

Smart home and building solutions. Global. Secure. Connected.

KNX RF development with Weinzierl solutions

Dr. Thomas Weinzierl Weinzierl Engineering GmbH www.weinzierl.de

WEINZIERL

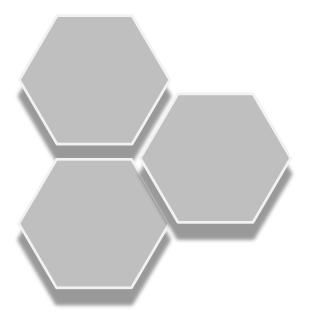






Agenda

- About Weinzierl
- KNX System Overview
- KNX RF with ETS
- KNX BAOS Modules
- KNX Stack NGS
- Demo with Net'n Node









Weinzierl Engineering GmbH

- Founded 2001
- Burgkirchen / Alz
 - South East of Germany
- System solutions for KNX
 - KNX Stacks & Modules
 - KNX Development Tools
- Testing
 - KNX accredited Test Lab
- Production
 - KNX Devices









KNX RF History

- Since 2002
 - Medium RF specified
 - Mainly for Easy Mode, no ETS
 - Only a few manufacturers
- Since 2014
 - For System Mode
 - Now in-line with TP & IP
 - Fully integrated in ETS
- Since 2017
 - KNX Security
 - Growing number of products









Application Area

- KNX wireless devices
 - Sensors
 - Actuators
 - Remote control
 - ...
- RF-only Installations
 - Renovation market
- Hierarchical Installations
 - RF combined with TP and IP
 - In one ETS project





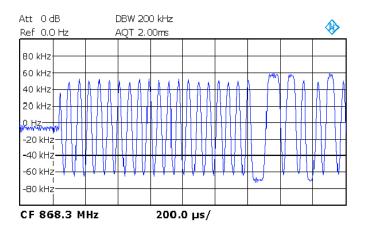






KNX Radio Frequency - RF

- Short range device
 - ISM Band 868 MHz
 - FSK Modulation
- Good range within buildings
 - Very reliable
 - No Mesh required
 - Re-transmitters possible
- No dedicated KNX transceiver required
- Low cost production

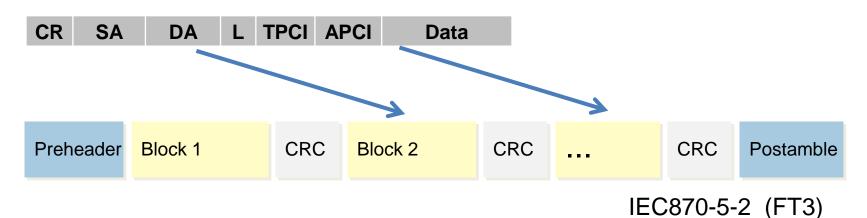








Frame format KNX RF ready



- KNX Data in FT3 block format
 - Preheader 176 chips
 - First block 10 bytes (fixed length), RF specific (SN / DoA)
 - Further blocks 16 bytes (variable length), KNX telegram
 - Last block
 - CRC 2 bytes CRC after each block
 - Postamble

2 to 8 chips, end of frame

1 to 16 bytes







Addressing Modes

Destination Address on KNX TP

Destination	n Address	Addressing Mode
IA	DAF = 0	Individual Address
GA	DAF = 1	Group Address
GA = 0x0000	DAF = 1	Broadcast

Destination Address on KNX RF

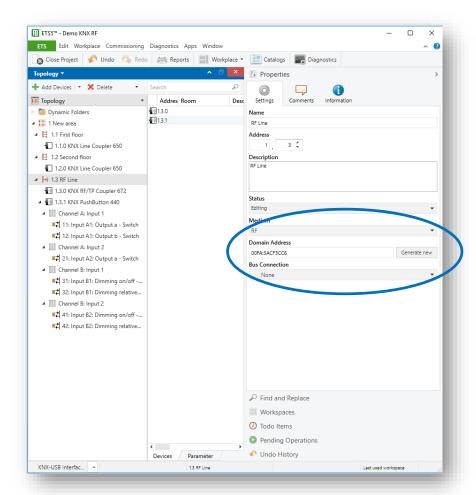
Block 1	Block 2, De	st. Address	Addressing Mode
SN	GA	DAF = 1	Ext. Group Address (PB Mode)
DoA	GA	DAF = 1	Group Address
DoA	IA	DAF = 0	Individual Address
DoA	GA = 0x0000	DAF = 1	Broadcast
SN	GA = 0x0000	DAF = 1	System Broadcast





ETS & RF

- What's new
 - Lines for RF
 - Domain addresses
 - Connection via USB / RF Interface
 - RF / TP Coupler
- What's unchanged
 - Group Objects
 - Group Addresses
 - Parameters
 - Download

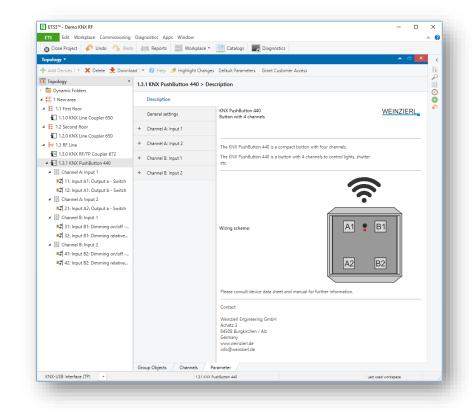






ETS – Group Objects & Parameters

- Group Objects
 - Linked via group addresses
 - Configured by flags
- Parameters
 - Device configuration
 - Set in parameter dialog
- Download
 - Via KNX network
 - Via USB / RF Interface
 - Via TP and RF / TP Coupler
 - Local USB connection







Topology: RF-only Installation

- Minimal RF Setup
 - KNX RF Devices
 - 2..255
 - KNX Interface to PC
 - USB, optional
 - For commissioning only



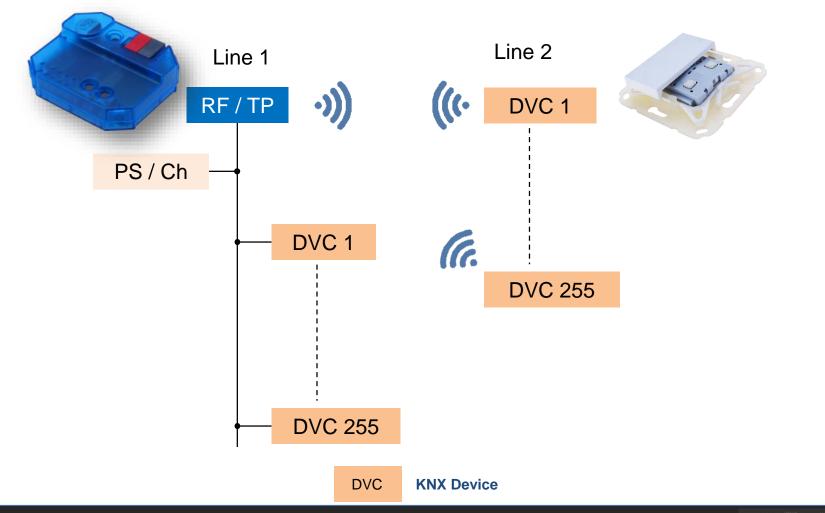








Topology: TP line + RF line





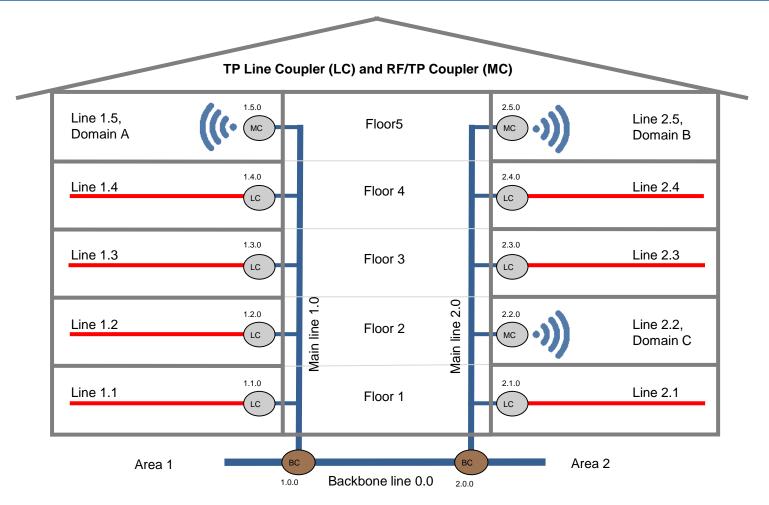




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Topology: Structure in building



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Further aspects about KNX RF

- Semi-bidirectional devices
 - For battery driven sensors
 - Bidirectional for commissioning
 - Unidirectional during runtime
- Segment coupler
 - Extend TP line with RF/TP Coupler
- Secure Proxy
 - Connect secure and unsecure segments





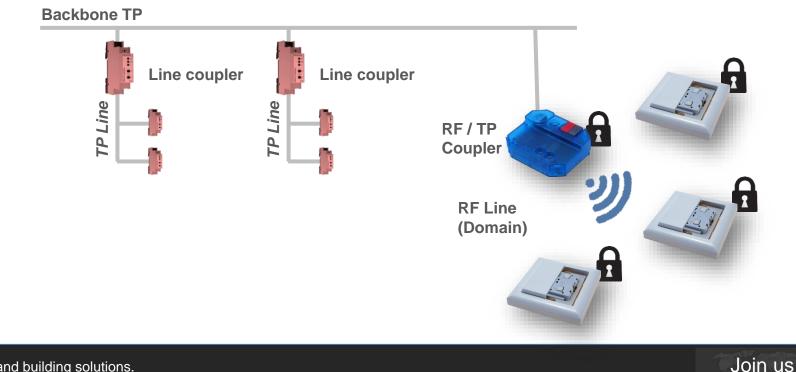




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Mixing secure and non-secure Communication

- Security per link
- Security in sub-systems
 - KNX Secure Proxy
 - Supported by ETS







KNX Security

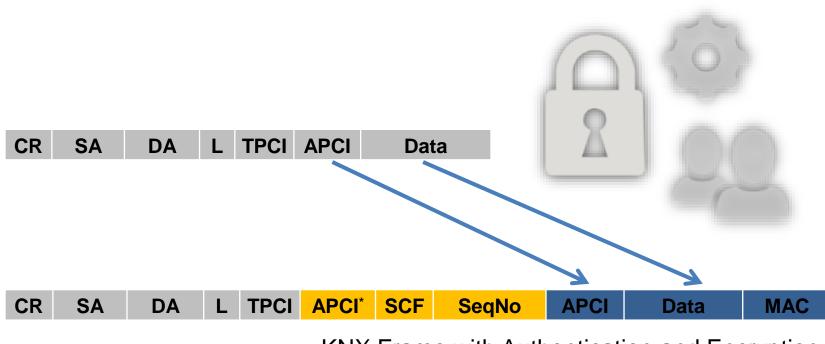


- Based on standard security technologies
- Based on AES
 - Advanced Encryption Standard
 - Block length: 128 bits
 - Key length: 128 bits
- Challenge: KNX System aspects
 - E.g. group addressing





KNX Data Security: Frame Format



KNX Frame with Authentication and Encryption

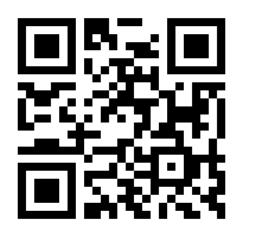






KNX Data Security: Keys & Counters

- FDSK (Factory default setup key)
 - Set by manufacturer, shown as QR-Code
 - Reactivated after master reset



- Tool key
 - Replace FDSK
- Group keys
 - Runtime communication
- Sending counter
 - One per device
 - Persistency required







KNX Security in ETS

- Fully Integrated since ETS5
- Using camera for QR-Code
- Secure configuration
- Secure Download



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oology 🔻									D D
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		00C5:FFFFEE22	0001030	04050607090	0A0B0C0D0E0F				

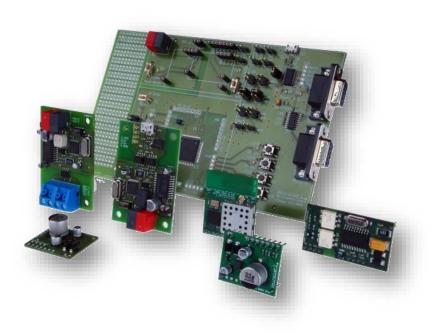






KNX Development

- Development solutions for KNX manufacturers
- KNX BAOS Modules
 - KNX Stack on HW
- KNX Stack NGS
 - Full integration
 - Scalable
- Tools
- Services
 - Development
 - Test Lab









Development with BAOS solutions



- Bus Access and Object Server
- Bus Access
 - Telegram level
 - Programming interface for the ETS
 - Object Server
 - Object Level
 - Allows a fast integration of non-KNX devices into a KNX network
- Host interface
 - Serial, USB, IP





KNX BAOS Modules: Application Area

- When using a module?
 - Low and medium quantities
 - Extension for existing devices
- Benefits
 - Fast time to market
 - Low impact to application
 - Low investments
 - Certified system software

- ETS product database
 - Available as generic
 - Individualization possible
 - Up to 1000 data points

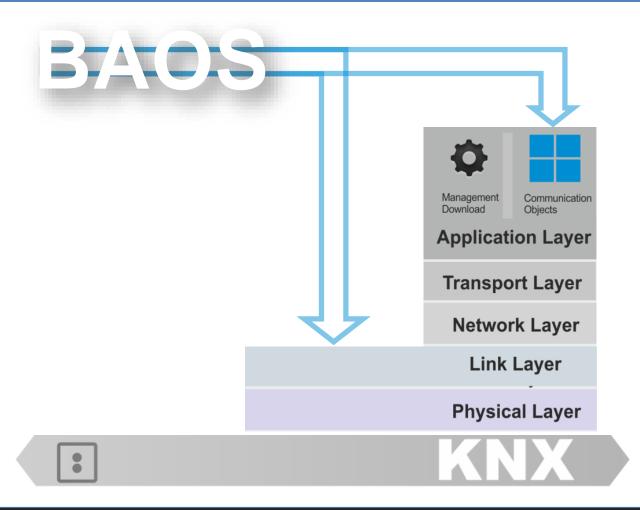








Access on different layers



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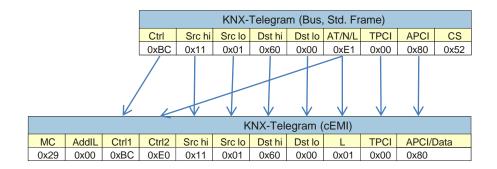
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Telegram Access: common EMI

- Send and receive KNX telegrams
- Access to Data Link Layer
- Message Protocol cEMI defined in KNX
- Embedded into an FT1.2 frame





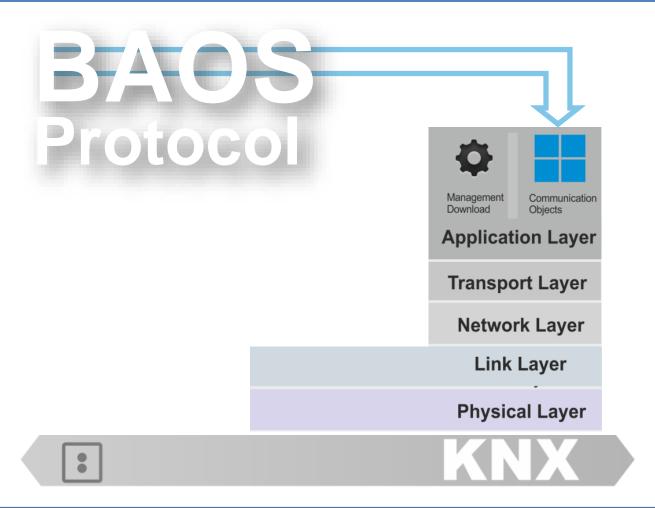


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Application: data points







BAOS Protocol: Object Server

- BAOS
 - Bus Access and Object Server
- Abstraction
 - Separates KNX handling from client
 - Client communicates to BAOS module
 - No KNX telegrams to be handled by client
- BAOS data
 - Data points (group objects)
 - Parameters (ETS)
 - Server items (Module related)

	\$	
	Management Download	Communication Objects
A	Applicat	ion Layer
	Transpo	ort Layer
	Netwo	rk Layer
	Link	Layer
	Physic	al Layer





Advantages of the object server

- No handling of KNX telegrams required
 - No knowledge of group addresses
- The object server always keeps the current values
 - Even if the application is not connected
 - No group-value-read required
 - Short latencies
- ETS download handled by BAOS
 - Decoupling from user application



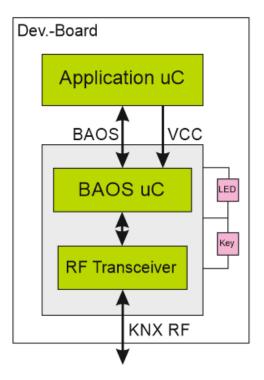






HW structure using BAOS RF Modules

- KNX BAOS 840
- Power supply
 - By application
- Module
 - Microcontroller
 - KNX RF Transceiver
 - Antenna output
- Development board
 - Microcontroller for application
 - USB, virtual Comport
 - Some IOs





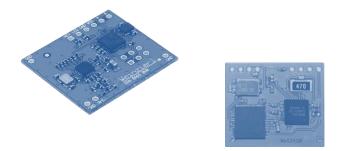




KNX BAOS Firmware

- Certified KNX Stack
- BAOS Protocol
 - Bus access (telegrams)
 - Object server (data points)
- Serial protocol 'FT1.2'
 - Universal frame format
 - IEC 0870-5-1 /-2
 - Well-tried in KNX





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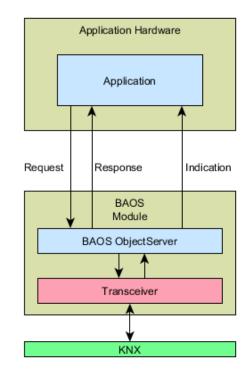




BAOS Protocol: Communication

- Request-response architecture
- Indications for object updates
- Access to Group Objects
 - GETDATAPOINTVALUE.REQ / RES
 - SETDATAPOINTVALUE.REQ / RES
 - DATAPOINTVALUE.IND
- Access to ETS Parameter
 - GETPARAMETERBYTE.REQ / RES

		В	AOS protocol				
Byte 0	Byte 1		Byte 2		Byte 3		Byte 4
7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0	76	5 4 3 2 1 0	76	5 4 3 2 1 0	76	5 4 3 2 1 0
Main service	Sub service		Start		Number		Error code or
0xF0	000 3011000		item		of items		First item ID
			BAOS protocol				
Byte 5	Byte 6		Byte n-2		Byte n-1		Byte n
7 6 5 4 3 2 1 0	7 6 5 4 3 2 1 0		7 6 5 4 3 2	1 0	7 6 5 4 3 2	10	7 6 5 4 3 2 1
First item data length	First item data		Last item ID		Last item data le	ength	Last item data



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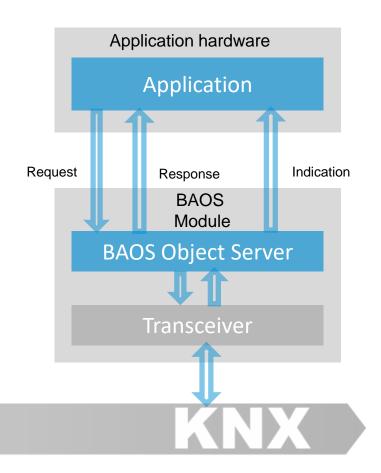
BAOS Protocol: Communication

Access to communication objects

- GETDATAPOINTVALUE.REQ
- GETDATAPOINTVALUE.RES
- DATAPOINTVALUE.IND
- SETDATAPOINTVALUE.REQ
- SETDATAPOINTVALUE.RES

Access to ETS parameters

- GETPARAMETERBYTE.REQ
- GETPARAMETERBYTE.RES



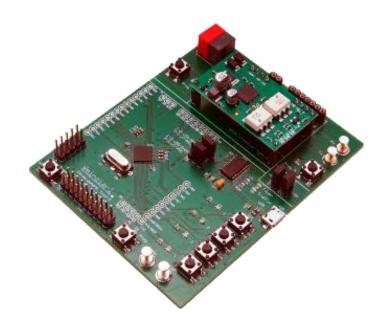






SW Framework & API

- Free demo code
 - Framework for KNX devices
 - Handling of BAOS protocol
 - Simple demo application
- For BAOS dev. board
- Prepared for Cortex M0x
 - Project for Atmel Studio
 - GCC compiler
- Can be ported to any µC
 - UART / Timer









Framework & API

- Change and send a data point value:
- uint8_t nValue = LED_OFF;
- MnxBaos_SendValue(1, DP_CMD_SET_SEND_VAL, 1, &nValue);
- Get response of data point change:
- void App_HandleSetDatapointValueRes(
- uint8_t nStartDatapoint)
- {
- Implement this
- }

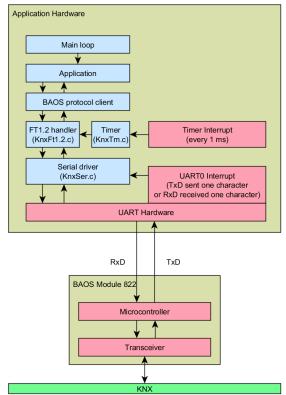






Framework & API

- Get notification of data point value change:
- void App_HandleDatapointValueInd(
- uint8_t nDpId,
- uint8_t nDpState,
- uint8_t nDpLength,
- uint8_t* pData)
- {
- // Implement this
- }









ETS database entry

- Generic ETS database entry for a quick start
- DCA for import/export

Device: 1.1.1 KNX IP BAOS 771			
Common	· · · · · · ·	DPT 01 - Binary - 1 bit	
IP configuration 1	Type of datapoint 1	DPT 01 - binary - 1 bit	
IP configuration 2	Description of datapoint 1	Light Living Room	
Datapoints 1 to 10			
Datapoints 11 to 20	Type of datapoint 2	DPT 03 - Dim up/down - 4 bits 🔹	
Datapoints 21 to 30	5 1 K K K K K K K		
Datapoints 31 to 40	Description of datapoint 2	Dimmer Living Room	
Datapoints 41 to 50	Type of datapoint 3	DPT 09 - Float value - 2 bytes -	
Datapoints 51 to 60	21 1		
Datapoints 61 to 70	Description of datapoint 3	Temperature	
Datapoints 71 to 80	Type of datapoint 4	DPT - Unknown - 1 byte	
Datapoints 81 to 90	Type of datapoint 4	UPT - Offkriowit - I byte	
Datapoints 91 to 100	Description of datapoint 4	Value	
Datapoints 101 to 110			
Datapoints 111 to 120	Type of datapoint 5	Disabled 🔹	
Datapoints 121 to 130	Description of datapoint 5		
Datapoints 131 to 140	Description or datapoint 5		
Datapoints 141 to 150	Type of datapoint 6	Disabled 🔹	
Datapoints 151 to 160			
Datapoints 161 to 170	Description of datapoint 6		
Datapoints 171 to 180	Type of datapoint 7	Disabled 🔹	
Datapoints 181 to 190	Type of datapoint 7	Uisabled •	
Datapoints 191 to 200 +	Description of datapoint 7		
Device objects / Parameters / Con	nmissionina /		

- Individual ETS database entries
 - By the manufacturer using KNX MT
 - As service from Weinzierl Engineering





Net'n Node

- Busmonitor program
 - Free edition
- Multiple port architecture
 - USB, IP, Serial
- For all KNX media
 - TP, RF, IP
- For BAOS Protocol
 - BAOS view

net'n node

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KNX BAOS solutions for RF

- KNX BAOS Module 840 RF
 - Host interface with serial FT1.2
 - To extend embedded devices with KNX RF
- KNX USB Stick 340 RF
 - USB Stick for ETS
 - Host interface with USB HID
 - Support of KNX BAOS Protocol
 - As external KNX RF stack for devices with OS like Linux





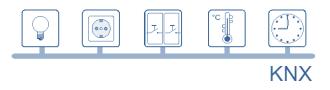




KNX Stack NGS: Application Area

- For KNX end devices
- When using a stack?
 - High volumes
 - Many device types
- Benefits
 - High flexibility
 - Low cost production
- Take into account
 - High investment, also in the team
 - For skilled developers



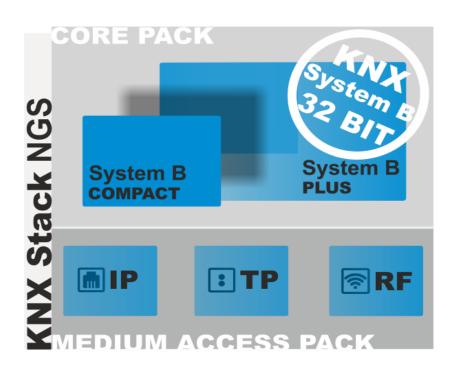






KNX Stack Implementation NGS

- Professional solution for high volume products
- KNX Security integrated
- Modular
 - Twisted Pair TP
 - Radio Frequency RF
 - Ethernet / IP
- Scalable
 - Compact
 - Plus
- Development HW
- Tools



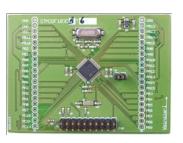


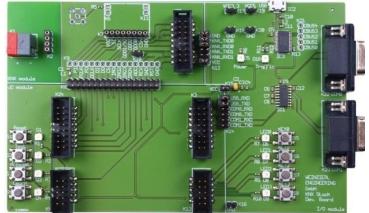




Modular Development Boards

- Base Board
- Micros
 - Broad range 8..32 Bit
- Bus Access
 - KNX TP
 - KNX RF
 - KNX IP

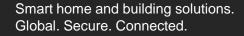












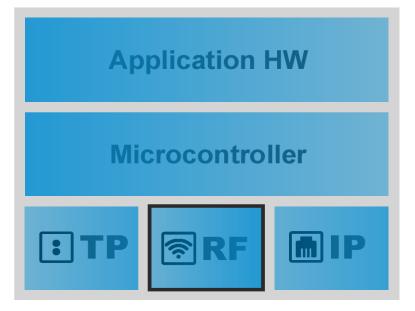






Medium Access Pack RF

- Bus-Access
 - KNX RF
 - Data link layer for ISM Transceiver
 - SPI Driver for Data & Configuration





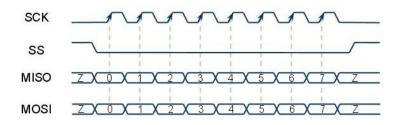






Hardware Connection

- Use schematic of RF transceiver
- Add microcontroller with clock, etc.
- Connect RF configuration interface
 - 4-wire interface
 - uC is master
- Connect RF data interface
 - SPI interface
 - uC is slave
 - Bit clock generated by RF chip
- Add application specific parts









ISM Transceivers

- Microchip MRF89XA
- Semtech SX1211
- Silicon Labs Si4431 / Si4432
- TI / Chipcon CC1101
- ST S2LP







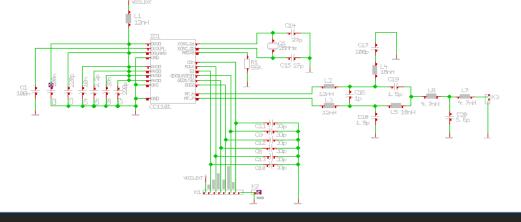
SEMTECH



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Modules for KNX RF

- Standard ISM Solutions
 - Microchip MRF89XA / Semtech SX1211
 - Silicon Labs Si4431 / Si4432
 - TI / Chipcon CC1101
 - ST Spirit 1 / S2LP
- Transceiver Modules
 - For Weinzierl Development Boards
 - For Products
- Antenna
 - Wire, PCB, Chip
 - Matching required









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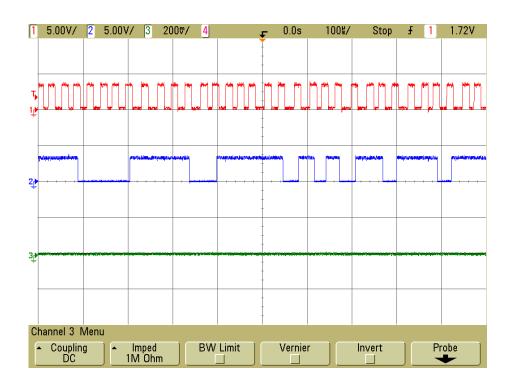






Sending & Receiving

- Sending
 - Pre-header
 - Manchester Coding
- Receiving
 - Transceiver in NRZ mode
 - Not synchronized
 - Permanent sampling
 - Chip rate 32 768 cps
 - 4 096 patterns per second
 - Manchester decoding



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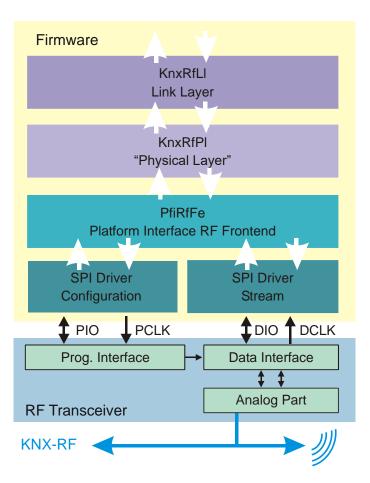
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Physical & Link Layer

- Link Layer
 - Block building
 - Checksum
- Bit handling
 - Pre-header sending/detection
 - Manchester coding/decoding
- HW driver
 - Interface to transceiver
 - Interrupts



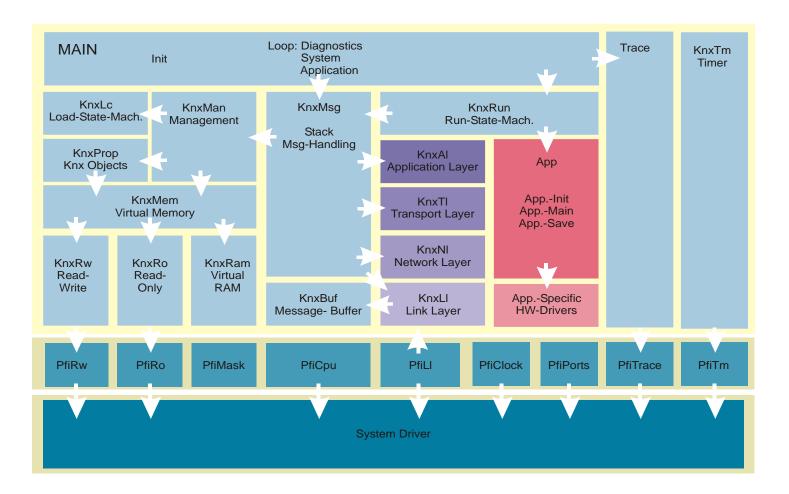
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Firmware Overview





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Additional Services for RF

- Services for open media
 - APCI_DOMAINADDRESS_WRITE
 - APCI_DOMAINADDRESS_READ
 - APCI_DOMAINADDRESS_SER_NUM_WRITE
 - APCI_DOMAINADDRESS_SER_NUM_READ
 - APCI_DOMAINADDRESS_SER_NUM_RESP





KNX Development Tools

- Net'n Node
 - Bus Monitor and Analyzer
- TraceMon
 - Optimized debug support
- kScript
 - Model driven design
 - Script based system
 - Automated generation of ETS product entries
- kDrive SDK
 - For tool development
 - Bus access and services
 - Free and commercial versions

net'n'node kScript kDrive







Conclusion

KNX RF

- Fully integrated in the KNX System
- One tool fits all: ETS6
- Potential for complex topologies
- Security enables new applications
- Technology available
 - Specification, ETS, EITT
 - KNX Stack and Modules
 - Development tools







Thanks.

KNX RF development with Weinzierl solutions

For general questions: info@knx.org – www.knx.org



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