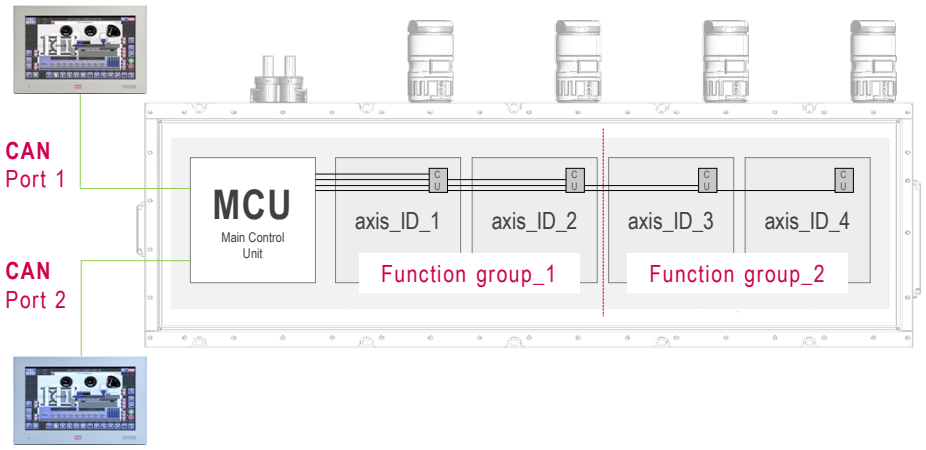

COMBIVERT **T6 App Utility**

PROGRAMMING MANUAL | MCU - App Utility **– V1.1**

Translation of the original manual
Document 20237944 EN 01

Content

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.

i	➢ 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 CE mark and the EU declaration of conformity, that our device complies with the essential safety requirements.

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

1.4 Warranty and liability

The warranty on design, material or workmanship for the acquired device is given in the current terms and conditions.

	Here you will find our general terms of sale. AGB	

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 devices in the target products is beyond of our control and therefore exclusively the 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 we expressly reserve the right to make changes, especially 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.

Inspections and tests can only be carried out by the customer within the scope of the intended end use of the product (application). 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 programming manual and other documents accompanying the device or parts thereof 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 included in the instructions for use. The instructions for use are already available to you, are freely available for download on 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 safety and warning instructions!
- ➢ If anything is unclear, please ask!

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.
- Understanding of the function in the used machine.
- Detection of hazards and risks of the electrical drive technology.

2.2 Validity of this manual

This part of the programming manual describes the AppUtiliy of the COMBIVERT T6 APD.

This part of the programming manual

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

2.3 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 !

- ➢ Check especially during initial start-up or replacement of the drive converter if 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

The MCU is the head-end station of the T6. Various apps for the subordinate DCUs can be selected here.

3.1 Specified application

The T6 MCU AppUtility is a modular software concept that enables individual solutions for individual vehicles. For each axis node, independent apps can be selected from a pool of existing apps.

The different apps can act and work completely independently of each other. Thus it is possible to combine different functionalities.

Two CAN ports are available on the MCU to interact with the apps.

The operation is carried out exclusively via the explicitly provided parameterization, diagnosis and commissioning tool COMBIVIS studio 6 or COMBIVIS 6. The application focus is on commercial vehicles.

3.2 Unintended use

Means:

- Operation outside the limit values specified in the technical data.
- 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 electromobility product portfolio
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, commissioning and diagnosis. Note: Always axis_ID at pos. 0 [0].
Function modules	Are the MCU, inverter modules A, B, C at 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 board on the inverter modules A, B or C
axis_ID	Axis Identifier - describes the function modules in the T6 APD system at positions 0... 6. Note: MCU = axis_ID [0], DCU`s = axis_ID`s [1-6].
COMBIVIS studio 6	Assistant-guided component selection, CAN configuration, drive parameterization and IEC61131-3 project generation
COMBIVIS 6	Parameterization, diagnosis (InverterScope) and commissioning tool for COMBIVERT 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 assistants in COMBIVIS for easy commissioning of the T6 APD

Term	Description
CAN J1939 App	IEC 61131 basic project as CAN communication gateway in the MCU
DCU_DownloadFile	Parameter list as download for the control unit (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 diagnosis
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 J1939 protocol 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). identifies the content of a message. The recipients decide whether a message is relevant for them or not based on the identifier.
CAN node address	Each device in the CAN (vehicle) network is 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 communication instances, called Controller Application, for representation as independent ECU in the CAN BUS. See SAE J1939-81 Network Management.
Function group	Controller Application CA - function groups (see Fig. 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 describes the combination of DCU parameters that are configured for cyclic exchange with the MCU and with participants in the (CAN bus network).
Communication mapping	A mapping of parameters, which can be configured in the inverter
Freeze Frame Mapping	One of the inverter communication mappings to be used to create the DM4 Freeze Frame
Receive telegram ID	CAN ID - 29 bit identifier / header based on the specification CAN 2.0B, divided in J1939 into sections / fields with defined meaning - in receive direction (from the view of the T6 APD)
Transmit telegram ID	CAN ID 29 Bit Identifier / Header - in transmission direction (from the wiew of the T6 APD)
PDO	PDO = Process data object (image / container / etc.) of the DCU parameters that are exchanged with the (MCU / CA).
Transmit PDO	The DCU parameters which are to be transmitted cyclically by the inverter modules

Term	Description
Receive PDO	The DCU parameters which are 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: a 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 kind and type of an error that has occurred.
OC	J1939 - Occurence Count - A counter that counts the occurrence of the error status 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	worldwide valid standard for programming languages of programmable controllers
EVCU	Electronic Vehicle Control Unit - electronic vehicle control unit
ECU	Electronic Control Unit - electronic control, this term is typically used
Supercap	Ultracapacitor to provide the lowest currents for data retention of static memories (SRAM) or backup battery for real-time clocks.
PDU	Protocol data unit – designation of a single CAN frame within the J1939 standard
UDS	Universal diagnostic services – a collection of diagnostic services specified by the ISO 14229-1
OSI	Open systems interconnection model – a communication model that separates communication protocols in 7 different standardized layers
crc	Cyclic redundancy check – an operation to check the integrity of a received message

Table 3-1: Used terms and abbreviations

4 J1939 Basics

Many functions, applications and services of the T6 are based on J1939. In this chapter the most important points of the J1939 protocol shall be explained.

4.1 CA – Controller Application

According to the J1939 standard an ECU is able to represent several J1939 nodes at the same time. These nodes are called "controller application". The T6 uses this function to create two controller applications in a MCU. These are coupled to the two physically separated CAN ports.

The two controller application instances work completely independently of each other. Each creates its own error history and its own apps are assigned via parameter DS01.

In this way it is possible to divide the T6 into two individual function groups.

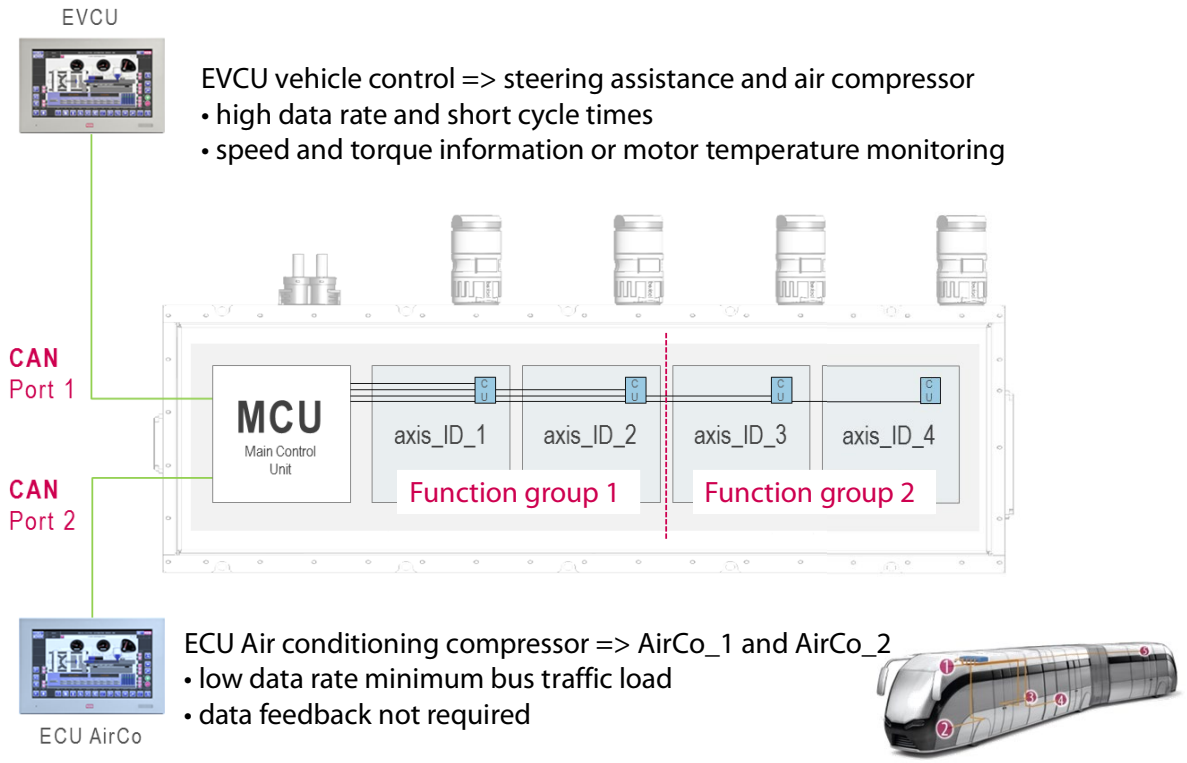

Figure 1: Example application with two individual controller applications

Each Controller Application instance sends an address claimed PG during startup. This message contains the "NAME of controller application". The AC PG is structured as follows:

PGN	Id-Text	Name	Function
0xEE00..0xEEFF	AC	Address claim	Advice all nodes at the fieldbus the "NAME", which contains various information about the ECU.

Byte	Function	Value	Plaintext	Note
1..3.5	Identity number	0.. 2097151	Unique identification number	The T6 places a part of its Mac address in this field. Thus each T6 has a unique identifier
3.6..4	Manufacturer code	684	Vendor dependent identifier	KEB is registered in the SAE with the vendor number 684 (0x2AC)
5.1..5.3	ECU Instance	0..1	Identification of the individual CA instances	The AC of the two CA instances can be distinguished by this index
5.4..5.8	Function Instance	1	Instance of the function identifier	
6	Function	255	Function identification	
7.1	Reserved	FALSE		
7.2..7.8	Vehicle System	0	Vehicle identification	
8.1..8.4	Vehicle System Instance	0	Vehicle identification instance	
8.5..8.7	Industry Group	0	Industry identifier	
8.8	Arbitrary Address Capable	FALSE		

4.2 PDU – Protocol data unit

A single CAN frame is also called PDU (protocol data unit) in J1939. This consists of a 29 bit telegram ID and 64 bit telegram data.

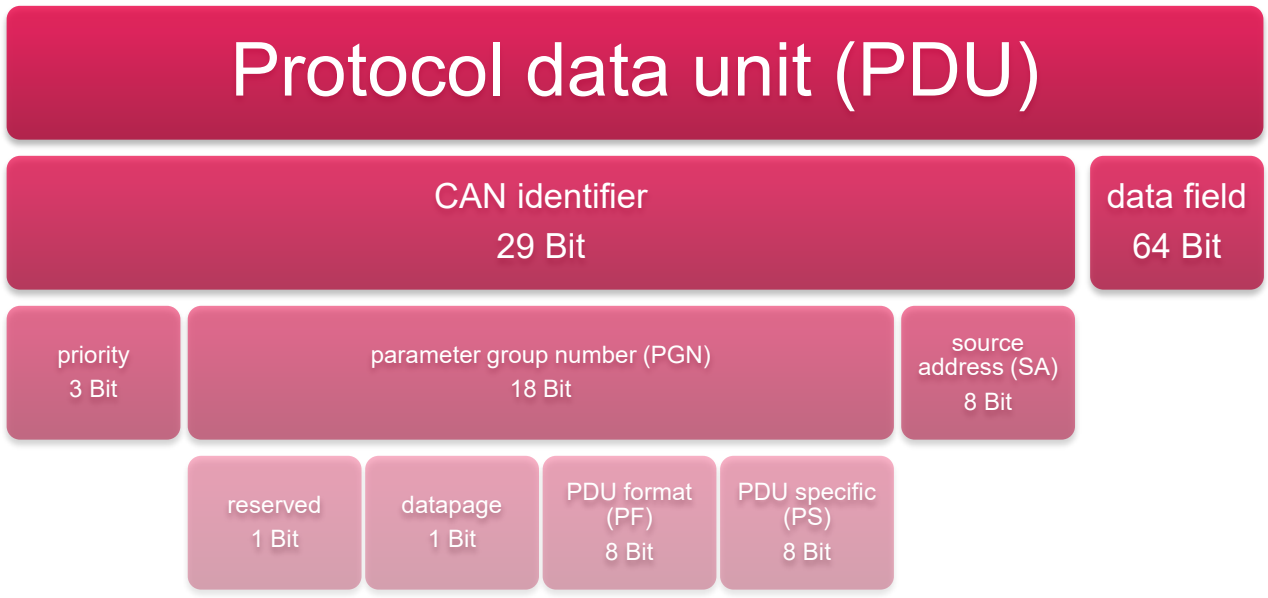

Figure 2: Breakdown of a PDU

4.2.1 Priority, reserved and datapage

The first 5 bits of the identifier are masked out by T6. They are not important for the reception of data.

The reserved and datapage bit is not supported by T6 and is always set to 0.

The priority can be changed via parameter CA05. However, it is set to 6 by default, which is a recommended value for auxiliary units.

4.2.2 Parameter group number

The parameter group number defines the type of the parameter group (PG). At this point in the header it is determined how the following data field is structured.The PGN consists of PDU Format and PDU Specific

4.2.2.1 PDU Format/Specific

There are basically two different formats for a PDU. PDU1 and PDU2 format. PDU1 is a connection-oriented format (peer to peer). Here the PDU Specific Field is used for the Destination Address. PDU2 is a format that is generally sent as broadcast. No destination address is required. Instead, the PDU Specific Field is used as an extension to define further PGNs.

	PDU Format Field	PDU Specific Field
PDU1 Format	0-239	Destination Address
PDU2 Format	240-255	Group Extension

Table 4-1: Differentiation PDU1 and PDU2 format

4.2.3 Source address

The last byte of the ID in the J1939 network always contains the source address of the sender. This is only relevant for the T6 if it is a PDU1 format connection or if the app offers a filter for source address.

4.3 Transport Protocol

A PDU can contain a maximum of 8 bytes of user data. Since this is not sufficient for many PGs, the J1939 standard was extended with a transport protocol (document SAE J1939_21 APPENDIX C). This allows a PG to be sent as a sequence of many PDUs, thus extending the amount of user data to a maximum of 1785 bytes.

The transport protocol distinguishes between two transfer methods. The connection mode data transfer (CMDT) method for PGNs in PDU1 format and the broadcast announce message (BAM) for broadcast messages in PDU2 format.

4.3.1 Connection mode data transfer (CMDT)

The basic functions of the T6 do not require CMDT connections. Some apps could use CMDT if necessary.

The CMDT is described in document SAE J1939_21 APPENDIX C

4.3.2 Broadcast announce message (BAM)

A BAM is always sent when a PG in PDU2 format exceeds the limit of 8 bytes. Only one BAM can be active per controller application. If many PGs > 8 bytes are active at the same time, they are transferred sequentially. This may affect transfer times and cycle rates. It is recommended to keep the amount of PGs > 8 byte low.

4.3.2.1 Transport Protocol – Connection Management (TP.CM_BAM)

The connection management parameter group is used for establishing and disabling of connections via the transport protocol. The first byte of the data field (control byte) defines the command or connection type.

Here the structure of a CM telegram in case of a BAM

➢ The value in the control byte defines how the data structure is structured. The following table describes the structure for the case BAM (0x20)

PGN	Id-Text	Name	Function
0xECFF	TP.CM_BAM	Transport Protocol – Connection Mgmt	Establishing and terminating connections in the transport protocol

Byte	Function	Value	Plaintext	Note
1	Control byte	16	Request to send	Part of the CMDT connection sequence
		17	Clear to send	Part of the CMDT connection sequence
		19	End of message acknowledge	Part of the CMDT connection sequence
		32	Broadcase announce message	This message announces a BAM and informs the recipient about all details of the message
		255	Connection abort	Used to abort an existing connection
2..3	Message size	0..1785	Size of the PG in byte	
4	Number of packets	2..255	Number of data packets	After the CM_BAM follows a sequence of n data packets (TP.DT)
5	Unused	255		This field is not required for a BAM transfer
6..8	PGN	0..65535	Parameter group number	Contains the PGN of the message to be transmitted

4.3.2.2 Transport Protocol – Data Transfer (TP.DT)

After sending the TP.CM_BAM message, a sequence of TP.DT messages follows. The first byte within this sequence is always a packet index. The remaining 7 bytes are then filled with the data of the announced PG.

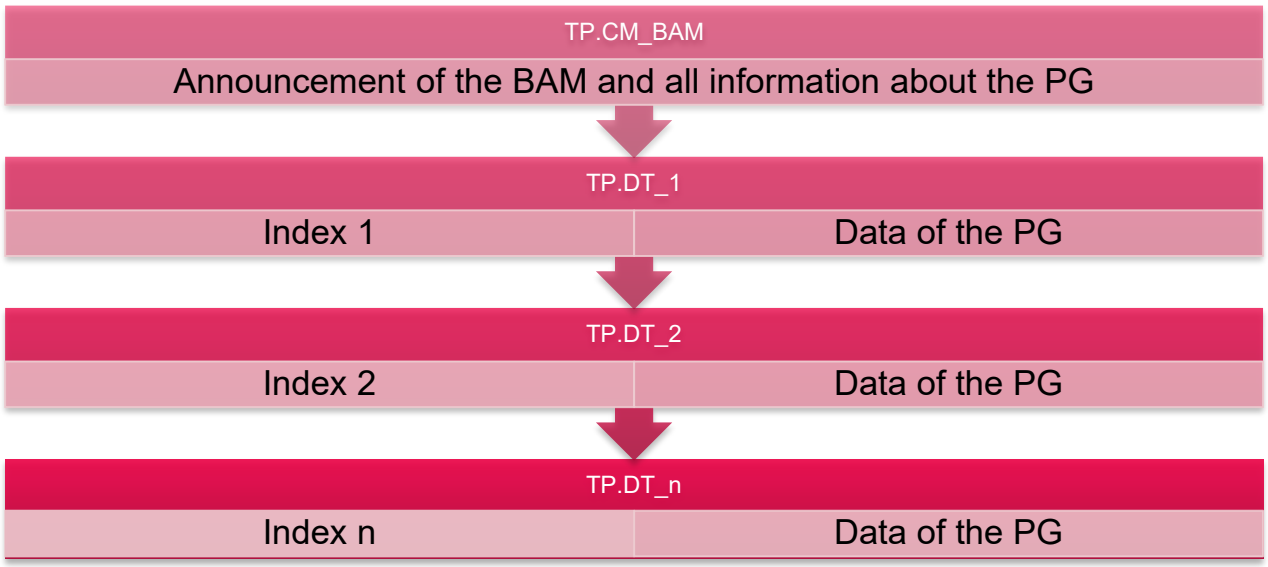

Figure 3: Example of a BAM transmission sequence

4.4 Request

Some PGs are not sent cyclically. Instead, these are only sent as response to a "request".For this purpose a special "Request" parameter group has been defined in J1939. Since a request is in PDU1 format, the PGN has a target address. In this way a target for a request is defined. A global request can also be sent to all ECUs in the network via the target address 0xFF.

PGN	Id-Text	Name	Function
0xEA00..0xEAFF	RQST	Request	Is used to trigger the transmission of non-cyclic PGs

Byte	Function	Value	Plaintext	Note
1..3	PGN	0..FFFF	Parameter group number	Contains the PGN of the requested PG

4.4.1 Acknowledgement

Certain requests trigger an action in the target. In this case the target responds with an acknowledgement PG. An example for such a case is the DM03 (Diagnostic Data Clear) function. 0

PGN	Id-Text	Name	Function
0xE800..0xE8FF	ACKM	Acknowledgement	Feedback from ECUs as response to requests that trigger an action

Byte	Function	Value	Plaintext	Note
1	Control byte	0	Positive Acknowledgement (ACK)	Requested action has been successfully executed
		1	Negative Acknowledgement (NACK)	Requested action could not be executed
		2	Access Denied	Origin of the request is not entitled to request this action
		3	Cannot Respond	Requested action not known
2	Function group	255	Function group	Not assigned in T6
3..4	Reserved			
5	Address Acknowledged	0..255	Address confirmation	Address of the request source (to confirm the request of the drive controller)
6..8	PGN	0..FFFF	Parameter group number	The PGN which was requested in the request

4.5 Diagnostic Message (DM)

Errors and status information are transmitted in J1939 via diagnostic messages (DM). The T6 supports the Diagnostic Messages 1-4.

4.5.1 Lamp Status

Some diagnostic messages transmit a lamp status. In DM01 this is mostly used to control LEDs in the driver's cockpit.

Name	Function
Lamp Status	Reporting of errors via signal lamps in the cockpit for the vehicle driver

Byte	Function	Value	Note
1.1..1.2	Protect Lamp	3(not available)	The Protect Lamp indicates errors in a non-electrical subsystem
1.3..1.4	Amber Warning Lamp	0..1	The Amber Warning Lamp signals errors which do not require the vehicle to stop
1.5..1.6	Red Stop Lamp	0..1	The Red Stop Lamp signals a critical condition with the vehicle and informs the driver to stop the vehicle immediately
1.7..1.8	Malfunction Indicator Lamp	3(not available)	The Malfunction Indicator Lamp signals a malfunction which has an effect on the emissions of the vehicle

2.1..2.2	Flash Protect Lamp	3(not available)	Let the Protect Lamp flashing
2.3..2.4	Flash Amber Warning Lamp	3(not available)	Let the Amber Warning Lamp flashing
2.5..2.6	Flash Red Stop Lamp	3(not available)	Let the Red Stop Lamp flashing
2.7..2.8	Flash Malfunction Indicator Lamp	3(not available)	Let the Malfunction Indicator Lamp flashing

The T6 only supports the Amber Warning and Red Stop Lamp. The Amber Warning Lamp is controlled with every error in the system, while the Red Stop is only triggered when the affected node gets the authorization via parameter DS05.

4.5.2 Diagnostic Trouble Codes (DTC)

The Diagnostic Trouble Codes can be found in all diagnostic messages and consist of four elements

Id-Text	Name	Function
DTC	Diagnostic Trouble Code	This structure is used by all diagnostic messages to describe an error status of the systems

Byte	Function	Value	Plaintext	Note
1..2 + 3.6..3.8	SPN	517000..523999	Suspect parameter number	The SPN describes "what" is faulty
3.1..3.5	FMI	31	Error Mode Identifier	The FMI is a generic collection of error codes that describe the error state of the SPN
4.1..4.7	OC	1..127	Occurence Count	The OC is a counter which indicates the frequency of this error since commissioning or since the last clearing of the error memory.
4.8	CM	0	SPN Conversion Method	If this bit is set, the format of the DTC refers to a documentation before 1996. In T6 this bit is always 0, so the format is to be interpreted as indicated

- The generic error codes of the FMI are not suitable for a high voltage frequency inverter. Therefore the FMI codes are not used.
- Since there is no suitable SPN for the T6 in J1939, it uses the "Manufacturer Assignable SPN" range

4.5.2.1 Suspect parameter number

The SPN of the T6 is always in the "Manufacturer Assignable SPN" range between 517000 and 523999. To get a readable error code it is recommended to subtract the base offset 517000 first.

This gives a range of 0-6999.

The thousands digit describes the position in the form of the node address. The value 0-999 contains the error code itself. In order to be able to distinguish the different error types of the T6 within this error code, they are set to different value ranges by means if offsets.

Error type	Offset	Resulting value range

Error type	Offset	Resulting value range
DCU Axis error	0	0-289
MCU error	290	290-299
DCU App error	300	300-999

Breakdowns of the axis and MCU error codes in chapter 6.1. A breakdown of the DCU app errors must be taken from the corresponding app.

4.5.3 Active Diagnostic Trouble Codes (DM01)

The DM01 is sent by all ECUs in a cycle of 1s. Regardless whether or not an error is present. In this way it can also be used as heartbeat. The message contains the Lamp Status and a list of all currently active DTCs.

➢ If more than one DCT is available, a BAM is automatically sent. Up to 13 DCTs can be active at the same time.

PGN	Id-Text	Name	Function
0xFECA	DM01	Active Diagnostic Trouble Codes	Sends a list of all active error messages of the node

Byte	Function	Plaintext	Note
1..2		Lamp Status	Display of the current status LEDs. Details in chapter 4.5.1
3..6	DTC1	Diagnostic Trouble Code	Listing of all active Diagnostic Trouble Codes. Details in chapter 4.5.2
7..10	DTC2	Diagnostic Trouble Code	
11..14	DTC3	Diagnostic Trouble Code	
…	DTC…	Diagnostic Trouble Code	

4.5.4 Previously Active Diagnostic Trouble Codes (DM02)

The DM02 parameter group has the same structure as the DM01 parameter group. However, DM02 is not sent cyclically but only as response to a request. It contains all the DTCs that have been stored in the error memory of the ECU over time. The active DTCs are not transmitted.

PGN	Id-Text	Name	Function
0xFECB	DM02	Previously Active Diagnostic Trouble Codes	Sends a list of all non-active error messages within the error memory

Byte	Function	Plaintext	Note
1..2		Lamp status	Display of the current status LEDs. Details in chapter 4.5.1
3..6	DTC1	Diagnostic Trouble Code	Listing of all active Diagnostic Trouble Codes. Details in chapter 4.5.2
7..10	DTC2	Diagnostic Trouble Code	
11..14	DTC3	Diagnostic Trouble Code	
…	DTC…	Diagnostic Trouble Code	

4.5.5 Diagnostic Data Clear/Reset for Previously Active DTCs (DM03)

The Diagnostic Data Clear (DM03) PG is a special PG. This PG triggers an action in the recipient. In this case the complete error memory of the CA is deleted and the deletion is confirmed with an acknowledgement. More information about the Acknowledgement in chapter 0.

The DM03 parameter group contains no data. The receipt of the message alone is enough to trigger the command.

PGN	Id-Text	Name	Function
0xFECC	DM03	Diagnostic Data Clear/Reset for Previously Active DTCs	Command for clearing the error memory (does not contain any data)

4.5.6 Freeze Frame Parameters (DM04)

The CA also stores a time stamp for each error in the error memory. Additionally, 4 DWORDs are stored for each error. These can be filled with data by the author of an app. In this way, actual states at the time of the error can be "frozen" to provide further information about the cause of the error.

This "Freeze Frame" data can be retrieved via the DM04 parameter group.

➢ Some freeze frame data are already defined by the standard. These are currently not supported by T6.

PGN	Id-Text	Name	Function

0xFECD	DM04	Freeze Frame Parameters	Sends the complete error history including the freeze frame data that was saved to the error
Byte	Function	Plaintext	Note
1	Length	Length of the Freeze Frame	A Freeze Frame can vary in length. In T6 a Freeze Frame always has the length of 24Byte
2..5	DTC	Diagnostic Trouble Code	The DTC is a basic component of every Freeze Frame
6..21	Custom FF data	Application-specific Freeze Frame data	This area contains the 4 DWORDs which apps can be filled specific. Details on their content must be taken from the documentation of the respective apps
22	Seconds	Seconds	The time stamp consists of the following 6 bytes.
23	Minutes	Minutes	
24	Hours	Hours	
25	Month	Month	
26	Day	Day	
27	Year	Year	An offset of 1970 is to be added to the year.

4.6 Signal transmission/Data Format

Data transmission in the J1939 is in little-endian format (Intel format).

4.6.1 Signal value table

Not all transmitted values are valid signal values. Some special values contain information superior to the signal.

Domain name	1 Byte	2 Byte	4 Byte
Valid signal	0..250 0x00..0xFA	0..64255 0x00..0xFAFF	0..4211081215 0x00..0xFAFFFFFF
Reserved	251..253 0xFB..0xFD	64256..65023 0xFB00..0xFDFF	4211081216..4261412863 0xFB000000..0xFDFFFFFF
Value invalid / value incorrect	254 0xFE	65024..65279 0xFE00..0xFEFF	4261412864..4278190079 0xFE000000..0xFEFFFFFF
Not available	255 0xFF	65280..65535 0xFF00..0xFFFF	4278190080..4294967295 0xFF000000..0xFFFFFFFF

4.6.2 Signal SLOT

So-called "SLOTs" are assigned for signals. These describe scaling, limit and the offset of a signal (SLOT = Scaling, Limit, Offset and Transfer Function). The offset is required if the signal can also contain negative values. It is subtracted from the value before transmission and added back to the value when data is received.

Many SLOTs are already defined in the standard.

Example:

SLOT ID	SLOT Name	Scaling	Offset	Length
378	SAEvr07	1 rpm/Bit	-32127 rmp	2 bytes

Example data:

CAN Data	Signal value
0x7D7F	0 rpm
0x7DE3	100 rpm
0x7997	-1000 rpm

5 MCU functions

The MCU functionality is limited to general and global functions. The intrinsic drive functions are implemented in the axis-specific selected apps.

5.1 System commissioning

The MCU software ensures complete commissioning of the entire system. For this purpose, download files can be stored on the file system of the MCU.

If required, the downloads can be set to a certain hardware.

5.1.1 Configuration Download

When the T6 is started, the file system is searched for a file with the prefix "cfg_" (e.g. cfg_McuDefault.dw5). This parameter file is then downloaded to the MCU parameters. In this way, the MCU parameterization can be done in series production using only the configuration file on the T6 file system.

- Only one configuration file may exist on the file system
- The download is only executed once until the configuration file is changed

If desired, the configuration file can be set to a specific hardware. This ensures that the configuration is only compatible with a specific hardware. The target configuration can be defined in parameters DS02[1-6] (see chapter 0).

5.1.2 DCU Download

The DCU parameters can also be loaded via the MCU and an associated download file. For this purpose a "Default Download ident" can be set in the MCU parameters, depending on the node.
This is an identification number which is set as prefix in the file name.
Example: Default Download ident = 123 -> 123_Exampledownloadfile.dw5
In this way, the entire system parameterization in series production can be executed via download files on the file system

- Each default download id may exist only once on the file system
- A default download can also be used for several axes (e.g. if the same motor is installed)
- If 0 is entered, no download is carried out

If desired, the default download file can be set to a specific hardware. This ensures that the download is only compatible with a specific DCU axis type.
If parameter de28 (rated inverter current) is included in the default download list, this parameter defines the target DCU axis type.

5.2 Diagnosis

The MCU offers a variety of diagnostic options

5.2.1 Diagnosis via COMBIVIS 6

Diagnosis information about the current system status can be requested via the RU parameter group. This includes information such as error messages, boot status, inverter release, overload protection status and power values of the entire system. Detailed information on the parameter groups in chapter 6

Information about the error history can also be read out via COMBIVIS. These can be found in the parameter group AD. Details in chapter 6.6

5.2.2 Diagnosis via J1939

The most important J1939 diagnosis functions are parameter groups DM01-DM04. These are activated as soon as a valid address (<0xFE) is entered in parameter CA04 for a controller application. Details in chapter 0

In addition to the error messages, status information about the entire system can also be sent. A cyclic status information can be activated in parameter AD06

PGN	Id-Text	Name	Function
0xFFFF	PropB_255	Propriatary B	This parameter group is used to send proprietary data. In this case (0xFFFF) status information are sent via the T6 entire system

Byte	Function	Value	Offset	Resolution	Note
1..2	DC link voltage	0..6553.5	0	0.1V/Bit	Current DC link voltage in the DC bus of the T6
3..4	Total motor power	0..642550	0	10W/Bit	Current total motor power of all DCU nodes
5..6	Regenerative total power	0..642550	0	10W/Bit	Current generated regenerative total power of all nodes
7	Heat sink temperature	-125..125	-125	1C°/Bit	Current heat sink temperature
8	Overload protection status	0..100	0	1%/Bit	Status of the OL function

5.2.3 Diagnosis via log file

The error memory of the controller applications is stored in the file system of the T6 as CSV file. This can be requested via the COMBIVIS Drive storage or the KEB-FTP function.

5.3 Overload protection

The DC bus of the T6 is designed for a maximum current of 120A. In order not to overload the DC bus in continuous operation, the MCU has a protective function which monitors the power consumption of the DCU modules.

The protection function can be monitored via parameter ru10 or via PGN 0xFFFF (chapter 5.2.2). The OL value starts to rise if the limit value of 120A is exceeded. The rate of increase depends on the amount of exceedance.

Example: With a current value of 180A the OL value reaches 100% in about 60s.

When the OL value reaches 100% the MCU starts to shut down DCU nodes. The switch-off sequence can be defined via parameter DS04.

Once switched off, the drive remains inactive until the OL value falls below the "OL reset threshold". This can be set in parameter CA03.

Before the "hard" shutdown occurs, the CA1 of the T6 sends a DM01 error message with a yellow lamp as warning signal. The threshold value for this warning can be set in parameter CA02. This warning allows to react to the overload and to prevent shutdown.

➢ Shutdown via the MCU is a supervising shutdown to the apps. KEB recommends to avoid this shutdown and to use the warning level instead to take measures before.

6 T6 APD parameter groups

Index	Group	Name	Function
0x2Cxx	ru	Run Parameter	Information about the current T6 status
0x20xx	de	Device info	Information about software versions
0x21xx	ca	Controller Application settings	Controller Application specific settings
0x22xx	ds	Dcu settings	Axis-specific settings
0x23xx	as	Application settings	App specific settings
0x24xx	ad	Advanced Diagnostics	Advanced error diagnostics

6.1 ru Parameter

Run-Parameter

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

Note: At subindex-based parameters the subindex indicates the node address of the DCUs.

Index	Id-Text	Name	Function / value range
0x2C00	ru01	MCU exception state	Display of the current MCU error message
Note: see table 6- 1 "MCU exception state"			0..9
0x2C01	ru02	DCU[1..6] exception state	Display of the current DCU error messages 1-6
Subindex 1	ru02	DCU[1] exception state	0… 124
…			
Subindex 6	ru02	DCU[6] exception state	0… 124
Note: see table 6- 2 "MCU exception state"			
0x2C02	ru03	App[1..6] exception state	Display of the current app error messages 1-6
Subindex 1	ru03	App[1] exception state	0..999
…			
Subindex 6	ru03	App[6] exception state	0..999
Note: see table 6- 3 "MCU exception state"			
0x2C03	ru04	App init state [1-6]	Initialization state of the apps 1-6
Subindex 1	ru04	App init state [1]	0… 10
…			
Subindex 6	ru04	App init state [6]	0… 10
0x2C04	ru05	DCU release state [1-6]	Inverter modules [1-6] Release state
Subindex 1	ru05	DCU release state [1]	0… 6
…			
Subindex 6	ru05	DCU release state [6]	0… 6
0x2C05	ru06	Act. used power	Sum of all motor DCU power

			-2147483.648…2147483.647 rpm
0x2C06	ru07	Act. generative power	Sum of all generative DCU power
			-2147483.648…2147483.647 rpm
0x2C09	ru10	Act. OL value	Current overload state
			0… 100 %
0x2C10	ru11	Dcu Count	Number of detected DCU nodes
			0… 6

List of MCU states of emergency:

ru01	Fault text	Description
0	no exception	No error
1	No config file found	No file with the predix cfg_ could be found in the T6 file system. See chapter 5.1.1
2	Invalid j1939 license	No J1939 license file was found on the T6 file system
3	Error download config file	An error occurred while loading the cfg_ file
4	OL protection active	The protective function of the T6 has been triggered. At least 1 DCU node is inactive. See chapter 5.3
5	Invalid app selection	Invalid app selection (two apps are active for one node)
6	OL warning active	The protection function has exceeded the warning level. See chapter 5.3

Table 6-1: MCU exception states

List of MCU states of emergency:

ru02	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

ru02	Fault text	Description
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)
44	ERROR invalid power unit data	Invalid power unit data
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
62	ERROR power unit changed	Power unit changed (de20 / de21)
64	ERROR power unit type changed	Power unit type changed (de26 / de27)
66	ERROR overcurrent PU	Overcurrent
67	ERROR max acc/dec	Max. acceleration/deceleration setting exceeded (monitoring especially necessary for cyclic synchronous operating modes)
97	ERROR overspeed (EMF)	pn72 overspeed level (EMF) has been exceeded
107	ERROR over frequency	The maximum output frequency de 120 has been exceeded. (599Hz)
112	ERROR 24V supply low	active 24V supply (internal or external) has fallen to a lower value than 18V
119	ERROR extreme overpotential	Extreme overvpotential in the DC link (can lead to damage of the DC capacities)
120	ERR0R capacitor damaged	DC capacities have been damaged by too long / too high over-voltage in the DC link
121	ERROR runtime	Activation of too many functions. See runtime monitoring

Table 6-2: DCU exception states

List of App states of emergency

ru03	Error text	Description
0	no exception	No error
1	No axis	No axis detected at node
2	Error reading mapping	Boot phase: The DCU mapping could not be read
3	Error reading rated current	Boot phase: The rated current of the inverters could not be read
4	Error rated current mismatch	Boot phase: The rated current of the inverters does not match the requested rated current from parameter DS02. See chapter 5.1.1
5	Error write pll offset	Boot phase: The Pll offset parameter of the inverter could not be written
6	Error auto mapping	Boot phase: Error during execution of the automatic mapping
7	Error interlink communication	Error in the T6 internal communication between MCU and DCU

ru03	Error text	Description
8	Error ol parameter	Boot phase: The parameters required for the OL evaluation could not be found in the process data
9	Incompatible default download	Boot phase: The default download does not correspond to the preset target hardware. See chapter 5.1.2
10	Error download default download	Boot phase: The default download could not be downloaded
11	Default download not found	Boot phase: The specified default download from parameter DS06 could not be found
12	Error CAN data timeout	The selected app has detected a CAN timeout
13	Error CAN data invalid	The data transmitted by CAN was evaluated by the app as incompatible
14	Invalid license	No suitable license was found for the selected app
15	Error reinit app	Boot phase: Error during initialization of the app
19	Generell application error	Generic app error message

Table 6-3: DCU exception states

➢ The app exception states refer exclusively to boot error messages or generic error messages. The list of errors can be extended by the author of the app from a value of 20. The extension can be found in the documentation of the respective app.

6.2 de Parameter

Device info

The de parameters are used exclusively for version tracking of the different software components within the MCU. This information is mainly for KEB service personnel.

Index	Id-Text	Name	Function / value range
0x2010	de16	McuApp software version	Software version of the MCU boot project.
0x2011	de17	McuApp software date	Change date of the MCU boot project.
0x2012	de18	MCU firmware version	Firmware version of the MCU control
0x2013	de19	MCU firmware date	Modification date of the MCU firmware
0x2014	de20	App util lib. version	Software version of the App Framework component
0x2015	de21	J1939 lib. version	Software version of the J1939 component
0x2016	de22	App pool lib. Version	Software version of the app pool component

6.3 ca Parameter

Controller Application settings

All controller application specific settings are made in the ca parameters. For details on the Controller Application, see chapter 4.1

Note: For subindex-based parameters, the subindex represents the instance of CA. Parameters without subindex are functions that are only contained in CA1.

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 Subindex 2	ca01 ca01	CAN port baudrate [1] CAN port baudrate [2]	see table parameter values CAN Port (1-2) baudrate

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	OL warning threshold	Threshold value of the protection function for signalling a warning. See chapter 5.3
			1… 99
0x2102	ca03	OL reset threshold	Threshold value for the automatic reset of an OL error. See chapter 5.3
			1… 99
0x2103	ca04	CA address [1-2]	J1939 Address of the Controller Application.
Subindex 1 Subindex 2	ca04 ca04	CA address [1] CA address [2]	0… 254 0… 254
Note: Value 254 deactivates the controller application			
0x2104	ca05	default priority [1-2]	Standard J1939 CAN priority for the T6 APD. The value 6 is provided for auxiliary aggregates (lower value corresponds to higher priority)
Subindex 1 Subindex 2	ca05 ca05	default priority [1] default priority [2]	0… 7 0… 7

6.4 ds Parameters

Dcu settings

All axis-specific parameters are located in the DCU settings.

Note: For subindex-based parameters, the subindex represents the node address of CA.

Index	Id-Text	Name	Function / value range
0x2200	ds01	assigned controller application [1-6]	Assignment of the DCU (and the associated app) to a controller application
Subindex 1	ds01	assigned controller application [1]	1… 2
…			
Subindex 6	ds01	assigned controller application [6]	1… 2
0x2201	ds02	Node type [1-6]	Specification of the rated current expected for the DCU [1-6]
Subindex 1	ds02	Node type [1]	See table parameter values node type
…			
Subindex 6	ds02	Node type [6]	

Bit	Function	Value	Plaintext	Note
0	Node Type	0	No check	No specification of the expected DCU type for this index
		1650	DCU A	Expect DCU type A (rated current 16.5 A)
		3300	DCU B	Expect DCU type B (rated current 33 A)
		6000	DCU C	Expect DCU type C (rated current 60 A)

0x2202	ds03	App Selection [1-6]	Selection of the app. With this selection a corresponding app is loaded from the pool for this DCU. Selection 0 enables an app to be loaded via IEC code
0x2203	ds04	OL Prio [1-6]	The OL Prio determines the sequence in which the protective function switches off the DCU nodes. OL Prio = 1 corresponds to the highest priority See chapter 5.3
Subindex 1	ds04	OL Prio [1]	1… 6
…			
Subindex 6	ds04	OL Prio [6]	1… 6
0x2204	ds05	CAN settings [1-6]	Axis-specific general settings on J1939
Subindex 1	ds05	CAN settings [1]	see table parameter values CAN settings
…			
Subindex 6	ds05	CAN settings [6]	

Bit	Function	Value	Plaintext	Note
0	Lamp Mode	0	Amber Warning	Limits the error message authorization of the DCU node at "Amber Warning
		1	Red Stop	Authorizes the DCU node to trigger a "Red Stop". See chapter 4.5.1

0x2205	ds06	Default download ident [1-6]	Defines the default download list for the DCU node. See chapter 5.1.2
Subindex 1	ds06	Default download ident [1]	0… 4294967295
…			
Subindex 6	ds06	Default download ident [6]	0… 4294967295
0x2206	ds07	App Version [1-6]	Defines which version of the app selected in ds03 should be loaded. (if ds03 is changed, this parameter is automatically set to the latest available version)
Subindex 1	ds07	App Version [1]	0.0.0.0… 255.255.255.255
…			
Subindex 6	ds07	App Version [6]	0.0.0.0… 255.255.255.255
0x2209	ds10	Inverter UDS address [1-6]	Defines the UDS address of the different inverter nodes.
Subindex 1	ds10	Inverter UDS address [1]	0… 254
…			
Subindex 6	Ds10	Inverter UDS address [6]	0… 254
Note: Value 254 deactivates the controller application			

6.5 as Parameters

Application settings

The application settings is a collection of generic undefined parameters. These can be used individually within the various apps.

A total of 40 DWORDs for settings and 40 DWORDs for status display are available for each app.

A detailed description of the parameters can be found in the respective app manual.

6.6 ad Parameters

Advanced Diagnostics

Extended error diagnosis is possible in the ad parameter group, the error history, among other things, can be read out here. The error history contains a maximum of 40 entries. If the history is full and a new error occurs, the oldest error from the history will be overwritten.

Each CA has an independent error memory. Therefore, most parameters are twice with different prefix (CA1 or CA2)

Note: For subindex-based parameters, the subindex represents the index of the error entry in the history.

Index	Id-Text	Name	Function / value range
0x2400	ad01	CA1 error type [1-40]	Displays the type of the respective error.

Subindex 1			ad01	CA1 error type [1]	See table parameter values error type
…					
Subindex 40			ad01	CA1 error type [40]	
Bit	Function	Value	Plaintext	Note	
0	Error type	0	MCU error	Identifies the displayed error in ad02 as MCU error	
		1	DCU error	Identifies the displayed error in ad02 as DCU error	
		>=2	App error	Identifies the displayed error in ad 02 as App error.	
0x2401			ad02	CA1 error list [1-40]	List of up to 40 error messages from MCU, DCU or App (not sorted)
Subindex 1			ad02	CA1 error list [1]	0 … [4294967295] -1
…					
Subindex 40			ad02	CA1 error list [40]	0 … [4294967295] -1
Note: see chapter 6.1 for the breakdown of the error codes5.2					
0x2402			ad03	CA1 node [1-40]	The node address of the respective error index from the error list in parameter ad02
Subindex 1			ad03	CA1 node [1]	0… 6
…					
Subindex 40			ad03	CA1 node [40]	0… 6
0x2403			ad04	CA1 error hist. date [1-40]	Time stamp of the respective error index from the error list in parameter ad02
Subindex 1			ad04	CA1 error hist. date [1]	dd/mm/yyyy - hh/mm/ss
…					
Subindex 40			ad04	CA1 error hist. date [40]	dd/mm/yyyy - hh/mm/ss
Example: 2/7/2020 06:28:15					
0x2404			ad05	CA1 occurence count [1-40]	Count value of the respective error index from the error list in parameter ad02
Subindex 1			ad05	CA1 occurence count [1]	0… 65535
…					
Subindex 40			ad05	CA1 occurence count [40]	0… 65535
0x2405			ad06	CA1 Diagnostic CAN frame	Activates the diagnostic CAN frame. This frame is only available to CA1. Details in chapter 5.2.2
					See table parameter values Diagnostic CAN frame
Bit	Function	Value	Plaintext	Note	
0	Diag frame	0	Disable	Deactivate diagnostic CAN frame	
		1	Enable	Activate diagnostic CAN frame	
0x2410			ad01	CA2 error type [1-40]	Displays the type of the respective error.
Subindex 1			ad01	CA2 error type [1]	See table parameter values error type
…					
Subindex 40			ad01	CA2 error type [40]	
Bit	Function	Value	Plaintext	Note	
0	Error type	0	MCU error	Identifies the displayed error in ad02 as MCU error	
		1	DCU error	Identifies the displayed error in ad02 as DCU error	

		>=2	App error		Identifies the displayed error in ad 02 as App error.
0x2411			ad02	CA2 error list [1-40]	List of up to 40 error messages from MCU, DCU or App (not sorted)
Subindex 1			ad02	CA2 error list [1]	0 … [4294967295] -1
…					
Subindex 40			ad02	CA2 error list [40]	0 … [4294967295] -1
Note: see chapter 6.1 for the breakdown of the error codes5.2					
0x2412			ad03	CA2 node [1-40]	The node address of the respective error index from the error list in parameter ad12
Subindex 1			ad03	CA2 node [1]	0… 6
…					
Subindex 40			ad03	CA2 node [40]	0… 6
0x2413			ad04	CA2 error hist. date [1-40]	Time stamp of the respective error index from the error list in parameter ad12
Subindex 1			ad04	CA2 error hist. date [1]	dd/mm/yyyy - hh/mm/ss
…					
Subindex 40			ad04	CA2 error hist. date [40]	dd/mm/yyyy - hh/mm/ss
Example: 2/7/2106 06:28:15					
0x2414			ad05	CA2 occurence count [1-40]	Count value of the respective error index from the error list in parameter ad12
Subindex 1			ad05	CA2 occurence count [1]	0… 65535
…					
Subindex 40			ad05	CA2 occurence count [40]	0… 65535

7 UDS

7.1 Communication

The UDS standard and its different OSI communication layers are separated in different standard. This way UDS is available for different kind of networks and hardware.
The T6 APD uses the following standard for the different layers:

Layer	Standard
Application	ISO 14229-1
Transport	ISO 15765-2
Network	
Data Link	CAN
Physical	

7.1.1 Application layer

The ISO 14229-1 describes numerous different services. The T6 only support a specific set of services. The description and detailed information about the supported services can be found in this section of this document

7.1.1.1 SAE J2012 for diagnostic trouble codes

The ISO 14229-1 does not describe diagnostic trouble codes. It allows the use of different DTC standards. The T6 uses the standard J2012.
The T6 will always belong to the J2012 system “body” (8000h)

7.1.2 Transport and Network layer

The transport and network layer are strictly developed regarding the ISO 15765-2. For more information use the corresponding ISO documents.

7.1.3 Data Link and Physical layer

The T6 CAN port is used for the physical access to the telegram.
The UDS telegram identifiers are based on the J1939 parameter group KWP2 – Daxx.

The KWP2 is a PDU1 format parameter group and therefore a peer to peer connection.

Sample:
UDS Server address (T6): 50h
UDS Client address: 10h

Request CAN-ID: 18DA5010h
Response CAN-ID: 18DA1050h

7.1.3.1 Addressing

Each node of the T6 has its own unique UDS address. The addresses can be setup inside the T6 MCU Parameter ds10.

The MCU address is selected in the parameter ca04. It uses the same address cell as the J1939 main stack.

The DCU Addresses have an UDS exclusive address cell that operates independent from all J1939 functions. The address can be setup in the parameter ds10.

7.2 UDS Services

This section shall describe all available services and their manufacturer specific parts that are not described in the ISO14429-1

In some services the behaviour might differ between MCU or DCU.
Some services might only be available inside the MCU

Service	**MCU**	**DCU**	Default session	Programming session	Extended diag session	Security level
10h	X	X	X	X	X	0
11h	X		X	X	X	1
14h	X	X			X	1
19h	X	X	X		X	0
22h	X	X	X		X	0
27h	X	X		X	X	0
2Eh	X	X			X	1
31h	X	X	(routine specific)	(routine specific)	(routine specific)	(routine specific)
34h	X			X		1
36h	X			X		0
37h	X			X		0
38h	X			X		1
3Eh	X	X	X	X	X	0

7.2.1 10h – Diagnostic session control

Available sessions:

1. Default session:
   In the default session the UDS stack is in a “read only” mode. Means only services that read out data are available
2. Programming session
   This session allows the client to transfer software or parameter updates to the T6
3. Extended diagnostic session
   This session is designed for qualified persons and allows the user to access and change all parameters in the T6

7.2.2 11h – ECU reset

Available subfunctions		Details about subfunction
01h	Hard reset	Reboots the T6. Equal behaviour to a power off reset

7.2.3 14h – Clear diagnostic information

The diagnostic clear command clears the T6 from active or historical errors.
The command can target a single DTC, a DTC system group (in this case body) or all DTC's

7.2.4 19h – Read DTC information

Available subfunctions		Details about subfunction
02h	read DTC by status mask	Reads the DTCs from the T6 based on the status mask
04h	Read DTC snapshot record by DTC number	Reads the snapshot data of a DTC based on the DTC number

A list of all available DTCs can be found here.

7.2.5 22h – Read data by identifier

This service gives read access to all DIDs stored in the T6. Details to the DIDs can be found in this section

7.2.6 27h – Security access

Some services won't respond without authentication of the user. For a valid authentication, the user needs to transform a seed into a key. The transformation method won't be described here. Please contact KEB directly for more details.

7.2.7 2Eh – Write data by identifier

This service gives write access to all DIDs stored in the T6. Details to the DIDs can be found in this section

7.2.8 31h – Routine control

This service allows the user to activate routines stored inside the T6. There are system routines and application specific routines.
Information about system routines can be found here.
Information about application specific routines can be found inside the application specific manuals

7.2.9 34h – Request download

The request download service is used to download a software to an ECU. A regular ECU writes the new software directly into the flash. For the T6 this is not possible because the software is placed inside its file system.
It is still possible to download a new software with this service by applying the following rules for the request data:

#Byte	Parameter Name	Value	Details
#1	Service identifier	34h	
#2	DataFormatIdentifier	0h	The T6 does not support any compression methods

#3	AddressAndLength-FormatIdentifier	46h	This parameter defines the parameter size of next two parameters (MemoryAddress and MemorySize). In the T6 the size of these parameters is fixed to 4 and 6 bytes
#4-#9	MemoryAddress		In the T6 the MemoryAddress parameter does not really point to an address. Instead it contains more parameters that are needed to handle the different download possibilities
#4.0-#4.4	FileType	0h-2h	Different files can be downloaded: 0- APP: T6 main software 1- CRC: Crc check for the application file 2- DW5: Parameter setup file for MCU or DCU
#4.5-#4.7	TargetController	0h-6h	The file can be targeted to different controllers inside the T6. Please note that the application file and the crc file is only supported by the MCU controller 0- MCU 1- DCU1 n- DCUn
#6-#9	DefaultDownloadID	0h-FFFFFFFFh	If the file type is a dw5 file and the target MCU is a DCU, it is necessary to define the DefaultDown-loadID, that shall be used to store the file. This DownloadID shall be transferred here. In any other case this parameter is not used and can stay empty
#10-#13	MemorySize	0h-FFFFFFFFh	The expected size of the file that shall be transfered

7.2.10 36h – Transfer data

This service is used to transfer the data from service 34h or 38h. The T6 implementation follows strictly the ISO 14229.

7.2.11 37h – Request transfer exit

This service is used to end a data transfer. When the service is requested, the T6 will check if the transferred data amount matches the announced amount of data.

7.2.12 38h – Request file transfer

This service can be used alternatively to the request download service. It gives you full access to the file system of the T6

7.2.13 3Eh – Tester present

If another mode then default mode is active and the T6 doesn't receive any UDS requests, the T6 will automatically fall back to the default mode after 5 seconds. To keep the extended or programming mode active, the tester present service can be used.

7.3 Data identifiers – DIDs

The DIDs inside the T6 are separated into three different groups

Index	Name	Function
0-5FFh	Parameter groups	The parameter groups are DIDs only created for the UDS diagnostics. Each DID contain a group of controller specific parameters. This way, the tester gets an easier access to the most important inverter parameters.
600h-FFFh	Application specific parameters	Each application has the option to create application specific DIDs. The information about these DIDs can be found in the application specific manual.
2000h-FFFFh	Controller specific parameters	All parameters that can be found inside the controllers. Details about the available parameters can be found inside the MCU (Programming manual – T6 App Utility) or DCU (Programming manual T6 Drive Control Unit) manuals.

7.3.1 Parameter groups

7.3.1.1 MCU

Index	Name	Parameter	Pos [byte]	Offset	Scaling	Type
100h	Version infos	De16 – McuApp software version	0	0	1	DWORD
		De17 – McuApp software date	4	0	1	DWORD
		De18 – MCU firmware version	8	0	1	DWORD
		De19 – MCU firmware date	12	0	1	DWORD
		De20 – App Utility library version	16	0	1	DWORD
		De21 – J1939 library version	20	0	1	DWORD
		De22 – App pool library version	24	0	1	DWORD

7.3.1.2 DCU

Index	Name	Parameter	Pos [byte]	Offset	Scaling	Type
100h	Version infos	De00 – device serial number	0	0	1	DWORD
		De16 – control software version	4	0	1	DWORD
		De17 – control software date	8	0	1	DWORD
		De44 – KTY software version	12	0	1	DWORD
		De45 – KTY software date	16	0	1	DWORD
200h	Internal counter	De100 – hour counter	0	0	1	DWORD
		De101 – mod hour counter	4	0	1	DWORD
		De102 – OC error count	8	0	1	DWORD
		De103 – OL error count	12	0	1	DWORD
		De104 – OP error count	16	0	1	DWORD
		De105 – OH error count	20	0	1	DWORD
		De106 – OHI error count	24	0	1	DWORD
300h	Error snapshot info	Occurrence count	0	0	1	BYTE
		severity	1	0	1	BYTE

	(only available via the service 19h read DTC informations)	Second	2	0	1	BYTE
		Minute	3	0	1	BYTE
		Hour	4	0	1	BYTE
		Month	5	0	1	BYTE
		Day	6	0	1	BYTE
		Year	7	1970	1	BYTE
400h	Voltage info	Ru14 – actual Uic voltage	0	0	1/10	WORD
		Ru15 – peak Uic voltage	2	0	1/10	WORD
		Ru16 – actual output voltage	4	0	1/10	WORD
		Ru17 – modulation grade	6	0	100/16384	WORD
		Ru07 – actual frequency	8	0	1/8192	DINT
401h	Current info	Ru10 – actual apparent current	0	0	1/100	DINT
		Ru11 – actual active current	4	0	1/100	DINT
		Ru12 – actual reactive current	8	0	1/100	DINT
		Ru13 – peak apparent current	12	0	1/100	DINT
402h	Torque info	Torque actual value [%]	0	0	1/10	WORD
		Allowed max torque [%]	2	0	1/10	WORD
		Dr09 – rated torque	4	0	1/1000	DWORD
		Ru81 – Actual torque [Nm]	8	0	1/1000	DWORD
403h	Temp info	Ru25 – heatsink temperature	0	0	1/10	INT
		Ru26 – internal temperature	2	0	1/10	INT
		Ru28 – motor temperature	4	0	1/10	INT
		Ru29 – OL counter	6	0	1/10	WORD
		Ru27 – OL2 counter	8	0	1/10	WORD
		Ru32 – motor protection counter	10	0	1/10	WORD
404h	Velocity info	Target velocity	0	0	1	INT
		Velocity demand	2	0	1	INT
		Velocity actual value	4	0	1	INT
405h	Position info	Target position	0	0	1	DWORD
		Position demand value	4	0	1	DWORD
		Position actual value	8	0	1	DWORD
406h	Generell info	Ru01 – exception state	0	0	1	BYTE
		Ru03 – warning state	1	0	1	BYTE
		Ru06 – ramp out display	2	0	1/8192	DINT
		Ru08 – actual value	6	0	1/8192	DINT
		Ru11 – actual apparent current	10	0	1/100	DWORD
		Ru13 – peak apparent current	14	0	1/100	DWORD
		Ru14 – actual Uic voltage	18	0	1/10	WORD
		Ru15 – peak Uic voltage	20	0	1/10	WORD
		Ru17 – modulation grade	22	0	1/10	WORD
		Ru18 – digital input state	24	0	1	WORD

		Ru23 – reference torque	26	0	1/10	WORD
		Ru24 – actual torque [%]	28	0	1/10	WORD
		Ru81 – actual torque [Nm]	30	0	1/1000	DWORD
		Ru50 – actual torque limit positive	34	0	1/10	WORD
		Ru51 – actual torque limit negative	36	0	1/10	WORD
500h	Position control setup	Ps00 – position control mode	0	0	1	WORD
		Ps01 – KP position controller	2	0	1/10	WORD
		Ps10 – position control limit %	4	0	1/10	WORD
501h	Velocity control setup inertia	Cs17 – Inertia load	0	0	1/100	DWORD
		Cs99 – Optimisation factor	4	0	1/10	BYTE
		Is07 – Deadtime compensation mode	5	0	1	WORD
		Cs00 – Control mode	7	0	1	BYTE
502h	Velocity control setup Kp Tn	Cs01 – KP speed	0	0	1/10000	DWORD
		Cs05 – Tn speed	4	0	1/1000	DWORD
		Is07 – Deadtime compensation mode	8	0	1	WORD
		Cs00 – Control mode	10	0	1	BYTE
503h	ASCL/SCL setup	SCL rotor detection	0	0	1	WORD
		Rotor detection current	2	0	1/10	WORD
		Speed search mode	4	0	1	WORD
		Speed search current	6	0	1/10	WORD
		SCL stabilisation current	8	0	1/10	WORD
		SCL standstill current	10	0	1/10	WORD
		(A)SCL filter speed calc.	12	0	1/1000	WORD
504h	Motor data	Motor type	0	0	1	BYTE
		Rated current	1	0	1/100	DINT
		Rated speed	5	0	1/64	DWORD
		Rated voltage	9	0	1	WORD
		Rated frequency	11	0	1/1000	DWORD
		ASM rated cos(phi)	15	0	1/100	BYTE
		Rated torque	16	0	1/1000	DWORD
		Max torque	20	0	1/10	WORD
		Max current	22	0	1/10	WORD
		Inertia motor	24	0	1/100	DWORD
		Motor temp sensor type	28	0	1	BYTE
		Motordata control	29	0	1	BYTE
		Control mode	30	0	1	BYTE

7.4 Diagnostic trouble codes – DTCs

7.4.1 MCU

DTC	Error text	FTB	FTB text
B1001h	no config file found	55h	Not Configured
B1002h	invalid license	57h	Invalid / Incompatible Software Component
B1003h	error config download	89h	Data Transfer Failure
B1004h	OL protection active	9Ah	Component or System Operating Conditions
B1005h	invalid app selection	56h	Invalid / Incompatible Configuration
B1006h	OL warning active	85h	Signal Above Allowable Range

7.4.2 DCU

DTC	Error text	FTB	FTB text
B1003h	Overcurrent PU	19h	Circuit Current Above Threshold
B1004h	overcurrent analog	19h	Circuit Current Above Threshold
B1005h	overpotential	17h	Circuit Voltage Above Threshold
B1006h	underpotential	16h	Circuit Voltage Below Threshold
B1007h	overload	19h	Circuit Current Above Threshold
B1008h	reset E. overload	19h	Circuit Current Above Threshold
B1009h	overload 2	19h	Circuit Current Above Threshold
B100Ah	overheat powmod.	4Bh	Over Temperature
B100Bh	reset E. overheat pmod.	4Bh	Over Temperature
B100Ch	overheat internal	4Bh	Over Temperature
B100Dh	reset E. overheat intern	4Bh	Over Temperature
B100Eh	motorprotection	9Ah	Component or System Operating Conditions
B100Fh	reset E. motorprotection	9Ah	Component or System Operating Conditions
B1010h	drive overheat	4Bh	Over Temperature
B1011h	reset E. drive overheat	4Bh	Over Temperature
B1012h	overspeed	85h	Signal Above Allowable Range
B1014h	error drive data	81h	Invalid Serial Data Received
B1015h	error motordata not stored	04h	System Internal Failure
B1016h	error ident	0Ah	General Electrical Failures - 2
B1017h	error diff speed	02h	General Signal Failure
B101Bh	WARNING overload	19h	Circuit Current Above Threshold
B101Dh	WARNING overload 2	19h	Circuit Current Above Threshold
B101Eh	WARNING overheat powmod.	4Bh	Over Temperature

B1020h	WARNING overheat intern.	4Bh	Over Temperature
B1022h	WARNING motorprotection	19h	Circuit Current Above Threshold
B1024h	WARNING drive overheat	4Bh	Over Temperature
B102Ch	invalid power unit data	02h	General Signal Failure
B1038h	error software switch left	05h	System Programming Failure
B1039h	error software switch right	05h	System Programming Failure
B103Ah	fieldbus watchdog	47h	Watchdog / Safety µC Failure
B103Bh	error prg. input	56h	Invalid / Incompatible Configuration
B103Eh	power unit changed	01h	General Electrical Failure
B1040h	power unit type changed	01h	General Electrical Failure
B1042h	overcurrent PU	19h	Circuit Current Above Threshold
B1043h	max acc/dec	85h	Signal Above Allowable Range
B1061h	overspeed (EMF)	85h	Signal Above Allowable Range
B106Bh	over frequency	37h	Signal Frequency Too High
B106Eh	error OH ramp	02h	General Signal Failure
B106Fh	error OHI ramp	02h	General Signal Failure
B1070h	24V supply low	A2h	System Voltage Low
B1077h	extreme overpotential	22h	Signal Amplitude > Maximum
B1078h	DC capacitor damaged	00h	No Sub Type Information
B1079h	error runtime	00h	No Sub Type Information
B1101h	no axis	4Ah	Incorrect Component Installed
B1102h	error read mapping	89h	Data Transfer Failure
B1103h	error read rated current	89h	Data Transfer Failure
B1104h	rated current mismatch	04h	System Internal Failure
B1105h	error write PLL offset	89h	Data Transfer Failure
B1106h	error auto mapping	04h	System Internal Failure
B1107h	error interlink communication	04h	System Internal Failure
B1108h	error OL parameter	9Ah	Component or System Operating Conditions
B1109h	default download incompatible	57h	Invalid / Incompatible Software Component
B110Ah	error default download	89h	Data Transfer Failure
B110Bh	default download not found	89h	Data Transfer Failure
B110Ch	CAN data timeout	88h	Bus off
B110Dh	CAN data invalid	81h	Invalid Serial Data Received
B110Eh	invalid license	57h	Invalid / Incompatible Software Component
B110Fh	error reinit app	04h	System Internal Failure
B1113h	generell app error	02h	General Signal Failure

7.5 System Routines

The system routines are designed for software or parameter updates. Every update routine can be undone by the corresponding backup routine

7.5.1 201h – Load new app

Using the service 34h for a software download does only transfer the data of the software. To set the new software active, it is necessary to execute this routine.
As soon as this routine was executed, the previously active software is stored in a backup memory. In case the new software is not working as intended, this backup can be restored.

7.5.2 202h – Load backup app

This routine activates a software stored in the backup memory. At the same time it transfers the previously active software into the backup memory.

7.5.3 203h – Load new configuration

Using the service 34h for a config file download does only transfer the data of the config file. To set the new configuration active, it is necessary to execute this routine.
As soon as this routine was executed, the previously active configuration is stored in a backup memory. In case the new configuration is not working as intended, this backup can be restored.

7.5.4 204h – Load backup configuration

This routine activates a configuration stored in the backup memory. At the same time it transfers the previously active configuration into the backup memory.

7.5.5 205h – Load new default download

Using the service 34h for a DCU default download does only transfer the data of the download file. To set the new download active, it is necessary to execute this routine.
As soon as this routine was executed, the previously active DCU default download is stored in a backup memory. In case the new download is not working as intended, this backup can be restored.

7.5.6 206h – Load backup default download

This routine activates a DCU default download stored in the backup memory. At the same time it transfers the previously active configuration into the backup memory.

7.6 Software/parameter update

The software/parameter update is done by using several services in a specific order. The following table shall describe the order and purpose of the different steps.

Step	Service	description
1	**-**	Set the T6 out of function. KL15 must be low
2	**10h**	Set the T6 in programming session
3	**27h**	Login with the security access

4	**34h**	Start the software download At this point we have 3 different options. **1. Downloading a new MCU AppUtility version** In this case we need to transfer two files. Therefore, we need to execute the service 34h twice with different file types. Service, format ident, target, type, DCU def. download ID, size Sample1: New App file to MCU with a size of 4660 byte 34 00 46 00 00 00 00 00 00 00 00 12 34 Sample2: New crc file to MCU with a size of 28 byte 34 00 46 01 00 00 00 00 00 00 00 00 1C **2. Downloading a new MCU AppUtility configuration** Transfer a new cfg_ file to the T6. This will change the parameter of the MCU Sample: New MCU configuration with a size of 123 byte 34 00 46 02 00 00 00 00 00 00 00 00 7B **3. Downloading a new DCU default download (transfer 1 file: dw5)** Transfer a new default download to a DCU node. This will change the parameter of an inverter node Sample: New DCU default download with the download ID 45924783 to inverter node 3 with a size of 200 byte 34 00 46 32 00 02 BC C1 AF 00 00 00 C8 **Note**: this will only transfer the file. The download identifier needs to be defined inside the cfg_ file.
5	**36h**	Transfer the announced data
6	**37h**	End transmission after the transfer
7	**31h**	After the download, the file is only stored but not active. Activate the downloaded file by executing the corresponding routine Routine 201h, 203h or 205h
8	**10h or 11h**	The final step is to reset the ECU. This can be done by switching back to default session using service 10h or executing service 11h. In both cases a hard reset of the ECU is triggered.

8 History of changes

Chapter	Change	Date
	First version created	23.04.2020
7	Added UDS feature	09.03.2022

Benelux | KEB Automation KG
Dreef 4 – box 4 1703 Dilbeek Belgium
Tel: +32 2 8580
E-Mail: info.benelux@keb.de Internet: www.keb.de

Brazil | KEB SOUTH AMERICA - Regional Manager
Rua Dr. Omar Pacheco Souza Riberio, 70
CEP 13569-430 Portal do Sol, São Carlos Brasilien Tel: +55 16 31161294 E-Mail: roberto.arias@keb.de

P.R. China | KEB Power Transmission Technology (Shanghai) Co. Ltd. No. 435 QianPu Road Chedun Town Songjiang District
201611 Shanghai P.R. China
Tel: +86 21 37746688 Fax: +86 21 37746600
E-Mail: info@keb.cn Internet: www.keb.cn

Germany | **Geared Motors**
KEB Antriebstechnik GmbH
Wildbacher Straße 5 08289 Schneeberg Germany
Telefon +49 3772 67-0 Telefax +49 3772 67-281
Internet: www.keb-drive.de E-Mail: info@keb-drive.de

France | Société Française KEB SASU
Z.I. de la Croix St. Nicolas 14, rue Gustave Eiffel
94510 La Queue en Brie France
Tel: +33 149620101 Fax: +33 145767495
E-Mail: info@keb.fr Internet: www.keb.fr

United Kingdom | KEB (UK) Ltd.
5 Morris Close Park Farm Indusrial Estate
Wellingborough, Northants, NN8 6 XF United Kingdom
Tel: +44 1933 402220 Fax: +44 1933 400724
E-Mail: info@keb.co.uk Internet: www.keb.co.uk

Italia | KEB Italia S.r.l. Unipersonale
Via Newton, 2 20019 Settimo Milanese (Milano) Italia
Tel: +39 02 3353531 Fax: +39 02 33500790
E-Mail: info@keb.it Internet: www.keb.it

Japan | KEB Japan Ltd.
15 - 16, 2 - Chome, Takanawa Minato-ku
Tokyo 108 - 0074 Japan
Tel: +81 33 445-8515 Fax: +81 33 445-8215
E-Mail: info@keb.jp Internet: www.keb.jp

Austria | KEB Antriebstechnik Austria GmbH
Ritzstraße 8 4614 Marchtrenk Austria
Tel: +43 7243 53586-0 Fax: +43 7243 53586-21
E-Mail: info@keb.at Internet: www.keb.at

Poland | KEB Automation KG
Tel: +48 60407727
E-Mail: roman.trinczek@keb.de Internet: www.keb.de

Switzerland | KEB Automation KG
Witzberg 24 – 8330 Pfäffikon/ZH Switzerland
Tel: +41 43 2886060 Fax: +41 43 2886088
E-Mail: info@keb.ch

Spain | KEB Automation KG
c / Mitjer, Nave 8 - Pol. Ind. LA MASIA
08798 Sant Cugat Sesgarrigues (Barcelona) Spain
Tel: +34 93 8970268 Fax: +34 93 8992035
E-Mail: vb.espana@keb.de

Republic of Korea | KEB Automation KG
Room 1709, 415 Missy 2000 725 Su Seo Dong
Gangnam Gu 135- 757 Seoul Republic of Korea
Tel: +82 2 6253 6771 Fax: +82 2 6253 6770
E-Mail: vb.korea@keb.de

Czech Republic | KEB Automation GmbH
Videnska 188/119d 61900 Brno Czech Republic
Tel: +420 544 212 008
E-Mail: info@keb.cz Internet: www.keb.cz

United States | KEB America, Inc
5100 Valley Industrial Blvd. South Shakopee, MN 55379 USA
Tel: +1 952 2241400 Fax: +1 952 2241499
E-Mail: info@kebamerica.com Internet: www.kebamerica.com

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Automation **mit Drive**

www.keb.de

KEB Automation KG Südstsraße 38 32683 Barntrup Tel. +49 5263 401-0 E-Mail: info@keb.de