30-8405 COMBINED CHARGING UNIT

6.6kw On Board Charger + 2.5kw DC-DC
350Vdc Nominal Output

Acronym	Description	
HV	High Voltage	Typically refers to the 300-800V system that is used to drive the electric vehicle. This includes the battery pack, Inverter, chargers, etc…
LV	Low Voltage	Typically refers to the 12v system that powers most of the non-propulsion system in a car. Headlights, Stereo, power windows, etc…
OBC	On Board Charger	Vehicle mounted module that takes grid power, either 120v or 240v AC and converts it into high voltage DC used to charge the vehicles battery pack.
DC-DC	DC-DC Converter	A device that steps down the DC high voltage from the battery pack into a lower voltage that that is suitable to recharge the vehicles 12v battery.
CCU	Combined Charge Unit	A module that combines the HV battery pack charger (OBC) and the LV battery charger (DC-DC) into a single device.
VCU	Vehicle Control Unit	A supervisory controller tasked with the overall control of an electric vehicle
HVIL	High Voltage Interlock Loop	HVIL is a continuous low-voltage loop that daisy chains through all the high-voltage connectors in an EV. If the low-voltage HVIL signal is interrupted the VCU is alerted that there is an issue with the high-voltage system.
CAN	Controller Area Network	Communications bus that most all devices use to communicate over.
ICE	Internal Combustion Engine	Fuel burning internal combustion engine
EVSE	Electric Vehicle Service Equipment	The land based EV charging equipment. This may be home based or a public charger.

Directory

1. Product Overview

1.1. Description

A Combined Charging Unit (CCU) is a module combining both an On-Board Charger (OBC) and a DC-DC Converter (DC-DC). The OBC charges the HV Battery Pack by taking 120v or 240v AC energy from the grid, converting it to high voltage DC and charging the high voltage battery in the vehicle. The DC-DC converter takes the high voltage from the battery pack and converts it to low voltage to maintain the charge in the vehicles 12V battery. The DC-DC converter performs the duties that the alternator does in an ICE vehicle. The CCU is fully controlled by the VCU via the CAN bus and the OBC and DC-DC report voltage, current and status information back to the VCU.

1.2. Product Features

Combining the functions of an OBC and a DC-DC converter into a single module simplifies the EV drive system. The AEM CCU is very compact and light weight, while offering high efficiency, stable charging, long life, high protection level, and high reliability. The AEM CCU is 100% driven via CAN by the VCU and does not interface with the charge plug connector or the off vehicle EVSE (Electrical Vehicle Service Equipment).

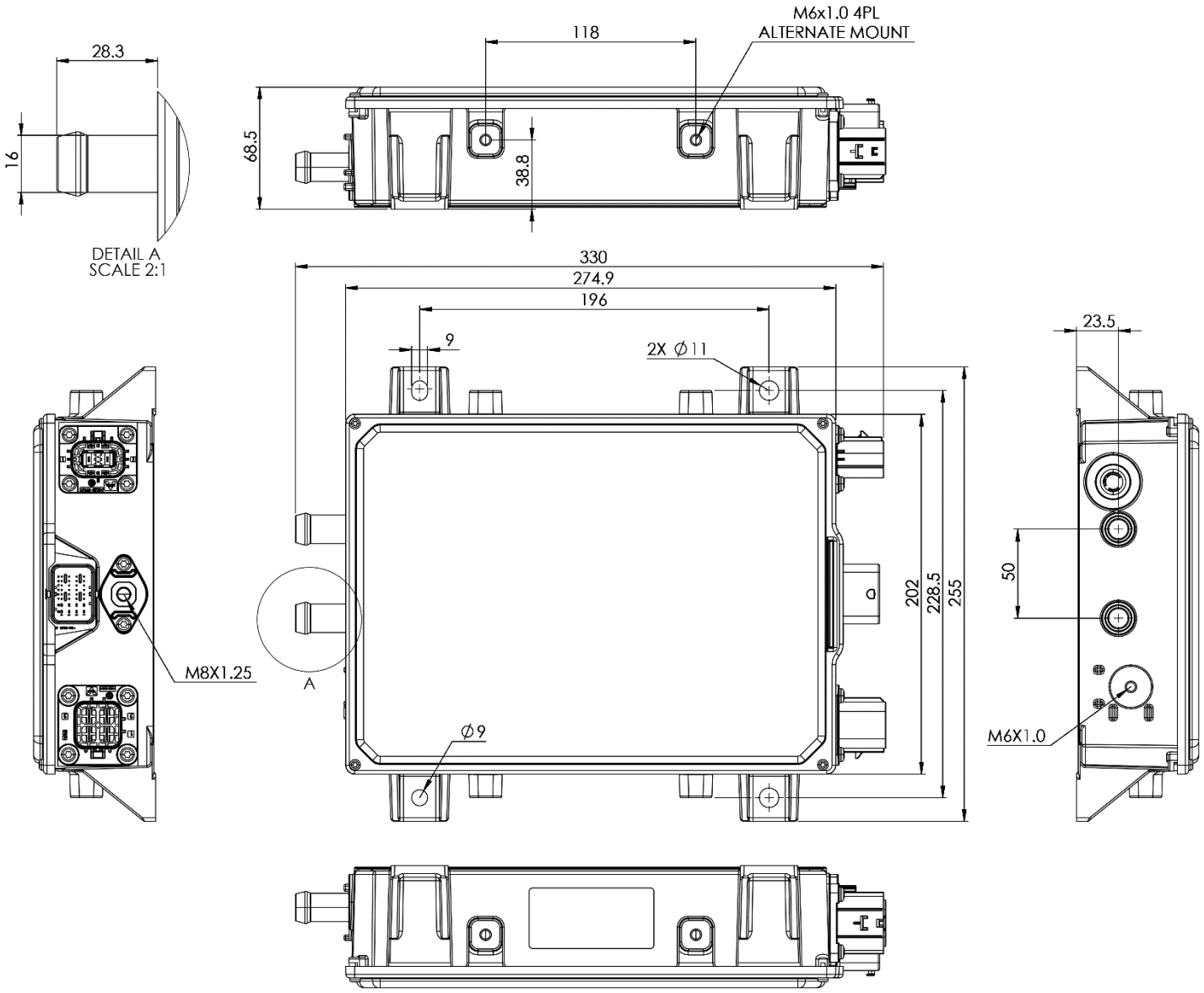
The CCU has the following protection functions:

- Input over and under voltage protection
- High Voltage Output over and under voltage protection
- High and Low Voltage Output short circuit protection
- Overtemperature Protection

1.3 Structure Size and Weight

Length	275 mm	10.8 in
Width	202 mm	7.9 in
Height	68 mm	2.7 in
Weight	5.5 kg	12.2 lbs

Dimensions without water nozzle, connectors or mounting bracket



2. Installation Requirement

2.1. Installation location requirements

Recommended installation locations:

- Vertical and horizontal beams in the front compartment of the vehicle body
- Inside the battery pack and on the fixed beam
- The bottom bracket of the toolbox
- On the main beam of the trunk
- The bottom beam of the seat, etc.

If the above positions need to be converted into small brackets, the strength of the brackets shall be considered, and simulation analysis shall be performed.

Installation locations not allowed:

- The electric motor or its support.
- The bottom of the vehicle or within 400 mm of the ground.

- Supports with poor reliability, anti-collision beams, baffles, etc.

2.2. Coolant header tank height requirements

The top surface of the charger must be lower than the bottom surface of the coolant tank.

2.3. Cooling Requirements

The unit must have circulating coolant whenever the OBC or DC-DC converter is operating. A 50/50 mix of water and Ethylene Glycol is required. Never run plain water as a coolant. Normal operating range is -40C to +65C and if temps exceed +65C then the unit must be run at a reduced output. Never exceed +85C. The coolant connection direction is unimportant, either one may be the input or output.

3. Electrical Specifications

3.1. Electrical Characteristics

On Board Charger

AC Input	
Max Input voltage range	90～264 Vac
Level 1 Charging	120V/16A (1.92kW)
Level 2 Charging	220V/30A (6.6kW)
Rated input voltage	220 Vac
Input frequency range	45-65 Hz
Input current	32 A max
Power Factor	≥0.99@Rated
High Voltage Output	
Output Voltage Range	240V～450 Vdc
Rated Output Voltage	350 Vdc
Max Output Current	22 A
Output Voltage Accuracy	≤±1%
Output Current Accuracy	≤±3%@＞10A; ≤±0.3A @＜10A
Output Voltage Ripple Factor	≤±5%
Output Power	6.6 kW max
Efficiency	93.5%@Rated Input, Rated Output Full Load
Low Voltage Input	
Input Voltage Range	9～16 Vdc
Quiescent Current	≤1 mA

DC-DC Converter

Low Voltage Output	
Output Voltage Range	11～16Vdc
Output Rated Voltage	14 Vdc
Output Current	178 A continuous
Output Power in normal vehicle state	2.5 kW continuous
Output Power while charging	2 kW max
Efficiency	91.5%@Rated output and input
Output Voltage Accuracy	≤±1%
Output Voltage Ripple	≤500 mVp-p@20 MHz
Output Voltage Overshoot	≤5% Vout
Low Voltage Input	
Input Voltage Range	9～16 Vdc
Quiescent Current	≤1 mA

3.2. Environmental Conditions

Working Temperature	-40～+85°C
Storage Temperature	-40～+105°C
Working Environment and Humidity	5%～95%, No Condensation
Protection level	IP67

3.3. Cooling requirements

Cooling Method	Liquid cooling

Cooling Port Connections	5/8”ID Hose (16mm)
Coolant Requirements	50/50 Water and Ethylene Glycol
Coolant Temperature - Normal	-40～+65 ℃
Coolant Temperature - Derate	+65～+85 ℃
Coolant flow	≥6L/min

3.4. Safety characteristics

Dielectric strength	AC to high voltage output: 2800 Vdc AC to low voltage output (shell): 2800 Vdc High Voltage output to low voltage output (shell): 2800 Vdc
Insulation Properties	Test voltage 500 Vdc AC to high voltage output: ≥10 MΩ AC to low voltage output (shell): ≥10 MΩ High-Voltage output to low-voltage output (shell): ≥10 MΩ
Grounding Characteristics	The resistance between the charger shell and PE<0.1 Ω

3.5. Reliability

Durability	OBC meets QC/T 895-2011 Standard
	DC-DC meets QC/T 24347-2009 Standard

4. Function Description

4.1. Low voltage control characteristics

4.1.1. Low voltage input

The CAN communication working voltage range of CCU is: 6～16 Vdc; the normal working voltage range is: 9～16 Vdc.

4.1.2. Low-voltage static power consumption

In sleep mode, the low-voltage input current of CCU is not more than 1mA.

4.1.3. High voltage interlock signal

The integrated product has a high-voltage interlock function to ensure a safe and reliable connection between the high-voltage output connector and the AC input connector of the integrated product. The interlock signal is given through the low-voltage signal connector, and the vehicle controller detects its on- off.

4.2. Wake-up function

4.2.1. Wake-up method

The CCU is a CAN controlled device and CAN messages are required to set and enable the OBC and DC-DC Functions. The CCU will not operate as a stand-alone OBC or DC-DC converter. There are individual hardware wake-up inputs for both the OBC and DC-DC components but under normal circumstances these should always be connected to switched +12V and the CAN enable flag should be used to control the device. For the OBC to function, pin 3C must have +12v applied. For the DC-DC to function, pin 3D must have +12v applied. In most cases these pins should be wired to the VCU Wake circuit.

4.3. CAN communication

4.3.1. Terminal resistance

The CCU does not have an internal CAN termination resistor. All CAN networks must have two 120Ω terminal resistors on the network.

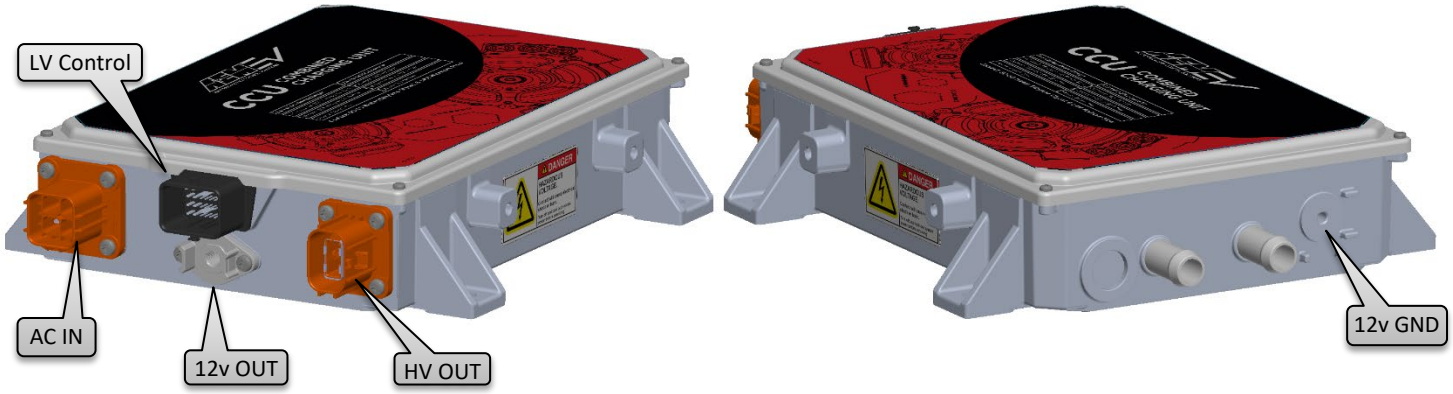
4.3.2. Communication protocol

The CAN Baud Rate is 500kbs. The CCU is controlled via CAN messages. The complete CAN communication protocol is included as Appendix A and a dbc file is available from AEM.

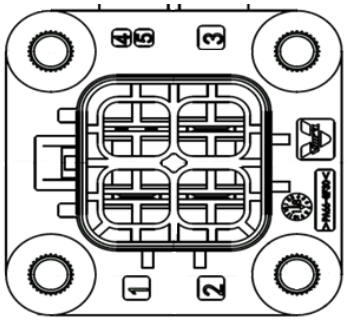
5. Product Interface Requirements

5.1. Connector Information

Connection	Module		Harness Side	
	P/N	Mfg	P/N	Mfg
AC Input	YGC1174-EV- P(3+2)R/1	Yonggui	YGC1174-EV-S(3+2)P	Yonggui
High Voltage Output	YGC1174-EV- P(2+2)RA	Yonggui	YGC1174-EV- S(2+2)PA	Yonggui
DC-DC 12v Out			M8x1.25 14mm deep	
DC-DC 12V Ground Out			M6x1.0 14mm deep	
Low Voltage Control	64334-0100	MOLEX	64319-3211	MOLEX

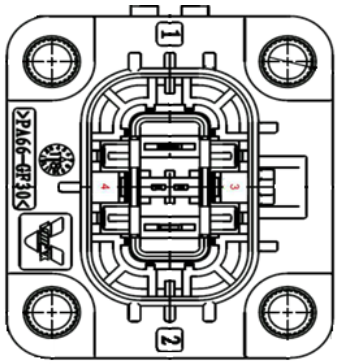


5.2. AC Input



Pin	Name	Description	Type	Max Current
1	L1	AC Line 1	Power	32A
2	N	AC Neutral for 120V AC Line 2 for 220V	Power	32A
3	PE	Protective Earth	Grounded	32A
4	HVIL_In	Interlock In	Signal	20mA
5	HVIL_Out	Interlock Out	Signal	20mA

5.3 High Voltage Output

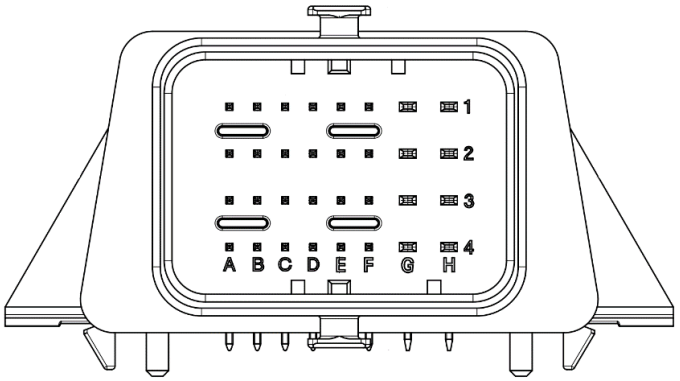


Pin	Name	Description	Type	Max Current
1	HV+	High Voltage Out Pos	Power	22A
2	HV-	High Voltage Out Neg	Power	22A
3	HVIL_In	Interlock In	Signal	20mA
4	HVIL_Out	Interlock Out	Signal	20mA

5.4. DC-DC Low Voltage Output

Pin Number	Description	Signal Type	Peak Current	Connection
12V OUT	DC-DC Positive Out	Power	180A	M8x1.25 8 AWG Terminal
12V GND	DC-DC Ground Out	Ground	180A	M6x1.0 8 AWG Terminal

5.5. Low Voltage Control Connector



NOTE: The connector will appear to be upside down when mounted in the CCU!
Contacts 1G-4G & 1H-4H are oversize

Pin	Name	Description	Signal Type	Current Capability
1A	Reserved			
1B	Reserved			
1C	Reserved			
1D	Reserved			
1E	Reserved			
1F	Reserved			
1G	Reserved			
1H	WakePower	Wake Power (+12V)	Power In	3A
2A	Reserved			
2B	Reserved			
2C	Reserved			
2D	Reserved			
2E	Reserved			
2F	Reserved			
2G	Reserved			
2H	Reserved			
3A	Reserved			
3B	Reserved			
3C	OBC_Wakeup_In	OBC Wake-Up Input, +12V	Input	20mA
3D	DCDC_Wakeup_In	DC-DC Wake-Up Input, +12V	Input	20mA
3E	Reserved			
3F	Reserved			
3G	Reserved			
3H	Reserved			
4A	CAN_H	CAN high	Digital	20mA
4B	CAN_L	CAN low	Digital	20mA
4C	HVIL_In	Interlock Input	Output	20mA
4D	HVIL_Out	Interlock Output	Output	20mA
4E	Reserved			
4F	Reserved			
4G	Ground	Ground (-12V)	Power In	3A
4H	Reserved			

Appendix A. CAN Protocol

The CAN Bus is unterminated, 500 kbps with 11 bit addressing. All messages are packed Big Endian (MSB first) and all raw data is unsigned. CAN messages will only be sent & received when the Wakeup inputs (3C & 3D) are sent +12v.

Message ID (hex):	0x213	This message should be sent to the CCU every 500mS with the desired DCDC output settings.
Source:	VCU	
Length:	8	
Name:	DCDC_CMD	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0		8	7	DCDC_OutputEnableCMD	1	170 "Start" / 85 "Stop"	0	0	255	DCDC enable request
1-2		16	15	DCDC_OutputVoltageCMD	0.1 V/bit		0	0	6553.5	DCDC output voltage setting
3-4		16	31	DCDC_OutputCurrentCMD	0.1 A/bit		0	0	6553.5	DCDC max current setting

Message ID (hex):	0x261	This message should be sent to the CCU every 500mS with the desired charging mode.
Source:	VCU	
Length:	8	
Name:	OBC_CMD	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
4		8	39	OBC_ControlCMD	1	3 "Charge Complete" 2 "Heating" 1 "Protect - Stopped" 0 "Charging"	0	0	255	Charge mode request

Message ID (hex):	0x262	This message should be sent to the CCU every 500mS with the desired Max OBC output settings.
Source:	VCU	
Length:	8	
Name:	OBC_CMD2	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0-1		16	7	OBC_MaxChargingVoltageCMD	0.1 V/bit		0	0	6553.5	Maximum allowable charging voltage
2-3		16	23	OBC_MaxChargingCurrentCMD	0.1 A/bit		0	0	6553.5	Maximum allowable charging current

Message ID (hex):	0x313	This message is broadcast by the CCU every 500mS and contains DCDC status information.
Source:	CCU	
Length:	8	
Name:	DCDC_State	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0		2	3	DCDC_FaultRank	1	3 "Fault" / 0 "OK"	0	0	3	DCDC fault rank
		4	7	DCDC_OutputStatus	1	6 "Shutdown" 5 "Power off" 4 "Work" 3 "HV Batt OK" 2 "Standby" 1 "Init" 0 "Reserved"	0	0	15	DCDC working state
1		1	8	DCDC_InputOverVoltageAlarm	1	1 "Fault" / 0 "OK"	0	0	1	HV over voltage protection
		1	9	DCDC_InputOverCurrentAlarm	1	1 "Fault" / 0 "OK"	0	0	1	HV over current protection
		1	10	DCDC_OutputOverVoltageAlarm	1	1 "Fault" / 0 "OK"	0	0	1	LV over voltage protection
		1	11	DCDC_OutputShortCircuitProtect	1	1 "Fault" / 0 "OK"	0	0	1	LV side short(DCDC output)
		1	12	DCDC_OverTempProtect	1	1 "Fault" / 0 "OK"	0	0	1	DCDC over temp protection
		1	13	DCDC_OutputUnderVoltageAlarm	1	1 "Fault" / 0 "OK"	0	0	1	LV under voltage protection
		1	14	DCDC_DowntimeAlarm	1	1 "Fault" / 0 "OK"	0	0	1	
		1	15	DCDC_LSCurrentSenseFault	1	1 "Fault" / 0 "OK"	0	0	1	
2		1	16	DCDC_TempSensorFault	1	1 "Fault" / 0 "OK"	0	0	1	Temperature sensor error
		1	17	DCDC_CommsFault	1	1 "Timeout" / 0 "OK"	0	0	1	VCU CAN timeout
		1	19	DCDC_InternalFault	1	1 "Fault" / 0 "OK"	0	0	1	Run fail
3-4	24	16	31	DCDC_HVInputVoltage	0.1 V/bit		0	0	6553.5	HV side voltage
5	40	8	47	DCDC_HVCurrentUsage	0.1 A/bit		0	0	25.5	HV side current
6	48	8	55	DCDC_DTCCode	1		0	0	255	DCDC DTC

Message ID (hex):	0x323	This message is broadcast by the CCU every 500mS and contains DCDC status information.
Source:	CCU	
Length:	8	
Name:	DCDC_State2	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0-1		16	7	DCDC_OutputVoltage	0.1 V/bit		0	0	6553.5	DCDC actual output voltage
2-3		16	23	DCDC_OutputCurrent	0.1 A/bit		0	0	6553.5	DCDC actual output current
4		8	39	DCDC_MOSFET_Temp	1C/bit		-40	-40	215	DCDC MOSFET temperature. Debug only, do not use as DCDC unit temp

Message ID (hex):	0x326	This message is broadcast by the CCU every 500mS and contains OBC status information.
Source:	CCU	
Length:	8	
Name:	OBC_State	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0-1		16	7	OBC_ChargingVoltage	0.1 V/bit		0	0	6553.5	Actual HV side voltage
2-3		16	23	OBC_ChargingCurrent	0.1 A/bit		0	0	6553.5	Actual HV side current
4		1	32	OBC_HardwareFailureStatus	1	1 "Fault" / 0 "OK"	0	0	1	Hardware status
4		1	33	OBC_TemperatureStatus	1	1 "Fault" / 0 "OK"	0	0	1	OBC temperature status
4		1	34	OBC_InputVoltageStatus	1	1 "Fault" / 0 "OK"	0	0	1	AC side voltage error
4		1	35	OBC_PowerStatus	1	1 "On" / 0 "Off"	0	0	1	OBC power state
4		1	36	OBC_CommsStatus	1	1 "Fault" / 0 "OK"	0	0	1	CAN communication timeout
4		1	37	OBC_HVBatteryConnected	1	1 "Connected" 0 "Not Connected"	0	0	1	HV side battery connection status
5		8	47	OBC_Temp	1C/bit		-40	-40	215	OBC temperature

Message ID (hex):	0x346	This message is broadcast by the CCU every 500mS and contains additional OBC status information.
Source:	CCU	
Length:	8	
Name:	OBC_State2	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0-1		16	7	OBC_ACInputVoltage	0.1 V/bit		0	0	6553.5	AC side voltage (OBC input voltage)
4		8	39	OBC_ChargerCurrentLimit	0.1 A/bit		0	0	25.5	HV side current limit
5-6		16	47	OBC_ChargerOutputVoltage	0.1 A/bit		0	0	6553.5	HV side voltage
7		4	59	OBC_ChargingStatus	1	6 "Failure" 5 "Sleep" 4 "Charge OK" 3 "CV charging" 2 "CC charging" 1 "Standby" 0 "Init"	0	0	15	OBC charge status
7		4	63	OBC_ErrorFlag	1	11 "HV over voltage" 10 "HV under voltage" 9 "PFC under voltage" 8 "PFC over voltage" 6 "AC over voltage" 5 "AC under voltage" 4 "CAN time out" 3 "HV over current" 2 "Over temp protect"	0	0	15	OBC error flag

Message ID (hex):	0x366	This message is broadcast by the CCU every 500mS and contains additional OBC status information.
Source:	CCU	
Length:	8	
Name:	OBC_State3	

Byte	Bit	Length	Start	Label	Scale	Bit String	Offset	Min	Max	Description
0-1		16	7	OBC_ACInputCurrent	0.1 A/bit		0	0	6553.5	AC side current (OBC input current)
2		8	23	OBC_DTCCode	1		0	0	255	OBC DTC