CAN BUS COMMUNICATION MANUAL

TLP5000 Series



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1 Communication manual application

This document, along with product specification and a standard CAN database file (BCG.20036_1-0_TLP5000_series_CAN_dbc_file.dbc), is intended to provide the user with the information necessary to successfully control and monitor device.

This document applies to the following products:

Part number	Input voltage range	Output voltage range	Output power	Max output current
TLP5000-1012	3x400 Vac	-	-	-
TLP5000-1024	3x400 Vac	-	-	-
TLP5000-1048	3x400 Vac	38,5 – 57,5 Vdc	5000 W	110 A
TLP5000-1060	3x400 Vac	38,5 – 65,5Vdc	5000 W	84 A

1.1 Definitions

Following table contains list of abbreviations used in this document:

Table 1 List of abbreviations

Abbreviation	Description
ECU	Electronic control unit
Device	AC-DC converter
NVM	Non-volatile memory
CRC	Cyclic redundancy check (Checksum)
CNT	Rolling Counter (AUTOSAR E2E)
MCU	Microcontroller unit
CAN	Controller Area Network
ACK	Acknowledge message
NACK	Negative Acknowledge message
DBC	CAN database file
DTC	Diagnostic Trouble Code
GND	Ground
PGN	Parameter Group Number
OTP	Over Temperature Protection

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1.2 Communication overview

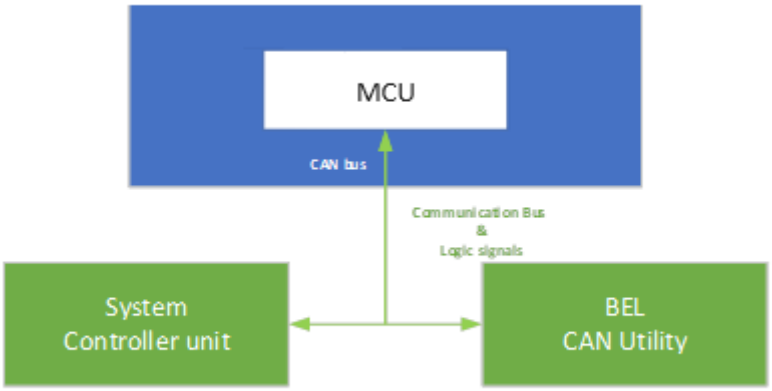


Figure 1

1.3 CAN BUS interface - SAE J1939

Description of CAN BUS interface and standards used.

CAN-bus communication allows complete integration of charger in the electrical system. CAN bus interface will be implemented according to:

- SAE J1939-11 Physical layer, 125 (or configurable) or 250 or 500 Kbits/s, twisted shielded pair
- SAE J1939-21 Data link layer
- SAE J1939-71 Slots and transport protocol messages

The Convertor CAN Bus interface allows for reception of messages for control of the convertor and transmission of messages that reflect its status. Control messages (setpoint and setting commands) uses proprietary A messages format and status messages use proprietary B message. Proprietary information (information used for manufacturing purpose diagnostic and development purpose) uses proprietary A2 message.

The data format within the J1939 CAN data frames adhere to the following conventions: each CAN message consist of 8 bytes of data defined as 1-8 and each byte is defined as bits 0-7. More than 8 bits variables are sent LSB first. Values are normally given in decimal but may be also indicated in hexadecimal (preceding 0x) or binary (preceding 0b).

Control message is indexed, which means that byte 3 of the data fields indicates the functional content of the other seven bytes.

Default messages priority is 6, in standard J1939 messages (ACK, request, etc.) as defined in J1939.

1.4 Enable and disable device

Connecting of AC input voltage wakes up the device.

Output enable is done by enabling standby and inhibit hardware inputs together with software standby and inhibit signals in control word. Control word can be set by CAN.

Disconnecting the AC input voltage turn off the device

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Table 2 Operation modes

Hw StandBy	Hw Inhibit	Sw StandBy	Sw Inhibit	PFC Running	DC running	Output
0	0	0	0	On	On	On
0	0	0	1	On	Off	Off
0	0	1	0	Off	Off	Off
0	0	1	1	Off	Off	Off
0	1	0	0	On	Off	Off
0	1	0	1	On	Off	Off
0	1	1	0	Off	Off	Off
0	1	1	1	Off	Off	Off
1	0	0	0	Off	Off	Off
1	0	0	1	Off	Off	Off
1	0	1	0	Off	Off	Off
1	0	1	1	Off	Off	Off
1	1	0	0	Off	Off	Off
1	1	0	1	Off	Off	Off
1	1	1	0	Off	Off	Off
1	1	1	1	Off	Off	Off

1.5 CAN bus addressing

Default CAN base address of device is 0xC0 – same address serves as group address. Group address can be used to command multiple devices at the same time. It can be changed over CAN command to a new value within range 0x80 to 0xF7 (according to SAE J1939-81). Base address is stored in non-volatile memory and is loaded each time device is powered up. If base address can`t be loaded for any reason (faulty non-volatile memory) default hardcoded value of 0xC0 is used.

Offset can be added to base address using address pins:

Table 3 CAN address setting

ADDR2pin	ADDR1 pin	ADDR0 pin	ADDR offset	Example: Base Address 0xC0
Open	Open	Open	1	0xC1
Open	Open	GND	2	0xC2
Open	GND	Open	3	0xC3
Open	GND	GND	4	0xC4
GND	Open	Open	5	0xC5
GND	Open	GND	6	0xC6
GND	GND	Open	7	0xC7
GND	GND	GND	8	0xC8

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1.6 Functional safety requirements for CAN communication

To ensure integrity of data being sent and received on CAN Bus, Autosar E2E profile can be used for every message with specific PGN. Evaluation for received messages is disabled by default. Transmitted messages use by default Autosar E2E Encryption Profile 1 – Variant A. Different profile can be selected by command PGN 0x00EF00:0x21 – E2E_Profile_Selection.

1.7 Scaling and used SLOTs

Scaling of variables which are used in CAN communication is based on SAE slots defined in *SAE J1939-71 APPENDIX A*.

Table 4 Used scaling and SLOTs

Parameter	Unit	Resolution	Offset	Data range	Data length	SLOT ID
Voltage	[V]	0.01 V/bit	0 V	0 – 642.55 V	2 bytes	221
Current	[A]	0.05 A/bit	-1600 A	-1600 to 1612.75 A	2 bytes	104
Real power	[W]	2 W/bit	0 W	0 to 128510W	2 bytes	107
Temperature	[°C]	1 °C/bit	-40 °C	-40 to 210 °C	1 byte	67
Frequency	[Hz]	1 Hz/bit	0 Hz	0 to 64255Hz	2 bytes	1009

All values are transferred in LSB first format.

For example, of data encoding/decoding and byte-organising see Appendix 7

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2 CAN BUS PGN Definitions

Following table contains PGN definitions for all broadcasted messages by device. Each broadcast message has transmit interval defined. There are broadcast messages which can also be explicitly requested. When such request is sent, device unit shall send reply message out of the defined transmit interval.

Table 5 PGN definitions of broadcast messages

PGN	Transmit interval	CAN broadcast message
0x00FFD0	0.1 s	PGN 0x00FFD0 – Overall_Status
0x00FFD1	0.1 s	PGN 0x00FFD1 – Detailed_Status
0x00FFD2	0.1 s	PGN 0x00FFD2 – Fault_Flags
0x00FFD3	0.1s	PGN 0x00FFD3 – Warning_Flags
0x00FFD4	0.1s	PGN 0x00FFD4 - Standby_Output
0x00FFD5	0.1 s	PGN 0x00FFD5 – Output_Readbacks
0x00FFD6	0.1 s	PGN 0x00FFD6 – Output_Setpoints
0x00FFD7	0.1 s	PGN 0x00FFD7 – Input_Voltages
0x00FFD8	0.1s	PGN 0x00FFD8 – Input_Frequency
0x00FFD9	1 s	PGN 0x00FFD9 – Temperatures
0x00FFDA	0.1 s	PGN 0x00FFDA – Margin
0x00FFDB	10 s	PGN 0x00FFDB – CAN_Address
0x00FFDC	0.1s	PGN 0x00FFDC- Out_Power
0x00FEDA	10 s /on request	PGN 0x00FEDA – Software_Identification
0x00FEEB	10 s /on request	PGN 0x00FEEB – Component_identification
0x00FDC5	On request	PGN 0x00FDC5 – ECU_identification

Following table contains PGN definitions for all setpoint messages. No specific transmit interval is defined for setpoint messages, each setpoint message should be sent as needed.

Table 6 PGN definitions of command messages

PGN	Index(Data 3)	CAN command message
0x00EF00	0x00	Control
	0x01	Output_Set
	0x02	Clear_Fault
	0x03	CAN_Address_Set
	0x04	CAN_Address_Set_SN
	0x05	CAN_Bitrate_Set
	0x06	reserved
	0x07	reserved
	0x20	E2E_DataID_Set
	0x21	E2E_Profile_Selection
	> 0xC1	Bootloader commands – See UAE.20004

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2.1 Broadcast messages

Brief description of broadcast message group, e.g.: Broadcast messages are group of messages which are transmitted by device automatically or on request. It is up to ECU/VCU to perform data integrity check on messages broadcasted by device and act accordingly.

2.1.1 PGN 0x00FFD0 – Overall_Status

Message: PGN 0x00FFD0
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD0yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD0yy	CRC8	CNT_TX	OverallStatus			StateMachine State	Shutdown Reason	Can't start reason

OverallStatus – Bitmap containing Status flags describing device overall state

Bit	Name	I	C	Description in active state (logical 1)
0	bRunning	N	O	1= Device is running, output nominal
1	bFault	N	R	1= General Fault flag (any recovery fault, latch or failure detected)
2	bWarning	N	Y	1= General Warning flag
3	bEnabled	N	O	1= Device output enabled by CAN command
4	bReady	N	O	1= Device is ready to start-up (no faults)
5	bStandBy	N	O	1= Device is in Standby (PFC, DC are off, communication is running)
6	bInhibit	N	O	1= Device is in Inhibit (PFC is on, DC is off, comm. is running)
7	bInputOK	N	O	1= Input values are within allowed range
8	bOutputOK	N	O	1= Output values are within allowed range
9	bOtpFault	N	R	1= Overtemperature has been detected on any temperature sensor
10	bInrushEnabled	N	O	1= Inrush has been enabled during start-up
11	bPfcEnabled	N	O	1= Pfc has been enabled during start-up (???)
12	bPfcOk	N	G	1= Primary stage
13	bPfcFault	N	R	1= Fault on Pfc stage (Error Prim)
14	bDcEnabled	Y	O	0= DC stage has been enabled
15	bDcOK	N	G	1= DC stage is Ok
16	bDcFault	N	R	1= Fault on DC stage has been detected (Error Sec)
17	b2PhaseOperate	N	O	1= 2 Phase operation has been selected
18	bMarginPinInUse	N	O	1= Margin pin is used for output voltage setpoint
19	bHiccup	N	O	1= output cycling when overloaded
20	bNa20	N	O	
21	bNa21	N	O	
22	bNa22	N	O	
23	bNa23	N	O	

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StateMachine – Active State-Machine state

Value	State name	Description
0	INIT	Initialize state after device start-up
1	PRIMARY_ENABLE	Enabling of the primary side and checking input voltages
2	START_UP_PRIMARY	Starting up device primary side
3	SECONDARY_ENABLE	Enabling of the secondary side
4	START_UP_SECONDARY	Starting up secondary side
5	STARTUP	Device start-up
6	RUNNING	Device is running
7	SHUTDOWN	Device is shutting down
8	INHIBIT	Device is in inhibit state – output is disabled
9	STANDBY	Device is in standby state – output is disabled
10	RECOVERY	Recovery fault is detected and active
11	LATCH	Latch fault is detected and active
12	HICCUP	Device is hiccup mode
13	FAILURE	Failure fault is detected and active
14	UPLOAD_FW	Firmware update is in process

Shutdown/Can't start reason – reason of last shutdown or why start-up failed

Value	Reason name	Description
0	NONE	None
1	VIN_L12_UNDERVOLTAGE	Reference bVinL12Uv.
2	VIN_L23_UNDERVOLTAGE	Reference bVinL23Uv
3	VIN_L31_UNDERVOLTAGE	Reference bVinL31Uv
4	VIN_L12_OVERVOLTAGE	Reference bVinL12Ov
5	VIN_L23_OVERVOLTAGE	Reference bVinL23Ov
6	VIN_L31_OVERVOLTAGE	Reference bVinL31Ov
7	VIN_ASSYMETRY	Reference bVinAsym
8	VIN_SAG	Reference bVinSAG
9	PFC_CONTROL	Reference bPfcControl
10	INRUSH	Reference bInrush
11	PFC_OVERTEMPERATURE	Reference bOtpTpfc. Cool down device for output enable.
12	PFC_OVERCURRENT	Reference bOcPfc.
13	VAUX_FAULT	Reference bAux
14	VINT_UNDERVOLTAGE	Reference bVintUV
15	VOUT_UNDERVOLTAGE	Reference bVoutUV
16	VOUT_OVERVOLTAGE	Reference bVoutOV
17	OUTPUT_OVERLOAD	Reference bOverload
18	AMBIENT_UNDERTEMPERATURE	Reference bUtpTamb. Heat-up down device for output enable.
19	AMBIENT_OVERTEMPERATURE	Reference bOtpTamb. Cool down device for output enable.
20	SYNC_RECT_UNDERTEMPERATURE	Reference bUtpTsr. Heat-up down device for output enable.
21	SYNC_RECT_OVERTEMPERATURE	Reference bOtpTsr. Cool down device for output enable.
22	HEAT_SINK_UNDERTEMPERATURE	Reference bUtpThs. Heat-up down device for output enable.
23	HEAT_SINK_OVERTEMPERATURE	Reference bOtpThs. Cool down device for output enable.
24	DC_OVERCURRENT	Reference bOcDc

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25	AMBIENT_THERMISTOR_FAULT	Reference bSensFailTamb. Contact Bel Support.
26	SYNC_RECT_THERMISTOR_FAULT	Reference bSensFailTsr. Contact Bel Support.
27	HEAT_SINK_THERMISTOR_FAULT	Reference bSensFailThs. Contact Bel Support.
28	NVM_CRC	Reference bNvmCrc. Contact Bel Support.
29	HW_REVISION	Reference bHwRevFail. Contact Bel Support.
30	RTOS	Reference bRtos. Restart device by disconnecting WAKE_UP. If fault persist, contact Bel Support
31	E2E_EXT_CAN	Reference bE2EExtCan. Verify VCU is using correct CRC and counter.
32	FUNCTIONAL_SAFETY	Reference bSafety. Contact Bel Support
…		
100	INHIBIT_CMD	Device has been turned off by CAN command from VCU
101	INHIBIT_PIN	Device has been turned off by external pin
102	STANDBY_CMD	Device has been turned off by CAN command from VCU
103	STANDBY_PIN	Device has been turned off by external pin

2.1.2 PGN 0x00FFD1 – Detailed_Status

Message: PGN 0x00FFD1
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD1yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD1yy	CRC8	CNT_TX	DetailedStatus			ProprietaryStatus		

DetailedStatus – Bitmap containing Status flags describing DC detailed state

Bit	Name	I	C	Description
0	bRecovery	N	O	1= Device in fault, recoverable automatically
1	bLatch	N	O	1= Device in latch, recoverable by Clear Fault command
2	bFailure	N	O	1= Device in failure, no recovery possible
3	bNa3	N	O	
4	bEnableVoutUV	N	O	1= Output under-voltage evaluation enabled
5	bFloatingSwOvpEn	N	O	1= Floating software overvoltage protection has been enabled
6	bNa6	N	O	
7	bInhibitSw	N	O	1= Inhibit by control word is active
8	bStandBySw	N	O	1= StandBy by control word is active
9	bInhibitPin	N	O	1 = Inhibit by external inhibit pin
10	bStandyByPin	N	O	1 = StandBy by external standby pin
11	bComparator UV	N	O	1= Comparator UV
12	bComparator OV	N	O	1= Comparator OV
13	bAddr0Pin	N	O	1= Addr0 pin state
14	bAddr1Pin	N	O	1= Addr1 pin state
15	bAddr2Pin	N	O	1= Addr2 pin state
16	bActiveBankA	N	O	1= App running from bank A, otherwise bank B
17	bSigInBtlMode	N	O	1= Signal stage is in Bootloader (FW flash) mode

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18	bE2EEvalEnExtCan	N	O	1= AUTOSAR E2E evaluation of Rx messages enabled on External CAN Bus
19	bNa19	N	O	
20	bNa20	N	O	
21	bNa21	N	O	
22	bNa22	N	O	
23	bNa23	N	O	

ProprietaryStatus – for interpretation see PROPRIETARY manual UAE.20005

2.1.3 PGN 0x00FFD2 – Fault_Flags

Message: PGN 0x00FFD2
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD2yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD2yy	CRC8	CNT_TX	FaultFlags					

Fault flags – Bitmap containing Fault flags.

Bit	Name	I	C	Description in active state (logical 1)	Severity
0	bVinL12Uv	N	R	1 = Input voltage undervoltage on phase-to-phase L1-L2	Recovery
1	bVinL23Uv	N	R	1 = Input voltage undervoltage on phase-to-phase L2-L3	Recovery
2	bVinL31Uv	N	R	1 = Input voltage undervoltage on phase-to-phase L3-L1	Recovery
3	bVinL12Ov	N	R	1 = Input voltage overvoltage on phase-to-phase L1-L2	Recovery
4	bVinL23Ov	N	R	1 = Input voltage overvoltage on phase-to-phase L2-L3	Recovery
5	bVinL31Ov	N	R	1 = Input voltage overvoltage on phase-to-phase L3-L1	Recovery
6	bVinAsym	N	R	1 = Input voltage phases asymmetry	Recovery
7	bVinSAG	N	R	1 = Input voltage SAG detected	Recovery
8	bPfcControl	N	R	1 = PFC control circuit fault detected	Latch
9	bInrush	N	R	1 = Inrush circuit fault detected	Latch
10	bOtpTpfc	N	R	1 = PFC stage overtemperature	Recovery
11	bOcPfc	N	R	1 = PFC stage overcurrent	Latch
12	bAux	N	R	1 = Internal auxiliary power supply fail	Latch
13	bVintUV	N	R	1 = Output voltage undervoltage	Latch
14	bVoutUV	N	R	1 = Output voltage undervoltage	Latch
15	bVoutOV	N	R	1 = Output voltage overvoltage	Latch
16	bOverload	N	R	1 = Output is overloaded	Latch
17	bUtpTamb	N	R	1 = Ambient temperature under-temperature	Recovery
18	bOtpTamb	N	R	1 = Ambient temperature over-temperature	Recovery
19	bUtpTsr	N	R	1 = Synchronous-rectifier temperature under-temperature	Recovery
20	bOtpTsr	N	R	1 = Synchronous-rectifier temperature over-temperature	Recovery
21	bUtpThs	N	R	1 = Heat-sink temperature under-temperature	Recovery
22	bOtpThs	N	R	1 = Heat-sink temperature over-temperature	Recovery
23	bOcDc	N	R	1 = DC stage overcurrent	Latch
24	bSensFailTamb	N	R	1 = Ambient temperature sensor fault (short/open)	Failure

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25	bSensFailTsr	N	R	1 = Synchronous-rectifier temp. sensor fault (short/open)	Failure
26	bSensFailThs	N	R	1 = Heat-sink temp. sensor fault (short/open)	Failure
27	bNvmCrc	N	R	1= Internal FW failure	Failure
28	bHwRevFail	N	R	1= Hardware revision failure	Failure
29	bRtos	N	R	1= Internal FW failure	Failure
30	bE2EExtCan	N	R	1= Invalid messages received on Ext CAN	Recovery
31	bSafety	N	R	1= Any of Functional safety feature failed (CAN loop-back test/ECC/Clock fail, ..)	Failure
32	bModel	N	R	1= Incorrect Model version	Failure

2.1.4 PGN 0x00FFD3 – Warning_Flags

Message: PGN 0x00FFD3
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD3yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD3yy	CRC8	CNT_TX	WarningFlags					

WarningFlags – Bitmap containing Warning flags

Bit	Name	I	C	Description
0	bVinL1Uv	N	Y	1 = Input voltage undervoltage on phase-to-phase L1-L2
1	bVinL2Uv	N	Y	1 = Input voltage undervoltage on phase-to-phase L2-L3
2	bVinL3Uv	N	Y	1 = Input voltage undervoltage on phase-to-phase L3-L1
3	bVinL1Ov	N	Y	1 = Input voltage overvoltage on phase-to-phase L1-L2
4	bVinL2Ov	N	Y	1 = Input voltage overvoltage on phase-to-phase L2-L3
5	bVinL3Ov	N	Y	1 = Input voltage overvoltage on phase-to-phase L3-L1
6	bVinAsym	N	Y	1= Input voltage phases asymmetry
7	bOverSetpoint	N	Y	1= The setpoint values have exceeded the maximum unit capacity.
8	bNa8	N	Y	
9	bPbus	N	Y	1= Internal bus voltage out of range
10	bVoutUV	N	Y	1= Output voltage undervoltage
11	bVoutOV	N	Y	1= Output voltage overvoltage
12	bOverload	N	Y	1= Output is overloaded
13	bUtpTamb	N	Y	1= Ambient temperature under-temperature
14	bOtpTamb	N	Y	1= Ambient temperature over-temperature
15	bUtpTsr	N	Y	1= Synchronous-rectifier temperature under-temperature
16	bOtpTsr	N	Y	1= Synchronous-rectifier temperature over-temperature
17	bUtpThs	N	Y	1 = Heat-sink temperature under-temperature
18	bOtpThs	N	Y	1 = Heat-sink temperature over-temperature
19	bInvalidSetpoint	N	Y	1= Last received setpoint was Out of Range
20	bActiveMWP	N	Y	1= Last NVM write was unsuccessful because of NVM Multi-write Protection (each value can be written only once in device power-cycle)
21	bRtos	N	Y	1= Rtos task overflow
22	bWatchDog	N	Y	1= MCU was restarted due to watchdog
23	bCanLoopback	N	Y	1= Can Loopback test failed

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24	bECC	N	Y	1= Error Correction Code exception occurred
25	bHardFault	N	Y	1= Hard Fault exception occurred
26	bOscClock	N	Y	1= External oscillator fault detected
27	bNvmCrcConfig	N	Y	1= Configuration section in non-volatile memory has incorrect CRC
28	bNvmCrcStatic	N	Y	1= Static data section in non-volatile memory has incorrect CRC
29	bNvmCrcCalib	N	Y	1= Calibration data section in non-volatile memory has incorrect CRC
30	bNvmCrcDiag	N	Y	1= Diagnostics data section in non-volatile memory has incorrect CRC
31	bNvmCrcDtc	N	Y	1= Dtc data section in non-volatile memory has incorrect CRC
32	bNvmCrcVoset	N	Y	1= Static data section in non-volatile memory has incorrect CRC
33	bNvmCrcCW	N	Y	1= Control Word data section in non-volatile memory has incorrect CRC
34	bNvmBackup	N	Y	
35	bNvmLog	N	Y	
..				
..				
..				
47				

2.1.5 PGN 0x00FFD4 - Standby_Output

Message: PGN 0x00FFD4
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD4yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD4yy	CRC8	CNT_TX	Vstandby		Istandby		VauxS	

Vstandby [V] – Standby output voltage readback
Istandby [A] – Standby output current readback
VauxS [V] – Internal auxiliary supply voltage readback

2.1.6 PGN 0x00FFD5 – Output_Readbacks

Message: PGN 0x00FFD5
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD5yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD5yy	CRC8	CNT_TX	Vout		Iout		Vint	

Vout [V] – Output voltage readback
Iout [A] – Output current readback
Vint[V] - Internal voltage value readback

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2.1.7 PGN 0x00FFD6 – Output_Setpoints

Message: PGN 0x00FFD6
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD6yy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD6yy	CRC8	CNT_TX	VoutSet		IoutSet		ControlWord	

VoutSet [V] – Setpoint Output Voltage value
IoutSet [A]– Setpoint Output Current value
ControlWord – Readback of current ControlwordSet value setting. See **PGN 0x00EF00:0x00 – Control**

2.1.8 PGN 0x00FFD7 – Input_Voltages

Message: PGN 0x00FFD7
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD7yy
Transmission repetition rate: 0.1 s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD7yy	CRC8	CNT_TX	VinL23		VinL31		VinL12	

VinL23 [V] – AC voltage readback
VinL31 [V] – AC voltage readback
VinL12 [V] – AC voltage readback

2.1.9 PGN 0x00FFD8 – Input_Frequency

Message: PGN 0x00FFD8
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD8yy
Transmission repetition rate: 0.1 s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD8yy	CRC8	CNT_TX	VinFreqL23		VinFreqL31		VinFreqL12	

VinFreqL23 [Hz] – AC voltage frequency readback
VinFreqL31 [Hz] – AC voltage frequency readback
VinFreqL12 [Hz] – AC voltage frequency readback

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2.1.10 PGN 0x00FFD9 – Temperatures

Message: PGN 0x00FFD9
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFD9yy
Transmission repetition rate: 1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFD9yy	CRC8	CNT_TX	Tamb	Tsr	Ths	0xFF	0xFF	0xFF

Tamb [°C] – Ambient temperature (located at DC stage)
Tsr [°C] – Synchronous-rectifier temperature (located at DC stage)
Ths [°C] – Heat-sink temperature (located at DC stage)

2.1.11 PGN 0x00FFDA – Margin

Message: PGN 0x00FFDA
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFDAy
Transmission repetition rate: 0.1 s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFDAyy	CRC8	CNT_TX	Vmargin		Imargin		0xFF	0xFF

Vmargin [V] – Margin pin voltage readback
Imargin [A] – Margin pin current readback

2.1.12 PGN 0x00FFDB – CAN_Address

Message: PGN 0x00FFDB
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFDByy
Transmission repetition rate: 10 s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFDByy	CRC8	CNT_TX	AddrAct	AddrBase	AddrOffset	AddrMaster	0xFF	0xFF

AddrAct – Currently active address (until next reset)
AddrBase – Base address stored in non-volatile memory. Loaded on every DC unit start-up
AddrOffset – Address offset set by address pins, see CAN bus addressing
AddrMaster – Source address of last received command message

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2.1.13 PGN 0x00FFDC – Out_Power

Message: PGN 0x00FFDC
Message Type: Broadcast
Priority: 6
29 Bit identifier: 0x18FFDCyy
Transmission repetition rate: 0.1s

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18FFCyy	CRC8	CNT_TX	OUT_PWR		0xFF	0xFF	0xFF	0xFF

OUT_PWR – Currently out power in W

2.1.14 PGN 0x00FEDA – Software_Identification

Message: PGN 0x00FEDA
Message Type: Broadcast
Transmission repetition rate: 10 s / On request

Byte:
1 - Number of software identification fields
2- n Software identification(s)
Delimiter (ASCII "*")

The software identification field is variable in length and may contain up to 125 software identification designators. An ASCII "*" is used as a delimiter to separate multiple software identifications. Additional software identification fields may be added at the end, each separated by an ASCII "*" as a delimiter. An ASCII "*" is required at the end of the last software identification field, even if there is only one software identification designator.

Device unit has its software ID:

"1* SIG=FW:02.03.04-BLD:02.03-HW:01*"

Where:
SIG = Signal uC revisions

FW = Application Firmware Major, Minor, Build version. String, range 0-99
BLD = Bootloader Firmware Major, Minor version. String, range 0-99
HW = Hardware version. String, range 0-99

Version ID is standard J1939 message defined by J1939-71.

2.1.15 PGN 0x00FEEB – Component_identification

Message: PGN 0x00FEEB
Message Type: Broadcast
Transmission repetition rate: 10 s / On request

Message is filled with string (ASCII characters):

"*PART_NUMBER*SERIAL_NUMBER*REV*"

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Where: PART_NAME is unit name(type), SERIAL_NUMBER is serial number and REV is revision. Component Identification is standard J1939 message defined in J1939-7.

2.1.16 PGN 0x00FDC5 – ECU_identification

Message: PGN 0x00FDC5
Message Type: Response to request
Transmission repetition rate: On request

Message is filled with string (ASCII characters):

"*ECU Part number * ECU Serial number * ECU Location * ECU Type * ECU Manufacturer Name*"

Component Identification is standard J1939 message defined in J1939-71.

2.2 Commands

All setpoint commands have PGN 0x00EF00 and are differentiated based on index byte (Data 3, range 0x80-0xF0). Each signal in setpoint command have either defined range or specified allowed values. When command with all signals valid is received (each signal value within defined range or signal value from allowed values group set), device responds with ACK message. When value of any signal within CAN command is outside of its defined range or contain unspecified value, whole message is ignored, and NACK message is sent as a response.

Typical response time is expected to be no more than 5ms. Therefore, it is suggested to maintain delay of at least 5ms between individual setpoint commands.

2.2.1 PGN 0x00EF00:0x00 – Control

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x00	ControlWordSet		ControlWordMask		0xFF

ControlWordSet – control word bits to device control.
Some of them are applicated immediately, some of them in next operation cycle (AC input voltage disconnect/connect). Control word can be saved to non-volatile memory by bWriteToNVM bit.
Application of each bit can be masked by ControlWordMask.

Bit	Name	Description	Applied
0	bStandBy	1= StandBy Mode is set (PFC and DC stage disabled)	Immediately
1	bInhibit	1= Inhibit mode is set (PFC enabled, DC stage disabled)	Immediately
2	b2PhaseOperation	1= 2 Phase operation is selected	
3	bFloatingSwOvp	1= Floating overvoltage controlled by firmware is enabled	Immediately
4	bMarginPinEn	1= Usage of margin pin to set output voltage is enabled	Immediately
5-14	Unused		

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15	bWriteToNVM	1= Store control word to NVM as default setpoints. Received values are not used as actual setpoints. This can be performed only once in unit-power-cycle	

ControlWordMask – mask for application of control word bits. To apply setting appropriate bit has to be set.

Example 1: Standby is requested to be set, other setting to be ignored

ControlWordSet => 0x01

ControlWordMask => 0x01

Example 2: Standby and Margin pin is requested to be set, other settings to be ignored

ControlWordSet => 0x21

ControlWordMask => 0x21

2.2.2 PGN 0x00EF00:0x01 – Output_Set

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x01	VoutSet		IoutSet		Setting

VoutSet [V] – Output voltage value to be set as setpoint
IoutSet [A] – Current value to be set as setpoint
Setting – Bitfield specifying which setpoint value should be used:

Bit	Name	Description
0	bIgnoreVoutSet	1= Ignore new Vout Setpoint value – use actual value
1	bIgnoreIoutSet	1= Ignore new Iout Setpoint value – use actual value
2 - 6	bReserved	Reserved for future use
7	bSetpointsWriteToNVM	1= Store set values to NVM as default setpoints. Received values are not used as actual setpoints. This can be performed only once in unit-power-cycle.

Response: ACK if both Setpoints are in range (and storage to NVM succeed if requested), otherwise NACK

2.2.3 PGN 0x00EF00:0x02 – Clear_Fault

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x02	Clear	0xBD	0x44	0x09	0x1E

Clear –0x4A – Clears all faults with recovery and latch severity. Failure severity faults are not cleared.
Response: ACK if Data 4 – Data 8 are valid and command is executed, otherwise NACK

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2.2.4 PGN 0x00EF00:0x03 – CAN_Address_Set

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x03	NewCanAddr	SerialNumber (lower 5 digits)			

NewCanAddr – CAN base address can be set to a new value within range 0x80 to 0xF7 (according to SAE J1939-81). In case of 0xFF default address 0xC0 is set.
SerialNumber – This is optional parameter – used only if one wants to specify destination unit by its Serial-number. Contains lower 5 digits of serial-number of addressed unit. If this field is used device is awaiting second message (see next section and examples below). If *SerialNumber* = 0xFFFFFFFF check of *SerialNumber* is ignored and address is store to non-volatile memory.

New CAN address is applied after unit restart. If Serial-number is not valid NACK is sent. New CAN address is saved to non-volatile memory automatically. Command is accepted only once per operation cycle, otherwise warning flag bActiveMWP is activated.

Can address set examples:

1. Requested address 0xE0 without specifying device serial number:
    a. Valid CAN message from VCU is following:
        i. 0x18EFB1xx CRC8 CNT 0x03 0xE0 0xFF 0xFF 0xFF 0xFF
    b. Ack message will be received
    c. New address applied after device restart
2. Requested address 0xE0 for specific serial number device (1234567854321):
    a. Serial number has to be split into to 2 parts :
        i. First (lower 5 digits) part to be send in first message: 54321 => 0x0000D431
        ii. Second (upper 8 digits) part to be send in second message: 12345678 = > 0x00BC614E
    b. VCU sends following message Set CAN Adress:
        i. 0x18EFB1xx CRC8 CNT 0x03 0xE0 0x31 0xD4 0x00 0x00
    c. Ack message will be received
    d. VCU sends following message Set CAN Adress SN:
        i. 0x18EFB1xx CRC8 CNT 0x04 0xE0 0x4E 0x61 0xBC 0x00
    e. Ack message will be received
    f. New address applied after device restart

2.2.5 PGN 0x00EF00:0x04 – CAN_Address_Set_SN

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x04	NewCanAddr	SerialNumber (upper 8 digits)			

NewCanAddr [-] – Same CAN address has to be used as in CAN_Address_Set message, otherwise command is ignored, and NACK is send as a response.
SerialNumber [-] – Actual Serial number of addressed unit. Upper 8 digits converted to unsigned long.

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2.2.6 PGN 0x00EF00:0x05 – CAN_Bitrate_Set

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x05	CAN_Bitrate	0xE4	0xD8	0x32	0x3F

Can_Bitrate [-] – Determines CAN bitrate used by the DC unit in case CAN_BAUD_IN is connected to GND. Allowed values:

- 1 – CAN bitrate 125 kbps (ACK responded)
- 2 – CAN bitrate 250 kbps (ACK responded)
- 3 – CAN bitrate 500 kbps (ACK responded)
- 4 – CAN bitrate 1000 kbps (ACK responded)
- Other value - NACK is sent

Applied after unite restart.
Bytes Data 5 – Data 8 contain key values.
Selected value is saved to non-volatile memory automatically. Command is accepted only once per operation cycle, otherwise warning flag bActiveMWP is activated.

Response: ACK if Data 5 – Data 8 are valid and command is executed, otherwise NACK

2.2.7 PGN 0x00EF00:0x20 – E2E_DataID_Set

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x20	E2E_DataID		0xFF	0xB5	0xE8

E2E_DataID – New Data ID value for E2E protection mechanism.

Applied after device restart.
Bytes Data 6 – Data 8 contain key values.
Selected value is saved to non-volatile memory automatically. Command is accepted only once per operation cycle, otherwise warning flag bActiveMWP is activated.

Response: ACK if Data 6 – Data 8 are valid and command is executed, otherwise NACK

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2.2.8 PGN 0x00EF00:0x21 – E2E_Profile_Selection

Message: PGN 0x00EF00
Message Type: Command
Priority: 6
29 Bit identifier: 0x18EFyyxx (yy – destination address, xx source address)

CAN ID	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8
0x18EFyyxx	CRC8	CNT_RX	0x21	E2E_profile	0xFF	0xFF	0x45	0x89

E2E_profile [-] – Select E2E profile

- 0 = No profile is selected (CRC and counter are not evaluated)
- 1 = E2E Profile1 Variant A is selected
- Other value - NACK is sent

Applied after device restart.
Bytes Data 6 – Data 8 contain key values.
Selected value is saved to non-volatile memory automatically. Command is accepted only once per operation cycle, otherwise warning flag bActiveMWP is activated.

Response: ACK if Data 6 – Data 8 are valid and command is executed, otherwise NACK

2.3 OBD Diagnostic

2.3.1 PGN 0xFECA – DM1 OBD message

Brief description of OBD messages diagnostic group, e.g.: Converter CAN Bus interface support SAE J1939-73 DM1 message for active Diagnostic Trouble Codes. See section 5.7.1 of J1939-73 for explanation of the format and data fields of a DM1 message. The conditions that cause active DTC and the associated SPN's and FMI are are shown below.

Amber warning lamp status is used for all DTCs.

DTC	SPN	FMI	FMI Description
No DTCs defined			

A DM1 message shall be transmitted, regardless of the presence or absence of any DTC, once every second and on state change. In the event that multiple active DTC's occur at once on the Converter, the DM1 message must be transmitted in multiple frames. The multiple frames are broadcast using the Transport Protocol with a connection management type of Broadcast Announce Message (BAM).

2.3.2 PGN 0x00FECB – DM2 OBD message

Device CAN Bus interface support SAE J1939-73 DM2 message for previously active Diagnostic Trouble Codes. See section 5.7.1 of J1939-73 for explanation of the format and data fields of a DM2 message.
The conditions that cause active DTC and the associated SPN's and FMI are shown in DM1 section.

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In the event that multiple previously active DTC's occur at once on the Converter, the DM2 message must be transmitted in multiple frames. The multiple frames are broadcast using the Transport Protocol with a connection management type of Broadcast Announce Message (BAM).

2.3.3 PGN 0x00FECC – DM3 OBD message

Device CAN Bus interface support SAE J1939-73 DM3 message for reset of Previously Active Diagnostic Trouble Codes. See section 5.7.3 of J1939-73 for explanation of the format and data fields of a DM3 message. The conditions that cause active DTC and the associated SPN's and FMI are shown in section 4.2.1. Positive/Negative acknowledge is sent as the answer.

2.3.4 PGN 0x00FED3 – DM11 OBD message

Device CAN Bus interface support SAE J1939-73 DM11 message for clear of Active Diagnostic Trouble Codes. See section 5.7.11 of J1939-73 for explanation of the format and data fields of a DM11 message. The conditions that cause active DTC and the associated SPN's and FMI are shown in section 4.2.1. Positive/Negative acknowledge is sent as the answer.

2.3.5 PGN 0x00DF00 – DM13 OBD message

Device CAN Bus interface support SAE J1939-73 DM13 message to disable/enable broadcasting of messages by unit. See section 5.7.13 of J1939-73 for explanation of the format and data fields of a DM13 message. The conditions that cause active DTC and the associated SPN's and FMI are shown in section 4.2.1. Positive/Negative acknowledge is sent as the answer.

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3 Commissioning

This section describes typical (advised) setup procedure of the unit before first start-up.

3.1 Hardware preparation

Refer to installation instruction BCM.20148

Necessary pin connections of signal connector are:

3. CAN bus: CAN_L pin U4, CAN_H pin U5
4. Address pins: ADDR_0 pin T3, ADDR_1 pin T4, ADDR_2 pin T5 (with multiple units)
5. Power Supply Standby Pin E5: Open circuit or “High” to SRTN means Standby mode – Vout is disabled with low power consumption
6. Output Inhibit Pin U3: Open circuit or “High” to SRTN shuts OFF Vout

3.2 Software setting and memory

When unit powered up first time, its adjustable settings saved in non-volatile memory are set to default values. When integration of the unit to the system requires change of these default values, individual commands shall be used as follows:

1. to change third option of CAN bitrate use CAN_Bitrate_Set,
2. to change CAN base address use CAN_Address_Set (and CAN_Address_Set_SN).
3. to change E2E settings E2E_DataID_Set and E2E_profile_selection
4. to enable or change E2E profile E2E_Profile_Selection and Data Id E2E_DataID_Set

While setting up the unit, following notes shall be considered:

- All these settings can be changed when unit is in IDLE state
- Saving of each of these settings is done automatically upon reception of valid command which must be acknowledged by ACK response (or series of commands in case of change of base CAN address).
- Command is accepted only once per operation cycle, otherwise warning flag bActiveMWP is activated.
- New settings become active after unit restart – disconnect and reconnect WAKE_UP signal.

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4 Firmware update procedure

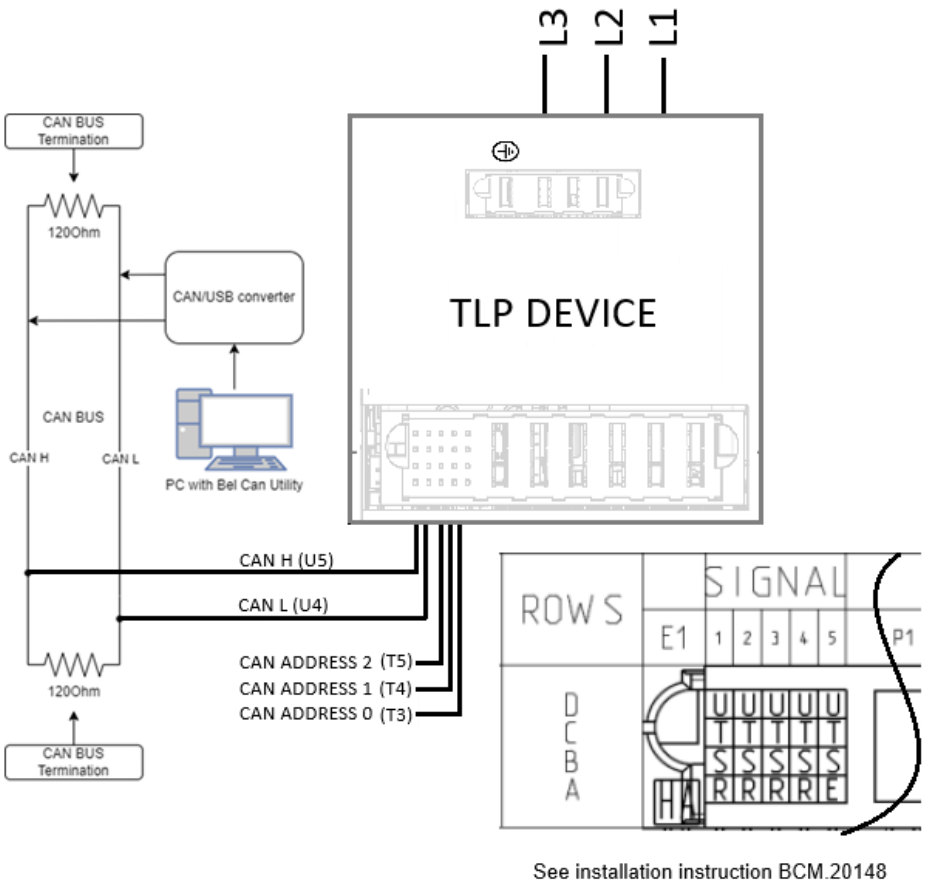
4.1 Connection

4.1.1 Tools and equipment

Following tools are required….

- USB/CAN Converter
  - Total Phase CAN Komodo Adapter (Solo or Duo)
  - Vector – all CAN converters
  - Kvaser – all CAN converters
  - PEAK Systems - all CAN converters
- 3 PHASE AC Power supply
- CAN Bus terminating resistor (2x 120Ω)
- Bel_CAN_Utility software (download from ftp://swdcaftp.psbel.com/Bel_CAN_Utility/)

4.1.2 Setup



Prepare connection of AC power supply/voltage.

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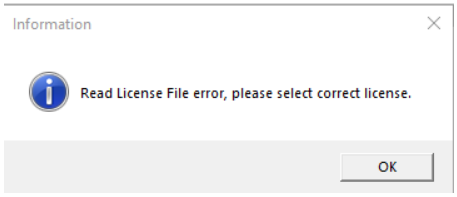
Device CAN address is configured via HW pins ADDR_0, ADDR_1, ADDR_2 in signal connector. Base Address is conjunction with NVM settings (see CAN bus addressing) Default Device address is floating Pins (not connected) and base address is 0xC0 are: 193 (0xC1)

Note: Firmware versions after 1.0.24 and lower have a default Device address of 176 (0xB0)

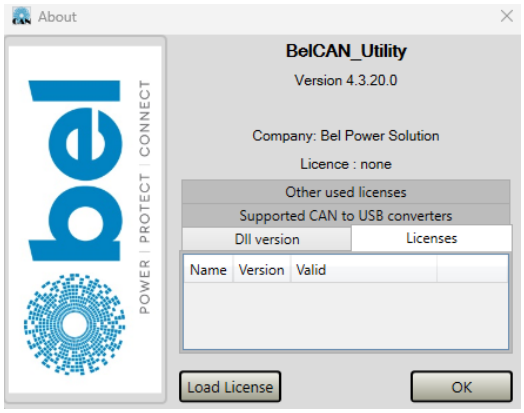
Default CAN Bitrate is 500kbps.

4.2 Software installation

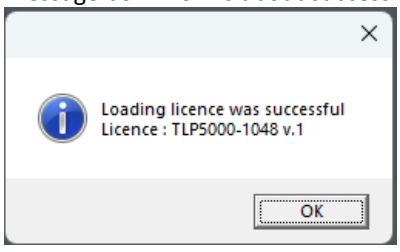
- Download Bel_CAN_Utility software from ftp://swdcaftp.psbel.com/Bel_CAN_Utility/. Credentials are provided in software release notes. If credentials are not available, please contact Bel Support.
- Run Bel_CAN_Utility-Installer-xx.yy.zzz.msi and follow installation steps.
- Run Bel_CAN_Utility from start menu or from shortcut on the desktop.
- Following Message box will open



- Click OK
- Click button Load License and select provided license file (*.lic)

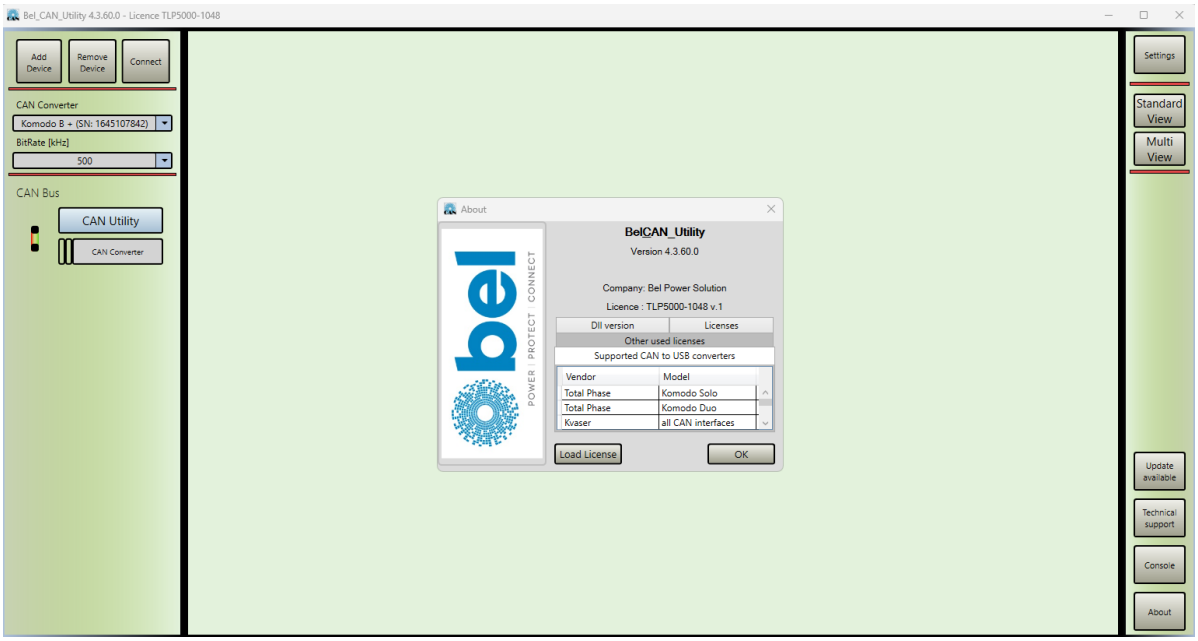


- Message box informs about successful license loading.



- License can be checked also in About window

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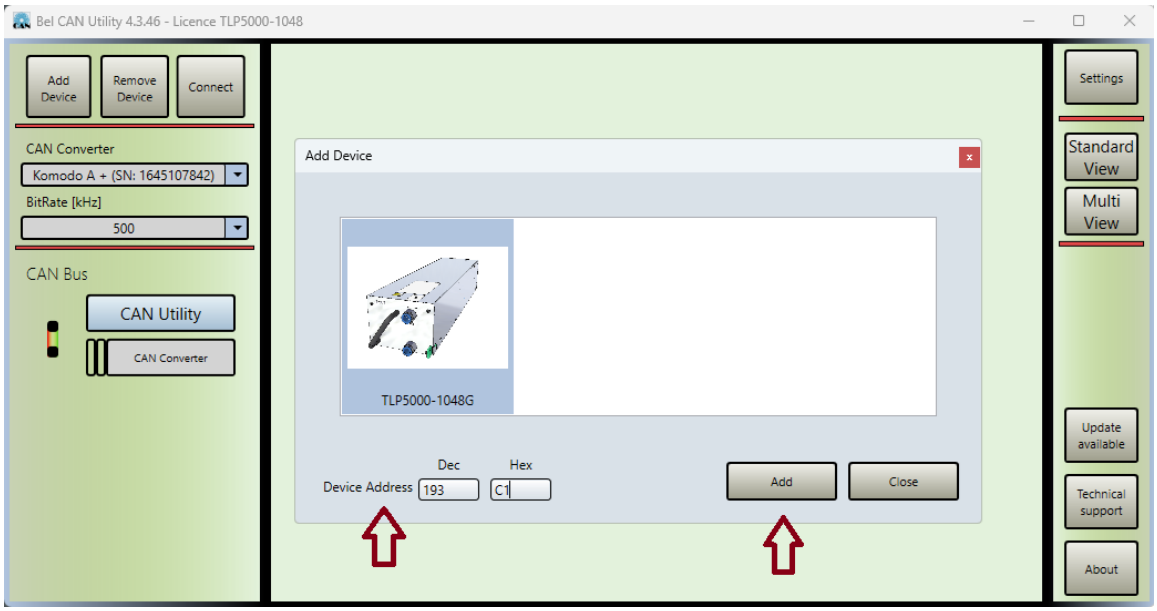


Note: Licence file must be placed In folder where administration rights are not required. Otherwise license load fails. Recommendation is to place license file on desktop.

4.3 Software configuration

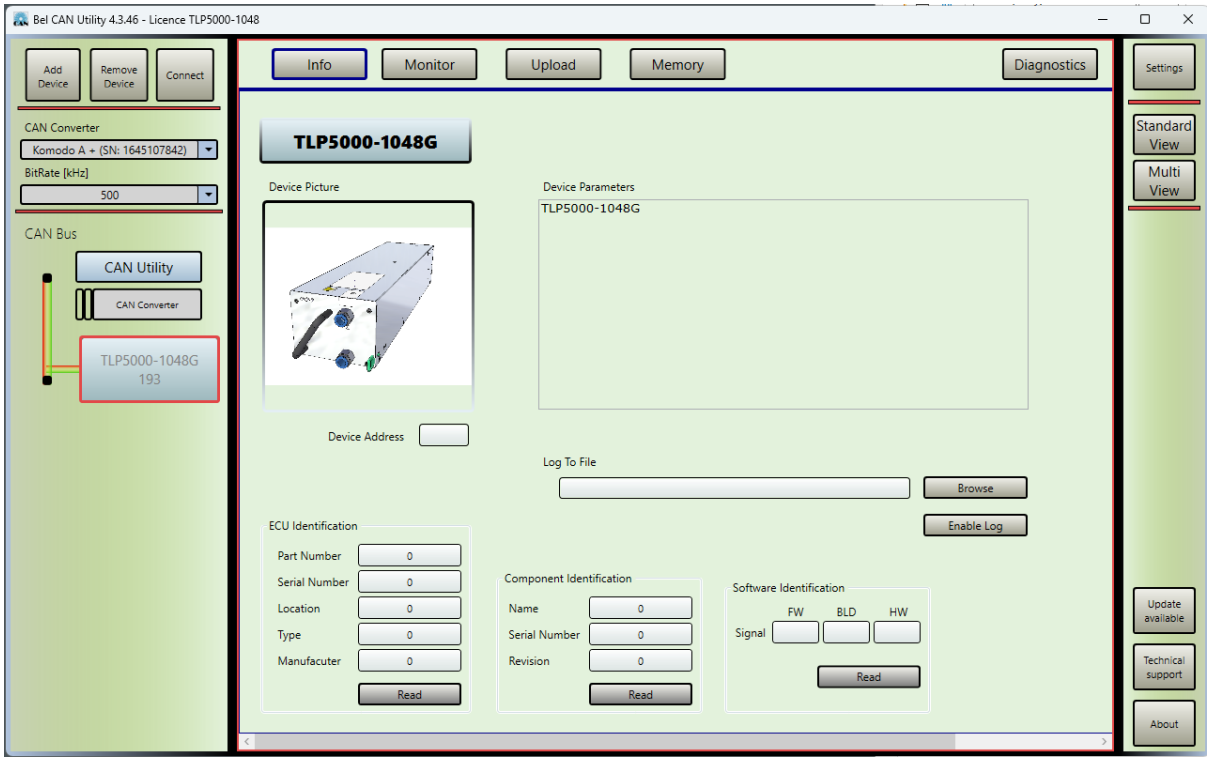
When the application is open first time there is no device in the device list.

- Add device by clicking to Add Device button
- Choose your device and set CAN address. (default prefilled is 193)
- Click Add button

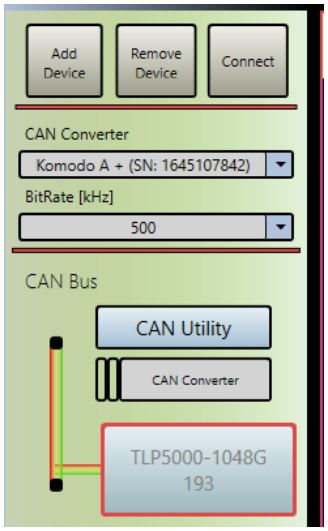


- Selected device is added to the device list in the left side of the utility
  (In this example Info tab is selected, it is possible to change the device address at any time in the future)

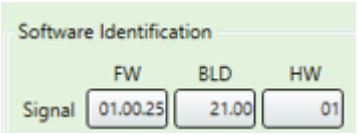
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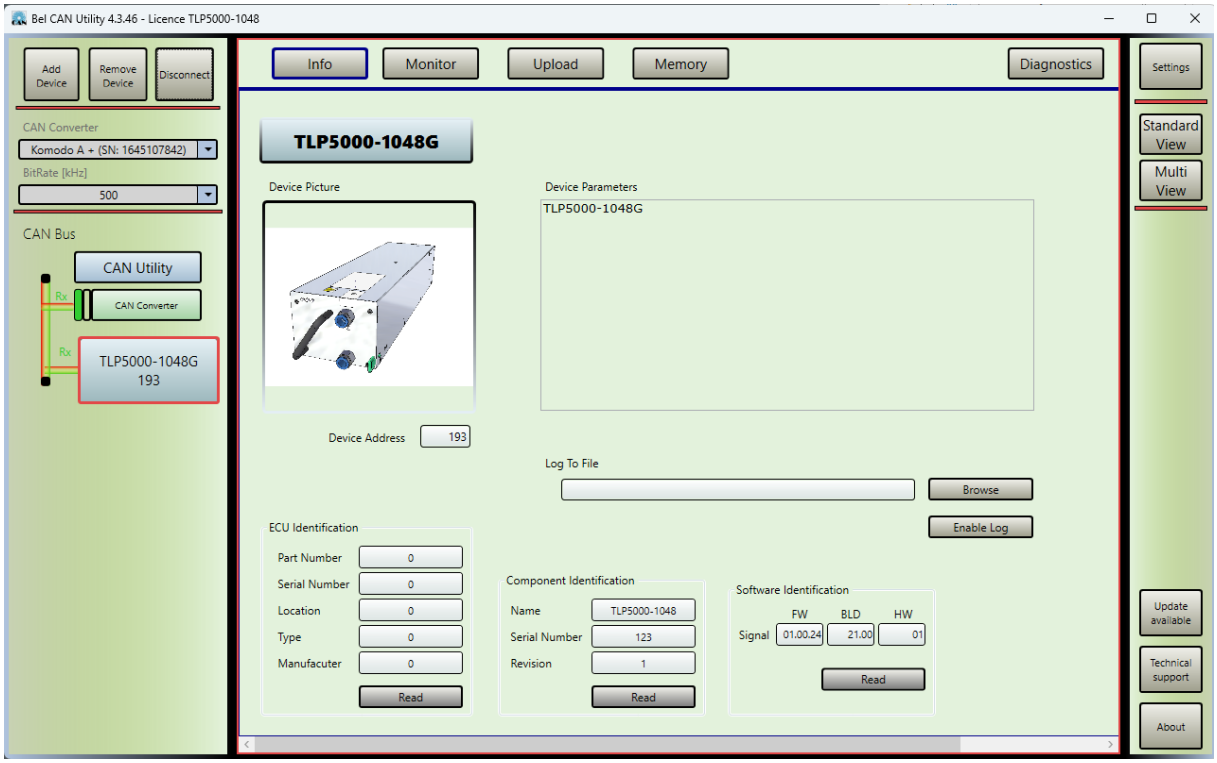
- Configure CAN converter
  (It is important to set the correct bitrate and address which must correspond with hw config of device).



- Click Connect button
- Select Monitor tab, check Enable write checkbox. Active communication is indicated by Rx and Tx symbol blinking next to selected device in device list.
- Check actual FW of microcontroller in Info Tab



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If communication is not established check the following:

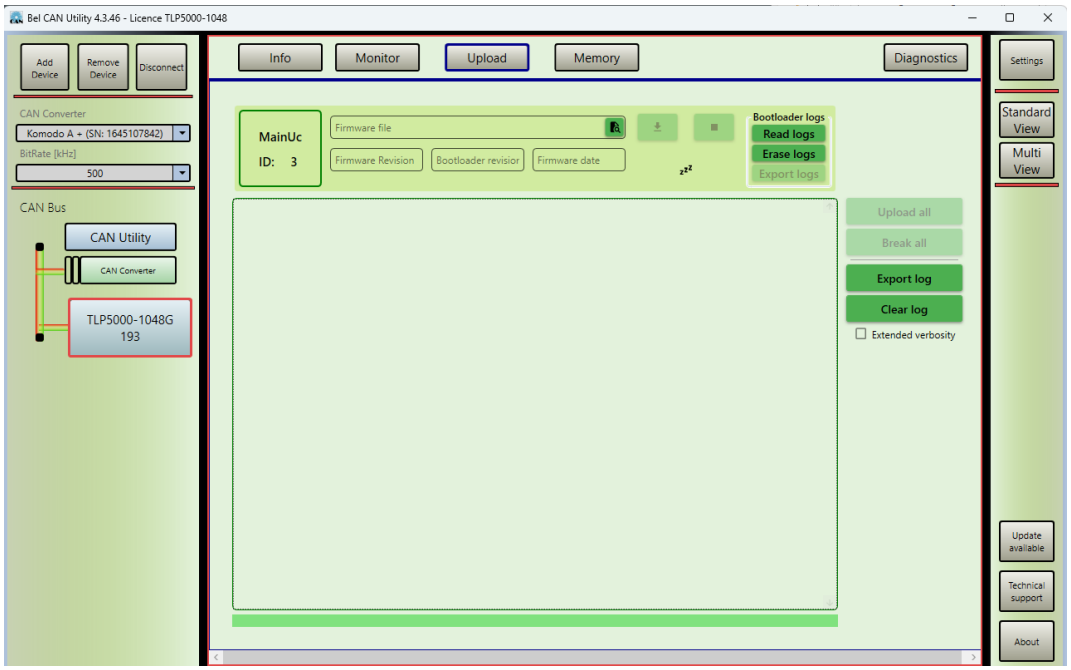
- ✓ Device CAN address set in Bel Can Utility
- ✓ Device CAN address HW configured via signal connector (ADDR_0, ADDR_1, ADDR_2 pins)
- ✓ USB to CAN converter bitrate (set in Bel Can Utility)

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4.4 Firmware update

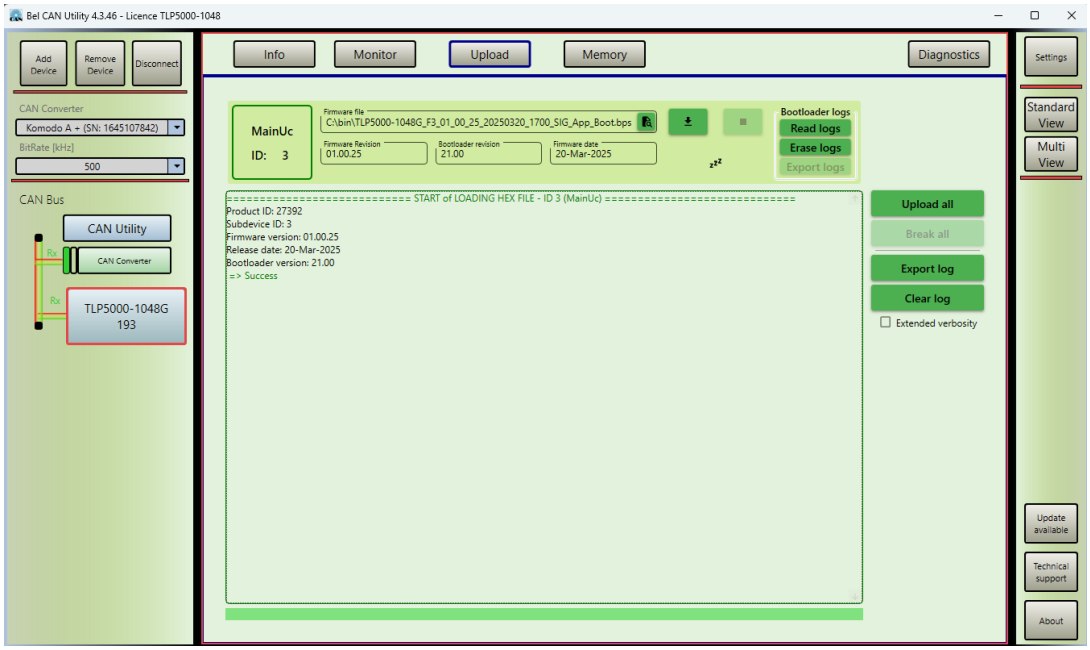
Firmware update is able only if steps in software configuration section was successful and device is not in starting or is in running mode.

- Select Upload tab to select upload section

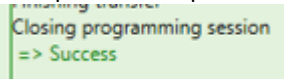


- Select required firmware file (*.bps) by button
  (*.bps file will be loaded, check in log window, correct file is selected)

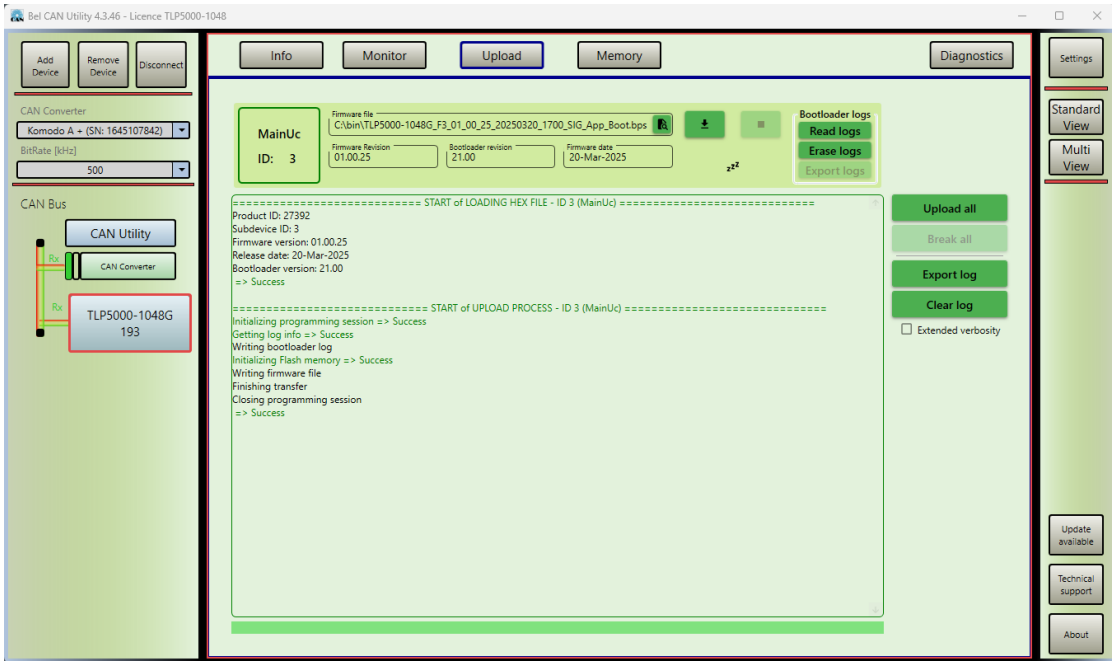
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- Click button to start firmware flashing process
  (During the process Tx and Rx symbols are blinking, progress bar in bottom side of the screen is increasing and log window is refreshed by actual flashing information)
- Flash process completion is indicated by success message in log window.

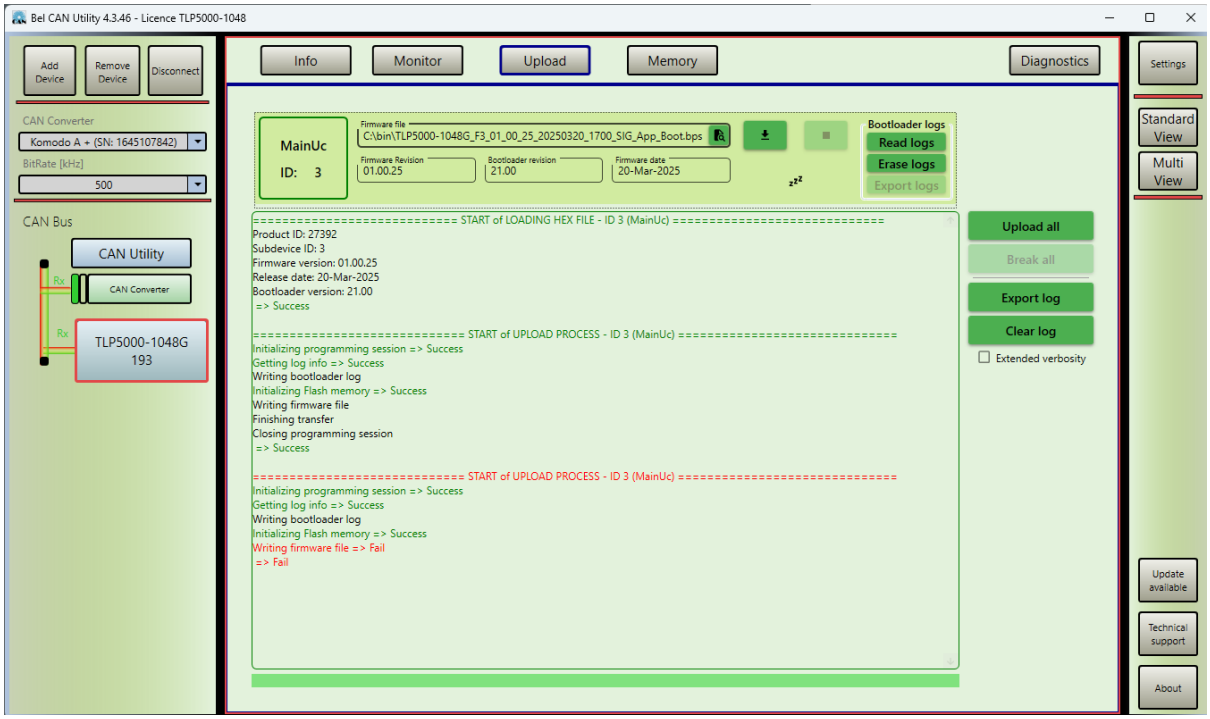


- Check applied firmware version in Info Tab



- If something goes wrong (e.g. power supply voltage drops during the flash process) or by click the stop button the flashing process will be aborted. The previous FW version is applied.

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5 References

[1] - https://www.autosar.org/fileadmin/standards/R21-11/CP/AUTOSAR_SWS_CRCLibrary.pdf

[2] - https://www.autosar.org/fileadmin/standards/R22-11/CP/AUTOSAR_SWS_E2ELibrary.pdf

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6 Revision history

Table 7 Document revision history

Rev	Description of change	Release Date	Required FW revision	Required DBC file revision	Author
1	Initial release	8-Apr-2025	01.00.25	1	Prno,Dobias(SW)
2	Update tables	12-Jan-2026	01.01.10	1	Prno,Dobias(SW)

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7 Appendices

7.1 Encoding, decoding and byte-organising Examples

Byte-organising:

Encoded value $Val = 6910 = 0x1AFE$ sent/received as argument will look:

Arg(n)	Arg(n+1)
Val [V]	
0xFE	0x1A
254	26

Universal encode formula:

$$V_{en} = \frac{V + Offset}{Resolution}$$

Universal decode formula:

$$V = V_{en} * Resolution - Offset$$

Voltage encode example:

Let us take voltage value $V = 138{,}2\ V$. Encoded value would be obtained as:

$$V_{en} = \frac{V + Offset}{Resolution} = \frac{138{,}2 + 0}{0.02} = 6910$$

Voltage decode example:

Let us take encoded voltage value $V_{en} = 6910$. Decoded value V would be obtained as:

$$V = V_{en} * Resolution - Offset = 6910 * 0.02 + 0 = 138{,}2\ V$$

7.2 Bitmap table structure legend

Bitmap/Status/Flag tables follow following pattern:

Bit	Name	I	C	Description
0	bExample	N	F	1= bExample HIGH meaning

, where

- Column **I** states for Inversion. Options Y/N (Yes/No)
- Column **C** states for GUI Colors. Options:
  - F = Fail – Red(1)/Green (pass/fail)
  - O = On/Off – Blue(1)/Gray
  - R = Red – Red(1)/Gray (Fail)
  - Y = Yellow – Yellow(1)/Gray (Warning)
  - G = Green – Green(1)/Gray (Operation)

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7.3 Flags severity

7.3.1 Fault flags

- Failure – device is broken, contact Bel support for the next steps.
- Latch – apply clear fault command or restart device. Apply 3 attempts. Contact Bel support in case latch fault persist and is not resolved.
- Recovery – wait until fault is removed, device recover automatically

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