

<< EnergyBus <<

Advantages and Implementation Options

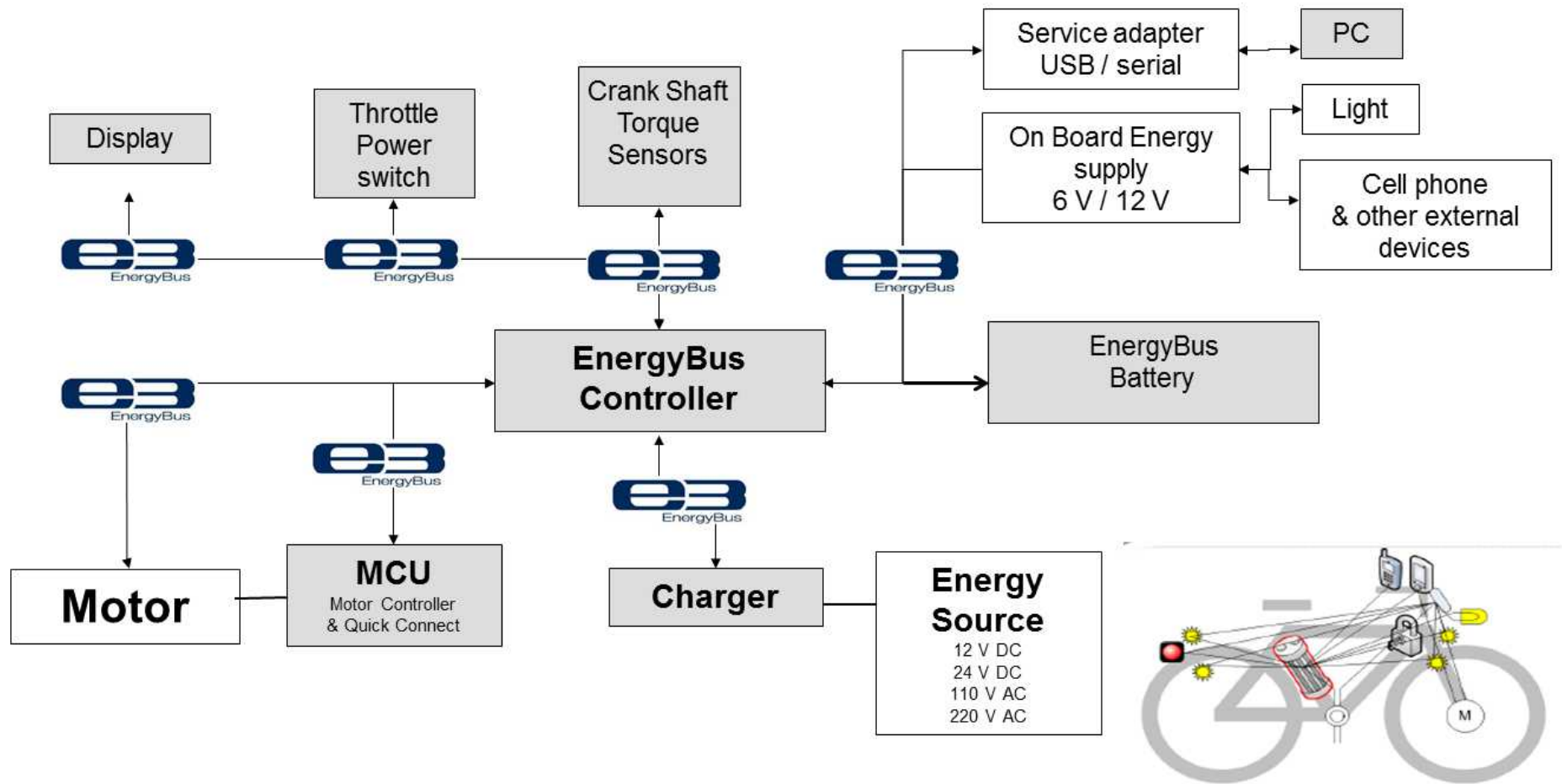
Torsten Gedenk
emtas GmbH
ged@emtas.de



<< Agenda <<

- **What is EnergyBus?**
- What are its benefits?
- How does EnergyBus works?
- How can it be implemented?

<< EnergyBus <<



«« EnergyBus e.V. ««

The image displays a grid of logos for EnergyBus e.V. members, organized into eight horizontal categories. Each category is highlighted with a red header bar. The categories and their members are as follows:

- DRIVE UNIT:** alber, BionX, brose, SEW EURODRIVE, BOSCH, clean mobile, electragil, and three smaller circular logos.
- HUMAN-MACHINE-INTERFACE:** ACEWELL and Cha Co International.
- ENERGY STORAGE DEVICE & CHARGERS:** BMZ, HITECH, Panasonic, PHYLION, SANYO, STL Technology, SUNROAD, and VARTA.
- VEHICLE:** DEPIOS, Haberstock Mobility, KTM, MATRA, +STROMER-, SBEC, and WINORA.
- CONNECTOR & CABLE-HARNESS:** IMS CONNECTION SYSTEMS, Rosenberger, and SINGATRON.
- COMPONENTS & DEVELOPMENT HOUSES:** ABUS, DEBALOG, PHILIPS, RAFI, ropa, and TESH.
- INFRASTRUCTURE & OPERATORS:** DB BAHN, LEISER+RAD, MOVELO, wsm, and ZIEGLER.

- EnergyBus e.V. founded in 2007
- Currently more than 80 members
- EnergyBus e.V. promotes EnergyBus and its international standardization (ISO/IEC)
- Conformance Test by EnergyBus GmbH
- Cooperation with CAN in Automation e.V. to define the communication protocols

<< Motivation <<



- Single connector between battery and charger
- Interoperability between batteries and chargers of different manufacturers
- Plug'n'Play
- Public Charging Infrastructure
- Risk reduction
- Defined Service interface
- Defined communication with additional components like motor controllers, displays, ..

<< Agenda <<

- What is EnergyBus?
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◀◀ Benefits of EnergyBus ◀◀

- Public charging infrastructure for all brands
- Interoperability of various components
- Multiply batteries, motors, chargers at a single Pedelec
- Common Service interfaces for dealers
- Theft protection and history of components by unique device IDs
- Creative accessories
- Market for used batteries thanks to detailed diagnostic information
- Multiple use cases in other industries for batteries and charger:
 - RV vehicles, isolated grids, fork lifts and more (VDMA)
- Reduced development and service costs by reduced number of variants

<< EnergyBus Conformance Test <<

- Ensures Compliance to EnergyBus and CANopen specifications (CiA 454 and CiA 301)
- Quality label for customers and retailers
- Offered by EnergyBus GmbH

<< Agenda <<

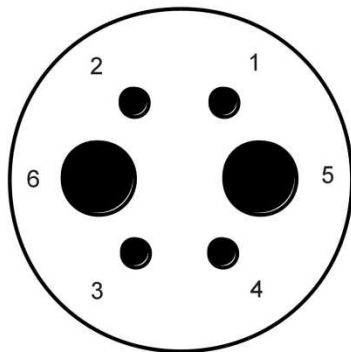
- What is EnergyBus?
- What are its benefits?
- **How does EnergyBus works?**
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«« EnergyBus Connector ««

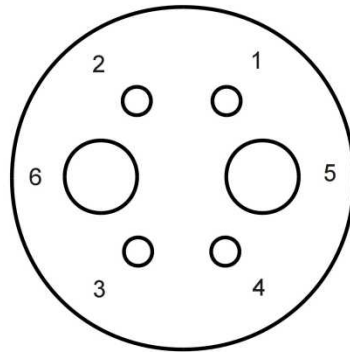


- Voltage up to 60V (Power line)
- Current up to 50A
- 2 pin for power (Power line)
- 2 pins for 12V auxiliary voltage (for passive devices and to wake up deeply-discharged batteries)
- 2 pins for CAN communication
- Magnetic reverse polarity protection

Plug

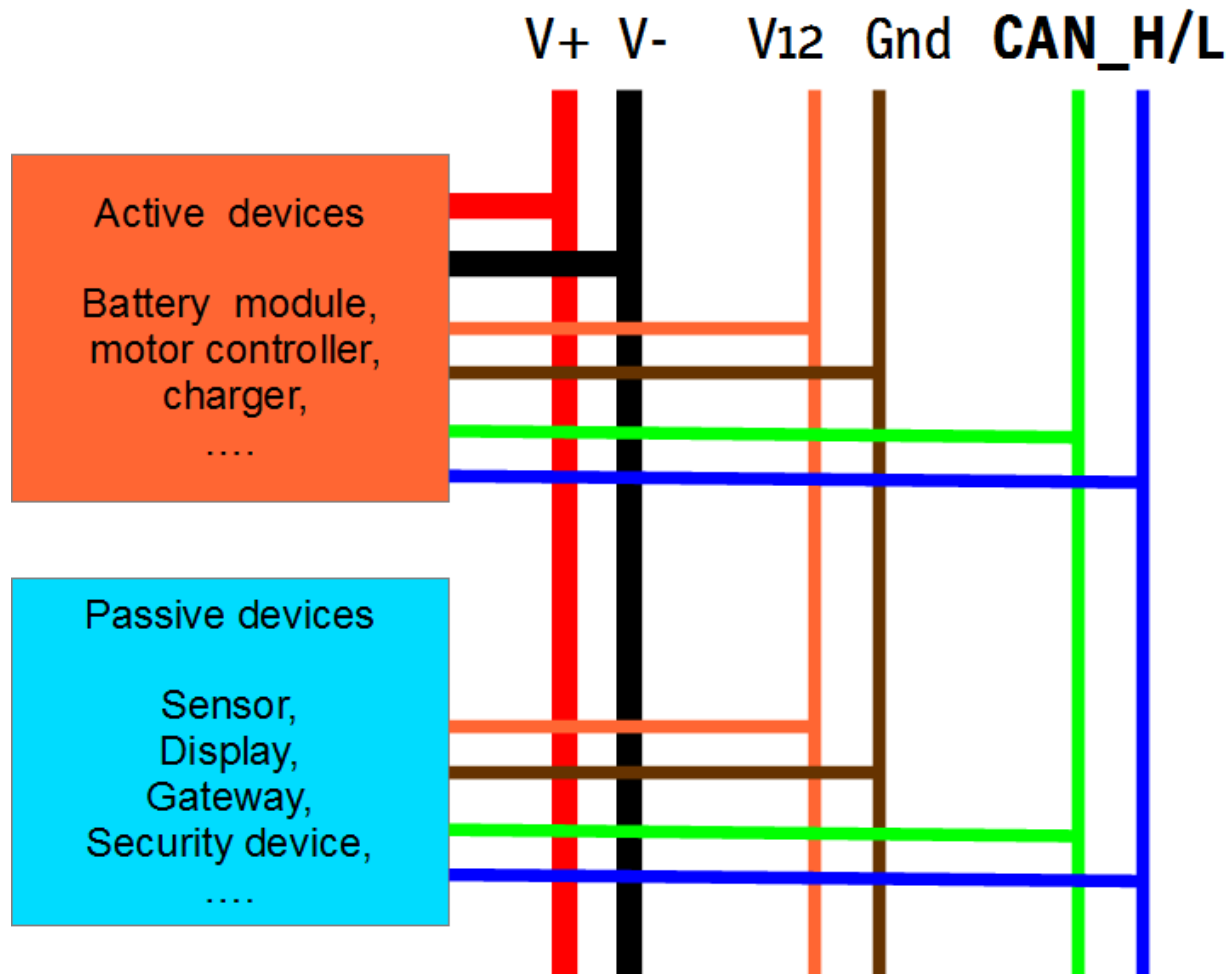


Socket



Pin	Signal	Description
1	CAN_H	CAN_H bus line
2	CAN_L	CAN_L bus line
3	AUX_V	+12V auxiliary voltage
4	AUX_GND	Auxiliary ground
5	POW_V	Power line voltage (up +48V)
6	POW_GND	Power line ground

EnergyBus Communication



- Communication based on CAN (250 kBit/s)
- CANopen is used as higher-layer protocol
- EnergyBus communication is defined as CANopen application profile






◀◀ CANopen ◀◀


- Higher-Layer-Protocol based on CAN
- Up to 127 devices (nodes) possible in a CANopen network
- Defined list of device parameters = Object Dictionary
- Defined communication services
 - Service Data Object service (SDO)
 - Access to all data in Object Dictionary
 - Process Data Object service (PDO)
 - Fast access to process data
 - Implemented as pure CAN messages
 - Emergency messages = defined alarm or error messages
 - Layer Setting Services for dynamical node-ID assignment
- Behaviour defined in device or application profiles

<< CANopen in multiple industries <<

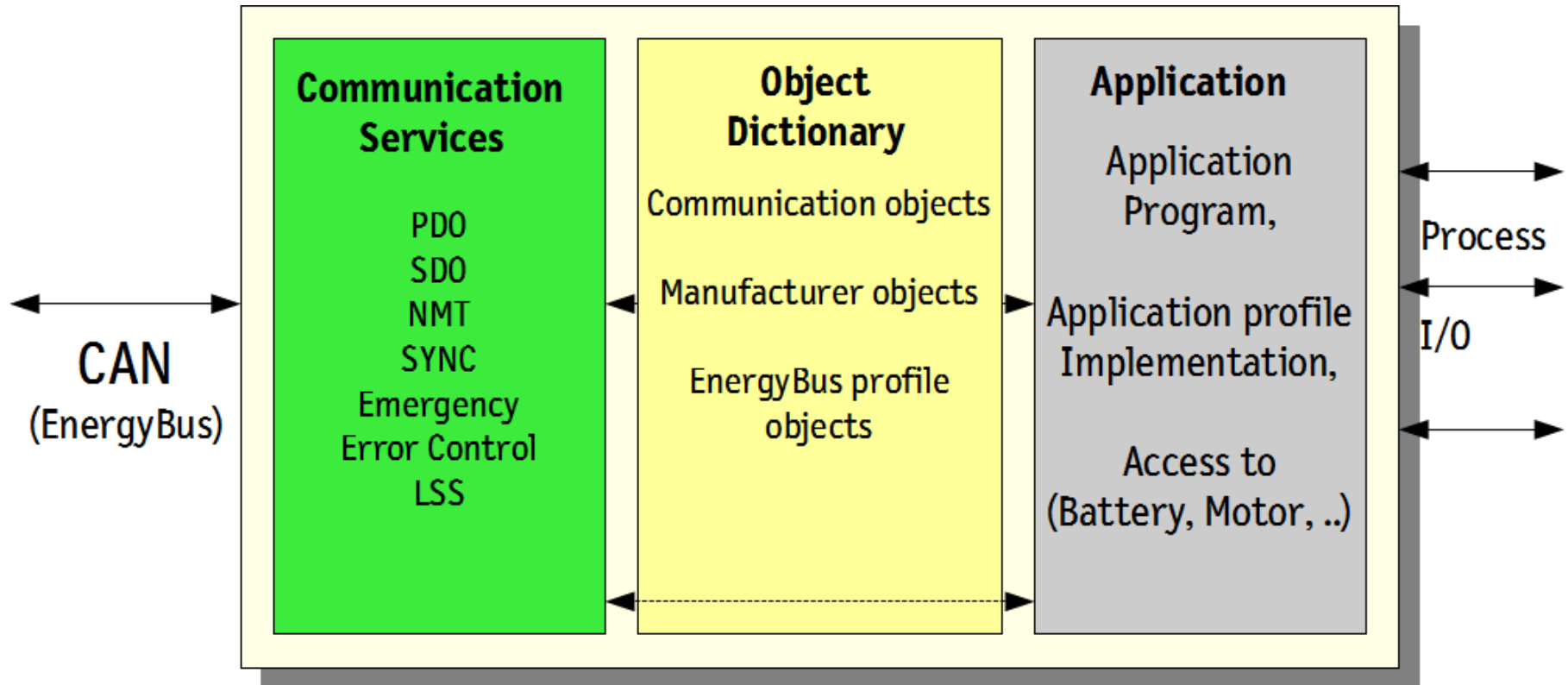
CAN

Vertical CANopen markets

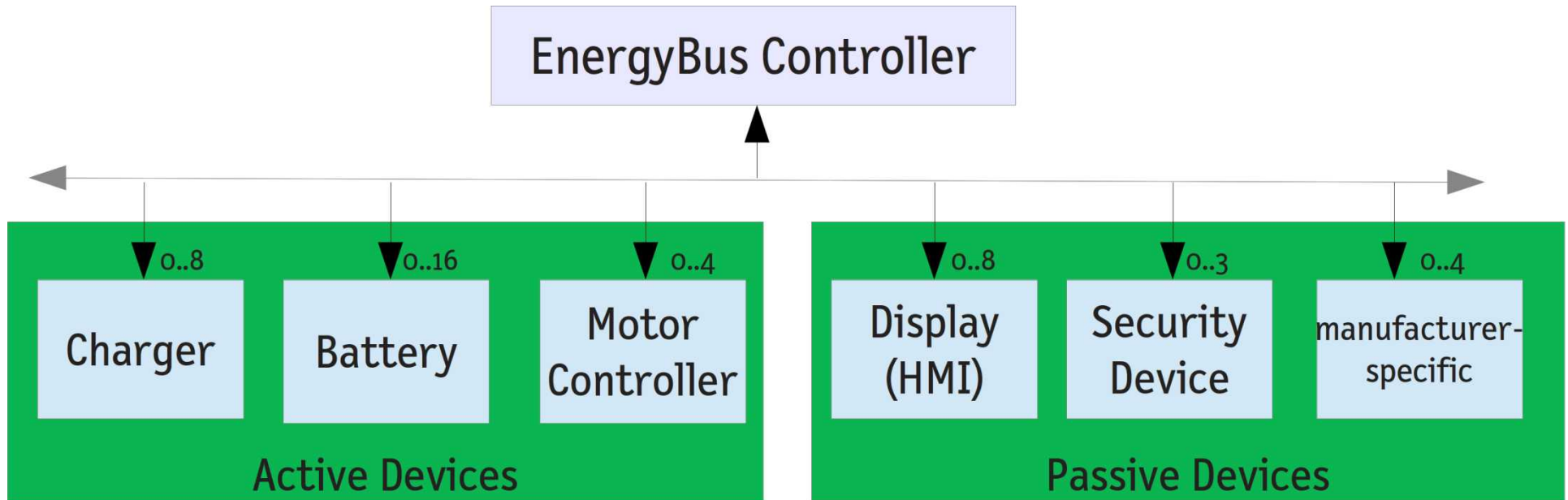
 <ul style="list-style-type: none"> • Truck superstructures • Light electric vehicles • Special purpose cars 	 <ul style="list-style-type: none"> • Factory automation • Production line • Process automation
 <ul style="list-style-type: none"> • Light rail vehicles • Locomotives and passenger coaches 	 <ul style="list-style-type: none"> • Embedded machine control <ul style="list-style-type: none"> • Textile machines • Plastic machines • Printing machines • Packaging machines
 <ul style="list-style-type: none"> • Maritime electronics • Off-shore • Sub sea applications 	 <ul style="list-style-type: none"> • Medical devices • Operating room • Patient bed
 <ul style="list-style-type: none"> • Military applications 	 <ul style="list-style-type: none"> • HVAC control • Lift control • Embedded door control
 <ul style="list-style-type: none"> • Cranes • Construction machineries 	 <ul style="list-style-type: none"> • Renewable energy



«« CANopen Device Model ««



<< EnergyBus Network <<



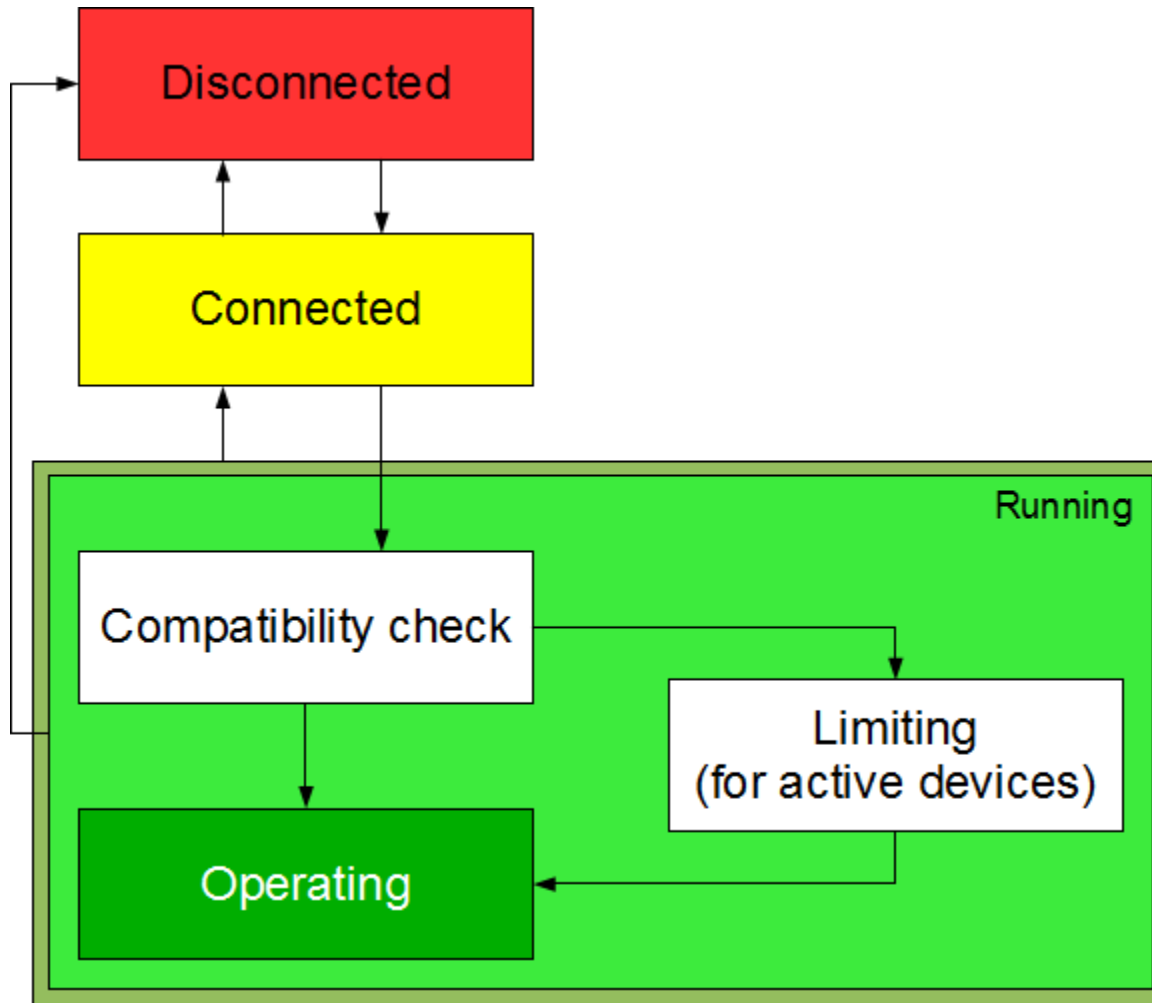
- Connected to POWERLINE
- Additionally 12V auxiliary voltage
- CANopen communication

- Additionally 12V auxiliary voltage
- CANopen communication

◀◀ CANopen Application Profile 454 ◀◀

- Definition of various components
 - Battery, Charger, Motor Controller, Display, „Lock“, ...
- Definition of mandatory and optional parameters for each component
- Definition of value representations (Value range , SI unit, direction of plus and minus, ..)
- Definition of various state machines
- Definition of cyclic process data (content and timing)
- Definition of alarm messages and further usage of CANopen services

◀◀ EnergyBus State Machine ◀◀



- Connected
 - Connection to CAN
- Compatibility Check
 - Check if devices fit together (voltages, currents, ..)
- Limiting
 - Configuration of limits
- Operating
 - Normal mode of operation

<< Agenda <<

- What is EnergyBus?
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- **How can it be implemented?**

<< What do we need for EnergyBus ? <<

- **EnergyBus Connector**
 - Rosenberger Hochfrequenztechnik GmbH & Co. KG
- **Microcontroller with CAN Controller**
 - Various manufacturers worldwide
- **Software for your Application**
 - You
- **Software for EnergyBus Communication**
 - **We are talking about it now.**

<< Software for EnergyBus Communication <<

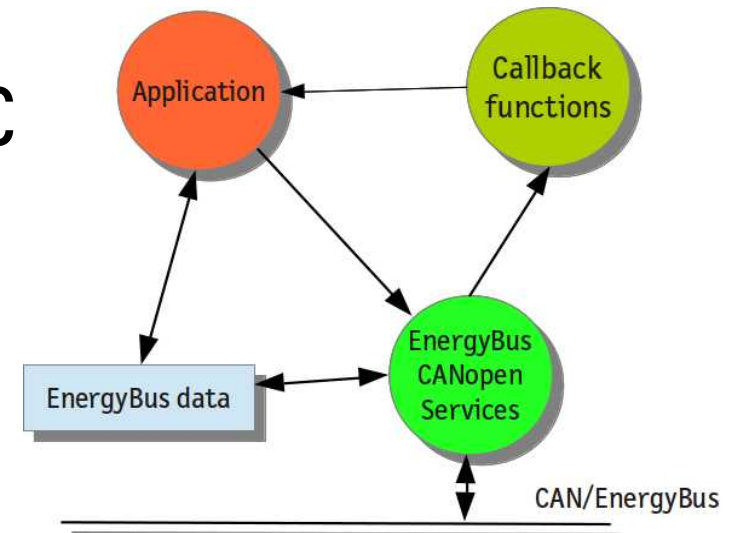
- CAN controller driver adaption
- CANopen protocol stack (Slave or Master for EBC or charger)
- Additional EnergyBus-specific functions and data structures
- *Adaption of application to CANopen protocol stack*
- *Application*



emtas
EnergyBus
Framework

<< EnergyBus Framework << the path to an easy implementation

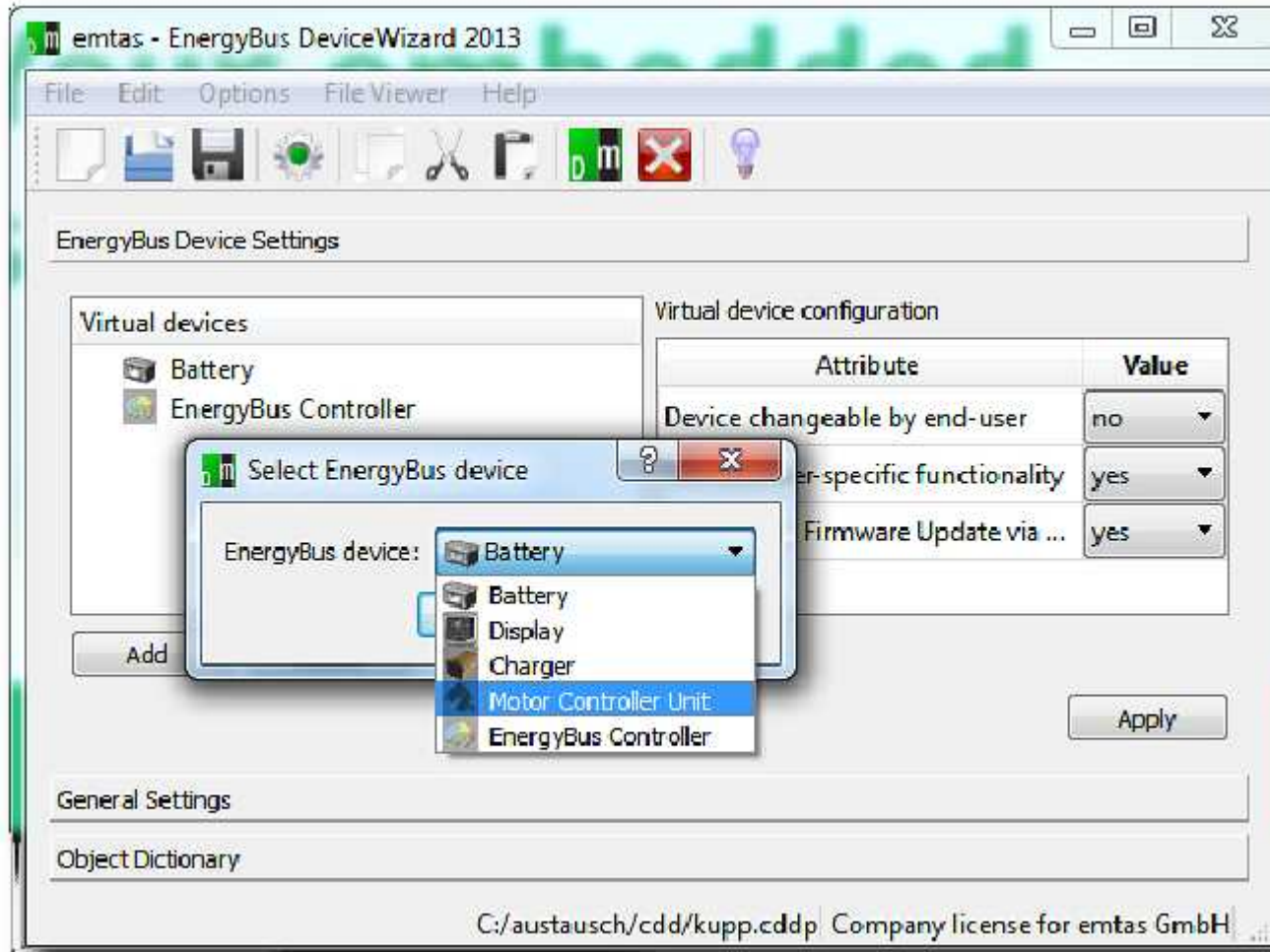
- EnergyBus Protocol software in C source code
- All EnergyBus (CiA 454) services and optimized CANopen Stack
- Automatic handling of EnergyBus State Machines and data
- Straight-forward configuration by EnergyBus DeviceWizard



◀◀ EnergyBus StarterKit ▶▶

- Pre-compiled EnergyBus Framework für STM32 (Object Code)
 - EnergyBus DeviceWizard
 - Evaluation board with STM32
 - EnergyBus Controller as PC Tool to control network
 - Device Explorer
 - USB-CAN Adapter, CAN cable, termination resistors
 - Upgrade to EnergyBus Framework (Source Code) possible
-
- Free DemoKit available: see <http://www.emtas.de/en>

«« EnergyBus DeviceWizard ««

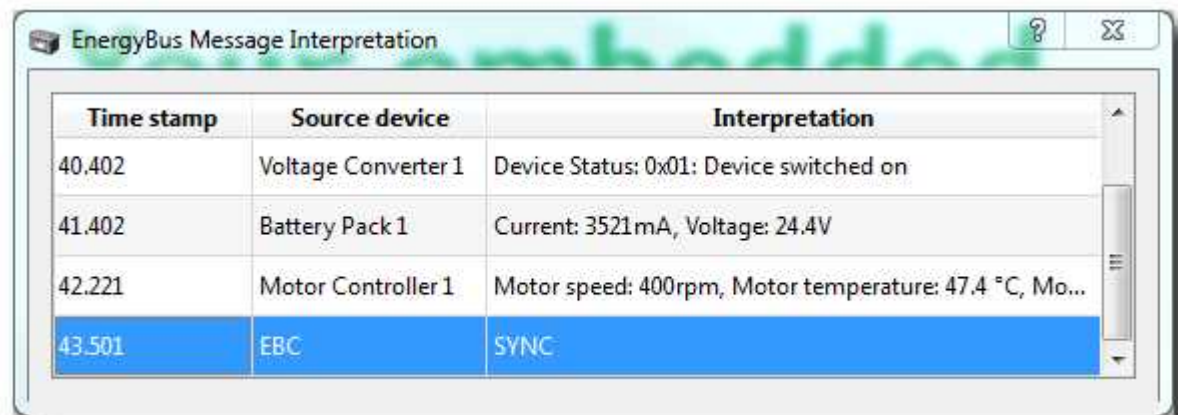


<< EnergyBus DeviceWizard <<

- Configuration of EnergyBus Framework and EnergyBus devices
- Basic EnergyBus devices can be created with a few clicks
- Generate C source and header files for EnergyBus Framework
- Detailed knowledge of EnergyBus and CANopen is not required

<< EnergyBus DeviceExplorer <<

- Access to all parameters of all devices
- EnergyBus interpretation of CAN/CANopen messages
- Overview on all EnergyBus devices and their parameters



The screenshot shows a window titled "EnergyBus Message Interpretation" with a table of message data. The table has three columns: "Time stamp", "Source device", and "Interpretation". The fourth row is highlighted in blue.

Time stamp	Source device	Interpretation
40.402	Voltage Converter 1	Device Status: 0x01: Device switched on
41.402	Battery Pack 1	Current: 3521mA, Voltage: 24.4V
42.221	Motor Controller 1	Motor speed: 400rpm, Motor temperature: 47.4 °C, Mo...
43.501	EBC	SYNC

EnergyBus Interpretation

MCU

Common

NMT: Node-ID: 1

Time	COB	State
394.221222	0x701	05 - Operational

PDOs:

Time	COB	Values
238.411196	0x18a	Status: 0x0201, Cur Lim In: 1027, Cur Lim Out: 1541, Vol Li...
303.328569	0x28a	Input Current: 513 mA, Device Voltage: 12293 mV

Device Status:

Cur. Input Cur. Output Cur. Lim. Vol. Lim

Device FSA: 0x08

EB FSA: **Disconnected**

SDO History:

88.158235 SDO 0x1000:0 Request
 88.684289 SDO 0x1000:0 Abort 0x00 0x00 0x04 0x05

SYNC:

Time	COB	Value
393.793049	0x80	SYNC

NMT History:

```
157.524410 Cmd Reset Node for node 3
159.196516 Cmd Start for node 3
194.871373 Cmd Reset Node for node 0
195.521615 Cmd Start for node 0
```

Battery

Voltage Converter

Load Monitoring

NMT: Node-ID: 17

NMT: Node-ID: 127

NMT: Node-ID: 124

Time	COB	State
394.221454	0x711	05 - Operational

Time	COB	State
394.22...	0x77f	7f - Pre-Operational

Time	COB	State
332.117649	0x77c	05 - Operati...

PDOs:

Time	COB	Values
350.631420	0x192	Status: 0x0000, Cur Lim In: 0, Cur Lim Out: 0, Vol Lim In 0
	0x292	

PDOs:

Time	COB	Values
380.207693	0x182	Status: 0x...
	0x282	

PDOs:

Time	COB	Values
	0x18e	

Device Status:

Cur. Input Cur. Output Cur. Lim. Vol. Lim

Device FSA: specific FSA not active

EB FSA: **Disconnected**

SDO History:

96.322152 SDO 0x1000:0 Request
 96.822174 SDO 0x1000:0 Abort 0x00 0x00 0x04 0x05

Device Status:

Cur. In Cur. O Cur. Li Vol. Li

Device FSA: **Reserved: 0x7f**

EB FSA: reserved

SDO History:

151.322644 SDO 0x1000:0 Request
 151.822548 SDO 0x1000:0 Abort
 0x00 0x00 0x04 0x05

Device Status:

Cur. In Cur. O Cur. Li Vol. Li

Device FSA:

EB FSA:

SDO History:

137.324462 SDO 0x1000:0 Request
 137.824437 SDO 0x1000:0 Abort
 0x00 0x00 0x04 0x05

◀◀ Simulated EnergyBus Devices ◀◀

- PC tools to simulate EnergyBus devices
- Application and communication parameters like real devices
- Useful for EBC development or residual bus simulation

EBC Info

Device	Node-Id	NMT State	EB State	Locked
EBC	1	OPERATIONAL	OPERATING	U
MCU	1	OPERATIONAL	OPERATING	
Battery	17	OPERATIONAL	OPERATING	
Security	5	OPERATIONAL	OPERATING	U
LoadMonitor	20	OPERATIONAL	OPERATING	U
Charger	121	OPERATIONAL	COMP_CHECK	

Sleep Set Sleep End Start Charging Stop Charging

Operational device type: 7
Network OPERATING
Operational device type: 8
Operational device type: 10
Operational device type: 6

Battery Set

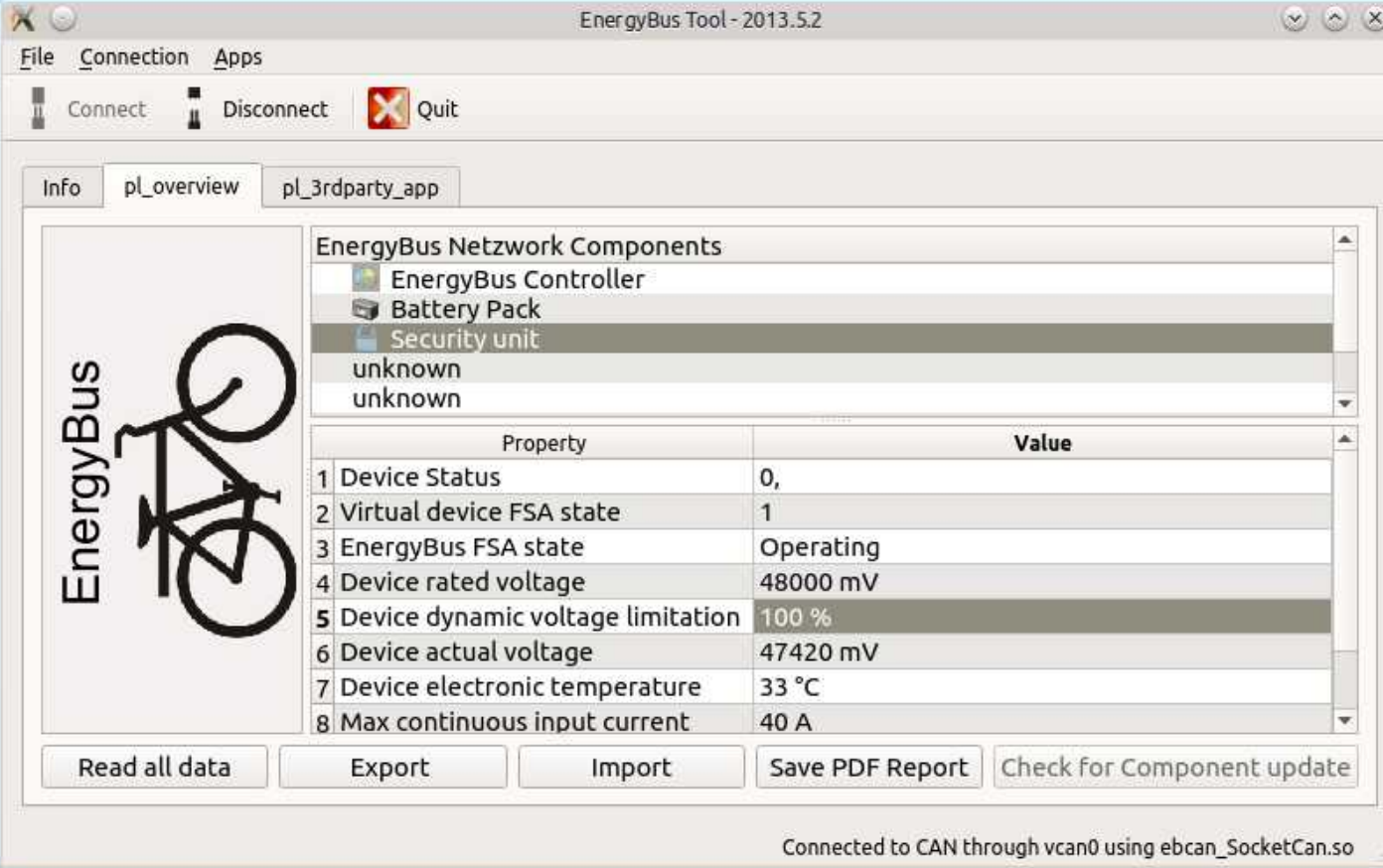
Battery State: Ready To Attach

EB State: Comp Check Limiting Operating

Set Battery-State: Normal Operation Rdy to attach

- Scripting Engine to simulate application and to provoke errors (optionally)

« EnergyBus Tool »



The screenshot displays the EnergyBus Tool interface (version 2013.5.2). The window title is "EnergyBus Tool - 2013.5.2". The menu bar includes "File", "Connection", and "Apps". The toolbar contains "Connect", "Disconnect", and "Quit" buttons. The main area is divided into tabs: "Info", "pl_overview", and "pl_3rdparty_app". The "Info" tab is active, showing the "EnergyBus Network Components" list and a table of device properties.

EnergyBus Network Components

- EnergyBus Controller
- Battery Pack
- Security unit
- unknown
- unknown

Device Properties Table

Property	Value
1 Device Status	0,
2 Virtual device FSA state	1
3 EnergyBus FSA state	Operating
4 Device rated voltage	48000 mV
5 Device dynamic voltage limitation	100 %
6 Device actual voltage	47420 mV
7 Device electronic temperature	33 °C
8 Max continuous input current	40 A

Buttons at the bottom: Read all data, Export, Import, Save PDF Report, Check for Component update.

Connected to CAN through vcan0 using ebc_n_SocketCan.so

◀◀ EnergyBus Tool ◀◀

- Joint development of emtas and EnergyBus e.V.
- Target groups: dealers, hobbyists, experienced end-users
- Basic edition:
 - Read available parameters of all connected EnergyBus devices
 - Export, Import and PDF report of all data
 - Check availability of updates
 - Free-of-charge
- Additional features in non-free edition
- Possibility to add 3rd party apps into the EnergyBus Tool

◀◀ Additional EnergyBus products or services ◀◀

- EnergyBus StarterKit
- EnergyBus training
- Consulting
- Integration of EnergyBus software into devices
- Complete embedded software development
- Hardware design by partners

<< Energy Bus – Advantages and implementation options <<

We are happy to assist you with EnergyBus questions.

emtas GmbH
Tel.: +49 3461 / 79416 - 0
service@emtas.de
www.emtas.de

