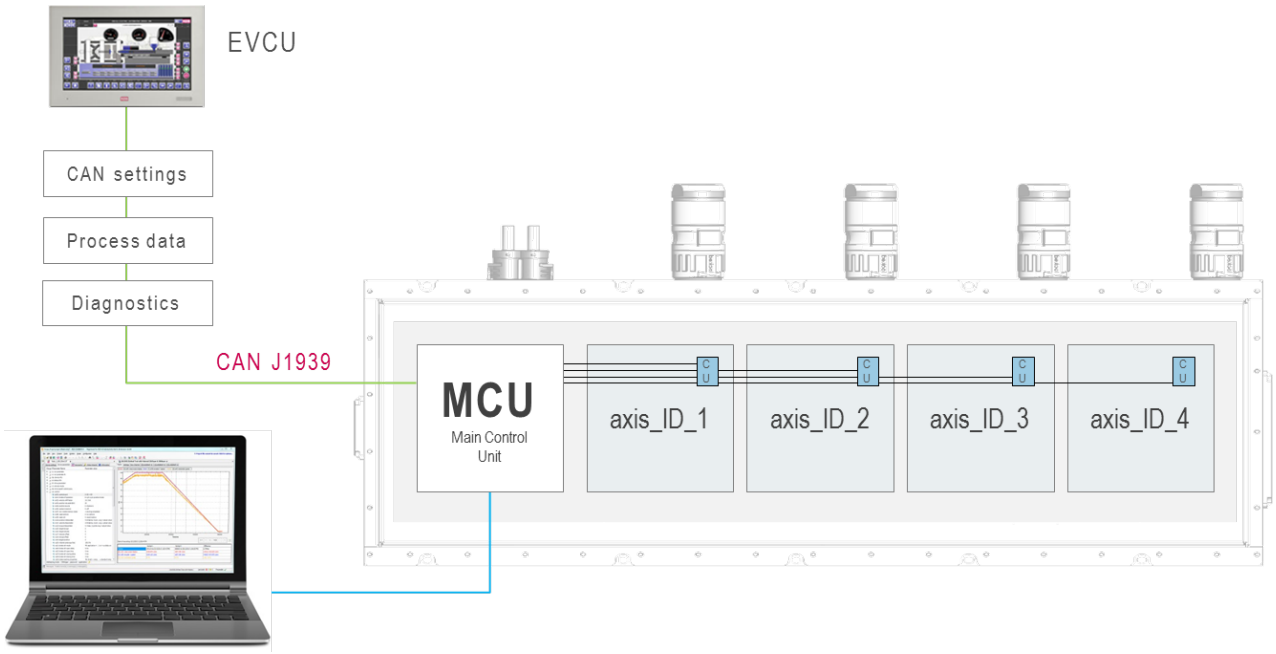

COMBIVERT **T6 APD**

PROGRAMMING MANUAL | MCU – J1939 CAN App **– V1.0**

Translation of the original manual
Document 20152007 EN 02

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1 Preface

The described hardware and software are developments of the KEB Automation KG. The enclosed documents correspond to conditions valid at printing. Misprint, mistakes and technical changes reserved.

1.1 Signal words and symbols

Certain operations can cause hazards during the installation, operation or thereafter. There are safety informations in the documentation in front of these operations. Security signs are located on the device or on the machine. A warning contains signal words which are explained in the following table:

⚠ DANGER	➢ Dangerous situation, which will cause death or serious injury in case of non-observance of this safety instruction.
⚠ WARNING	➢ Dangerous situation, which may cause death or serious injury in case of non-observance of this safety instruction.
⚠ CAUTION	➢ Dangerous situation, which may cause minor injury in case of non-observance of this safety instruction.
NOTICE	➢ Situation, which can cause damage to property in case of non-observance.

RESTRICTION

Is used when certain conditions must meet the validity of statements or the result is limited to a certain validity range.

	➢ Is used when the result will be better, more economic or trouble-free by following these procedures.

1.2 More symbols

► This arrow starts an action step.

• / - Enumerations are marked with dots or indents.

=> Cross reference to another chapter or another page.

	Note to further documentation. Document search on www.keb.de	

1.3 Laws and guidelines

KEB Automation KG confirms with the EC declaration of conformity and the CE mark on the device nameplate that it complies with the essential safety requirements.

The EC declaration of conformity can be downloaded on demand via our website. Further information is provided in chapter "Certification".

1.4 Warranty and liability

The warranty and liability on design, material or workmanship for the acquired device is given in the general sales conditions.

	Here you will find our general sales conditions. www.keb.de/terms-and-conditions	

Further agreements or specifications require a written confirmation.

1.5 Support

Through multiple applications not every imaginable case has been taken into account. If you require further information or if problems occur which are not treated detailed in the documentation, you can request the necessary information via the local KEB Automation KG agency.

The use of our units in the target products is outside of our control and therefore lies exclusively in the area of responsibility of the customer.

The information contained in the technical documentation, as well as any user-specific advice in spoken and written and through tests, are made to best of our knowledge and information about the intended use. However, they are regarded as being only informal and changes are expressly reserved, in particular due to technical changes. This also applies to any violation of industrial property rights of a third-party. Selection of our units in view of their suitability for the intended use must be done generally by the user.

Tests can only be done within the intended end use of the product (application) by the customer. They must be repeated, even if only parts of hardware, software or the unit adjustment are modified.

1.6 Copyright

The customer may use the instructions for use as well as further documents or parts from it for internal purposes. Copyrights are with KEB Automation KG and remain valid in its entirety.

This KEB product or parts thereof may contain third-party software, including free and/or open source software. If applicable, the license terms of this software are contained in the instructions for use. The instructions for use are already available to you, can be downloaded free of charge from the KEB website or can be requested from the respective KEB contact person.

Other wordmarks or/and logos are trademarks (™) or registered trademarks (®) of their respective owners.

2 Basic Safety Instructions

The COMBIVERT is designed and constructed in accordance with state-of-the-art technology and the recognised safety rules and regulations. However, the use of such devices may cause functional hazards for life and limb of the user or third parties, or damages to the system and other material property.

The following safety instructions have been created by the manufacturer for the area of electric drive technology. They can be supplemented by local, country- or application-specific safety instructions. This list is not exhaustive. Non-observance will lead to the loss of any liability claims.

NOTICE

Hazards and risks through ignorance!

- ➢ Read the instructions for use !
- ➢ Observe the safety and warning instructions !
- ➢ If anything is unclear, please contact KEB !

2.1 Target group

This instruction manual is determined exclusively for electrical personnel. Electrical personnel for the purpose of this instruction manual must have the following qualifications:

- Knowledge and understanding of the safety instructions.
- Skills for installation and assembly.
- Start-up and operation of the product.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.
- Knowledge of DIN IEC 60364-5-54.
- Knowledge of national safety regulations (e.g. DGUV Regulation 3).

2.2 Validity of this manual

This part of the programming manual describes the MCU J1939 CAN App of the COMBIVERT T6 APD.

This part of the programming manual

- contains only supplementary safety instructions.
- is only valid in connection with the instructions for use COMBIVERT T6 APD.
- is only valid in connection with the programming manual DCU of the COMBIVERT T6 APD.

2.3 Electrical connection

⚠ DANGER

Electrical voltage at terminals and in the device !
Danger to life due to electric shock !

- ➢ For any work on the unit switch off the supply voltage and secure it against switching on..
- ➢ Wait until the drive has stopped in order that no regenerative energy can be generated.
- ➢ Await capacitor discharge time (5 minutes) if necessary, measure DC voltage at the terminals.
- ➢ Never bridge upstream protective devices (also not for test purposes)

For a trouble-free and safe operation, please pay attention to the following instructions:

- The electrical installation shall be carried out in accordance with the relevant requirements.
- Cable cross-sections and fuses must be dimensioned according to the design of the machine manufacturer. Specified minimum / maximum values may not be fallen below /exceeded.
- With existing or newly wired circuits the person installing the units or machines must ensure the EN requirements are met.
- For drive converters that are not isolated from the supply circuit (in accordance with *EN 61800-5-1*) all control lines must be included in other protective measures (e.g. double insulation or shielded, earthed and insulated).
- When using components without isolated inputs/outputs, it is necessary that equipotential bonding exists between the components to be connected (e.g. by the equipotential line). Disregard can cause destruction of the components by equalizing currents.

2.4 Start-up and operation

The drive converter must not be started until it is determined that the installation complies with the machine directive; Account is to be taken of *EN 60204-1*.

⚠ WARNING

Software protection and programming!
Hazards caused by unintentional behavior of the drive !

- ➢ Especially during initial start-up or replacement of the drive converter, check whether the parameterization is compatible to the application.
- ➢ Securing a unit solely with software-supported functions is not sufficient. It is imperative to install external protective measures (e.g. limit switch) that are independent of the drive converter.
- ➢ Secure motors against automatic restart.

3 Product Description

MCU – J1939 CAN App - Parameterization, operation and start-up

3.1 Specified application

With the MCU - J1939 CAN App, a CAN communication gateway for exchanging process data, parameters and diagnostic messages (DM1… DM4) via SAE J1939 is provided in the T6 APD system. The operation is carried out exclusively via the explicitly provided parameterization, diagnostic (InverterScope) and start-up tool COMBIVIS studio 6 or COMBIVIS 6.The application focus is in the field of commercial vehicles. The J1939 CAN App offers a solid data communication via CAN based on the specification CAN 2.0B. For direct exchange of set and actual data, the T6 APD offers two possible channels, which are defined in J1939: Proprietary A and B. In addition, the app offers a start-up assistant for the effective and efficient start-up and operation of later series applications/vehicles.

RESTRICTION

Other protocols such as ISOBUS according to ISO 11783 for agricultural machines or the UDS diagnostic communication protocol are not supported.

Observe the maximum task cycle times.

Observe the utilization on the CAN BUS network (see note in chapter 6.2 Proprietary data channels).

3.2 Improper use

This includes:

- Operation outside the limits specified in the technical data.
- An improper use leads to the loss of any liability claims.

3.3 Used terms and abbreviations

Term	Description
T6	KEB COMBIVERT product group T6 from the product portfolio Electromobility
APD	Auxiliaries Power Drives - Modular, scalable inverter system for auxiliary units and auxiliary drives in hybrid and electric commercial vehicles
MCU	Main Control Unit - for CAN communication, intelligent control, start-up and diagnosis. Note: Always axis_ID to Pos. 0 [0].
Function modules	Are the MCU, inverter modules A, B, C to the pos. 1 to 6 [1-6]?
Module A	Inverter module A - HV Power electronics 16.5 A (application drive)
Module B	Inverter module B - HV Power electronics 33 A (application drive)
Module C	Inverter module C - HV Power electronics 60 A (application drive)
DCU	Drive Control Unit - Control card on the inverter modules A, B or C
axis_ID	Axis identifier - Describes the function modules at positions 0…6 in the T6 APD system. Note: MCU = axis_ID [0], DCUs = axis_IDs [1-6].
COMBIVIS studio 6	Assistant-guided component selection, CAN configuration, drive parameterization and IEC61131-3 project generation

Term	Description
COMBIVIS 6	Parameterization, diagnostics (InverterScope) and start-up tool for COMBIVIS T6 APD
KEBFtp Tool	Data transfer to KEB devices via FTP
dw5	File format of a T6 parameter list
XML file	Extensible Markup Language - is a markup language for representing hierarchically structured data in the form of text files
Wizards	Wizards are various menu-guided wizards in COMBIVIS for easy start-up of the T6 APD
CAN J1939 App	IEC 61131 basic project as CAN communication gateway in the MCU
DCU_DownloadFile	Parameter list as download for the control (DCU) of the inverter modules
MCU_ConfigFile	Configuration file - the MCU ConfigFile contains the parameterization of the Main Control Unit with the settings for the J1939 CAN and the diagnostics.
T6 Interlink	Communication (technology) between the MCU and up to 1... 6 inverter modules - proprietary software area.
CAN_Port_0	Control connector X1A - CAN_H_0 at pin 3, 5 and CAN_L_0 at pin 4
CAN_Port_1	Control connector X1A - CAN_H_1 at pin 7 and CAN_L_1 at pin 8
SAE J1939	The protocol J1939 comes from the international Society of Automotive Engineers (SAE) and works on the Physical Layer with CAN high-speed according to ISO11898. The network management supports up to 254 logical nodes and 30 physical control units per segment
CAN 29 Bit Identifier	29-Bit-Identifier (Extended frame format - CAN 2.0B). Indicates the content of a message. The recipients use the identifier to decide whether a message is relevant to them or not.
CAN node address	Each device in the CAN (vehicle) network is uniquely identified by its node address
Proprietary A (PropA)	Proprietary data channel in J1939 (peer to peer)
Proprietary B (PropB)	Proprietary data channel in J1939 (broadcast)
CA	The pre-installed CAN J1939 App software contains up to 2 logical communicators, so-called controller application, for the representation as independent ECU in the CAN bus. See SAE J1939-81 Network Management.
Function group	Controller Application CA - function groups (see figure 1)
DTC	Diagnostic Trouble Codes - compound error codes for diagnosis in J1939.
DM1	Active Diagnostic Trouble Codes - all active DTCs are transmitted via DM1
DM2	Previously Active Diagnostic Trouble Codes - all previous, currently inactive DTCs are transmitted via DM2
DM3	Diagnostic Data Clear - Resets the error memory
DM4	Freeze Frame Parameters - Error memory with detailed information
BAM	Broadcast Announced Message, transport protocol for sending large amounts of data via broadcast
CMDT	Connection Mode Data Transfer, transport protocol for sending large amounts of data in peer to peer mode
Mapping	Mapping is a set of DCU parameters that are configured for cyclic exchange with the MCU and with nodes in the (CAN bus network).
Communication-Mapping	A mapping of parameters that can be listed in the inverter
Freeze Frame Mapping	One of the inverter communication mappings which should be used to create the DM4 Freeze Frame
Receive telegram ID	CAN ID - 29 Bit Identifier / Header based on the specification CAN 2.0B, in J1939 divided into sections / fields with defined meaning - in

Term	Description
	receive direction (from the view of the T6 APD)
Transmit telegram ID	CAN ID 29 Bit Identifier / Header - in transmission direction (from the view of the T6 APD)
PDO	PDO = Process Data Object (image / container / etc.) of the DCU parameters, which are exchanged with the (MCU / CA).
Transmit PDO	The DCU parameters to be sent cyclically by the inverter modules
Receive PDO	The DCU parameters to be received cyclically by the inverter modules
PG	J1939 Parameter Group - Each parameter group consists of an assignment of a J1939 ID and signals for the data content.
PGN	Parameter Group Number - Identification of a parameter group in J1939, part of the CAN 29 bit identifier
Signal	Smallest data unit in J1939. Summary in parameter groups. Example: one motor temperature value.
SPN	J1939 - Suspect Parameter Number. Independent of the PGN, a unique SPN is assigned to each signal.
FMI	J1939 - Failure Mode Identifier. Represents the type of an occurred error.
OC	J1939 - Occurence Count - A counter which counts the occurrence of the error state for each SPN and stores it, even if the error is no longer active.
RSL	Red Stop Lamp - signals serious errors
AWL	Amber Warning Lamp - Warning lamp for less serious errors
IEC 61131-3	Globally valid standard for programming languages of memory-programmable controls
EVCU	Electronic Vehicle Control Unit - electronic vehicle control
ECU	Electronic Control Unit - electronic control, this term is typically used
Supercap	Ultracapacitor for providing lowest currents for data retention of static memories (SRAM) or backup battery for real-time clocks.

Table 3-1: Used terms and abbreviations

4 KEB Operating Tools

https://www.keb.de/de/elektromobilitaet/tools

4.1 COMBIVIS studio 6

COMBIVIS studio 6, the KEB software tool based on CODESYS IEC 61131.

Assistant-guided component selection, fieldbus configuration, drive parameterization and IEC 61131-3 project generation.

4.1.1 Creating a T6 APD parameter list (DCU_DownloadFile)

A separate parameter list (download file in dw5 file format) must be created for all inverter modules (A, B or C) in the T6 APD multi-axis system. For more information about creating a DCU download file, see the DCU programming manual.

4.1.2 Creating a T6 APD configuration file (MCU_ConfigFile)

The MCU_ConfigFile contains the parameterization of the Main Control Unit with the settings for the J1939 protocol and the diagnostics.The single parameter lists (DCU_DownloadFile) are mapped for the T6 MCU in the configuration file (MCU_ConfigFile in dw5 file format) and then assigned to the corresponding axis_ID [1-6].If one of the inverter modules does not find a DCU_DownloadFile assigned by the MCU, this module will remain in the "Start-up mode". No CAN data are received or evaluated in this mode. Then the T6 APD system can only be operated in manual mode via COMBIVIS 6.

If the settings are complete, these settings will create an export in form of a *.dw5 download list, which must have the prefix "cfg_" in the name.

Example: cfg_MyConfigFile.dw5.

- The configuration file (MCU_ConfigFile) must have the prefix "cfg_" in the name. Example: cfg_MyConfigFile.dw5.
- Only one file with the prefix "cfg_" may be stored in the file system!

4.1.3 Intelligent network

If both, the DCU_DownloadFiles and the MCU_ConfigFiles have been created, the T6 APD system will automatically carry out an initialization and perform all downloads with the first switch on.

A new initial start-up (series vehicles) is then no longer required.

4.2 COMBIVIS 6

License-free operating and analysis program for KEB COMBIVERT T6 APD.

4.3 KEB Ftp Tool

This tool runs on Windows XP or higher with the .NET framework. It uses a COM port or the Windows IP stack to transfer files to and from KEB devices.

5 T6 APD Parameter Groups

Index	Group	Name	Function
0x200x	ru	Run Parameter	Information about the current T6 state
0x210x	ca	Controller Application	Make globally valid settings
0x220x	is	Inverter Settings	Values which are set in the MCU, but sorted by axis_ID
0x230x	ad	Advanced Diagnostics	Advanced error diagnosis

5.1 ru Parameters

Run Parameters

Information about the current status of the T6 APD system can be requested in the ru parameters.

Index	Id-Text	Name	Function / value range
0x2000	ru01	exception state [1-10]	Display of the current first 10 error messages from the MCU [0] or from the DCUs [1-6].
Subindex 1	ru01	exception state [1]	0… 255
…			
Subindex 10	ru01	exception state [10]	0… 255
Note: see table 5- 1 „exception state“			
0x2001	ru02	exception axis_ID [1-10]	The axis_ID [0-6] is displayed here suitable to ru.01 (error message)
Subindex 1	ru02	exception axis_ID [1]	0… 6
…			
Subindex 10	ru02	exception axis_ID [10]	0… 6
0x2002	ru03	act. used power	Display actual T6 system power
0x2003	ru04	inverter init state [1-6]	Inverter module axis_ID [1-6] initialization state
Subindex 1	ru04	inverter init state [1]	0… 8
…			
Subindex 6	ru04	inverter init state [6]	0… 8
0x2004	ru05	inverter release state [1-6]	Inverter module axis_ID [1-6] release state
Subindex 1	ru05	inverter release state [1]	0… 6
…			
Subindex 6	ru05	inverter release state [6]	0… 6
Note: The index represents the position of the inverter module axis_ID_x. If an associated download list is available for the inverter module, the state should remain in „init done“.			

List of "exception states":

ru01	Fault text	Description
0	no exception	No error
3	ERROR overcurrent PU	Overcurrent detection in the power unit has triggered (e.g. short circuit, defective power module)
4	ERROR overcurrent analog	Exceeded overcurrent level on the control board (e.g. Incorrect setting of the controller or the torque limiting characteristic)
5	ERROR over potential	Overvoltage in DC link
6	ERROR under potential	Undervoltage in DC link
7	ERROR overload	Module overload (I^2t) => OL (long-term mean current load is above 100%)
8	reset E. overload	Reset of overload possible OL counter (ru29) < 50% of the warning level
9	ERROR overload 2	Module overload 2 (fast overload protection – defined by standstill continuous current and short time current limit - has responded)
10	ERROR overheat powmod.	Overtemperature power components (heat sink)
11	reset E overheat pmod.	Overtemperature power components decreased (temperature 5° below OH level)
12	ERROR overheat internal PU	ERROR overheat internal power unit
13	reset E. overheat intern PU	no overheat internal power unit
14	ERROR motorprotection	electronic (software) motor protection has triggered
15	reset E. motorprotection	Error motor protection function can be reset
16	ERROR drive overheat	Temperature sensor in the motor (e.g. PTC or KTY) has triggered
17	reset ERROR drive overheat	Overtemperature motor decreased
18	ERROR overspeed	Overspeed (speed > pn26 * rated speed)
20	ERROR drive data	Error at presetting motor data (Standardization of the motor data triggers an error => motor data do not match)
21	ERROR motordata not stored	Motor data are not confirmed by dr99
22	ERROR ident	during identifikation an error occured (Information about the type of error in dr57)
23	ERROR speed diff	Speed difference higher than level (the monitoring of the difference between the setpoint speed and actual speed directly before the speed controller within a configurable time has responded pn38/pn39)
24	ERROR fieldbus memory	Incorrect drive software configuration
38	ERROR memory size	
40	ERROR FPGA conf.	Error in FPGA configuration
43	ERROR enc.intf. SACB comm.	no communication with encoder interface
44	ERROR invalid power unit data	Invalid power unit data
52	ERROR undervoltage phase	Phase failure at the mains input (L1,L2,L3)
56	ERROR software switch left	Software limit switch has triggered an error
57	ERROR software switch right	
58	ERROR fieldbus watchdog	Fieldbus watchdog has responded
59	ERROR prg. input	Error via programmable input

ru01	Fault text	Description
62	ERROR power unit changed	Power unit changed (de20 / de21)
63	ERROR enc. intf. changed	Encoder interface changed (de48)
64	ERROR power unit type changed	Power unit type changed (de26 / de27)
65	ERROR enc. intf. version	Invalid version of the encoder interface
66	ERROR overcurrent PU	Overcurrent
67	ERROR max acc/dec	Max. acceleration/deceleration setting exceeded (monitoring especially necessary for cyclic synchronous operating modes)
68	ERROR overcurrent Brake	Overcurrent at the brake output
89	ERROR at encoder type change	Incompatible encoder interface and drive software version
90	ERROR enc.intf.fast comm.	Communication error control board-encoder interface
91	init encoder interface	Encoder interface in initialisation routine
96	ERROR encoder missing	No encoder type is selected in ec16 in a mode that requires an encoder
97	ERROR overspeed (EMF)	pn72 overspeed level (EMF) has been exceeded
98	ERROR encoder A changed	Encoder A changed
99	ERROR encoder B changed	Encoder B changed
100	ERROR overcurrent out1	Overcurrent at digital output 1
101	ERROR overcurrent out2	Overcurrent at digital output 2
102	ERROR overcurrent out3	Overcurrent at digital output 3
103	ERROR overcurrent out4	Overcurrent at digital output 4
104	ERROR overcurrent fan	Internal fan defective
105	ERROR overcurrent encoder	Overcurrent at encoder interface
106	ERROR overcurrent 24V	Overcurrent at 24V outputs of the control terminal block
107	ERROR over frequency	The maximum output frequency de 120 has been exceeded. (599Hz)
108	reset E. overheat intern CB	No overheat control board
109	ERROR overheat internal CB	Overheat internal control board
112	ERROR 24V supply low	active 24V supply (intern or extern) decreased to a lower value than 18V
114	ERROR ext 24V low	extern 24V supply lower than 17V
115	ERROR GTR7 always OFF	GTR7 can not be switched on
116	ERROR GTR7 OC	UCE monitoring GTR7 displays OC
117	ERROR GTR7 always ON	GTR7 can not be switched off
800	Configuration invalid	Configuration invalid (e.g.: no inverters in cfg)
801	no config file found	No configuration file was found on the MCU
802	scan does not match to config file	The configuration file was created for another T6 APD type (the configuration of the axis modules is checked e.g. AABC)
803	Invalid license	
804	Error while filedownload	Error while filedownload of the MCU_ConfigFile
806	File with this prefix not found	The selected download ID was not found on the MCU
820	Can Frame missing	The cyclic CAN telegram which controls this node is missing for more than one cycle
821	PropA Can Frame to small	The cyclic CAN telegram type PropA is too small
822	PropA Can Frame to large	The cyclic CAN telegram type PropA is too large
823	PropB Can Frame to small	The cyclic CAN telegram type PropB is too small
824	PropB Can Frame to large	The cyclic CAN telegram type PropB is too large
902	Error receiving mapping from inverter	Error while reading the mapping information of the DCU node
903	Error receiving rated current val-	Error while reading the rated current of the DCU node

ru01	Fault text	Description
	ue from inverter	
904	Rated current in download does not match the current in the drive	The DCU_Download files were created for another axis type (the parameter de28 of the list is compared with the same name parameter of the inverter)
905	Error download inverter dw5	Error while downloading the DCU_Download file
906	Error write pll offset	Error when writing the pll offset
907	Error auto mapping	Error when creating the automatic process data assignment
908	Error internal communication (interlink)	

Table 5-1: exception states

5.2 ca Parameters

Controller Application Settings

All globally valid settings for the T6 APD are made in the ca parameters.

The MCU can be operated with one or more CAN node addresses, so-called CA Controller Application. In this way it is possible to group the inverters in the vehicle.

For example, the central CAN control (vehicle EVCU) could contain the "air conditioning compressor_1" (axis_ID_1), the "air conditioning compressor_2" (axis_ID_2), the "power steering pump" (axis_ID_3) and the "air compressor" (axis_ID_4).

Each controller application has a CAN address, a CAN priority, a cycle time and one destination address for the data to be cyclically exchanged.

The individual setting of priority and cycle time enables a systematic distribution of reaction speed, bus load and priority on the bus under the different drive groups. Thus there is the possibility to summarize "air conditioning compressor_1" and "air conditioning compressor_2" into a function group CA_1 and "Power Steering Pump" and "air compressor" into a second function group CA_2. It would also be possible to operate a CAN control EVCU (vehicle control) and a sub-control ECU (air conditioning compressors) as controller application with 2 function groups in the MCU (=> Figure 1).

➢ The maximum number of CA Controller Applications is limited to 2 function groups in the T6 APD system!

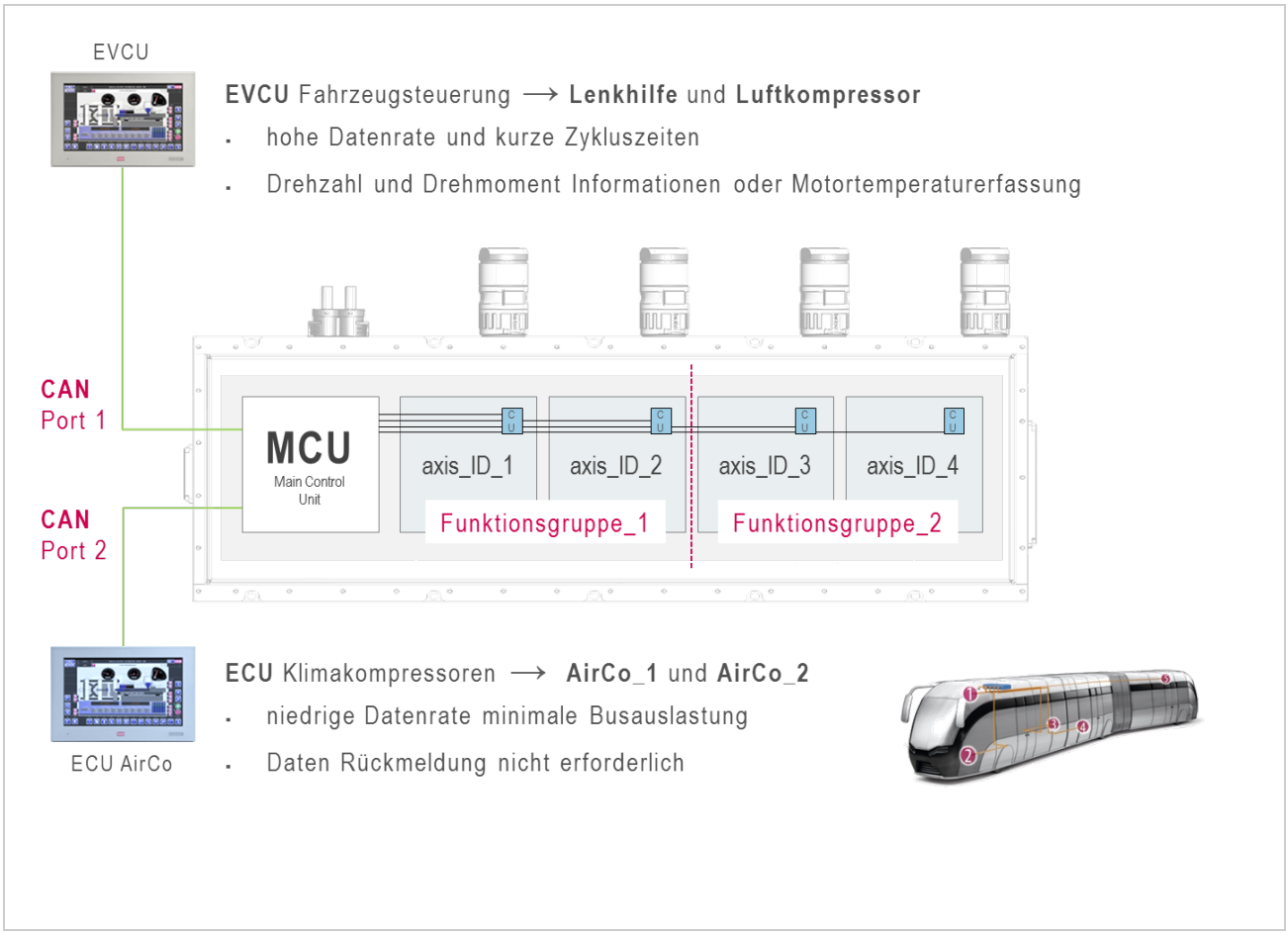

Figure 1: Application: CA Controller Application - Bus

Index	Id-Text	Name	Function / value range
0x2100	ca01	CAN port baudrate [1-2]	Setting of the baudrate for CAN_Ports 0 [1] and 1 [2]
Subindex 1	ca01	CAN port baudrate [1]	see table parameter values CAN Port (1-2) baudrate
Subindex 2	ca01	CAN port baudrate [2]	

Bit	Function	Value	Plaintext	Note
0	Baud rate	0	10	Kbit/s
		1	20	Kbit/s
		2	50	Kbit/s
		3	100	Kbit/s
		4	125	Kbit/s
		5	250	Kbit/s (default)
		6	500	Kbit/s
		7	1000	Kbit/s
		8	800	Kbit/s
		9	25	Kbit/s

0x2101	ca02	CAN port to use [1-2]	Assignment of the CAN port to the CA Controller Application
Subindex 1	ca02	CAN port to use [1]	1… 2
Subindex 2	ca02	CAN port to use [2]	1… 2
0x2102	ca03	CA address [1-2]	CAN node address of the T6 APD in the vehicle (EVCU)
Subindex 1	ca03	CA address [1]	0… 254
Subindex 2	ca03	CA address [2]	0… 254
0x2103	ca04	propA partner address [1-2]	CAN node address of the proprietary communication partner for proprietary A
Subindex 1	ca04	propA partner address [1]	0… 254
Subindex 2	ca04	propA partner address [2]	0… 254
Note: Proprietary A is a peer to peer connection. Therefore a target/source address is required.			
0x2104	ca05	com priority [1-2]	Standard J1939 CAN priority for the T6 APD
Subindex 1	ca05	com priority [1]	0… 7
Subindex 2	ca05	com priority [2]	0… 7
0x2105	ca06	propA cycle time [1-2]	Cycle time of the proprietary A communication
Subindex 1	ca06	propA cycle time [1]	0…10000ms
Subindex 2	ca06	propA cycle time [2]	0…10000ms
Note: The adjusted time indicates the cycle at which the T6 APD sends and receives its PropA data. A CAN error is triggered if there are no or invalid data from the communication partner for more than two communication cycles. This triggers the error response set in is05. If the adjusted data exceed a length of 8 bytes, the adjusted cycle time must not be set to lower than 100 ms according to the J1939 specification (with a data frame > 8 bytes, a CMDT session is automatically established and this cycle time must not be higher than 100 ms).			

5.3 is Parameters

Inverter Settings

The is parameter group contains all parameters that are adjusted in the MCU, but are sorted by axis_ID.

Index	Id-Text	Name	Function / value range
0x2200	is01	assigned controller application [1-6]	Assignment of the controller application for the axis_IDs [1-6]
Subindex 1	is01	assigned controller application [1]	1… 2
…			
Subindex 6	is01	assigned controller application [6]	1… 2
0x2201	is02	rated current [1-6]	Setting which rated current is expected for the axis_ID [1-6
Subindex 1	is02	rated current [1]	0…9999999.99 A
…			

Subindex 6	is02	rated current [6]	0…9999999.99 A
0x2202	is03	act. rated current [1-6]	Display which rated current was found for the axis_ID [1-6]
Subindex 1	is03	act. rated current [1]	0…9999999.99 A
…			
Subindex 6	is03	act. rated current [6]	0…9999999.99 A

Note: The settings in is02 are compared with the actual values in is03 during the boot process of the T6 APD. If the values do not match, the boot process is aborted. This routine prevents that the T6 APD is starting with an incompatible MCU_Configfile.

0x2203	is04	DCU file ident [1-6]	Identification number DCU_Download file for the axis_ID [1-6]
Subindex 1	is04	DCU file ident [1]	0 … [4294967295] -1
…			
Subindex 6	is04	DCU file ident [6]	0 … [4294967295] -1

Note: The DCU_Download files are stored with an identification number as prefix in the file name and a following underscore in the file system of the MCU. This can be in any value range from 0 to 4294967295. Example: 123456_MyFilename.dw5

0x2204	is05	CAN error settings [1-6]	Adjustable error settings
Subindex 1	is05	CAN error settings [1]	see table parameter values CAN error settings
…			
Subindex 6	is05	CAN error settings [6]	

Bit	Function	Value	Plaintext	Note
0	Lamp Mode	0	amber warning	Warning message
		1	red stop	STOP message (vehicle must be stopped)
1	CAN error behaviour	0	torque-off	Torque off
		2	keep actual speed	No reaction, the drive continues moving with the current settings until new setpoint data arrive.
		4	switch to error speed	The drive moves to a set speed (preset in parameter is06). Occurs only if the drive was in operation (set-point setting).
		6	quick-stop	Quick-stop with adjustable reaction

0x2205	is06	CAN error speed [1-6]	Set speed in error case if is05 = switch to error speed has been selected
Subindex 1	is06	CAN error speed [1]	32768… -32768
…			
Subindex 6	is06	CAN error speed [6]	32768… -32768

Note: To enable this function at least one communication mapping of the selected axis_ID must contain the parameter from pr: com profile objects 6042h - vl target velocity.

0x2206	is07	mappings for propA [1-6]	Selection of communication mapping for the axis_ID via which Proprietary A shall be communicated
Subindex 1	is07	mappings for propA [1]	see table parameter values PDO mapping propA
…			
Subindex 6	is07	mappings for propA [6]	

Note: If no mapping is selected here, the communication is deactivated via this channel.

Bit	Function	Value	Plaintext	Note
0	Mapping	1	1st tx PDO mapping	Transmit-PDOs 1 - Drive(DCU)→PLC(EVCU)

		2	2nd tx PDO mapping	Transmit-PDOs 2 - Drive(DCU)→PLC(EVCU)
		4	3rd tx PDO mapping	Transmit-PDOs 3 - Drive(DCU)→PLC(EVCU)
		8	reserved	
		16	1st rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		32	2nd rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		64	3rd rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		128	reserved	

0x2207	is08	mappings for propB [1-6]	Selection communication mapping for the axis_ID via proprietary B shall be communicated
Subindex 1 … Subindex 6	is08 is08	mappings for propB [1] mappings for propB [6]	see table parameter values PDO mapping propB

Note: If no mapping is selected here, the communication is deactivated via this channel.

Bit	Function	Value	Plaintext	Note
0	Mapping	1	1st tx PDO mapping	Transmit-PDOs 1 - Drive(DCU)→PLC(EVCU)
		2	2nd tx PDO mapping	Transmit-PDOs 2 - Drive(DCU)→PLC(EVCU)
		4	3rd tx PDO mapping	Transmit-PDOs 3 - Drive(DCU)→PLC(EVCU)
		8	reserved	
		16	1st rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		32	2nd rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		64	3rd rx PDO mapping	Receive-PDOs 1 - PLC(EVCU)→Drive(DCU)
		128	reserved	

0x2208	is09	propB ID [1-6]	Defines the proprietary B ID
Subindex 1 … Subindex 6	is09 is09	propB ID [1] propB ID [6]	0… 255 0… 255

Note: Each active propB telegram requires an individual ID which can be set here.
Each CAN node occupies two IDs, one transmit and one receive telegram.

The parameter value specifies the receive ID (ECU-> T6 APD), parameter value + 1 specifies the transmit ID (ECU <- T6 APD)
Example:
is09 = 4 → receive ID 4, transmit ID 5
Receive CAN telegram ID: xxFF04xx
Transmit CAN telegram ID: xxFF05xx
(Start and end of the telegram ID are defined by priority and device address)
Therefore the IDs of the different CAN nodes always must have a difference of at least 2.
Example:
CAN node 1, is09 = 2 → CAN node 2, is09 = 4 (or higher)

0x2209	is10	propB cycle time [1-6]	Cycle rate of proprietary B communi-cation with the respective CAN node address
Subindex 1 … Subindex 6	is10 is10	propB cycle time [1] propB cycle time [6]	0…10000 ms 0…10000 ms

Note: The adjusted time indicates the cycle at which the T6 APD sends and receives its propB data. A CAN error is triggered if there are no or invalid data from the communication partner for more than two communication cycles. This triggers the error response set in is05.

5.4 ad Parameters

Advanced Diagnostics

Advanced error diagnostics is possible in the ad parameter group, here it is possible to read out the error history.

Index	Id-Text	Name	Function / value range
0x2300	ad01	CA error index	Index if more than 1 CAN node address has been defined for the T6 APD system (CA Controller Application / Function Groups)
			1… 2
0x2301	ad02	error list [1-40]	List of the last 40 errors in the error memory (not sorted) - all errors that have occurred in the MCU or in the inverter modules!
Subindex 1	ad02	error list [1]	0 … [4294967295] -1
…			
Subindex 40	ad02	error list [40]	0 … [4294967295] -1
Note: see table 5- 1 „exception state“			
0x2302	ad03	error axis_ID [1-40]	The axis_ID [0-6] of the respective error index from the error list in parameter ad02
Subindex 1	ad03	error axis ID [1]	0… 255
…			
Subindex 40	ad03	error axis ID [40]	0… 255
0x2303	ad04	error hist. date [1-40]	Time stamp of the respective error index from the error list in parameter ad02
Subindex 1	ad04	error hist. date [1]	dd/mm/yyyy - hh/mm/ss
…			
Subindex 40	ad04	error hist. date [40]	dd/mm/yyyy - hh/mm/ss
Example: 2/7/2106 06:28:15			
0x2304	ad05	occurence count [1-40]	Count value of the respective error index from the error list in parameter ad02
Subindex 1	ad05	occurence count [1]	0… 65535
…			
Subindex 40	ad05	occurence count [40]	0… 65535
0x2305	ad06	freeze frame mapping [1-40]	Communication mapping axis_ID [1-6]
Subindex 1	ad06	freeze frame mapping [1]	0… 3
…			
Subindex 6	ad06	freeze frame mapping [6]	0… 3

Note: A communication mapping can be assigned as "freeze frame mapping" to each axis_ID [1-6]. This is freezing with the current values at the time of the error and stored in the error memory of the MCU. Then it can be read out again from the error memory via the diagnosis message DM4.

6 Communication

6.1 Inverter Mappings

Each DCU has three freely configurable in/out mappings for process data objects. These can be filled with any DCU parameters via the COMBIVIS T6 Start-up Wizard (T6 Wizard).

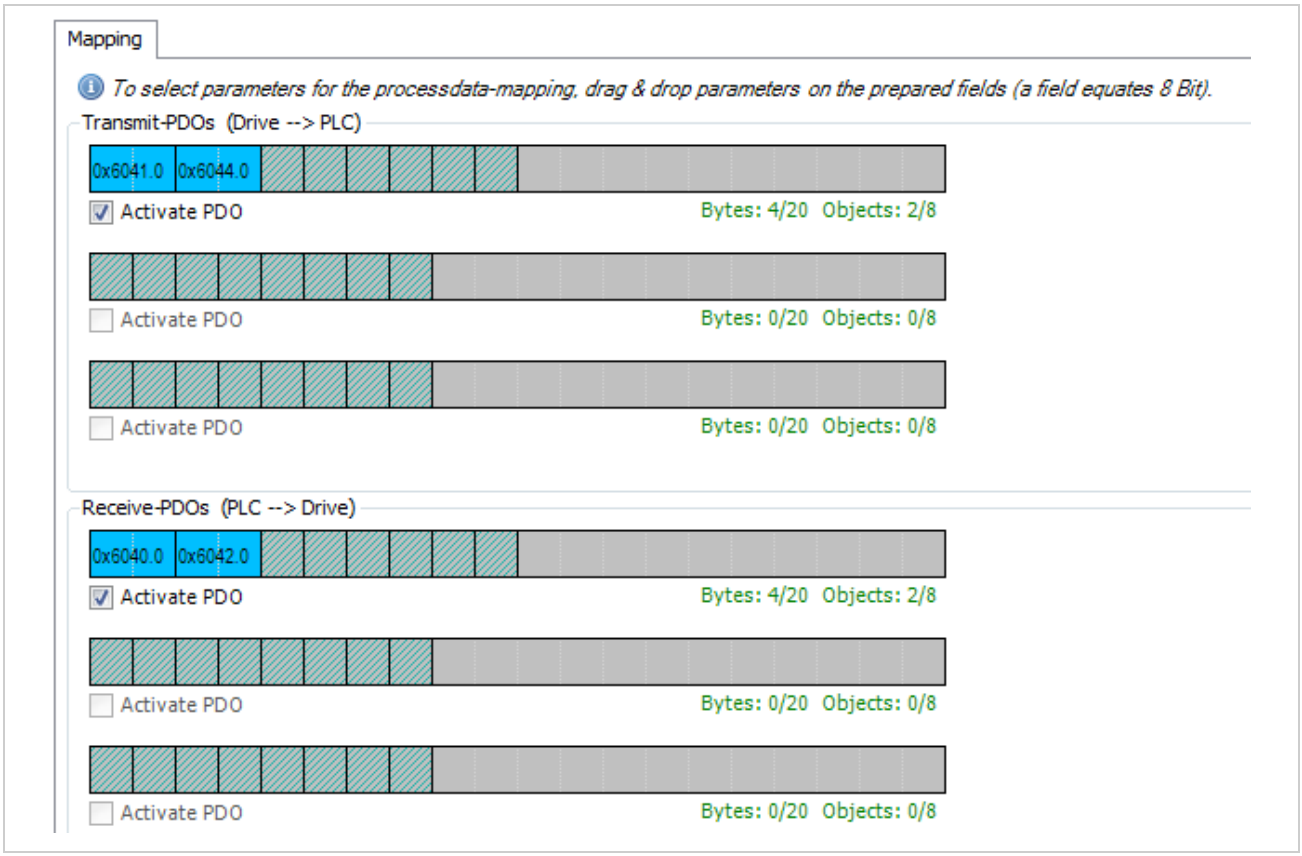

Figure 2: Example of a DCU mapping setting

The figure shows the PDO Wizard, filled with the CiA402 parameters, status word, control word, vl velocity actual value and vl target velocity.

The individual mappings can be used for different functions in the MCU parameters (see parameters is07, is08 or ad06).

Example:

The indicated node contains the settings shown in the figure. If now the setting 1 "Tx1" is set in parameter is08, then the Tx1 mapping in the illustrated form is transferred via J1939 PropB.

6.2 Proprietary data channels

For direct exchange of set and actual data, the T6 APD offers two possible channels, which are defined in J1939.

➢ Both channels have their advantages and disadvantages.

Proprietary **A**	Pro	Contra
	High cycle rates even with high data volumes through Peer-to-Peer (P2P) connection	Only one telegram per T6 APD and thus no division of the DCUs possible
	No blockage of the BAM transmitter within the MCU	Only one global cycle rate for the entire T6 APD
	All inverter data within a telegram	
Proprietary **B**	Pro	Contra
	Simple separation of all DCUs	No high cycle rates are possible due to BAM restrictions by data volumes > 8 bytes
	Different cycle times possible for each node	Limited amount of PropB ID in the vehicle
		Multiple use of data volumes > 8 bytes can cause a blockage of the BAM transmitter inside the MCU

The selection of the channel always depends on the possibilities of the connected ECU and the application conditions.

➢ KEB recommends proprietary A for the transmission of high data volumes.

6.2.1 Proprietary A (PGN: EFxx)

Each T6 APD system has a proprietary A in and out channel. If PropA mappings are stored in is07 for several axis_IDs [1-6], these will be lined up one after another.

Example: axis_ID_ 1 and 2 each have the mapping settings from figure 1 (chapter 5.1). Tx1 was selected in is07 for both axis_IDs. This results in the following CAN frame via PropA:

Statusword: axis_ID_1|vl velocity act value: axis_ID_1|statusword: axis_ID_2|vl velocity act value: axis_ID_2

If the data volume exceeds the 8 byte limit, the transport protocol CMDT is used automatically. This can transmit cyclically the maximum possible data volume (6*3*20 bytes = 360 bytes).

6.2.2 Proprietary B (PGN: FF00 - FFFF)

Each DCU has two proprietary B telegrams. The receive telegram ID can be adjusted via is09. The transmit telegram ID is always the receive telegram ID + 1. If value 24 is set in is09, a receive telegram ID 24 and a transmit telegram ID 25 are obtained.

Up to three mappings can be stored for each PropB telegram. If the data volume exceeds the 8 byte limit, a BAM is automatically generated.However, the BAM limits the cycle rate of the data according to the J1939 regulation. The following calculation can be done to calculate the resulting cycle rate: Data volume / 7 * 50ms + 50ms.

It must be observed that the T6 APD can only operate one BAM. If several nodes exceed the 8 byte limit, the individual nodes need to share the BAM transmitter. This must be taken into account in the cycle time setting.

KEB recommends to avoid exceeding the 8 byte limit when using proprietary B.

6.3 Diagnostic Trouble Codes

The services DM1-4 stored in J1939 are supported for diagnostic purposes.

6.3.1 DM1 - Active Diagnostic Trouble Codes (PGN: FECA)

All active DTCs are transmitted via DM1. A DTC consists of SPN (Suspect Parameter Number), FMI (Failure Mode Identifier) and OC (Occurrence Count). FMI is not supported by the T6 APD and is always transmitted with 1F "condition exists". The error codes of the device are displayed via the SPN. They are located in the proprietary SPN area 7F000 – 7FFFF. The first byte represents the error number and the first 4 bits of the second byte represents the axis_ID. Example: SPN: 7F2DC -> axis_ID_2, error number 220 - CAN Frame missing (timeout). If no error is active, SPN 0 is transmitted.

6.3.2 DM2 – Previously Active Diagnostic Trouble Codes (PGN: FECB)

On request, the DM2 diagnostic service transmits all DTCs stored in the error memory of the MCU.

6.4 DM3 – Diagnostic Data Clear (PGN: FECC)

The DM3 diagnostic service empties the entire error memory including all freezeframe information. After the deletion is complete, the process is confirmed with "acknowledge".

6.4.1 DM4 – Freeze Frame Parameters (PGN: FECD)

The DM4 diagnostic service transmits all DTCs available in the error memory including their freeze frame data. In addition to the freeze frame objects already specified in J1939, the T6 APD stores additional freeze frame data in the "Manufacturer Specific Information" area. They are structured as follows:

Freeze frame mapping (optional) + error time

The freeze frame mapping can be adjusted individually for each node. Thus, the structure of the freeze frame data can be different depending on the node. It is also possible to select no freeze frame mapping. In this case only the error time is transmitted.

The structure of the time stamp is structurally identical to the PGN: FEE6 (Time/Date) apart from the local offsets. Thus the structure is:

Seconds(SPN 959)|Minutes(SPN 960)|Hours(SPN 961)|Month(SPN 963)|Day(SPN 962)|Year(SPN 964)

PGNs: EEC_1, EEC_2, ET1, CCVS and IC1 are required for the J1939 freeze frame parameters. If these are not available on the bus, the respective missing values are filled up with 0.

6.4.2 Time/Date (PGN: FEE6)

After the boot process is completed, the T6 APD system requests the PGN time/date via broadcast. If it receives a time stamp, the internal clock of the MCU is set to the received time. Then this time is transmit also to the DCUs.

If no J1939 node responds to the time/date request, the internal clock of the MCU is transmit directly to the DCUs after 20 seconds.

The MCU has a supercap as backup battery of the time and can therefore also store a manually adjusted time via power-off for several days (approx. 1 week).

6.4.3 Optical diagnostic support

The J1939 error codes are signalled or represented via lights in the vehicle cockpit. The standard defines four different lights.

The following error codes are monitored in the T6 APD:

Red Stop Lamp (RSL):

Indicates serious errors when the vehicle must be stopped immediately.

Amber Warning Lamp (AWL):

Warning lamp for less serious errors when the vehicle does not need to be stopped immediately.

The T6 APD supports the following states:

- Lamp off
- Lamp permanently on

6.4.4 Property Editor in COMBIVIS - Data scaling, offsets and formatting

In addition to reading and writing of the DCU parameters also information about their properties can be queried via COMBIVIS. All important information can be read from the properties - unit, factor and data length.

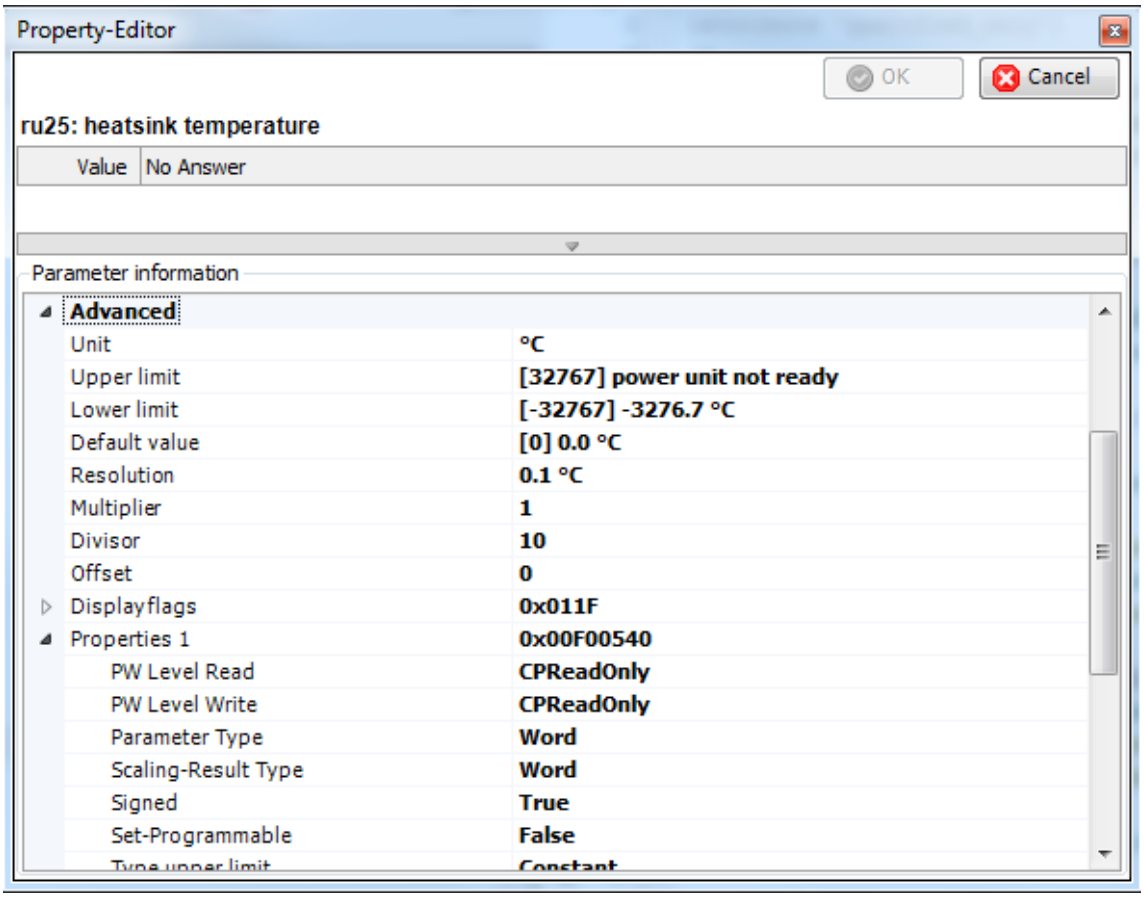

Figure 3: DCU parameter properties of parameter ru25

If a parameter should have a sign-sensitive value (Propertie "Signed" = True), the following offset must be added.

Data size in bytes	Offset (without factor)
1 (byte)	-125
2 (word)	-32,000
4 (long)	-2,000,000,000

Here are the settings of parameter ru25 from figure 3:

Length: 16 Bit

Factor: 0,1

Offset: -32000

Minimum: -3200,0

Maximum: 3225,5

If the parameter is a bit-coded value, this can also be displayed via the COMBIVIS Property Editor.

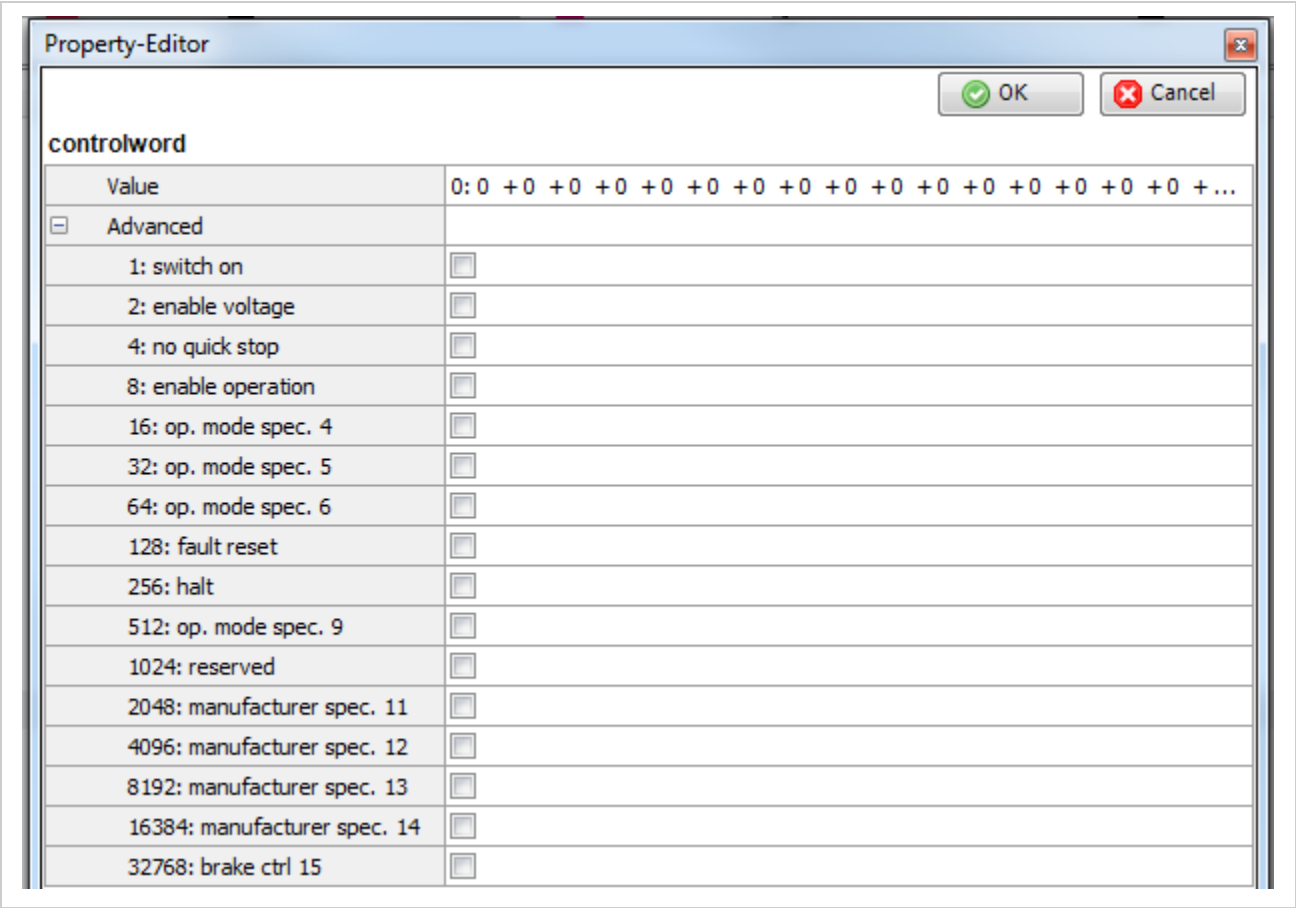

Figure 4: All values transferred via J1939 are transferred to Intel Byteorder

6.4.5 Communication settings in COMBIVIS

See Chapter 2.4 in the COMBIVIS 6 manual. Press key „F1“ in COMBIVIS.

7 History of changes

Chapter	Changes	Date
	First version generated	09.07.2018
5.1	Error table „exeption state“ up on value 200 reworked	22.07.2019

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