Battery Management Interface

Version: **2.0**

Date: **6.11.06**

Author: **AB - MD**

Changes to the document

Version	Date	Chapter	Description	Name
Beta 0.1	25.01.00	All		PL
1.0	10.03.00	All	Changes due to new system architecture.	FB
1.1	18.05.00	5	Modifications due to a transition phase where an NLG4 is used as a battery charger	FB
1.2	14.12.00	All	Review	FB
1.3	27.07.01	3	Messages for "heat discharge request" Vehicle and display messages reviewed	FB
1.4	19.10.01	3, 4, 5	CAN messages and timing for Vehicle and Charge CAN reviewed	FB
1.5	21.03.02	2, 3, 4	Added chapter 2 and review	FB
1.6	01.07.02	6	Added chapter 6 "Charge PWM"	FB
1.7	08.09.03		Introduced std 29 bit VehicleCAN	AB
1.8	23.09.05	4, 5, 7	Modified same CAN messages, inserted same display messages, newer description of the charge PWM	AB - MD
1.9	12.04.06	All	Sw BMI V3B4	AB
2.0	6.11.06	4,5	Sw BMI V3B4R21	AB

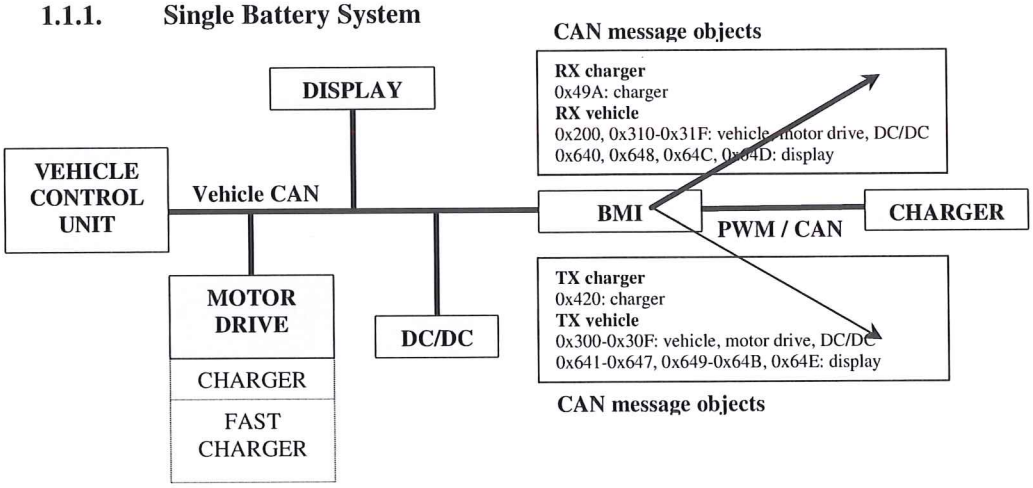
1. Overview

This document describes the standard battery management interface in terms of normal I/O signals and CAN communication messages for a single battery system.

The values of the single battery are sent as sys_values on the vehicle CAN. The sys_values for a multi battery system are described in the document "Multiple Battery Server".

1.1. CAN communication diagram

1.1.1. Single Battery System



2. BMI power supply

Ub (BMI pin 11) has to be connected to a permanent 12/24V power supply.

When all outputs are set to a low state, the maximum power required is 6W.

Dependent on the operation mode the BMI is supplied from three different sources.

- Discharge mode: (Ignition = ON, AC = OFF)
  Ignition (pin 3) allows the BMI to be supplied from *Ub* (pin 11).
- Charge mode: (AC = ON)
  The BMI has to be supplied via a 12/24V signal connected to *DC supply* (pin 10).
- Parking mode: (Ignition = OFF, AC = OFF)
  In order to avoid consumption from 12/24V on board battery, the BMI is supplied from HV via an internal DC/DC. The DC/DC is disabled when Tbat < 240°C or DIS = OPEN.

3. Standard interface

3.1. BMI block diagram

See STW document MDBMIS33 C (07.06.01).

3.2. BMI inputs

☞ Input

BMI pin number	2
Input type	10 kΩ / PD

☞ Ignition

BMI pin number	3
Input type	10 kΩ / PD

☞ Emergency switch

This is the power supply of the main conmtactors S1..S4.

BMI pin number	9
Input type	83 kΩ when S1..S4 OFF max. 5A

☞ Crash input 1

BMI pin number	14	
Input type	1 kΩ (1W) / PD	BMI-B1/B2
	1 kΩ (1W) / PD or 10 kΩ / PU	BMI-C

☞ Crash input 2

BMI pin number	6
Input type	10 kΩ / PU

3.3. BMI outputs

☞ PIN4

BMI pinnumber	4
Output type	High side max. 10A

☞ PIN 12

BMI pin number	12
Output type	High side, 10 kΩ / PD max. 100mA,
PWM frequency	305 Hz
STD, SAM.	PWM battery charger
ChIlim_SOC	If charge: PWM battery charger If discharge:PWM discharge current reduct. 10% PWM → full reduction 90% PWM → no reduction
Think_FC	.. >80% PWM → full reduction <20% PWM → no reduction
Think_A306 500Kbaude, std 11bit ID	Contactor (0% or 100% duty)

☞ PIN 13

BMI pin number	13
Output type	High side, 10 kΩ / PD max. 100mA,
PWM frequency	305 Hz
STD, Think_FC	DC enable
ChIlim_SOC	PWM 15% SOC = 0 % PWM 85% SOC >= 100%
SAM	Toggled each 30sec these info SOC: PWM 0% SOC = 0 % PWM 40% SOC >= 100% TEMP: PWM 60% TEMP < 260°C PWM 65% TEMP= 260°C PWM 95% TEMP= 360°C
Think_A306	SOC: PWM 80% if soc< 0% PWM 20% if soc >= 100% Linear between

4. Vehicle CAN

The CAN-controller (C167 CS, Siemens) fulfils the specification according "CAN-Specification 2.0 Part B".
The default data transfer rate is 125kBaud (250k and 500k on request) and in Broadcast Mode the repetition rate is 135ms, 30ms delay between the single messages!
The following ranges of identifier are reserved for the BMI communication and must not be used by the customer!!

- **200H: emergency message from vehicle to the BMI**
- **0300H-030FH: messages from the BMI**
- **0310H-031FH: messages to the BMI**
- **0640H-065FH: messages used by the display**
- **0500H-05FFH: Zebra Monitor Comunication (same available on request)**

4.1. Vehicle → BMI

4.1.1. Emergency

CAN_ID_EMERG_RX

Message: E0	**Emergency**			**Identifier: 0200H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
Emergency	Emergency of the vehicle active	0	0	1	Bool
CrashSensor	Crash signal active	0	1	1	Bool

4.1.2. Vehicle control unit

CAN_ID_VCU_REQ

Message: C0	**MasterCommand**			**Identifier: 0310H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
ChangeModeRequest	1: Change of communication-mode	0	0	1	Bool
BroadcastMode	1: Broadcast mode 0: Request mode	0	1	1	Bool
Requestdata	1: request of system data	0	2	1	Bool
Reserved	RESERVED for BMI: If transmitted must be zero.	1	13	1	Bool

Note: BMI at default starts in Broadcast Mode; if it is necessary change the communication-mode:
send the first time message C0 with ChangeModeRequest=1, BroadcastMode=0, Requestdata=0 to change from broadcast to request and then send each time message C0 with ChangeModeRequest=0, BroadcastMode=0, Requestdata=1 to request data

4.1.3. Fast/vehicle charger

CAN_ID_VPA_REQ

Message: C1	**VehicleCharge**			**Identifier: 0311H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
FastChargeRequest	Fast charge request	0	0	1	Bool
VehicleChargeRequest	Vehicle charge request	0	1	1	Bool

4.2. BMI → Vehicle

The organization of the messages is word-orientated (16-bit controller). The description of two-byte-values corresponds to the description used by Intel (low-byte on lower, high byte on higher address)

4.2.1. Initialisation

After the initialisation of the BMI is finished, the BMI will send these detection-messages

CAN_ID_BMI_STARTUP

Message: I0	**StartUp**			**Identifier: 0300H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
SW_Version	Software-Version	0	0	8	unsigned char
SW_Revision	Software-Revision	1	8	8	unsigned char
SW_ID1	Software-Identification byte 1 'B'	2	16	8	unsigned char
SW_ID2	Software-Identification byte 2 'M'	3	24	8	unsigned char
SW_ID3	Software-Identification byte 3 'I'	4	32	8	unsigned char
HW_Version	Hardware-Version	5	40	8	unsigned char
InitSuccessful	0: error occurred during initialization 1: init successful and BMI ready for communication	6	48	8	unsigned char
BatteryAddress	In a single battery system batteryAddress = 0	7	56	8	unsigned char

4.2.2. System data

In BroadcastMode the system data will be send periodically (each 4 x 40 = 160msec),
in RequestMode they will be send on request

CAN_ID_VCL_DATA0

Message: M0	**System data M0**				**Identifier: 0301H**	
Signal name	**Signal description**	**Resolution**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_current	Actual value of current	0,1 A	0, 1	0	16	signed short
sys_voltage	Actual value of voltage	0,1 V	2, 3	16	16	unsigned short
sys_dod	Actual depth of discharge in %	0,1 %	4, 5	32	16	unsigned short
sys_tempMean	Actual mean temperature	0,1 K	6, 7	48	16	signed short

CAN_ID_VCL_DATA1

Message: M1	**System data M1**			**Identifier: 0302H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_errGeneral	General error active ErrCat ≥ CATEGORY_NOTICE	0	0	1	bool
	NOT USED, fixed to zero	0, 1	1	15	
sys_isoerror	Internal or external ISO fault active	2	16	1	bool
	NOT USED, fixed to zero	2, 3	17	15	
sys_voltageMinDischarge	Min. discharge voltage (resolution 0,1V)	4, 5	32	16	unsigned short
sys_currentMaxDischarge	Max. discharge current (resolution 0,1A)	6, 7	48	16	unsigned short

CAN_ID_VCL_DATA2

Message: M2	System data M2				Identifier: 0303H
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_voltageMaxCharge	Max. regen. braking, vehicle or fast charge voltage (resolution 0,1V)	0, 1	0	16	unsigned short
sys_currentMaxCharge	Max. regen. braking, vehicle or fast charge current (resolution 0,1A)	2, 3	16	16	unsigned short
sys_vehicleChargeEnable	Vehicle charge enabled	4	32	1	bool
sys_regenBrakingEnable	Regen. braking enabled	4	33	1	bool
sys_dischargeEnable	Discharge enabled	4	34	1	bool
sys_fastchargeEnable	Fastcharge enabled	4	35	1	bool
sys_dcdcEnable	DC/DC enabled	4	36	1	bool
sys_ac	AC-supply connected	4	37	1	bool
	Not used	4	38	1	bool
sys_numberOfReleasedBatteries	1 : battery released 0 : battery not released	5	40	8	bool
sys_reducedNumberOfBatteries	1 : battery not released 0 : battery released	6	48	1	bool
sys_emergency	Emergency signal from the battery to the vehicle	6	51	1	bool
sys_crash	Crash signal from the battery to the vehicle	6	52	1	bool
sys_fan_status (*)	Fan active	6	53	1	bool
sys_SOC>102%	SOC > 102%	6	54	1	bool
Sys_iso_test_flag	Ios test flag activated during isolation test and 5 sec before	6	55	1	Bool
Sys_waiting_temp_err	Charge stopped waiting right temperature	6	56	1	bool

(*) Note :

sys_fan_status transmitted only if single system otherwise dieselElectricMode

CAN_ID_VCL_DATA3

Message: M3	System data M3				Identifier: 0304H
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_voltageMaxGenerator	Max. generator voltage (resolution 0,1V)	0, 1	0	16	unsigned short
sys_highestErrCat	Highest category among active errors in the system 0: no errors 1: category statistic 2: category notice 3: category delayed switch off 4: category switch off	2	16	4	--
Sys_EOC	End Of Charge	3	24	1	bool
Reach EOC please	Since too long time EOC has not been reached	3	25	1	bool
Waiting OK temperature	Charge stopped to wait right temperature	3	26	1	bool
Too_much_FC	In this battery the number of failed cell is too high to guarantee full functionality	3	27	1	bool
Acheater status	AC heater status, not considered duty cycle (bit activated 6 sec before and deactivate 6 sec after real heater)	3	28	1	bool

5. Vehicle CAN_29BIT

The CAN-controller (C167 CS, Siemens) fulfils the specification according "CAN-Specification 2.0 Part B".
The default data transfer rate is 125kBaud (250k. 500k on request) and in Broadcast Mode the repetition rate is 135ms, 30ms delay between the single messages.!
The following ranges of identifier are reserved for the BMI communication and must not be used by the customer!!

- **0CFF3E27Hex ElectronicVehiclecontrolUnit**
- **0500Hex..5FFHex Zebra Monitor Comunication (same available on request)**

5.1. Vehicle → BMI

5.1.1. Vehicle control unit

CAN_ID_EVCU2_DICO

Message: EVCU2_DICO	**ElectronicVehicleControlUnit**		**Identifier:**	**0CFF3E27H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
	NOT USED	0, 1, 2	0	28	
HevModeSelection	HEV mode selection 1: EV-Mode 2: HEV-Mode 4: constant generation mode 8: dieselelectric mode 12: charge mode	3	28	4	--
	NOT USED	4, 5, 6, 7	32	32	

Note: message 200x (Emergency), 310x (MasterCommand), 311x (VehicleCharge) are no more considered.

5.2. BMI →Vehicle

The organization of the messages is word-orientated (16-bit controller). The description of two-byte-values corresponds to the description used by Intel (low-byte on lower, high byte on higher address)

5.2.1. Initialisation

After the initialisation of the BMI is finished, the BMI will send these detection-messages

CAN_ID_BMI_STARTUP

Message: I0	**StartUp**			**Identifier: 0300H**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
SW_Version	Software-Version	0	0	8	unsigned char
SW_Revision	Software-Revision	1	8	8	unsigned char
SW_ID1	Software-Identification byte 1 'B'	2	16	8	unsigned char
SW_ID2	Software-Identification byte 2 'M'	3	24	8	unsigned char
SW_ID3	Software-Identification byte 3 'I'	4	32	8	unsigned char
HW_Version	Hardware-Version	5	40	8	unsigned char
InitSuccessful	0: error occurred during initialisation 1; init successful and BMI ready for communication	6	48	8	unsigned char
BatteryAddress	In a single battery system batteryAddress = 0	7	56	8	unsigned char

5.2.2. System data

In BroadcastMode the system data will be send periodically each 125ms

CAN_ID_VCL_29_DATA_M0

Message: M0_29BIT	**System data M0_29BIT**			**Identifier : 18FF9F1EH**	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_dod	Sum of depths of discharge among released batteries. (battery not released = 100% DOD) (Resolution 0,1%)	0, 1	0	16	unsigned short
sys_tempMean	Highest mean temperature among released batteries (Resolution 0,1K)	2, 3	16	16	signed short
sys_voltageMinDischarge	Highest value of min. discharge voltage among released batteries (resolution 0,1V)	4, 5	32	16	unsigned short
sys_currentMaxDischarge	Lowest value of max. discharge current among released batteries (resolution 0,1A)	6, 7	48	16	unsigned short

CAN_ID_VCL_29_DATA_M1

Message: M1_29BIT	**System data M1_29BIT**		**Identifier:**		**18FF9E1EH**
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_voltageMaxCharge	Lowest value of max. regen. braking, vehicle or fast charge voltage among released batteries (resolution 0,1V)	0, 1	0	16	unsigned short
sys_currentMaxCharge	Lowest value of max. regen. braking, vehicle or fast charge current among released batteries (resolution 0,1A)	2, 3	16	16	unsigned short
sys_voltageMaxGenerator	Lowest value of max.voltage generator among released batteries (resolution 0,1V)	4, 5	32	16	unsigned short
sys_errGeneral	1: general error active ErrCat ≥ CATEGORY_NOTICE (BMI1 = bit0 .. BMI8 = bit7)	6	48	8	unsigned short
sys_isoerror()>0	1: internal or external ISO fault active in one or more BMI	7	56	1	bool
sys_regenBrakingEnable	Regen. braking and generator charge enabled on **all** released batteries	7	57	1	bool
sys_dischargeEnable	Discharge enabled on **all** released batteries	7	58	1	bool
sys_reducedNumberOfBatteries	One or more batteries in the system are not released	7	59	1	bool
sys_emergency	Emergency signal from the battery to the vehicle	7	60	1	bool
sys_dieselElectricMode	MBS pin 35 is active. The system is set into dieselElectricMode, consequently main contactors (S1-S4) will open.	7	61	1	bool
sys_SOC>102%	SOC > 102% on **one or more** released batteries	7	62	1	bool
sys_ac	AC-supply connected to one or more batteries	7	63	1	bool

CAN_ID_VCL_29_DATA_M2

Message: M2_29BIT	**System data M2_29BIT**			**Identifier:**		**18FF9D1EH**
Signal name	**Signal description**		**Byte Nr**	**Bit Pos**	**Bits**	**Type**
sys_current	Sum of current values among released batteries	0,1 A	0, 1	0	16	signed short
sys_voltage	Average of voltage values among released batteries	0,1 V	2, 3	16	16	unsigned short
sys_numberOfReleasedBatteries	Released batteries in the system		4	32	1	bool
sys__DieselGenerator_Enable	If, among released batteries (availble for driving) SOCmax < 70%. (>68% hysteresis)		4	36	1	bool
sys_fan_status	Fan active		4	37	1	bool
sys_EOC	End Of Charge		4	38	1	bool
sys_highestErrCat	Highest category among active errors in the system 0: no errors 1: category statistic 2: category notice 3: category delayed switch off 4: category switch off		5	40	4	--
	Not used		5	44	4	
sys_dod2	Average of depths of discharge among available for driving batteries. (battery not released = not considered) (Resolution 1%)		6	48	8	unsigned char
Reach EOC please	Since too long time EOC has not been reached		7	56	1	bool
Waiting OK temperature	Charge stopped waiting right temperature		7	57	1	bool
Too_much_FC	In this battery the number of failed cell is too high to guarantee full functionality		7	58	1	bool
Acheater status	AC heater status, not considered duty cycle (bit activated 6 sec before and deactivate 6 sec after real heater)		7	59	1	bool

6. Display

The CAN-identifier 640H to 65FH are reserved for the data transmission of the display.

6.1.1. Display → BMI

CAN_ID_DISP_PWR_ON

Message:	DSPLY _Startup			Identifier: 0648H	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
StartUp_1	Start up byte 1 (0xAA)	0	0	8	char
StartUp_2	Start up byte 2 (0x55)	1	8	8	char

6.1.2. BMI → Display

Message:	DSPLY _SetCursor			Identifier: 0642H	
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**
CursorType	0: cursor blinking 1: cursor as blinking underline 2: cursor as blinking block	0	0	8	unsigned char

CAN_ID_DISP_SET_WRT_POS

Message:	DSPLY _WritePosition			Identifier: 0644H		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Range**
xPos	X-position of write cursor	0	0	8	unsigned char	0..19
yPos	Y-position of write cursor	1	8	8	unsigned char	0..3

CAN_ID_DISP_WRT_CHRS

Message:	DSPLY_WriteData			Identifier: 0646H		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Range**
DataByte_0	Data byte 0, ASCII	0	0	8	char	ASCII
DataByte_1	Data byte 1, ASCII	1	8	8	char	ASCII
DataByte_2	Data byte 2, ASCII	2	16	8	char	ASCII
DataByte_3	Data byte 3, ASCII	3	24	8	char	ASCII
DataByte_4	Data byte 4, ASCII	4	32	8	char	ASCII
DataByte_5	Data byte 5, ASCII	5	40	8	char	ASCII
DataByte_6	Data byte 6, ASCII	6	48	8	char	ASCII
DataByte_7	Data byte 7, ASCII	7	56	8	char	ASCII

6.1.3. Initial messages

The display shows its own initial message for a time of one second after connection to +12V (optional +24V):

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	O	P	U	S	-	l	i	g	h	t	+		C	A	N	-	B	U	S	
2	V	X	.	x	x	E		v	o	m		d	d	.	m	m	.	y	y	
3	B	U	s	s	p	e	e	d	:			x	x	x		k	B	a	u	d
4	B	A	s	e	-	A	d	d	:		x	x	x	x		(	d	e	z	)

Initial text
x.xx = OPUS software version, dd.mm.xx = date
xxx = baudrate in kBaud
xxxx = basic address for OPUS communication

Then the BMI initial message is displayed:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1				Z	E	B	R	A			B	A	T	T	E	R	Y			
2					B	M	I	-	H	W	:		v	.	r					
3					B	M	I	-	S	W	:		v	.	r					
4	M	E	S	-	D	E	A				d	d	/	m	m	/	a	a		

BMI-HW version with revision
BMI-SW version with revision
BMI-SW date

6.1.4. Status messages (line 1 and 2)

If sys_numberOfReleasedBatteries = 0 and sys_ac = FALSE, the display will show as following:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1					0	.	0		%					0		°	C			
2					0	.	0		A					0		V				
3				e	r	r	o	r		m	e	s	s	a	g	e	s			
4																				

Error messages may be displayed (see 3.3.5)
No information

If sys_numberOfReleasedBatteries = 1 or sys_ac = TRUE, the display will show as following:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1			x	x	x	.	x		%			y	y	y		°	C			
2			x	x	x	.	x		A			y	y	y		V				
3				e	r	r	o	r		m	e	s	s	a	g	e	s			
4	a	d	d	i	t	i	o	n	a	l			m	e	s	s	a	g	e	s

xxx = 100 - DOD, yyy = sys_tempMean
xxx = sys_current, yyy = sys_voltage
Error messages may be displayed (see 3.3.5)
Additional messages could be displayed (see 3.3.6)

6.1.5. Error messages (line 3)

If sys_errGeneral = TRUE and Sys_highestErrCat = CATEGORY_NOTICE:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3				s	y	s	t	e	m		w	a	r	n	i	n	g			

If sys_errGeneral = TRUE and Sys_highestErrCat = CATEGORY_DELAYED_SWOFF:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			1	m	i	n		s	w	o	f	f		e	r	r	o	r		

If sys_errGeneral = TRUE and Sys_highestErrCat = CATEGORY_SWOFF:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3					s	w	o	f	f			e	r	r	o	r				

If sys_isoerror = TRUE:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			i	n	s	u	l	a	t	i	o	n		e	r	r	o	r		

If sys_emergency or emergency from vehicle (CANID 0x310) = TRUE:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			e	m	e	r	g	e	n	c	y		a	c	t	i	v	e		

If TempMean is below 240°C:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3					b	a	t	t	e	r	y		c	o	l	d				

The battery has SOC >= 102%

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3						S	O	C		>			1	0	2	%				

The user battery has low voltage:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3				l	o	w		v	o	l	t		1	2	V	2	4	V		

If charging temperature error:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			W	a	i	t	i	n	g		O	K		t	e	m	P			

If active limitation for inverter:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			L	i	m	i	t	.		o	n		B	a	t	t	.			

If EOC not reached for long time:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
3			R	e	a	c	h	E	O	C		p	l	e	a	s	e			

If there is more than one error message all the messages are displayed in a cyclic mode.

6.1.6. Additional messages (line 4)

if sys_vehicleChargeEnable = TRUE or batteryCharge ENABLED (NLG4/NLG5/BC-Z-3):

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4				c	h	a	r	g	e		e	n	a	b	l	e	d			

if sys_fastchargeEnable = TRUE:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4		f	a	s	t	c	h	a	r	g	e		e	n	a	b	l	e	d	

Maximum charge current value, 16A, 10A, 7A:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4		M	a	x	M	a	i	n	s	C	u	r					x	x	A	

Yellow alert for PowerMethod management:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4				Y	E	L	L	O	W		A	L	E	R	T					

Red alert for PowerMethod management:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
4				R	E	D			A	L	E	R	T							

7. Charge CAN

7.1. NLG5

The CAN-controller (C167 CS, Siemens) fulfils the specification according "CAN-Specification 2.0 Part B".
The data transfer-rate is **125kBaud**.

7.1.1. BMI → NLG5

CAN_ID_BATCHG_DATA1

Message:	**CHARGE_data**			**Identifier: 0420H Repetition rate 900ms**		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Resolution**
ChargingVoltage	Battery charger set point	0, 1	0	16	unsigned short	0.1V
MainsCurrentMax	Max current from mains	2	16	8	unsigned char	0.2A
BatteryVoltage	Battery voltage	3, 4	24	16	unsigned short	0.1V
BatteryCurrent	Battery current	5, 6	40	16	unsigned short	0.1A
ChargingPower (*)	Charging power in %	7	56	8	unsigned char	1%

(*) **Note:**
ChargingPower = 0 → BatteryCharge = DISABLED
ChargingPower > 0 → BatteryCharge = ENABLED

7.1.2. NLG5 → BMI

CAN_ID_BATCHG_REQ

Message:	**CHARGE_request**			**Identifier: 049AH Repetition rate 900ms**		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Resolution**
BatteryChargeRequest	Battery charge request	0	0	1	bool	
ChargerFault	Charger fault	0	1	1	bool	
ChargerOverTemp	Charger over temperature	0	2	1	bool	
MainsCurrent	Mains current (measured)	1	8	8	unsigned char	0.2A
ChargingPower	Charging power in %	2	8	8	unsigned char	1%

7.2. NLG4

The CAN-controller (C167 CS, Siemens) fulfils the specification according "CAN-Specification 2.0 Part B".
The data transfer-rate is **500kBaud**.

7.2.1. BMI → NLG4

CAN_ID_BATCHG_DATA0

Message:	**CHARGE_data**			**Identifier: 0246H Repetition rate 90ms**		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Res.**
Charging active (NLG)	Battery charge enable	2	22	1	bool	
Release NLG	Battery charge enable	3	24	1	bool	

CAN_ID_BATCHG_DATA1

Message:	**CHARGE_data**			**Identifier: 0420H Repetition rate 900ms**		
Signal name	**Signal description**	**Byte Nr**	**Bit Pos**	**Bits**	**Type**	**Res.**
Charging close voltage	Battery charger set point	0, 1	0	16	int	0.1V
Max mains current	Max current from mains	2	16	8	byte	0.2A
Max output current NLG	Battery charger output current max	3, 4	24	16	int	0.1A

Maximum current in charge net connectors is 20A

7.2.2. NLG4 → BMI

CAN_ID_BATCHG_REQ

Message:	**CHARGE_request**			**Identifier: 049AH Repetition rate 900ms**		
signal name	**Signal description**	**Byte nr**	**Bit pos**	**Bits**	**Type**	**Res.**
Fault BL	Charger fault	0	0	1	bool	
Mains voltage detected	Battery charge request	0	2	1	bool	
Act. value mains current	Mains current (measured)	3	24	8	byte	0.2A
Overtemperature BL	Charger over temperature	7	59	1	bool	

8. Charge PWM

8.1. BC-Z-3

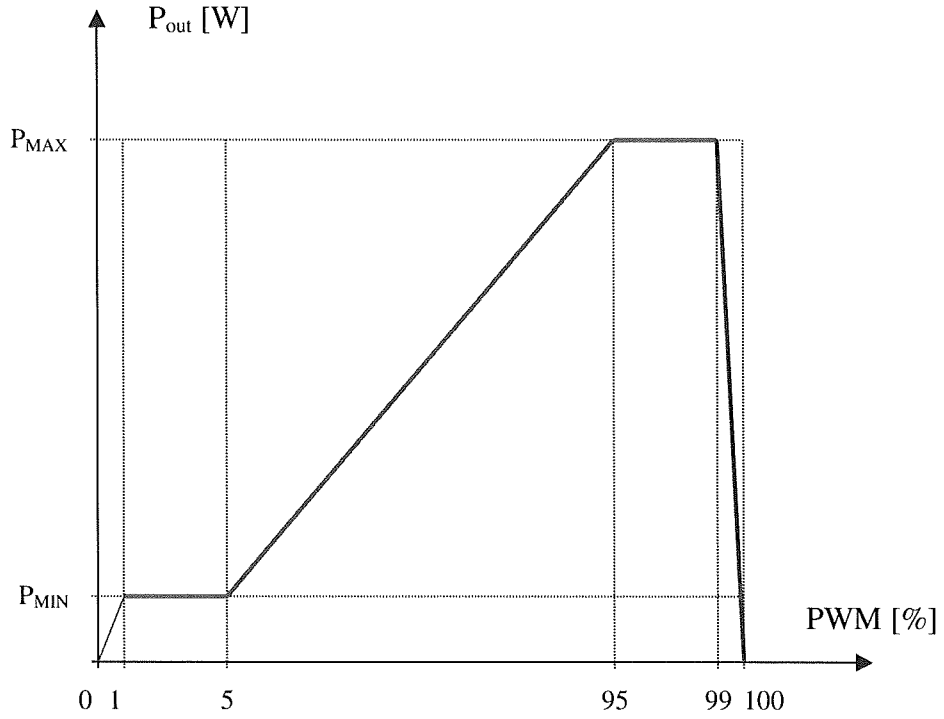
PWM signal from BMI to charger to control the charging power (12V level, 305Hz)
The computation of PWM if executed every 250msec.

The maximum PWM is limited in order to avoid to exceed the max mains current.
The mains current for AC heater and for charger are added in order to obtain the total mains current.
The mains current for charger is estimate using charger output power measurement, AC voltage measurement and an efficiency of the charger itself.
Due to the fact that the relationship between the charger power and the pwm is not linear, every time the estimated total mains current exceed the max allowed the max PWM is reduced up to the value comparison is verified.
No limitations are introduced on max PWM (this means max pwm 95%) if:
16A is the max mains current set with Zebra Monitor and if
the AC heater is not active or AC heater and charger on different line.
(max pwm = 95% is settable-modifiable with ZM)

The transmitted pwm is computed by the following algorithm:
1) Pwm max must not be exceeded.
2) If Pwm line is shorted then pwm is set to zero
3) Else If charging current is lower than 240mA/string:
starting from 20% increase of 1% the pwm up to 95% for one time.
4) Else If max charging voltage and max charging current are not reached then increase pwm of 10% up to 95%
5) Else
pwm increased (up to 95%) / reduced (up to 0%) of 0,5% if one / no limits are exceed.

Furthermore, if for more than 10sec the transmitted pwm is higher than 90% and the charging current is lower than 2A then the pwm is zeroed for 2 min and a error is set. This to avoid to stress the charger if it is limited by thermal limitation or something like that.

Following diagram shows variation of power output depending on PWM signal given by the BMI:



P_{MAX} = UAC * 15.5A * η

P_{MIN} = 50W