

# The world of BAOS

Easy connectivity for KNX with  
**Bus Access and Object Server**

Overview and applications

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## What is BAOS?

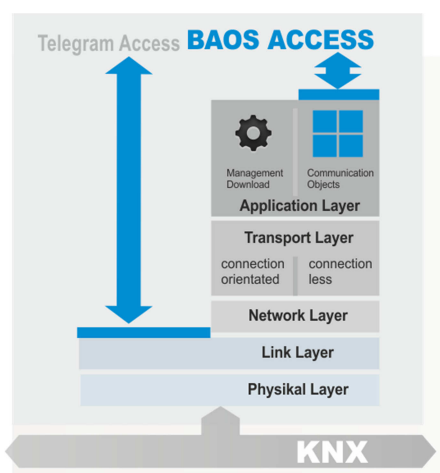
BAOS – short for "**B**us **A**ccess and **O**bject **S**erver" – is a universal architecture to enable KNX connectivity for a great variety of products. Within its range of KNX BAOS Solutions Weinzierl offers a scalable set of modules and powerful devices which rapidly enable the complete integration of applications into the KNX System.



Our BAOS Modules and Devices can be used as interfaces to connect to KNX both on the telegram and on the data-point level (the KNX Application Layer). Our BAOS Solutions allow an easy integration and implementation of KNX connectivity while releasing the application itself from the complexity of the KNX protocol, including the network management.

## KNX Communication

Devices that communicate via KNX require an implementation of the KNX protocol. The KNX protocol is specified according to the OSI (Open Systems Interconnection) reference model as a set of protocol layers.



The KNX system itself is a decentralized network and the runtime communication is based on group telegrams in multicast. To participate in the KNX runtime communication each device must be configured, e.g. group addresses must be assigned. Typically this is done via the ETS<sup>®</sup> (Engineering Tool Software) program, the official tool available from the KNX Association. The configuration can be loaded into the distributed devices via the KNX network

during the device download. These management procedures are complex and are also part of the KNX Standard.

In our KNX BAOS architecture all the KNX communication is handled within the BAOS Module or BAOS Device. A certified KNX Stack from Weinzierl ensures high performance runtime communication as well as complete compatibility with the ETS and all certified third-party KNX devices.

## KNX Serial BAOS Modules – easy integration into your devices

*Typical applications: Sensors, actuators or gateways to non-KNX systems*

With our KNX BAOS Modules we offer a quick and efficient solution to connect your devices to KNX. The compact PCBs include both a KNX transceiver and a microcontroller with a certified KNX stack. The modules can be integrated in devices and mounted via pin headers. The communication to the host device is realized via a serial connection.

A comprehensive user guide is available for our BAOS Modules on our website at [www.weinzierl.de](http://www.weinzierl.de). A generic ETS database with 250 group objects (1000 for the 830) is available to get you up and running. Custom ETS databases can also be created.

### KNX BAOS 820/830



The KNX BAOS Module 820 is powered via the bus and provides galvanic isolation to the host. The more powerful KNX BAOS Module 830 supports up to 1000 group objects.

### KNX BAOS 822



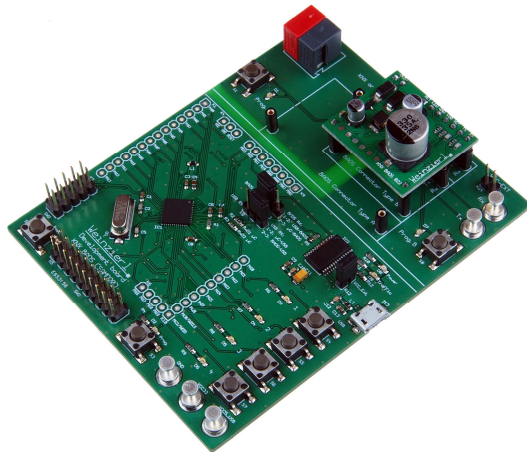
The KNX BAOS Module 822 offers the same feature set as the KNX BAOS 820 but with power from the bus for the application and without the galvanic isolation.

### KNX BAOS 840



The newest member within our BAOS module family is the KNX BAOS Module 840: it is the wireless variant (KNX RF) of the KNX BAOS Modules and implements KNX RF with full ETS5 support.

## BAOS Development Kit



To start your own project with our BAOS Solution a BAOS Development Kit is available which contains everything you need:

- BAOS Development board
- KNX BAOS Module 820/830
- KNX BAOS Module 822
- Tools and demo software
- USB cable for power supply

## KNX BAOS Devices – KNX ready to go for your devices

With our range of BAOS devices we bring the possibilities of our Bus Access and Object Server to the DIN rail – this enables integrating existing devices into KNX networks as external option but nevertheless with full integration in the ETS tool.

Our KNX Serial BAOS 870 with RS-232 is best suited if you make your first steps in KNX integration via the serial interface without changing the hardware of your existing product. For a link via LAN or Wi-Fi our KNX IP BAOS devices allow interfacing complex devices. Even powerful visualization apps for mobile devices can be easily realized using the KNX IP BAOS architecture.

### KNX Serial BAOS 870 – The external option via RS-232



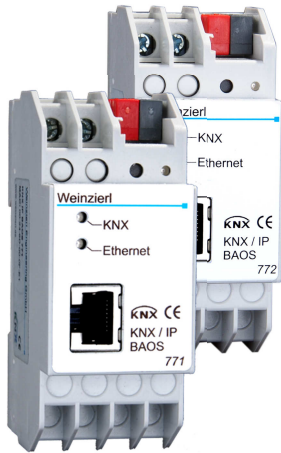
*Typical applications: KNX Interface for systems like heating or air conditioning without hardware changes.*

You can connect an existing device with KNX without changing your hardware as the complete functionality of our BAOS TP modules is also available as a rail mounted device: the KNX Serial BAOS 870 combines the flexibility of our BAOS platform with the commodity of a “ready-to-run” device.

The protocol and software functionality is identical to our build-in modules KNX BAOS 820 or 822. The hardware provides a galvanic isolation.

## KNX IP BAOS 771,772 and 777 – highest performance via IP

*Typical applications: Interface for devices with high communication capabilities like PLC (Programmable Logic Controller) or smartphone applications for home control.*



Using the KNX IP BAOS 771, 772 or 777 the KNX bus is accessible from everywhere via Ethernet. Connection over WiFi (with an extra router) or the Internet is possible, too. The IP settings as well as the data points can be configured with ETS software. The device requires either an external power supply or via Power-over-Ethernet (IEEE 802.3af) directly from the switch. This device can be also be used as a programming interface for ETS.

All variants are based on a tailored hardware with low power consumption. The KNX IP BAOS 771 supports up to 250 communication objects, the KNX IP BAOS 772 up to 1000.

The KNX IP BAOS 777 supports even up to 2000 data points and provides an OLED display and a web interface.



## Using KNX IP BAOS as application specific Gateway

The KNX IP BAOS 77x devices can be used as application specific Gateways for non-KNX systems. They can be used for example to connect heating devices, audio application and many more to KNX. For a quick start in development the generic ETS product entry can be used. The generic ETS entries support up to 2000 datapoints and implement a flat list of group objects that can be configured from a set of standard datapoint types, for example

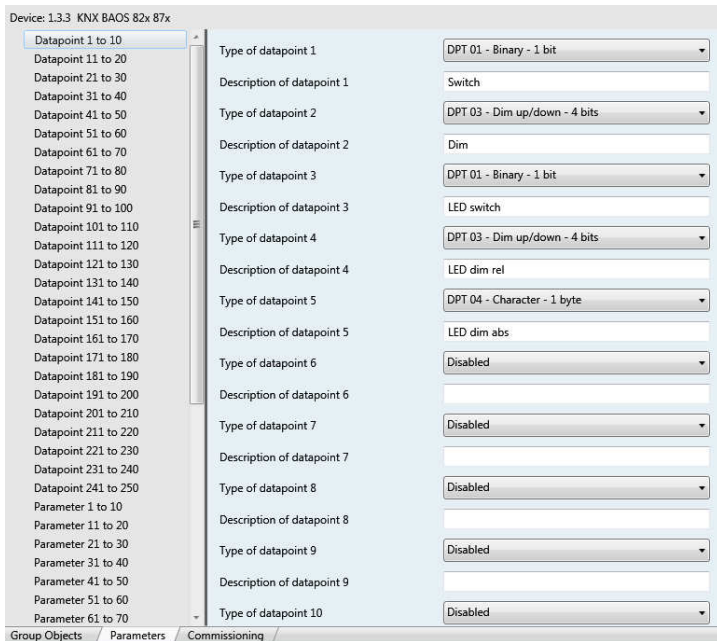
- DPT 1      1 Bit   Switching
- DPT 3      4 Bit   Dimming
- DPT 4      1 Byte Character
- DPT 5      1 Byte Scaling
- DPT 9      2 Byte Float Value
- DPT 10     3 Byte Time

To use the communication object of the BAOS object server, the data points have to be

configured. The KNX data point type has to be set and group addresses have to be assigned.

To simplify this task for each KNX BAOS Module or Device a corresponding ETS product entry is available from the Weinzierl website.

The generic ETS entry supports either 250, 1000 or 2000 data points, and the setting of single parameter bytes which can be used by the client. The generic



database can be used during product development and testing. For final products we recommend to create an individual database for your application to ensure an optimal representation of your product within the ETS. For further information about development with KNX IP BAOS devices please contact Weinzierl Engineering.

## Using KNX IP BAOS 77x as Residential Gateway

The KNX system is using a very specific protocol which is difficult to handle for non-KNX devices. With the well-tries BAOS architecture, the KNX IP BAOS 777 maps KNX data to an IT-friendly API (Application Programming Interface). Thus, it greatly reduces the effort to connect applications like control or visualization tools to KNX.

The KNX IP BAOS architecture not only allows access to the runtime data. In addition it retrieves the structure of the KNX installation. It encodes the rooms of a building as well as the available functions as a set of meta-data. Using the ETS commissioning tool the installer defines the rooms and which functions are available to the client. While a room is seen as a collection of functions, a function is a collection of datapoints representing a specific KNX interworking function. A simple example is a switching actuator with state which requires two datapoints. Functions are defined for, but not limited to:

- Switching Control
- Switching Control with State

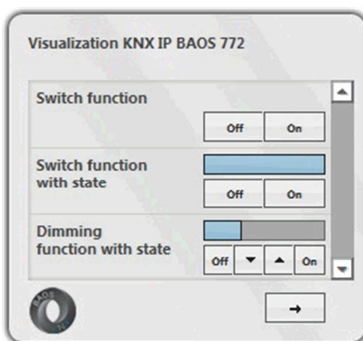


- Dimming Control
- Dimming Control with Switching State
- Dimming Control with Value State
- Temperature with Set Point
- RGB Control

## Smart integration of configuration data

The benefit of user parameters is to enable the possibility of configuring the application via the ETS parameter dialog. It is even possible to configure a visualization program just via the ETS.

## Powerful demonstration: KNX BAOS Gadget

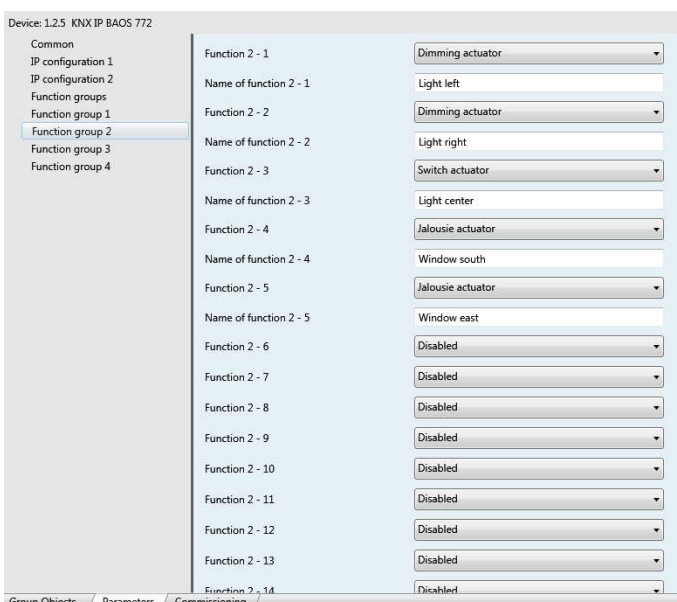


To demonstrate the KNX BAOS architecture the KNX BAOS Gadget has been created as a sample. It shows the possibilities to configure even complex applications like visualizations just using ETS parameters.

The KNX BAOS Gadget is a miniaturized visualization for the Windows® desktop that communicates via KNX IP BAOS 772 Interface with the BUS. The PC or Notebook is connected to the KNX IP BAOS via LAN or WLAN.

The graphical interface is generated automatically. An extra

Plug-In or editor is not required. The configuration is done only via the ETS parameters of the KNX IP BAOS 772 using the product database with building structure. The rooms and functions can be arranged very simply and can be denoted with any text you like. The appropriate communication objects are displayed automatically and can be linked with

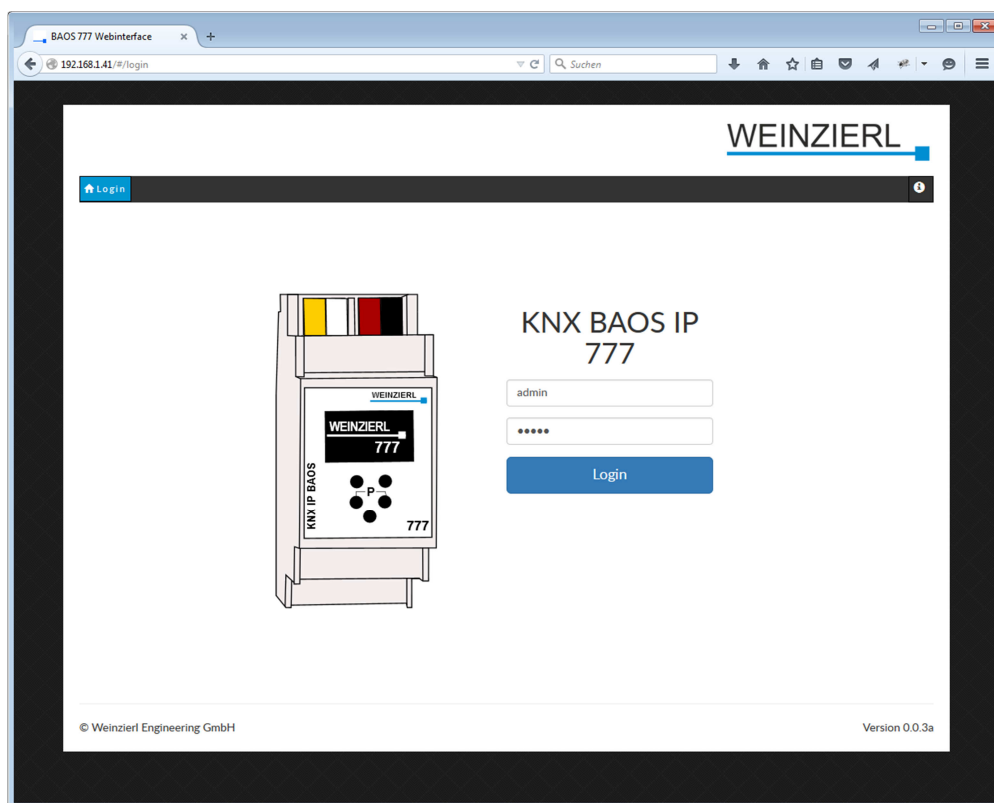


group addresses in ETS directly. The full configuration is transferred into the BAOS interface while downloading and can be read by the client. In this way, the consistency between the ETS project and visualization will always be ensured.

## Using KNX IP BAOS 777 with a Web Browser

The KNX IP BAOS 777 has an integrated web server which allows an easy and fast access to the building using a standard web browser. Using the ETS product entry with building structure the web server offers a visualization tool. Via the web interface also timers and history are available.

To access the web application, just enter the IP Address of the BAOS 777 into your browser. The IP address can be seen in the display of the device. Once a connection has been established to the BAOS you should see the login page. The username and password are by default “admin” and can be set in the ETS database.





## Smart with BAOS: Optimal basis for Smartphone apps

The KNX Gadget is just a sample. The main use case of this architecture is home and building control via mobile devices. Indeed this architecture is used by numerous smartphone applications available on the market from different manufactures.



The main advantages are:

- Fast and easy configuration of the app in ETS
- No additional editor for visualization
- No training needed
- Separation of graphical design and building structure
- Separation of building installation and app handling
- very low power consumption
- Object Server holds all actual values
- Simultaneous usage by multiple clients

KNX IP BAOS as micro server builds the interface to the building with semantic information from the installation. Only functions are available which explicitly have been added to the configuration. This increases security as well as safety for users and for the building.

## Behind the scene: The BAOS Protocol

The BAOS Protocol is a tailored solution to exchange data with an object server. It has a dynamic structure, not only for the length of individual data points but also for the number of data points encapsulated within one frame. That allows that in one request or indication multiple values can be transferred. This is essential for communication systems like IP which typically have a high bandwidth but sometimes quite high delays.

The communication structure of the BAOS architecture is client-server. The KNX BAOS Modules or Devices act as a server. The application is the client. Most services are sent from the client to the server which always sends a response. Asynchronous indications can be sent by the server to inform the client about updates of values via the KNX network.

The BAOS Protocol is used in three different formats:

- KNX BAOS Binary
- KNX BAOS Web Services
- KNX BAOS RESTful Web Services

The BAOS Binary Protocol uses arrays of bytes to code services. It is the best way to implement communication protocols directly in a microcontroller. The serial KNX BAOS Modules and Devices just use the binary protocol. The binary protocol is available as well on all KNX IP BAOS devices but in addition for IP the BAOS Web Service Protocol is available. It uses JSON (Java Script Object Notation) syntax to code the same content as the binary services. The Web Services have been introduced for client applications which run in a web browser. So the BAOS Web Services can easily integrated in web pages realized with Java Script.

As a new generation of Web Services the KNX IP BAOS 777 now supports all services in a RESTful API. The RESTful web services allow a semantic access to the structure of the installation. That means that the interpretation of the ETS parameters is now done in the KNX IP BAOS 777 device.

Currently the BAOS protocol is used in two versions, V1 and V2. The main difference is that in V1 identifiers are coded with just 1 byte. The resulting limitation to 255 group objects was very typical for KNX devices at this time. However in the meantime many applications require a higher number of objects, so version V2 has been defined. See the protocol specification for details.

	BAOS Binary V1	BAOS Binary V2	BAOS Web Services	BAOS RESTful Web Services
KNX Module BAOS 820	✓			
KNX Module BAOS 822	✓			
KNX Serial BAOS 870	✓			
KNX IP BAOS 771		✓	✓	
KNX IP BAOS 772		✓	✓	
KNX IP BAOS 777		✓	✓	✓

Table 1: BAOS protocol versions

## The Transfer Protocol

The BAOS Protocol just contains application data. It does not define a transport protocol, so it can be used on different connection types.

For the modules and devices which support a serial link, the BAOS Protocol is encapsulated in a FT1.2 frame which defines the start and the end of the packet as well as a checksum and acknowledgement. FT1.2 is an international standard (IEC 870-5-1 and 870-5-2).

The KNX IP BAOS Devices use either IP UDP or TCP packets as frames. The headers and usage is very similar to the KNXnet/IP specification however they use the BAOS data structure as content. Although in principle UDP is a connectionless communication, there is some kind of transport connection on top of UDP which is required to send asynchronous indications to the client. The KNX IP BAOS Devices always act as a communication server.

A major benefit of the IP protocol is the possibility of multiple connections. Up to 10 clients can be connected to a single KNX IP BAOS device via the IP BAOS protocol.

	Serial FT1.2	IP UDP	IP TCP
KNX Module BAOS 820	✓		
KNX Module BAOS 822	✓		
KNX Serial BAOS 870	✓		
KNX IP BAOS 771		✓	✓
KNX IP BAOS 772		✓	✓
KNX IP BAOS 777		✓	✓

Table 2: Frame formats

A demo application for KNX BAOS Binary for MS Windows® is available on our web page. The BAOS Binary Protocol is also available in the free version of Net'n Node 5. For easy integration of the KNX BAOS protocol into different environments free SDKs are available in source code also for download on our web page:

- SDK for BAOS Serial Protocol
- SDK for BAOS Binary Services
- SDK for BAOS Web Services

## SDK for BAOS Serial Protocol

A free software framework is available for download on our web page which integrates the FT1.2 protocol as well as the BAOS protocol. A simple application shows the usage of the communication drivers for embedded micros.

## SDK for BAOS Binary Services

The Software Development Kit SDK for BAOS Binary Services is a cross-platform C++ implementation of the KNX BAOS Binary Protocol. It can be used for a rapid development of native applications for KNX control which use the KNX BAOS IP Interfaces. The main use case for this SDK is the development of visualization apps for mobile devices such as smart phones or tablet computers.

## **SDK for BAOS Web Services**

The SDK for BAOS Web Services is a Java Script implementation of the KNX BAOS Web Services Protocol. It can be used for the rapid development of web applications for KNX control which are using the KNX BAOS IP Interfaces. The main use case for this SDK is the development of visualization apps running in a web browser. Web application can be used on nearly any computers as well as on mobile devices such as smart phones or tablet computers. Both BAOS SDKs support the KNX IP BAOS 771/772 and the KNX IP BAOS 777.

## **SDK for BAOS RESTful Web Services**

SDK and sample code for the RESTful Web Services is in preparation.

## **Product certification with BAOS**

For decades, its cross-manufacturer compatibility of various applications and products is the main pillar of the KNX system. This is achieved by the advanced certification system of the KNX Association. All devices with a KNX logo must be tested by a test laboratory accredited by the KNX Association for compatibility.

The KNX BAOS modules and devices build a perfect basis for applications which can be certified because a certified KNX Stack is implemented. If you are using a BAOS component the Stack is not required to be tested again. Therefore only the application specific tests, i.e. interworking and functionality, are required.

Weinzierl has its own accredited test lab for KNX certification. If you have any questions regarding product qualification please refer to our website or contact us directly.

## **...and what about the KNX Stack?**

A KNX Stack is a software solution as a basis for KNX device development. Also in all KNX BAOS Modules or Devices a Weinzierl KNX Stack is running. The usage of a stack gives a maximum on flexibility and can be integrated with the application on a single micro.

The application development on a KNX Stack typically requires more effort and system knowledge compared to the usage of a BAOS solution. It is mainly used for devices with a higher volume. For more information, please visit our web page at [weinzierl.de](http://weinzierl.de)

## **Any questions left?**

The choice of the best architecture for an application is not trivial but always necessary at the beginning. If you have any questions how to start KNX development or about our solutions please do not hesitate to contact us.