libraries, is also included or can be additionally installed. This includes image processing libraries such as OpenCV, Halcon Embedded, or Gstreamer. AI frameworks such as TensorFlow or solutions for over-the-air updates are also available.

Learn More:
www.phytec.eu/products/software



IVU TRAFFIC TECHNOLOGIES AG

Customer Testimonial

IVU Traffic Technologies AG has been ensuring punctual and reliable traffic in the world's major cities for over 35 years. PHYTEC develops and produces devices such as on-board computers and ticket printers for IVU and takes over delivery management tasks. For the Rotterdam subway, the IVU.BOX on-board computer was equipped with a video interface for platform control.

APPLICATION

- On-board computer for the driver control desk for the Rotterdam metro
- Integrated video interface for monitoring the vehicle entrances
- Connection of existing camera infrastructure to new on-board computers

PHYTEC PRODUCTS AND SERVICES

- Complete development of the IVU.BOX product range in close consultation with the customer
- Production and delivery management of the complete devices
- Use of ready-to-use hardware phyCARD-i.MX 6 and video decoder VM-008

Matthias Rust
Executive Management
IVU Traffic Technologies AG

„PHYTEC's expertise in electronics, software and mechanics complements IVU's in-house expertise perfectly."

Global Shutter Camera Modules

VM-010 / VM-012 / VM-016

For applications where exposure must be exactly simultaneous for all pixels of the sensor, PHYTEC offers camera modules with a global shutter.

Shutter Technologies and Differences

With the cost-effective rolling shutter technology, the individual lines of the image sensor are exposed one after the other from top to bottom. Fast moving objects can consequently be imaged distorted. In camera sensors with global shutter technology, all pixels are exposed at exactly the same time. There is no distortion of moving objects. For metrological applications with fast moving objects, global shutter sensors are therefore preferable. PHYTEC has developed three phyCAM camera modules with global shutter sensors for use in series production, which are characterized by a particularly good price-performance ratio.

Ready to use for High Demands

With the VM-010, VM-012 and VM-016 board cameras, the system developer has powerful CMOS image sensors with global shutter for direct use in series production. The sensors are also characterized by good sensitivity in close infrared. The camera modules can be configured in different variants and ordered ready to use with M12 or C/CS mount lens holders.

Rolling / Global Shutter: Shot of a rotating fan with different shutter technology.

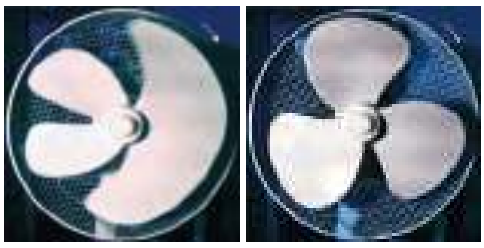


Image Resolution	1280 x 1024 (1.3MPix)		1280 x 800 (1MPix)			752 x 480 (WVGA)	
Color / Monochrome	-COL / -BW		-COL / -BW			-COL / -BW	
Image Sensor (-COL/-BW)	Vita1300		AR0144			MT9V024	
Color Format (-COL/-BW)	Bayer Pattern / Y		Bayer Pattern / Y			Bayer Pattern / Y	
Optical Format	1/2" 6.18 mm x 4.95 mm		1/4" 3.84 mm x 2.4 mm			1/3" 4.51 mm x 2.88 mm	
Pixel Size	4.8 µm x 4.8 µm		3 µm x 3 µm			6 µm x 6 µm	
Dynamic Range	60 dB		63.9 dB			> 55 dB (linear)	
High Dynamic Range	90 dB		–			> 80 up to 100 dB	
Shutter Type	Global and Rolling (selectable)		Global			Global	
Features (optional)	Strobe / Trigger / EEPROM		Strobe / Trigger / EEPROM			Strobe / Trigger / EEPROM	
Operating Temperature	-25°C...+85°C		-25°C...+85°C			-25°C...+85°C	
Frame Rate	37 fps @ 1.3 Mpixel / 130 fps @ VGA		60 fps @ 1 Mpixel / 66 fps @ HD 720p			60 fps @ WVGA	
Interface	phyCAM-P	phyCAM-S	phyCAM-P	phyCAM-S	phyCAM-M	phyCAM-P	phyCAM-S
Article Number	VM-012-COL VM-012-BW	VM-012-COL-LVDS VM-012-BW-LVDS	VM-016-COL-P VM-016-BW-P	VM-016-COL-S VM-016-BW-S	VM-016-COL-M VM-016-BW-M	VM-010-COL VM-010-BW	VM-010-COL-LVDS VM-010-BW-LVDS

The cameras are also available with lens holders (-M12, -H = C/CS-Mount).

Cost-effective **Camera Modules** for Professional Imaging Solutions

Flexible 5 Megapixel Cameras

VM-011 - phyCAM-P / S+
VM-017 - MIPI CSI-2

Versatile and Adaptable for your Application

Our 5 megapixel cameras strike a balance between high demands on image quality and performance on an embedded device. The high resolutions above the Full HD standard can be variably adapted to the requirements of the applications.

Due to the industrial design and long-term available sensors, the phyCAM series is suitable for almost all areas of application. The VM-017 is characterized by an excellent low- light performance and backside illumination technology. VM-011 and VM-017 are supported as Ready-to-Go V4L2 drivers in the matching phyCORE modules' BSPs.

Extract of the Resolution Options

Image Resolution	Name	Maximum Frame Rate in fps	
		VM-011 parallel	VM-017 8/10 Bit MIPI
2592 x 1944	(5 Megapixel)	15	60
1920 x 1080	Full HD	31	60
1280 x 720	HD	60	90
640 x 480	VGA	123	120

Image Resolution	**2592 x 1944 (5MPix)**		**2592 x 1944 (5MPix)**
Color / Monochrome	-COL / -BW		-COL / -BW
Image Sensor (-COL/-BW)	MT9P006 / MT9P031		AR0521
Color Format (-COL/-BW)	Bayer Pattern / Y		Bayer Pattern / Y
Optical Format	1/2.5" 5.7 mm x 4.28 mm		1/2.5" 5.7 mm x 4.3 mm
Pixel Size	2.2 µm x 2.2 µm		2.2 µm x 2.2 µm
Dynamic Range	67.74 dB		40 dB
Shutter Type	Rolling		Rolling
Features	Strobe / Trigger / EEPROM		Strobe / Trigger / EEPROM
Operating Temperature	-25°C...+70°C		-25°C...+85°C junction
Interface	**phyCAM-P** parallel	**phyCAM-S** LVDS	**phyCAM-M** MIPI CSI-2
Frame Rate (full-size image)	up to 15 fps	up to 12.5 fps	up to 60 fps (8/10bit)
Frame Rate (Standard Video)	60 fps (HD)	50 fps (HD)	60 fps (Full HD) (8/10 Bit)
Article Number	VM-011-COL VM-011-BW	VM-011-COL-LVDS VM-011-BW-LVDS	VM-017-COL-M VM-017-BW-M

The cameras are also available with lens holders (-M12, -H = C/CS-Mount).

Camera Module Overview

CMOS-Camera Boards for Microprocessor-Modules

The phyCAM-System –
Perfect Integration of Cameras in Serial Products
Camera boards with a phyCAM interface can be connected directly to the digital camera interface of the PHYTEC microprocessor boards. This enables the easy integration of camera technology into compact, customized products.

High Flexibility – Easy Adaption
Controller modules and camera boards together form a modular system from which the product developer can select the optimum combination. The cameras can be easily exchanged on the hardware side – even during the design phase.

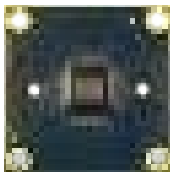
All camera boards have standardized dimensions. Each camera is optionally available as either a plain board version or with lens holders for C/CS-Mount or M12 lenses.

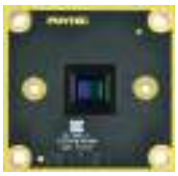
Software Driver Included
The Board-Support-Packages (BSPs) of compatible PHYTEC controller modules contain the appropriate software drivers for the cameras. This allows cameras to be directly integrated into applications under Embedded Linux. Under Linux, the cameras can be accessed via the V4L2 interface.

The camera properties are supported as V4L2 Controls. The Linux drivers are integrated into the BSPs, are ready for use and do not need to be adapted separately.

RTG Linux drivers "ready-to-go" are included in the phyCORE-BSPs!

NEW





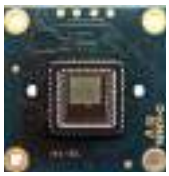


Image Resolution	2592 x 1944 (5 MPix)		2592 x 1944 (5 MPix)	1280 x 1024 (1.3 MPix)	
Camera Series	VM-011		VM-017	VM-012	
Color / Monochrome	-COL / -BW		-COL / -BW	-COL / -BW	
Image Sensor (-COL/-BW)	MT9P006 / MT9P031		AR0521	Vita1300	
Color Format (-COL/-BW)	Bayer Pattern / Y		Bayer Pattern / Y	Bayer Pattern / Y	
Optical Format	1/2.5" 5.7 mm x 4.28 mm		1/2.5" 5.7 mm x 4.3 mm	1/2" 6.18 mm x 4.95 mm	
Pixel Size	2.2 µm x 2.2 µm		2.2 µm x 2.2 µm	4.8 µm x 4.8 µm	
Dynamic Range	67.74 dB		40 dB	60 dB	
High Dynamic Range	-		-	90 dB	
Shutter Type	Rolling		Rolling	Global und Rolling	
Features (optional)	Strobe / Trigger / EEPROM		Strobe / Trigger / EEPROM	Strobe / Trigger / EEPROM	
Operating Temperature	-25°C...+70°C		-25°C...+85°C (Junction)	-25°C...+85°C	
PCB Dimensions	34 mm x 34 mm		34 mm x 34 mm	34 mm x 34 mm	
Interface	phyCAM-P parallel	phyCAM-S LVDS	phyCAM-M MIPI CSI-2	phyCAM-P parallel	phyCAM-S LVDS
Frame Rate (full-size image)	up to 15 fps	up to 12.5 fps	up to 60 fps	up to 37 fps	up to 37 fps
Frame Rate (Standard Video)	60 fps (HD)	50 fps (HD)	60 fps (FullHD)	50 fps (HD)	50 fps (HD)
Video Interface	8/10/12 Bit	8 Bit	8/10/12 Bit	8/10 Bit	8 Bit
Supply Voltage	2.8 V DC	3.3 V DC	2.8 V DC	3.3 V DC	3.3 V DC
Article Number	VM-011-COL VM-011-BW	VM-011-COL-LVDS VM-011-BW-LVDS	VM-017-COL-M VM-017-BW-M	VM-012-COL VM-012-BW	VM-012-COL-LVDS VM-012-BW-LVDS

Suitable Camera Cable

The phyCAM interfaces allow our camera modules to be connected to development and application boards without any adapters. Our delivery program includes various standard lengths. For series projects, the cables can be individually customized.

Lens Holder

Each phyCAM module is optionally available with a completely mounted M12 or C/CS mount lens holder.

Order code suffix	-M12	-H
Lens Holder	M12 (0.5), S-mount	C/CS-mount

Matching Lenses see page 24

Camera Cable

phyCAM-P

33 pol. Flat-Foil Cable (FFC) 0.5 mm pitch
Typ A, contacts on same side, reinforced

Article Number	Length
WF238	3 cm
WF250	9 cm
WF043	20 cm
WF057	40 cm

WF043

phyCAM-S

8 pol. LVDS cable CAT5e, shielded,
2x Hirose DF13-08S-1.25C

Article Number	Length
WK262-0.09	9 cm
WK353-0.2	20 cm
WK353-0.5	50 cm

WK353

phyCAM-S / S+

8 pol. LVDS-cable USB 3.0 quality
2x Hirose DF13-08S-1.25C

Article Number	Length
WK431-0.5	50 cm
WK431-5.0	5 m

phyCAM-M

30 pol. FFC 0.5 mm pitch, shielded
Typ A, contacts on same side

Article Number	Length
WF271	15 cm

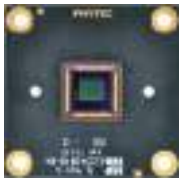
WF271

Trigger / Strobe cable

2x JST connectors 3 pin, 1 mm pitch

Article Number	Length
WK295	25 cm, 1 : 1
WK295-0.03	3 cm, 1 : 1
WK295-M	25 cm mirrored

WK295



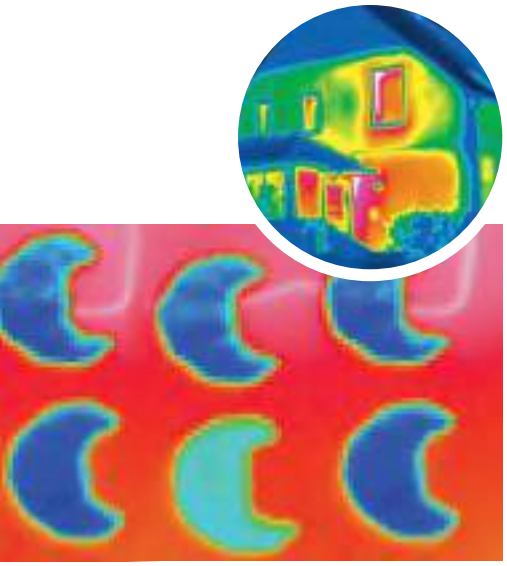
1280 x 1024 (1.3 MPix)		1280 x 800 (1 MPix)			752 x 480 (WVGA)	
VM-009		**VM-016**			**VM-010**	
-COL / -		-COL / -BW			-COL / -BW	
MT9M131		AR0144			MT9V024	
YUV, RGB, Bayer Pattern		Bayer Pattern / Y			Bayer Pattern / Y	
1/3" 4.6 mm x 3.7 mm		1/4" 3.84 mm x 2.4 mm			1/3" 4.51 mm x 2.88 mm	
3.6 µm x 3.6 µm		3 µm x 3 µm			6 µm x 6 µm	
71 dB		63.9 dB			> 55 dB (linear)	
-		-			> 80 up to 100 dB	
Rolling		Global			Global	
Strobe / EEPROM		Strobe / Trigger / EEPROM			Strobe / Trigger / EEPROM	
-25°C...+70°C		-25°C...+85°C			-25°C...+85°C	
34 mm x 34 mm		34 mm x 34 mm			34 mm x 34 mm	
phyCAM-P parallel	**phyCAM-S** LVDS	**phyCAM-P** parallel	**phyCAM-S** LVDS	**phyCAM-M** MIPI CSI-2	**phyCAM-P** parallel	**phyCAM-S** LVDS
up to 15 fps	up to 15 fps	up to 60 fps	up to 60 fps	up to 60 fps	up to 60 fps	up to 60 fps
30 fps (VGA)	30 fps (VGA)	66 fps (HD)	66 fps (HD)	66 fps (HD)	60 fps (WVGA)	60 fps (WVGA)
8/10 Bit	8 Bit	8/10/12 Bit	8 Bit	8/10/12 Bit	8/10 Bit	8 Bit
2.8 V DC	3.3 V DC	2.8 V DC	3.3 V DC	3.3 V DC	3.3 V DC	3.3 V DC
VM-009	**VM-009-LVDS**	**VM-016-COL-P** **VM-016-BW-P**	**VM-016-COL-S** **VM-016-BW-S**	**VM-016-COL-M** **VM-016-BW-M**	**VM-010-COL** **VM-010-BW**	**VM-010-COL-LVDS** **VM-010-BW-LVDS**

Thermal Image Camera Modules

Thermography Modules for Embedded Designs

Interesting information can be obtained in many applications by the temperature of objects. The new, cost-effective thermal imaging camera modules can be easily integrated into embedded systems via the camera interface. They are available with a resolution of 32 x 32 pixels or 80 x 64 pixels and various already integrated optics.

The raw data of the thermal image sensor is processed on the camera module so that the application software receives already corrected, real temperature values. The thermal imaging camera modules can be connected to controller modules with parallel phyCAM-P camera interface.



VM-050

VM-051

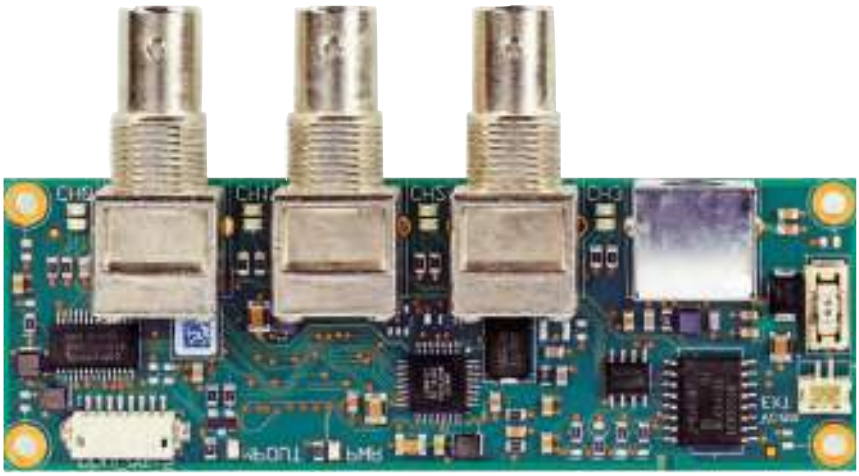
The advantages for you:

- Ready-to-use, calibrated thermography modules
- 32 x 32 pixels or 80 x 64 pixels
- Complete with optics, different focal lengths selectable
- Integrated preprocessing
- Data format, temperature window etc. adjustable
- phyCAM-P interface for parallel camera input on the controller
- Video 4 Linux driver for suitable CPU modules available

Model	VM-050-021-0	VM-050-050-0	VM-051-048-0	VM-051-105-0
Image Resolution / Pixel	32 x 32	32 x 32	80 x 64	80 x 64
Camera Interface	phyCAM-P	phyCAM-P	phyCAM-P	phyCAM-P
Image Sensor	HTPA32x32d	HTPA32x32d	HTPA80x64d	HTPA80x64d
Sensor Type	Thermopile Array	Thermopile Array	Thermopile Array	Thermopile Array
Therm. Pixel Time Const.	< 4 ms	< 4 ms	< 4 ms	< 4 ms
Frame Rate (cal.)	8.9 Hz	8.9 Hz	8.9 Hz	8.9 Hz
Object Temperature	-20... >1000 °C	-20... >1000 °C	-20... >1000 °C	-20... >1000 °C
Temperature Resolution	0.3 K	0.3 K	0.3 K	0.3 K
Accuracy (min.)	±2 K ± 2%	±2 K ± 2%	±2 K ± 2%	±2 K ± 2%
Operating Temperature	-20...+85°C	-20...+85°C	-20...+85°C	-20...+85°C
Control Interface	I²C	I²C	I²C	I²C
Video Interface	8 / 10 Bit parallel	8 / 10 Bit parallel	8 / 10 Bit parallel	8 / 10 Bit parallel
Data Format	8 / 10 / 16 Bit	8 / 10 / 16 Bit	8 / 10 / 16 Bit	8 / 10 / 16 Bit
Operating Voltage	3.3 V	3.3 V	3.3 V	3.3 V
Power Consumption approx.	400 mW	400 mW	400 mW	400 mW
Focal Length / Field of View	f=2.1 / 90°	f=5.0 / 33°	f=4.8 / 88x70°	f=10.5 / 38x31°
Aperture (F-No.)	0.8	0.85	0.8	0.95
Lens Type	Silicon	Germanium	Germanium	Germanium
PCB Dimensions	34 x 34 mm	34 x 34 mm	34 x 34 mm	34 x 34 mm

VM-008

Analog-Video Converter



PAL / NTSC Digitizer for Microprocessor Modules

The video converter with four signal inputs and as well phyCAM-P and phyCAM-S output interface enables the integration of analog video sources into embedded imaging systems.

This converter (color frame grabber) digitizes analog image signals (television systems PAL and NTSC) into a digital data stream. The digital image data is then made available to the processor board as ITU-R 601 or ITU-R 656 YCbCr (4:2:2) data stream via the phyCAM-P and phyCAM-S interface.

The converter can be used wherever analog cameras are already available or very long cable lengths to the camera must be overcome. Typical applications are security applications, special purpose vehicles and integration of analog image sources such as ultrasound devices in diagnostics.

Technical Data

Article Number	VM-008
Resolution PAL / NTSC	720 x 576 / 720 x 480
Video Decoder	Techwell 9910
Scanner System	interlaced
Frame Rate PAL / NTSC	25 fps / 30 fps
Inputs	3 BNC / 1 MiniDIN
Input Format	3 FBAS / 1 S-Video
Outputs	phyCAM-P / -S
Output Format	8 Bit digital, YCrCb
Control Interface	I^2C Bus
Power Supply	3.3 V DC
Features (optional)	EEPROM, LEDs
Operating Temperature	-25 °C up to +85 °C
Dimensions ca.	34 x 100 mm
Mounting Points	4x M2.5

Platforms for Embedded Imaging Applications

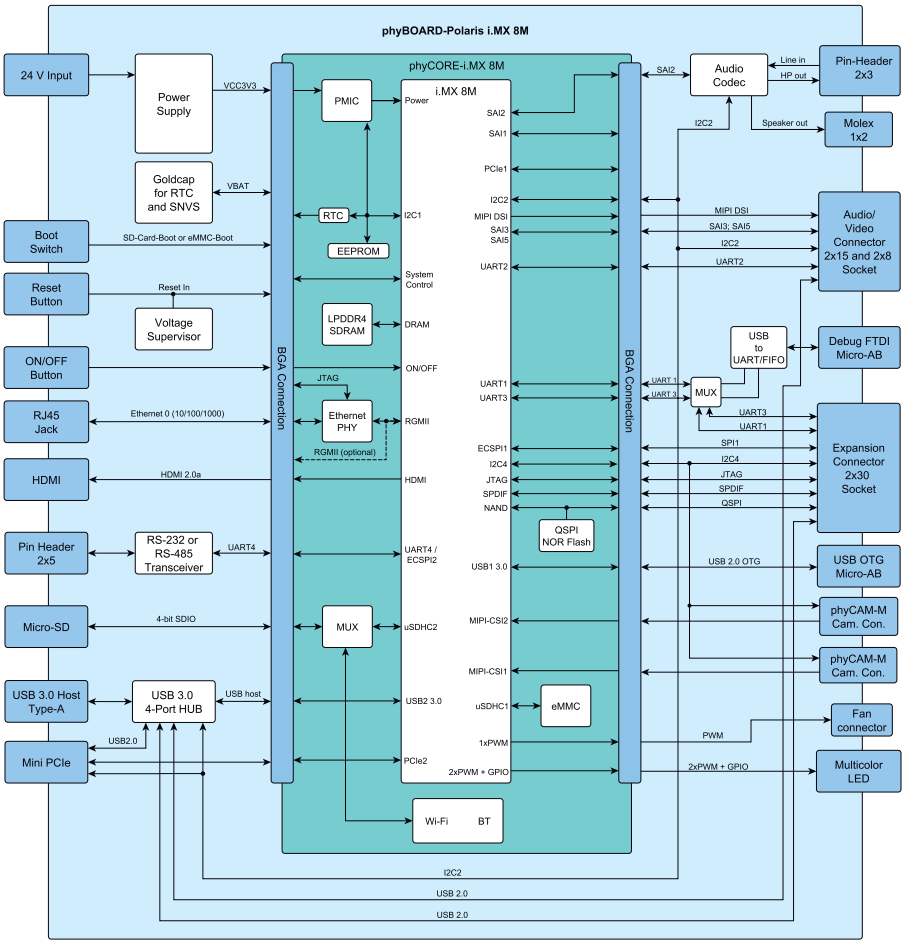
Our phyBOARDs not only represent optimal development platforms, but are also suitable for series and industrial use. The reference can go directly into series production as a single board computer if the appropriate prerequisites are met.

phyBOARD-Polaris

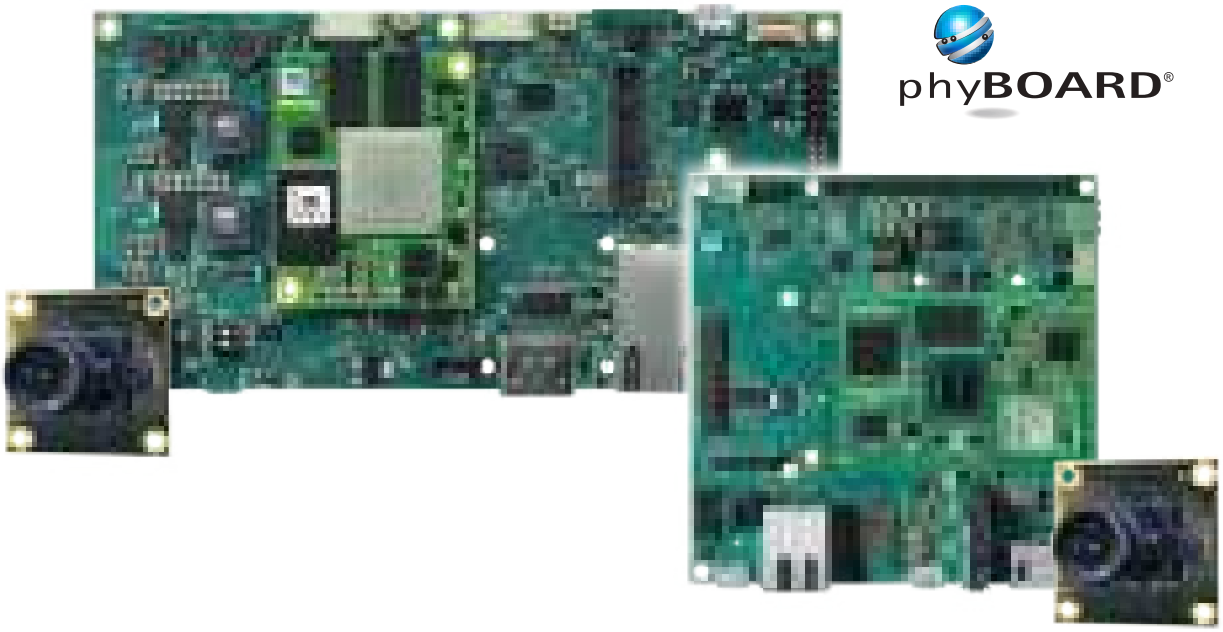
With the powerful i.MX 8M processor, the phyBOARD-Polaris is a single board computer for demanding image processing tasks. Up to two MIPI CSI-2 cameras with high data throughput can be connected via the two phyCAM-M interfaces. The Polaris can therefore be connected directly to the VM-016-M and VM-017-M camera modules without an adapter. The board can be operated with 12-24 V and features, among other interfaces, a Gigabit Ethernet and a USB 3.0 interface as well as integrated WLAN and Bluetooth functionality. The phyCORE-i.MX 8M module is soldered directly onto the Polaris carrier board to save costs.

phyBOARD-Nunki

PHYTEC has designed the phy-BOARD-Nunki specifically for image processing applications, a further development of our proven phyBOARD-Mira. For this purpose, the SBC has five physical camera interfaces: two parallel phyCAM-P interfaces, two serial phyCAM-S+ interfaces and a MIPI camera interface. Two camera interfaces can be used in parallel. Additional interfaces and a 12-24 V power supply are also integrated on board. The exchangeable phyCORE module with the NXP i.MX 6 processor makes it easy to adapt the memory expansion of the system. The phyCORE-i.MX 6 module is available as single, dual and quad-core version.



Block diagram phyBOARD-Polaris i.MX 8M



phyBOARD®

Features \ Name	phyBOARD-**Nunki**	Embedded Imaging Kit **Nunki**	phyBOARD-**Polaris**	Embedded Imaging Kit **Polaris**
Module	**phyCORE-i.MX 6**	**phyCORE-i.MX 6**	**phyCORE-i.MX 8M**	**phyCORE-i.MX 8M**
SOM Mounting	Connector	Connector	Direct Solder (DSC)	Direct Solder (DSC)
CPU	i.MX 6Quad	i.MX 6Quad	i.MX 8M Quad	i.MX 8M Quad
Clock Frequency	4x 1 GHz (A9)	4x 1 GHz (A9)	4x 1.3 GHz (A53)	4x 1.3 GHz (A53)
Memory	1 GB NAND, 1 GB RAM	1 GB NAND, 1 GB RAM	2 GB RAM, 8 GB NAND	2 GB RAM, 8 GB NAND
INTERFACES				
Ethernet	1x 10/100/1000 Mbit/s	1x 10/100/1000 Mbit/s	1x 10/100/1000 Mbit/s	1x 10/100/1000 Mbit/s
USB	1x Host, 1x OTG	1x Host, 1x OTG	1x USB3.0 Host, 1x OTG	1x USB3.0 Host, 1 x OTG
Serial	via microUSB	via microUSB	1x	1x
CAN	1x CAN	1x CAN	-	-
PCIe	1x miniPCIe	1x miniPCIe	1x miniPCIe	1x miniPCIe
Camera Interface	2x both with phyCAM-P or phyCAM-S+ or 1x phyCAM-M (MIPI CSI-2)	2x both with phyCAM-P or phyCAM-S+ or 1x phyCAM-M (MIPI CSI-2)	2x phyCAM-M (MIPI CSI-2)	2x phyCAM-M (MIPI CSI-2)
Camera	up to 2 phyCAM cameras optional	WVGA monochrome camera VM-010-BW-M12	up to 2 phyCAM-M cameras optional	HD color camera VM-016-COL-M-M12
Lens	-	12 mm, M12 (S-Mount)	-	12 mm, M12 (S-Mount)
Display and Touch	LVDS, Parallel	LVDS, Parallel	LVDS, MIPI DSI	LVDS, MIPI DSI
HDMI	1x	1x	1x	1x
Mass Memory	microSD Card Slot, SATA	microSD Card Slot, SATA	microSD Card Slot, SATA	microSD Card Slot, SATA
EXPANSION + CONFIGURATION				
Expansion Bus	1x	1x	1x	1x
Digital I/O	via Expansion Connector	via Expansion Connector	via Expansion Connector	via Expansion Connector
Audio	via Expansion Connector	via Expansion Connector	via Expansion Connector	via Expansion Connector
User Control Elements	Reset Button	Reset Button	Reset Button	Reset Button
Boot Source	SD Card, NAND, eMMC, SATA, USB Host	SD Card, NAND, eMMC, SATA, USB Host	SD Card, NAND, eMMC, SATA, USB Host	SD Card, NAND, eMMC, SATA, USB Host
RTC	Gold Cap Backup	Gold Cap Backup	Gold Cap Backup	Gold Cap Backup
Power Supply	12-24 V	12-24 V	12-24 V	12-24 V
Dimensions	150 x 75 mm	150 x 75 mm	100 mm x 100 mm	100 mm x 100 mm
Temperature Range	-25°C...+85°C	-25°C...+85°C	-25°C...+85°C	-25°C...+85°C
Kit Content	phyBOARD-Nunki with phyCORE-i.MX 6Quad	phyBOARD-Nunki with phyCORE-i.MX 6 Quad, Camera VM-010-BW-M12 incl. 12 mm lens, Cables, Power Supply	phyBOARD-Polaris with phyCORE-i.MX 8M	phyBOARD-Polaris with phyCORE-i.MX 8M, Camera VM-016-COL-M-M12 incl. 12 mm lens, Cables, Power Supply

Embedded Imaging Kits

Development Kits for Systems with Digital Cameras

Get started with an Embedded Imaging Kit
In our kits, we have put together all the necessary components of an embedded system with integrated image processing. This means you can quickly and effectively create your individual image processing solution. Due to the flexibility of the standardized camera interfaces, the camera characteristics can be adapted to your requirements even during the design phase.

Software driver included
Our development kits contain the appropriate software drivers to address the camera boards from your own applications. Access to the camera driver under Linux is via V4L2. This allows a variety of middleware such as GStreamer, OpenCV and HALCON or the application to access the phyCAM cameras directly via a widely used standard interface. The cameras are matched to the boards and do not require an adapter. Camera functions are adjustable via V4L2 controls. PHYTEC provides demo applications to test camera functions and to display a camera image.

The development kits can also be combined with other phyCAM cameras.

We are happy to advise you and put together your kit individually:
contact@phytec.de

	ARM	Cortex-A72/A53
	Kit Module	Embedded Imaging Kit **phyCORE-i.MX 8QM**
	Camera Interface	**2x phyCAM-M / 1x phyCAM-P**
Software	Operating System	Linux 4.x
	Real Time	–
	BSP / Image	yes / yes
	Bootloader	Barebox (Uboot)
	Toolchain	Yocto
	Compiler	GNU
	Debug Interface	JTAG
CPU	Processor	NXP i.MX 8QM
	Clock Frequency	2x 1.6 GHz (A72), 4x 1.26 GHz (A53), 2x 266 MHz (M4F)
	MMU	yes
	Video Accelerator	2x GPU GC7000, VPU, 2x DPU
	Image Processor	yes
Memory	RAM	2 GB DDR4
	SRAM	–
	NOR Flash	–
	NAND Flash	8 GB (eMMC)
	EEPROM	2x 4 kB
Interfaces	Ethernet	2x 10/100/1000 Mbit/s
	CAN	yes 2x
	USB	2x USB3.0, 2x USB2.0
	RS232	via micro USB
	Sound	yes
	SPI / I²C	yes / yes
	RTC	yes
	CF / SD / MMC	- / yes / yes
	Extension Bus	yes
	Camera Interface	2x phyCAM-M (30pol) / 1x phCAM-P (33pol)
Kit Contents	Module	phyCORE-i.MX 8QM
	Camera	5 Mpix color camera VM-017-COL-M-M12
	Lenses	12 mm, M12 with IR cut
	Carrier Board	yes
	Mapper Board	-
	Display	HDMI connector
	Touch	opt.
	BSP / Toolchain	USB-Stick
	QuickStart Instructions	yes
	Schematics	yes
	Free Support	yes
	Article Number	available Q3/2020

NEW

Cortex-A53	Cortex-A9		Cortex-A7	Cortex-A9
Embedded Imaging Kit **phyCORE-i.MX 8M**	Embedded Imaging Kit **phyCORE-i.MX 6 Nunki**	Embedded Imaging Kit **phyCORE-i.MX 6 Mira**	Embedded Imaging Kit **phyCORE-i.MX 6UL**	Thermal Imaging Kit **phyCORE-i.MX 6 Nunki**
2x phyCAM-M	**2x phyCAM-S+ / 2x phyCAM-P**	**phyCAM-S+**	**phyCAM-P**	**2x phyCAM-S+ / 2x phyCAM-P**
Linux 4.x	Linux 4.x	Linux 4.x	Linux 4.x	Linux 4.x
–	RTpreempt	RTpreempt	RTpreempt	RTpreempt
yes / yes	yes / yes	yes / yes	yes / yes	yes / yes
Barebox (Uboot)	Barebox	Barebox	Barebox	Barebox
Yocto	Yocto	Yocto	Yocto	Yocto
GNU	GNU	GNU	GNU	GNU
JTAG	JTAG	JTAG	JTAG	JTAG
NXP i.MX 8M	NXP i.MX 6	NXP i.MX 6	NXP i.MX 6UL	NXP i.MX 6
4x 1.3 GHz (A53), 2x 266 MHz (M4)	4x 1 GHz (A9)	4x 1 GHz (A9)	792 MHz (A7)	4x 1 GHz (A9)
yes	yes	yes	yes	yes
GPU GC7000Lite, VPU	2x IPUv3H, VPUv6	2x IPUv3H, VPUv6	parallel CSI	2x IPUv3H, VPUv6
yes	yes	yes	yes	yes
2 GB DDR4	1 GB DDR3	1 GB DDR3	512 MB DDR2	1 GB DDR3
–	–	–	–	–
–	16 MB (SPI)	16 MB (SPI)	–	16 MB (SPI)
8 GB (eMMC)	1 GB	1 GB	512 MB	1 GB
4 kB	4 kB	4 kB	4 kB	4 kB
2 x 10/100/1000 Mbit/s	10/100/1000 Mbit/s	10/1000 Mbit/s	2x 10/100 Mbit/s	10/100/1000 Mbit/s
–	yes	yes	yes	yes
USB3.0 Host, USB OTG	OTG HS, 1x Host	OTG HS, 1x Host	OTG HS, 2x Host HS	OTG HS, 1x Host
1x	via micro USB	1x	1x	via micro USB
yes	yes	yes	yes	yes
yes / yes	yes / yes	yes / yes	yes / yes	yes / yes
yes	yes	yes	yes	yes
– / yes / yes	– / yes / yes	– / yes / yes	– / yes / yes	– / yes / yes
yes	yes	yes	yes	yes
2x phyCAM-M (30pol)	2x phyCAM-S+ (8pol) / 2x phCAM-P (33pol)	phyCAM-S+ (8-pin)	phyCAM-P (33-pin)	2x phyCAM-S+ (8pol) / 2x phCAM-P (33pol)
phyCORE-i.MX 8M	phyCORE-i.MX 6Q	phyCORE-i.MX 6Q	phyCORE-i.MX 6UL	phyCORE-i.MX 6Q
1 Mpix color camera VM-016-COL-M-M12	WVGA monochrome camera VM-010-BW-M12	WVGA monochrome camera VM-010-BW-LVDS-M12	WVGA monochrome camera VM-010-BW-M12	Thermal camera 32x32 VM-050-050-0
12 mm, M12 with IR cut	12 mm, M12	12 mm, M12	12 mm, M12	5 mm, Germanium
yes	yes	yes	yes	yes
–	–	–	–	–
HDMI connector	HDMI connector	HDMI connector	WVGA 7"	HDMI connector
opt.	opt.	opt.	opt.	opt.
USB-Stick	USB-Stick	USB-Stick	USB-Stick	USB-Stick
yes	yes	yes	yes	yes
yes	yes	yes	yes	yes
yes	yes	yes	yes	yes
KPB-02419-Video-L01	**KPB-02301-Video-L01**	**KPB-01501-Video-L01**	**KPB-02013-Video-L01**	**KPB-02301-Video-L03**

Lenses

Perfectly fitting optics for your project

The advantages for you:

- Large selection of standard lenses
- Compact M12 or C/CS mount
- Low-priced, custom-made for your development
- Individual configurations (filter, iris settings)
- Complete mounting on camera module possible

We are happy to advise you in order to find the optimal solution for your task. Within the scope of OEM projects, we configure lenses according to your requirements. With our assembly service, we can deliver individually assembled camera modules with lens.

M12 Lenses (M12 x 0.5 / S-Mount)

Focal length	Iris range	MOD	IR-cut filter	Lens mount	Angle of view (D)	Article Number
Suitable for sensors up to 1/3" and up to 1 MPix					at 1/3"	
2.1 mm	2.0	0.4 m	-	S-Mount	155°	A0031-1
3.94 mm	2.0	0.4 m	-	S-Mount	92°	A0065
6 mm	2.0	0.4 m	-	S-Mount	58°	A0055
6 mm	2.0	0.4 m	yes*	S-Mount	58°	A0055-C
12 mm	1.6	0.2 m	-	S-Mount	32°	A0082
12 mm	1.6	0.2 m	yes*	S-Mount	32°	A0082-C
16 mm	2.0	0.4 m	-	S-Mount	21°	A0059
Suitable for sensors up to 1/2" and up to 1.3 MPix					at 1/2"	
10 mm	2.8	0.4 m	yes*	S-Mount	44°	A0054-C
Suitable for sensors up to 1/2" and up to 5 MPix					at 1/2.5"	
2.5 mm	2.4	0.1 m		S-Mount	166°	A0070.A1
2.5 mm	2.4	0.1 m	yes*	S-Mount	166°	A0070-C.A1
2.9 mm	1.6	0.1 m		S-Mount	152°	A0071.A1
2.9 mm	1.6	0.1 m	yes*	S-Mount	152°	A0071-C.A1
4.0 mm	1.8	0.4 m		S-Mount	112°	A0078
4.0 mm	1.8	0.4 m	yes*	S-Mount	112°	A0078-C
6.0 mm	1.8	0.4 m		S-Mount	68°	A0079
6.0 mm	1.8	0.4 m	yes*	S-Mount	68°	A0079-C
8.0 mm	1.8	0.55 m		S-Mount	52°	A0080
8.0mm	1.8	0.55 m	yes*	S-Mount	52°	A0080-C
12 mm	2.8	0.1 m		S-Mount	41°	A0062
12 mm	2.8	0.1 m	yes*	S-Mount	41°	A0062-C
Suitable for sensors up to 1/2.3" and up to 10 Mpix					at 1/2.3"	
5.4 mm	2.5	0.2 m		S-Mount	70°	A0076
5.4 mm	2.5	0.2 m	yes*	S-Mount	70°	A0076-C

* IR filter is recommended when using color cameras

Practical Tip

Lens Calculation

For a simple determination of the required focal length, you can use this approximate formula:

$$f = \frac{s}{O} \cdot D$$

f = Lens focal length
s = Sensor width
O = Object width
D = Distance camera to object

Sensor-Format		s
1/2"	(VM-012)	6.66 mm
1/2.5"	(VM-011/017)	5.7 mm
1/3"	(VM-010)	4.51 mm
1/3"	(VM-009)	4.60 mm
1/4"	(VM-016)	3.84 mm

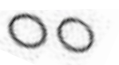
C/CS-Mount Fixed Focal Lengths 1/2", 1.3 Mpix

Focal length	Iris range	MOD	Lens mount	Angle of view 1/3"	Locking screws	Article Number
4.8 mm	1.8...C	0.2 m	C-Mount	55°07'	yes	**AO016**
6.0 mm	1.2...C	0.2 m	C-Mount	43°33'	-	**AO053**
8.5 mm	1.5...C	0.2 m	C-Mount	31°52'	yes	**AO047**
12 mm	1.2...22	0.2 m	C-Mount	22°04'	yes	**AO035**
16 mm	1.4...22	0.3 m	C-Mount	16°55'	yes	**AO026**
25 mm	1.4...22	0.3 m	C-Mount	10°58'	yes	**AO007**
35 mm	1.6...16	0.35 m	C-Mount	7°51'	yes	**AO051**
50 mm	2.8...22	0.9 m	C-Mount	5°30'	yes	**AO052**
50 mm	1.4...C	1.0 m	C-Mount	5°30'	yes	**AO049**

C/CS-Mount Zoom- and Vario-Lenses

Focal length	Iris range	MOD	Lens mount	diameter, length	Locking screws	Article Number
Suitable for sensors up to 1/3" and up to 1.3 MPix						
3.0..8.0 manual	1.0...C manual	0.3 m	CS-Mount	36.3 mm 44.4 mm	yes	**AO020.A1**
5.0..50.0 manual	1.4...C manual	1.0 m	CS-Mount	46.0 mm 60.2 mm	yes	**AO067**
8.0..48.0 manuell	1.2...C manual	1.2 m	C-Mount	57.0 mm 95.0 mm	yes	**AO006**
12.5..75.0 manual	1.5...C manual	1.0 m	C-Mount	51.0 mm 90.0 mm	-	**AO018**
Suitable for sensors up to 1/2" and up to 3 MPix						
4.0..12.0 manual	1.2...C manual	0.3 m	C-Mount	40.0 mm 50.3 mm	yes	**AO066**

Accessories, Adapter Ring Set



Components	Ring Sizes in mm	Lens mount	Article Number
Set, 6 pieces	0.5 / 1 / 5 / 10 / 20 / 40 mm	C/CS-mount	**AZ005**
C/CS-Adapter (1 piece)	5 mm	C/CS-mount	**AZ008**

Lens Mounting Services

PHYTEC configures your camera module's optics individually according to your project requirements. Special requirements, such as optical filters, can also be taken into consideration. At our dust-protected workstations, we assemble and adjust your camera modules according to your specifications.

We will advise you personally about the various possibilities: **contact@phytec.de**

USB Cameras

Ultra-compact USB cameras with up to 5 megapixel resolution

USB Cameras in Industrial Applications

The cameras of the USB-CAM series can be connected to any computer with a USB interface in a few easy steps. Due to the extremely compact metal housing and the mounting on all four sides, they can be installed almost anywhere. The cameras can be ordered in higher quantities without housing. Sub-resolutions can be easily selected via software so the camera can be adapted to a wide range of tasks.

Drivers for Windows 10 are included in delivery. Under Linux, the cameras can be addressed via the UVC interface. This means that the cameras can also be connected to PHYTEC microprocessor boards under Linux via V4L2.

Image Resolution	5 megapixels				WVGA			
Image Formats	2592 x 1944, 2048 x 1536, 1600 x 1200, 1280 x 960, 1024 x 768, 640 x 480; Binning Mode: 1280 x 960, 640 x 480				744 x 480, 640 x 480, 320 x 240			
Model	USB-CAM-051H	USB-CAM-151H	USB-CAM-052H	USB-CAM-152H	USB-CAM-003H	USB-CAM-103H	USB-CAM-004H	USB-CAM-104H
color / mono	monochrome	monochrome	color	color	monochrome	monochrome	color	color
Optical Format	1/2.5"				1/3"			
CMOS-Image Sensor	ON Semiconductor MT9P031				ON Semiconductor MT9V024			
Pixel Size	2.2 µm x 2.2 µm				6 µm x 6 µm			
Color Format	Y8	Y8	RGB32, RGGB (RAW)	RGB32, RGGB (RAW)	Y8	Y8	RGB32, RGGB (RAW)	RGB32, RGGB (RAW)
Lens Holder	C/CS-Mount							
Frame Rate (fps)	6 fps up to 52 fps				60 fps up to 150 fps			
Dynamic Range	8 Bit							
Shutter Type	Rolling				Global			
Reponsivity	1.4 V/lux-sec				4.8 V/lux-sec			
Interface	USB 2.0 HS							
Shutter Speed	1/10,000 s up to 30 s				1/10,000 s up to 1/4 s			
AWB / WB	–	–	-6 dB up to +6 dB	-6 dB up to +6 dB	–	–	-6 dB up to +6 dB	-6 dB up to +6 dB
Feature (optional)	–	ext. Trigger, Digital-Output	–	ext. Trigger, Digital-Output	–	ext. Trigger, Digital-Output	–	ext. Trigger, Digital-Output
Operating Temp.	-5°C up to +45°C							
Dimensions	36 mm x 36 mm x 25 mm							
Mounting Points	1/4", on all sides							
Article Number	AK091	AK093	AK092	AK094	AK087	AK089	AK088	AK090

Made in Germany

Production at the highest level

PHYTEC sees itself as a supplier for serial products. Our standard products and the individual hardware for your project are manufactured in Germany, in our own production facility in Mainz. This guarantees the highest quality and flexibility with regard to your production and delivery requirements. Fast availability of prototypes and scaleable services such as design and production according to industry-specific standards, e.g. VDA2 or KTA1401, are possible due to the close integration of development and production.

In an increasingly difficult component market, our obsolescence management takes over the product maintenance of your hardware, manages product change notifications of the component manufacturers and develops solutions to ensure delivery capability at all times.

The advantages for you:

- PHYTEC is your partner for the entire development and delivery cycle
- We take responsibility for your project and deliver complete solutions from proof of concept to series production
- Our project managers and developers develop your product realization in partnership with you
- Individual hardware at manageable development costs
- Earlier on the market through fast prototype production, longer on the market through PHYTEC's product care

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