

Responsible Martijn van Ras, TNO	DELIVERABLE REPORT		Page 1(58)
Issuer R. van Wezel TNO, comments F. Rentmeester TNO, Frank Engels TNO	Date Oct 2012	WP No 6300	Report No D.6300.2
Subject: Communication protocol for 2 nd generation HD Hybrids			Dissem. Level Public

D6300.2 Communication protocol for 2nd generation HD Hybrids

1 Summary

This document is a proposal for the standardization of the protocol for communication with hybrid components in a hybrid vehicle, based on the SAE J-1939 protocol. An overview will be given of the communication message with their parameters.

HCV Objective

The goal of this task is the development of a method to standardize communication between hybrid components (for example: Energy Storage System (battery), Inverter, Generator/Motor etc.) for heavy duty vehicle applications. This will increase competition between suppliers of components and will reduce the cost of hybrid systems.

Methodology

A communication protocol for standardization is proposed to connect all kind of equipment in a robust way, so that the communication between hybrid components is guaranteed.

Extensive research into current protocols and a validation of the various methods of modeling are performed. In this process, input and feedback from the other subprojects SP2000-5000 are utilized.

Result

A list is made of all possible messages for communication with hybrid components that can be sent over the CAN bus. The notation is adopted from the J1939 protocol.

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3 Introduction

The evolving emission legislation and the increasing fuel prices accompanied by a global CO₂ emission reduction discussion represent an extremely challenging demand for research and development. Known improvement measures of pollutant emissions usually come along with deterioration of engine efficiency and vice versa, e.g. the NOx/fuel economy trade-off is well known for diesel engines. Therefore the real challenge is to find new compromises on improved levels for both – fuel consumption and pollutant emissions. With this background, the hybrid electric vehicle is an excellent option for simultaneous reduction of fuel consumption and exhaust emissions.

The HCV project aims to develop urban buses and delivery vehicles with advanced second generation energy efficient hybrid electric powertrains. The advanced second generation hybrid vehicles are follow-ups of the First generation hybrids and Early second generation hybrids. Where first generation hybrids are vehicles with a gasoline engine and a powersplit electrical driveline with NiMH batteries as an electrical storage device, early second generation hybrid vehicles uses a diesel engine in combination with a Lithium-ion storage device.

The goal of this document is a proposal for a standardized CAN communication protocol for hybrid heavy duty drive lines to be used for the expansion of the SAE J-1939 standard. A summation will be given of all possible CAN messages and their format, to communicate between the different components.

4 Technical progress

4.1 Interface requirements for Hybrid Systems

This document will describe the interface requirements for hybrid vehicles. With Hybrid Vehicles in this document are predominantly meant the combination of Internal Combustion Engine and Electric driven vehicles. The main focus will be on hybrid-electric vehicles, however alternative energy storage systems will be taken into account.

This document will be used to serve as input for the development towards an interface standard for hybrid vehicles (as an extension of the SAE J-1939 standard). This proposal is set up to cover a large number of possible hybrid layouts in order to achieve a high applicability and to make the interface as universal as possible.

4.2 General requirements

4.2.1 Scope

The specification of the requirements described in this document are based on a questionnaire that was send out to several partries (DAF, Volvo, Iveco and Veolia). An overview of this process is given in Figure 1 and Figure 2.

From these requiremens the most extensive system to be covered here is a hybrid with up to 6 drive motors and one generator (thus total of 7 drive motors) and the extension of the storage capacity of up to 4 energy storage systems. Furthermore, several Auxillary drive motors (all non-traction motors e.g. for steeringpump, waterpump airconditioning, oilpump etc.) will be considered as an architecture option (up to 10).

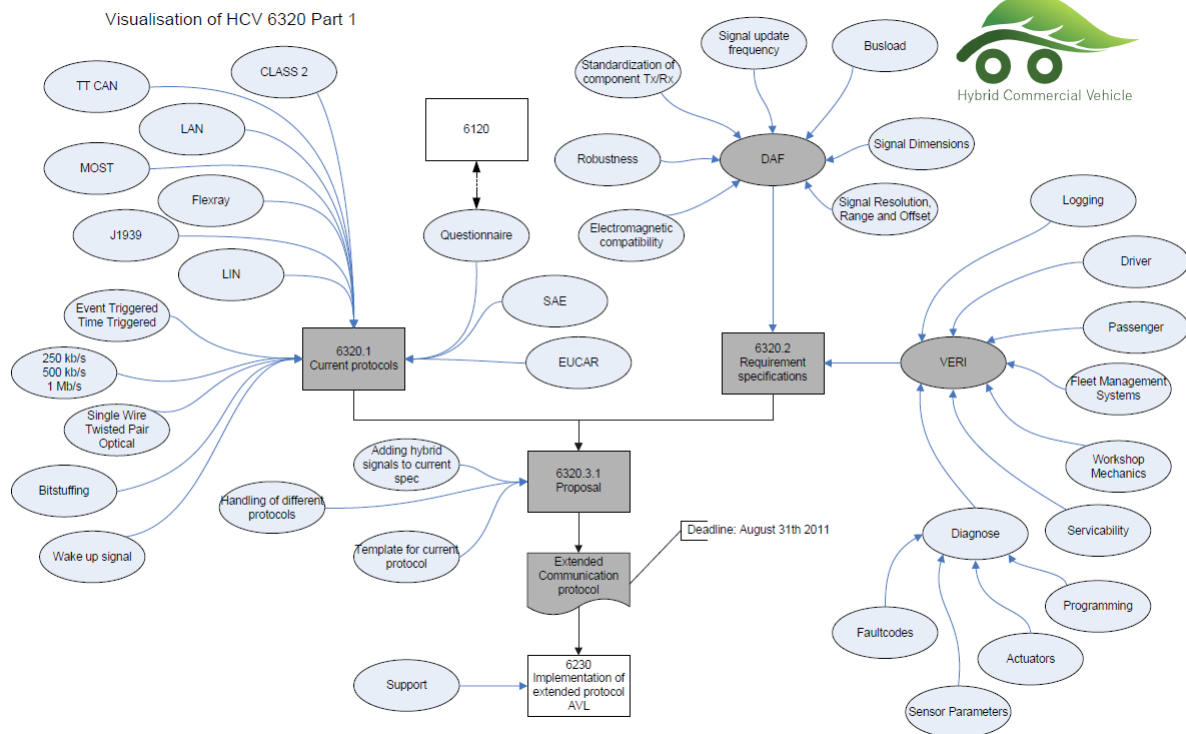


Figure 1 Overview of the requirement gathering for the HCV 6320 Part 1

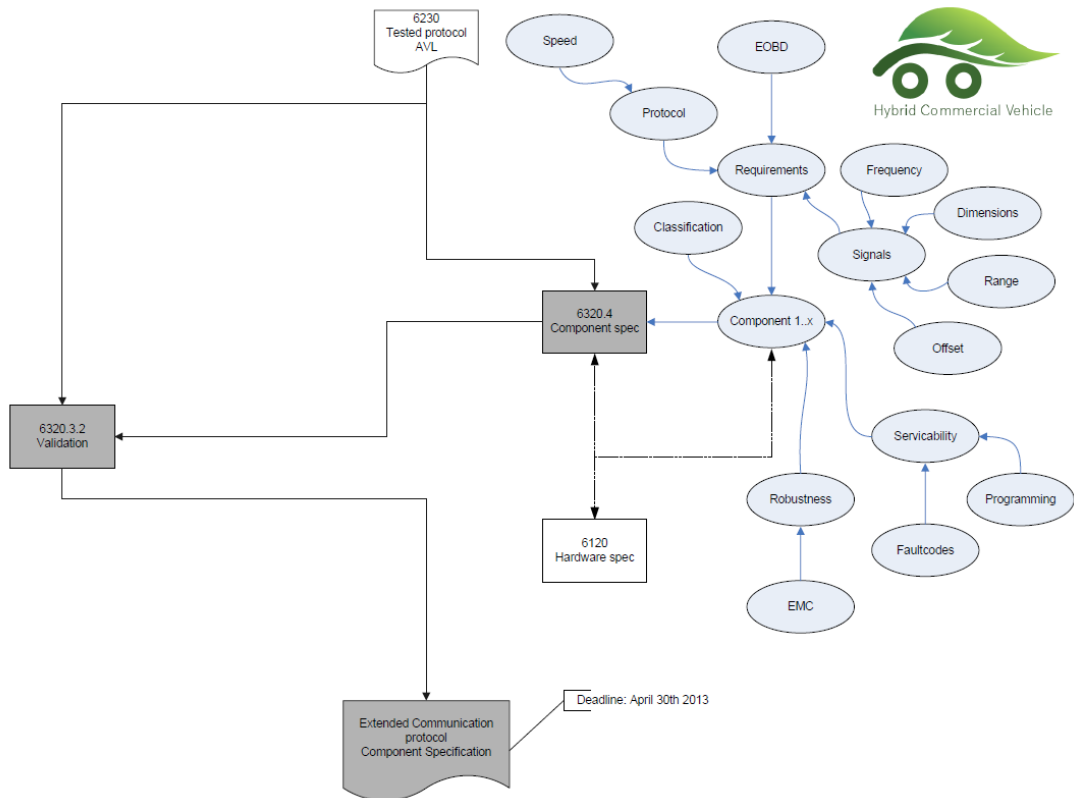


Figure 2 Overview of the requirement specification for the HCV 6320 Part 2

All vehicle manufacturers within this project are using the SAE J1939 protocol for communication between control units as described in the J1939-71 document from the SAE organisation (standards.sae.org). The scope will be limited to this protocol.

The purpose of this document is to provide a set of messages for common usage. It is not intended to provide a complete set of messages needed for every possible case. This matches with the scope of the SAE J1939 standard.

The following sections will give a list of all parameters divided into the following components:

- Energy Storage Systems (ESS)
- Electric Generator Motor (EGM)
- Auxiliaries inverter (DC/AC)
- Auxiliaries inverter (DC/DC)
- Auxiliaries Drive (AUX)
- Simple smart actuators
- Simple actuators

All the signals will be combined into groups called the Parameter Group Number (PGN). The PGN represents the identifier of a J1939 message. Every J1939 message has a unique PGN assigned to it by the SAE committee when the message is defined.

The PGN reference will be assigned with a number when the PGN from this document will be adopted in the J1939-71 standard, because the numbering will follow-up the PGN numbers already defined in the J1939-71 standard (standards.sae.org).

A PGN is 18-bits wide and is made up of the following fields: Extended Data Page, Data Page, PDU Format, and PDU Specific. Depending on the value of the PDU Format field, a message is either destination specific, meaning it is for a specific module, or global, meaning

it is for all modules. The PGN identifier is encoded to allow for a maximum of 8,672 unique PGNs.

5 List of Suspect Parameter Number (SPN)

Suspect Parameter Numbers are the definition of the parameters that can be sent to and from the components in the vehicle system.

SPN numbers are relative to the already existing SPN defined in the J-1939 document, for this reason the PGN reference is not filled-in in this document.

The numbering should start at a certain number X which still must be defined taking the J1939-71 standard into account.

The parameters (SPN) are listed below, grouped by their general requirements (GEN-xxx):

Req-ID	GEN-001
Requirement	Interface shall be easy to expand with new components
Rationale	New (electrified) components will come in the near future to increase the efficiency of hybrid vehicle
Priority	High

Req-ID	GEN-002
Requirement	Interface shall be easy to expand for signal resolution
Rationale	Once more experience is gained with hybrid vehicles the control algorithms will improve this could lead to a need of better accuracy of signals
Priority	High

Req-ID	GEN-003
Requirement	Interface shall be easy to expand for update rates
Rationale	Once more experience is gained with hybrid vehicles the control algorithms will improve this could lead to a need of higher update rate of signals
Priority	High

Req-ID	GEN-004
Requirement	The following information of the cooling systems shall be as <u>minimum</u> available on a communication network: <ul style="list-style-type: none"> - Temperature of cooling medium at position 1 to 10
Rationale	Information is needed in a central control unit that does control the complete energy management of the vehicle; this is independent of the number of separate cooling circuits.
Priority	High

SPN X+1 Temperature of cooling medium at position X

Slot Name: SAEtp01

Data Length: 1 byte

Resolution: 1 °C/bit, -40 offset

Data range: -40 to 210 °C

Type: Measured

PGN reference:
Refresh rate: 1 sec

SPN X+2 Position of temperature measurement

Slot Name: SAEtp01
Data Length: 1 byte
Resolution: 1/bit, 0 offset
Data range: 1 to 10 [-]
Type: Measured
PGN reference:
Refresh rate: 1 sec

Req-ID	GEN-005
Requirement	<p>The following information of the Energy Storage System (ESS) shall be as <u>minimum</u> available on a communication network:</p> <ul style="list-style-type: none"> - ESS information <ul style="list-style-type: none"> ○ ESS Status ○ ESS Type ○ ESS Dis-/enable request ○ ESS State of Health (SOH) ○ ESS State of Charge (SOC) ○ ESS Actual Electric Capacity ○ ESS Actual current ○ ESS Nominal/Continuous charge current ○ ESS Nominal/Continuous discharge current ○ ESS Maximal/Peak charge current ○ ESS Maximal /Peak discharge current ○ ESS Actual max. charge current ○ ESS Actual max. discharge current ○ ESS Actual voltage ○ ESS max. voltage ○ ESS min. voltage ○ ESS Actual Flow ○ ESS max. flow ○ ESS min. flow ○ ESS Actual pressure ○ ESS max. pressure ○ ESS min. pressure ○ ESS Actual torque ○ ESS max. torque ○ ESS Actual speed ○ ESS max. speed ○ ESS min. speed ○ ESS Power reference ○ ESS Actual power ○ ESS Nominal/Continuous charge power ○ ESS Nominal/Continuous discharge power ○ ESS Maximal/Peak charge power ○ ESS Maximal/Peak discharge power ○ ESS Actual max. charge power ○ ESS Actual max. discharge power ○ ESS Momentary Max. Charge Rate Time Limit ○ ESS Momentary Max. Discharge Rate Time Limit ○ ESS Maximum system temperature ○ ESS Minimum system temperature ○ ESS Actual average temperature ○ ESS Actual lowest system temperature

- ESS Actual highest system temperature

Rationale | Information is needed in a central control unit that does control the complete energy management of the vehicle

Priority | High

SPN X+3 ESS Status

SLOT Name: SAEbc02

000	Init
001	Enabled
010	After run
011-101	Reserved
110	Error
111	Not available or not installed

Data Length: 3 bits

Resolution: 8 states/2bit, 0 offset

Data range: 0 to 7

Type: Status

PGN reference:

Refresh rate: 1 s

SPN X+4 ESS Type

SLOT Name: SAEbc02

00	Electrochemical (Battery/supercap)
01	Accumulator (Hydraulic/pneumatic)
10	Kinematic (Flywheel)
11	Other

Data Length: 2 bits

Resolution: 4 states/2bit, 0 offset

Data range: 0 to 3

Type: Status

PGN reference:

Refresh rate: 5 sec

SPN X+5 ESS dis-/enable request

00	Command to disable ESS
01	Command to enable ESS
10	Reserved
11	Don't care/take no action

SLOT Name: SAEbc02

Data Length: 2 bits

Resolution: 4 states/2bit, 0 offset

Data range: 0 to 3

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+6 ESS State Of Health (SOH)

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+7 ESS State Of Charge (SOC)

Comment: SOC is given as a percentage of the actual electric capacity. This capacity may change over time, so absolute available amount of energy in ESS cannot be determined by SOC alone.

SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+8 ESS Actual Electric Capacity

Comment: The electric capacity of batteries will decrease overtime. The actual value of the electric capacity is given by this SPN and changes over time and can be related to the state of health (SOH) SPN.

SLOT Name: nav
Data Length: 2 bytes
Resolution: 0.1 Ah/bit
Data range: 0 to 6425.5 Ah
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+9 ESS Actual Current

Comment: Electric current flow to (negative) or from (positive) the ESS
 SLOT Name: SAEec01
 Data Length: 2 bytes
 Resolution: 0.05 A/bit, -1600 A offset
 Data range: -1600 to 1612.75 A
 Type: Measured
 PGN reference:
 Refresh rate: 100 ms

SPN X+10 ESS Nominal/Continuous Charge Current

Comment: Maximum value for the ESS current at which the ESS can be charged *continuously* (in general).
 SLOT Name: SAEec01
 Data Length: 2 bytes
 Resolution: 0.05 A/bit, -1600 A offset
 Data range: -1600 to 1612.75 A Operational range: -1600 to 0 A
 Type: Status
 PGN reference:
 Refresh rate: 5 s

SPN X+11 ESS Nominal/Continuous Discharge Current

Comment: Maximum value for the ESS current at which the ESS can be discharged *continuously* (in general).
 SLOT Name: SAEec01
 Data Length: 2 bytes
 Resolution: 0.05 A/bit, 0 A offset
 Data range: -1600 to 1612.75 A Operational range: 0 to 1612.75 A
 Type: Status
 PGN reference:
 Refresh rate: 5 s

SPN X+12 ESS Maximal/Peak Charge Current

Comment: Maximum value for the ESS current at which the ESS can be charged *temporarily*. The corresponding time limit is given in 'ESS Momentary Max. Charge Rate Time Limit'
 SLOT Name: SAEec01
 Data Length: 2 bytes
 Resolution: 0.05 A/bit, -1600 A offset
 Data range: -1600 to 1612.75 A Operational range: -1600 to 0 A
 Type: Status
 PGN reference:
 Refresh rate: 5 s

SPN X+13 ESS Maximal/Peak Discharge Current

Comment: Maximum value for the ESS current at which the ESS can be discharged *temporarily*. The corresponding time limit is given in 'ESS Momentary Max. Discharge Rate Time Limit'

SLOT Name: SAEec01

Data Length: 2 bytes

Resolution: 0.05 A/bit, 0 A offset

Data range: -1600 to 1612.75 A Operational range: 0 to 1612.75 A

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+14 ESS Momentary max. Charge Current

Comment: Maximum value for the ESS current at which the ESS can be charged at *current moment*.

SLOT Name: SAEec01

Data Length: 2 bytes

Resolution: 0.05 A/bit, -1600 A offset

Data range: -1600 to 1612.75 A Operational range: -1600 to 0 A

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+15 ESS Momentary max. Discharge Current

Comment: Maximum value for the ESS current at which the ESS can be discharged at *current moment*.

SLOT Name: SAEec01

Data Length: 2 bytes

Resolution: 0.05 A/bit, 0 A offset

Data range: -1600 to 1612.75 A Operational range: 0 to 1612.75 A

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+16 ESS Actual Voltage

SLOT Name: SAEev05

Data Length: 2 bytes

Resolution: 0.05 V/bit, 0 V offset

Data range: 0 to 3212.75 V

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+17 ESS max. Voltage

Comment: Maximum allowed voltage across terminals of ESS

SLOT Name: SAEev05

Data Length: 2 bytes

Resolution: 0.05 V/bit, 0 V offset

Data range: 0 to 3212.75 V

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+18 ESS min. Voltage

Comment: Minimum allowed voltage across terminals of ESS
SLOT Name: SAEev05
Data Length: 2 bytes
Resolution: 0.05 V/bit, 0 V offset
Data range: 0 to 3212.75 V
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+19 ESS Actual Flow

Slot Name: Nav
Data Length: 2 bytes
Resolution: 0.02 ltr./min per bit, -600 offset
Data range: -600 to 642.55 ltr./min
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+20 ESS max. Flow

Slot Name: Nav
Data Length: 2 bytes
Resolution: 0.02 ltr./min per bit, -600 offset
Data range: -600 to 642.55 ltr./min
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+21 ESS min. Flow

Slot Name: Nav
Data Length: 2 bytes
Resolution: 0.02 ltr./min per bit, -600 offset
Data range: -600 to 642.55 ltr./min
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+22 ESS Actual Pressure

Slot Name: SAEpr08
Data Length: 2 bytes
Resolution: 2 kPa/bit, 0 offset
Data range: 0 to 128510 kPa (=1285 bar)
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+23 ESS max. Pressure

Slot Name: SAEpr08
Data Length: 2 bytes
Resolution: 2 kPa/bit, 0 offset
Data range: 0 to 128510 kPa (=1285 bar)
Type: Status
PGN reference:

Refresh rate: 5 s

SPN X+24 ESS min. Pressure

Slot Name: SAEpr08
Data Length: 2 bytes
Resolution: 2 kPa/bit, 0 offset
Data range: 0 to 128510 kPa (=1285 bar)
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+25 ESS Actual Torque

Slot Name: Nav
Data Length: 2 bytes
Resolution: 0.01 Nm/bit, -320 offset
Data range: -320 to 322.55 Nm
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+26 ESS max. Torque

Slot Name: Nav
Data Length: 2 bytes
Resolution: 0.01 Nm/bit, 0 offset
Data range: -320 to 322.55 Nm
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+27 ESS Actual Speed

Slot Name: SAEvr03
Data Length: 2 byte
Resolution: 4 RPM/bit, 0 offset
Data range: 0 to 257020 RPM
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+28 ESS max. Speed

Slot Name: SAEvr03
Data Length: 2 byte
Resolution: 4 RPM/bit, 0 offset
Data range: 0 to 257020 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+29 ESS min. Speed

Slot Name: SAEvr03
Data Length: 2 byte
Resolution: 4 RPM/bit, 0 offset
Data range: 0 to 257020 RPM
Type: Status

PGN reference:
Refresh rate: 5 s

SPN X+30 ESS Power Reference

Slot Name: Nav
Data Length: 2 bytes
Resolution: 100 W/bit, -3200 kW offset
Data range: -3200 to 3225.5 kW
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+31 ESS Actual Power

Comment: Value indicated as percentage of ESS power reference
Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % to 132.02 %
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+32 ESS Nominal/Continuous Charge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS power at which the ESS can be charged *continuously* (in general).
Slot Name: SAEpc03
Data Length: 1 bytes
Resolution: 0.4 %/bit
Data range: 0 to 100 %
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+33 ESS Nominal/Continuous Discharge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS power at which the ESS can be discharged *continuously* (in general).
Slot Name: SAEpc03
Data Length: 1 bytes
Resolution: 0.4 %/bit
Data range: 0 to 100 %
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+34 ESS Maximal/Peak Charge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS power at which the ESS can be charged *temporarily*. The corresponding time limit is given in 'ESS Momentary Max. Charge Rate Time Limit'
Slot Name: SAEpc03
Data Length: 1 bytes
Resolution: 0.4 %/bit
Data range: 0 to 100 %
Type: Status

PGN reference:
Refresh rate: 5 s

SPN X+35 ESS Maximal/Peak Discharge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS power at which the ESS can be discharged *temporarily*. The corresponding time limit is given in 'ESS Momentary Max. Discharge Rate Time Limit'

Slot Name: SAEpc03
Data Length: 1 bytes
Resolution: 0.4 %/bit
Data range: 0 to 100 %
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+36 ESS momentary max. Charge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS power at which the ESS can be charged *at current moment*.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % to 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+37 ESS momentary max. Discharge Power

Comment: Value indicated as percentage of ESS power reference. Maximum value for the ESS current at which the ESS can be discharged *at current moment*.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % to 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+38 ESS Momentary Max. Charge Rate Time Limit

Comment: Time limit in which the ESS is able to accept an overload at current/power. Relates to SPN X+12 and/or SPN X+34.

Slot name: SAEtm04
Data Length: 1 byte
Resolution: 0.25 s/bit
Data range: 0 to 62.5 s
0s = no overload allowed
255s = not applicable (no time restriction)
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+39 ESS Momentary Max. Discharge Rate Time Limit

Comment: Time limit in which the ESS is able to deliver an overload at current/power.
Relates to SPN X+12and/or SPN X+35.

Slot name: SAEtm04

Data Length: 1 byte

Resolution: 0.25 s/bit

Data range: 0 to 62.5 s

0s = no overload allowed

255s = not applicable (no time restriction)

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+40 ESS maximum system temperature

Slot Name: Nav

Data Length: 1 byte

Resolution: 2 °C/bit, -40 °C

Data range: -40 to 460 °C

Type: Measured

PGN reference:

Refresh rate: 1 sec

SPN X+41 ESS minimum system temperature

Slot Name: Nav

Data Length: 1 byte

Resolution: 2 °C/bit, -40 °C

Data range: -40 to 460 °C

Type: Measured

PGN reference:

Refresh rate: 1 sec

SPN X+42 ESS Actual average system temperature

Slot Name: Nav

Data Length: 1 byte

Resolution: 2 °C/bit, -40 °C

Data range: -40 to 460 °C

Type: Measured

PGN reference:

Refresh rate: 1 sec

SPN X+43 ESS Actual lowest system temperature

Slot Name: Nav

Data Length: 1 byte

Resolution: 2 °C/bit, -40 °C

Data range: -40 to 460 °C

Type: Measured

PGN reference:

Refresh rate: 1 sec

SPN X+44 ESS Actual highest system temperature

Slot Name: Nav

Data Length: 1 byte

Resolution: 2 °C/bit, -40 °C

Data range: -40 to 460 °C

Type: Measured
PGN reference:
Refresh rate: 1 sec

Req-ID Requirement	<p data-bbox="384 226 1394 322">GEN-006 The following information of the Electric Generator Motor (EGM) system shall be as <u>minimum</u> available on a communication network:</p> <ul style="list-style-type: none"> <li data-bbox="437 360 1305 965">- EGM + inverter (DC/AC) information <ul style="list-style-type: none"> o EGM nominal/continuous reference torque o EGM maximal/peak reference torque o EGM Maximum Momentary Max. Torque Time Limit o EGM torque set point o EGM actual torque o EGM momentary max. available motoring torque o EGM momentary max. available regenerating torque o EGM percent nominal torque at zero speed point 1 o EGM percent nominal torque at (base) speed point 2a o EGM percent nominal torque at speed point 3 o EGM percent nominal torque at speed point 4 o EGM percent nominal torque at max. speed point 5 o EGM percent maximal torque at zero speed point 1 o EGM percent maximal torque at (base) speed point 2b o EGM percent maximal torque at speed point 3 o EGM percent maximal torque at speed point 4 o EGM percent maximal torque at max. speed point 5 <li data-bbox="533 999 1305 1227">o EGM speed at point 2a (base speed at nominal torque) <li data-bbox="533 1032 1305 1061">o EGM speed at point 2b (base speed at maximal torque) <li data-bbox="533 1066 863 1095">o EGM speed at point 3 <li data-bbox="533 1099 863 1128">o EGM speed at point 4 <li data-bbox="533 1133 1043 1162">o EGM speed at point 5 (max. speed) <li data-bbox="533 1167 855 1196">o EGM speed set point <li data-bbox="533 1200 823 1229">o EGM actual speed <li data-bbox="533 1263 1131 1292">o EGM nominal/continuous reference power <li data-bbox="533 1296 1058 1326">o EGM maximal/peak reference power <li data-bbox="533 1330 1246 1359">o EGM Maximum Momentary Max. Power Time Limit <li data-bbox="533 1364 855 1393">o EGM power set point <li data-bbox="533 1397 823 1426">o EGM actual power <li data-bbox="533 1431 1211 1460">o EGM momentary max. available motoring power <li data-bbox="533 1464 1262 1494">o EGM momentary max. available regenerating power <li data-bbox="533 1527 999 1556">o Actual max. available DC power <li data-bbox="533 1561 994 1590">o EGM actual DC inverter voltage <li data-bbox="533 1594 994 1624">o EGM actual DC inverter current <li data-bbox="533 1628 1023 1657">o EGM internal inverter temperature <li data-bbox="533 1662 943 1691">o EGM Temperature at intake <li data-bbox="533 1695 940 1724">o EGM Temperature at outlet <li data-bbox="533 1729 1082 1758">o EGM Temperature of inverter at intake <li data-bbox="533 1762 1078 1792">o EGM Temperature of inverter at outlet <li data-bbox="533 1796 922 1825">o EGM winding temperature
Rationale	Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

Analogue to PGN number 65291 (define in the J1939-71 document), the map of the EGM is defined as is done for the internal combustion engine. As shown in Figure 1, 5 points are defined per set for nominal torque (blue) and maximal torque (red line). The speed is given in absolute values, the torque as a percentage of the corresponding reference torque. This is done for the first quadrant; when the sign of speed and torque points is considered, the map can be expanded to the other quadrants.

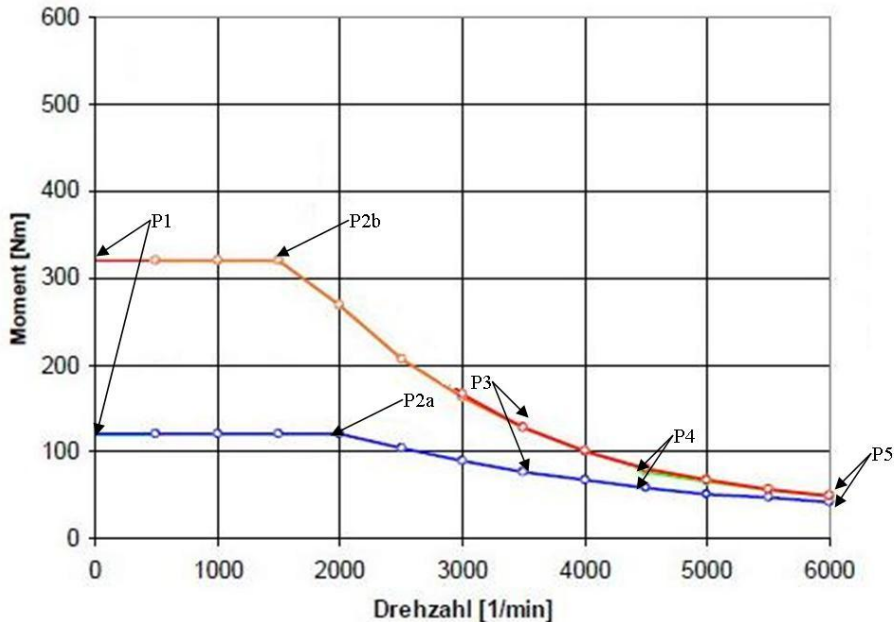


Figure 3 Electric Generator Motor configuration map mode

SPN X+45 EGM Nominal/Continuous Reference Torque

Comment: Maximum value for the EGM torque at which the EGM is able to deliver the torque *continuously* (in general).

Slot Name: SAEtq02
Data Length: 2 bytes
Resolution: 1 Nm/bit
Data range: 0 Nm to 64255 Nm
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+46 EGM Maximal/Peak Reference Torque

Comment: Maximum value for the EGM torque at which the EGM is able to deliver the torque *temporarily* (in general). The corresponding time limit is given in 'EGM Momentary Max. Torque Time Limit'

Slot Name: SAEtq02
Data Length: 2 bytes
Resolution: 1 Nm/bit
Data range: 0 Nm to 64255 Nm
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+47 EGM Momentary Max. Torque Time Limit

Comment: Time limit in which the EGM is able to deliver/absorb maximum torque as specified in the map.

Slot name: SAEtm04

Data Length: 1 byte

Resolution: 0.25 s/bit

Data range: 0 to 62.5 s

0s = no overload allowed

255s = not applicable (no time restriction)

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+48 EGM torque set point

Comment: Value indicated as percentage of EGM maximal/peak reference torque

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % to 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+49 EGM actual torque

Comment: Value indicated as percentage of EGM maximal/peak reference torque.
Measured torque at current moment.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+50 EGM momentary max. available motoring torque

Comment: Value indicated as percentage of EGM maximal/peak reference torque.
Maximum value for the EGM torque at which the EGM is able to deliver (motor mode) the torque *at current moment*.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+51 EGM momentary max. available regenerating torque

Comment: Value indicated as percentage of EGM maximal/peak reference torque.
Maximum value for the EGM torque at which the EGM is able to regenerate (generator mode) the torque *at current moment*.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+52 EGM percent nominal torque at zero speed point 1

Comment: Value indicated as percentage of EGM Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+53 EGM percent nominal torque at (base) speed point 2a

Comment: Value indicated as percentage of EGM Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+54 EGM percent nominal torque at speed point 3

Comment: Value indicated as percentage of EGM Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+55 EGM percent nominal torque at speed point 4

Comment: Value indicated as percentage of EGM Nominal/Continuous Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+56 EGM percent nominal torque at max. speed point 5

Comment: Value indicated as percentage of EGM Nominal/Continuous Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+57 EGM percent maximal torque at zero speed point 1

Comment: Value indicated as percentage of EGM Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+58 EGM percent maximal torque at (base) speed point 2b

Comment: Value indicated as percentage of EGM Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+59 EGM percent maximal torque at speed point 3

Comment: Value indicated as percentage of EGM Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+60 EGM percent maximal torque at speed point 4

Comment: Value indicated as percentage of EGM Maximal/Peak Reference Torque
SLOT Name: SAEpc03

Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+61 EGM percent maximal torque at max. speed point 5

Comment: Value indicated as percentage of EGM Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+62 EGM speed at point 2a (base speed at nominal torque)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+63 EGM speed at point 2b (base speed at maximal torque)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+64 EGM speed at point 3

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+65 EGM speed at point 4

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+66 EGM speed at point 5 (max. speed)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+67 EGM speed set point

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+68 EGM actual speed

Comment: Measured speed at current moment
Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+69 EGM nominal/continuous reference power

Comment: Maximum value for the EGM power at which the EGM is able to deliver/absorb the power *continuously* (in general).
Slot Name: Nav
Data Length: 2 bytes
Resolution: 100 W/bit, -3200 kW offset
Data range: -3200 – 3225.5 kW
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+70 EGM maximal/peak reference power

Comment: Maximum value for the EGM power at which the EGM is able to deliver/absorb the power *temporarily* (in general). The corresponding time limit is given in 'EGM Momentary Max. Power Time Limit'

Slot Name: Nav
Data Length: 2 bytes
Resolution: 100 W/bit, -3200 kW offset
Data range: -3200 – 3225.5 kW
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+71 EGM Momentary Max. Power Time Limit

Comment: Time limit in which the EGM is able to deliver/absorb maximum power (in general). Relates to SPN 071

Slot name: SAEtm04
Data Length: 1 byte
Resolution: 0.25 s/bit
Data range: 0 to 62.5 s
0s = no overload allowed
255s = not applicable (no time restriction)
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+72 EGM power set point

Comment: Value indicated as percentage of EGM maximal/peak reference power

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % to 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+73 EGM actual power

Comment: Value indicated as percentage of EGM maximal/peak reference power. Measured power at current moment.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % to 132.02 %
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+74 EGM momentary max. available motoring power

Comment: Value indicated as percentage of EGM maximal/peak reference power.
Maximum value for the EGM power at which the EGM is able to deliver (motor mode) the power *at current moment*.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % – 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+75 EGM momentary max. available regenerating power

Comment: Value indicated as percentage of EGM maximal/peak reference power.
Maximum value for the EGM power at which the EGM is able to absorb (generator mode) the power *at current moment*.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % – 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+76 EGM Actual DC Inverter Voltage

SLOT Name: SAEev05
Data Length: 2 bytes
Resolution: 0.05 V/bit, 0 V offset
Data range: 0 to 3212.75 V
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+77 EGM Actual DC Inverter Current

SLOT Name: SAEec01
Data Length: 2 bytes
Resolution: 0.05 A/bit, -1600 A offset
Data range: -1600 to 1612.75 A
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+78 EGM winding temperature

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+79 EGM Temperature at intake

SLOT Name: SAEtp01

Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+80 EGM Temperature at outlet

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+81 EGM internal inverter temperature

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+82 EGM Temperature of inverter at intake

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+83 EGM Temperature of inverter at outlet

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+84 EGM Status

SLOT Name: SAEbc02
000 Init
001 Enabled
010 After run
011-101 Reserved
110 Error
111 Not available or not installed

Data Length: 3 bits
Resolution: 8 states/2bit, 0 offset
Data range: 0 to 7
Type: Status
PGN reference:
Refresh rate: 1 s

Req-ID	GEN-007
Requirement	The following information of the Auxiliaries inverter (DC/AC) shall be as <u>minimum</u> available on a communication network: <ul style="list-style-type: none"> - Auxiliaries inverter (DC/AC) information <ul style="list-style-type: none"> o Auxiliaries inverter (DC/AC) system state o Actual auxiliaries inverter (DC/AC) temperature o Maximum auxiliaries inverter (DC/AC) temperature o Auxiliaries inverter (DC/AC) enable / disable command o Auxiliaries connected status o Auxiliaries inverter (DC/AC) input voltage o Auxiliaries inverter (DC/AC) input current o Auxiliaries inverter (DC/AC) output phase voltage o Auxiliaries inverter (DC/AC) output phase current o Auxiliaries inverter (DC/AC) error information
Rationale	Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

SPN X+85 Auxiliaries inverter (DC/AC) system state

SLOT Name: SAEbc02

000	Init
001	Enabled
010	After run
011-101	Reserved
110	Error
111	Not available or not installed

Data Length: 3 bits

Resolution: 8 states/2bit, 0 offset

Data range: 0 to 7

Type: Status

PGN reference:

Refresh rate: 1 s

SPN X+86 Actual Auxiliaries inverter (DC/AC) temperature

SLOT Name: SAEtp01

Data Length: 1 byte

Resolution: 1°C/bit, -40 °C offset

Data range: -40 to 210 °C

Type: Measured

PGN reference:

Refresh rate: 1 s

SPN X+87 Maximum Auxiliaries inverter (DC/AC) temperature

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Status
PGN reference:
Refresh rate: 1 s

SPN X+88 Auxiliaries inverter (DC/AC) enable / disable command

00	Command to disable ESS
01	Command to enable ESS
10	Reserved
11	Don't care/take no action

SLOT Name: SAEbc02
Data Length: 2 bits
Resolution: 4 states/2bit, 0 offset
Data range: 0 to 3
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+89 Auxiliaries connected

00	OFF
01	ON
10	Error
11	Don't care/take no action

SLOT Name: SAEbc01
Data Length: 2 bits
Resolution: 4 states/2bit, 0 offset
Data range: 0 to 3
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+90 Auxiliaries inverter (DC/AC) input voltage

Comment: Input is specified as the DC terminals.
SLOT Name: SAEev05
Data Length: 2 bytes
Resolution: 0.05 V/bit, 0 V offset
Data range: 0 to 3212.75 V
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+91 Auxiliaries inverter (DC/AC) input current

Comment: Input is specified as the DC terminals. Current in is negative current.
SLOT Name: SAEec01
Data Length: 2 bytes
Resolution: 0.05 A/bit, -1600 A offset
Data range: -1600 to 1612.75 A
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+92 Auxiliaries inverter (DC/AC) output phase voltage (RMS)

Comment: Voltage is RMS phase voltage.
SLOT Name: SAEev05
Data Length: 2 bytes
Resolution: 0.05 V/bit, 0 V offset
Data range: 0 to 3212.75 V
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+93 Auxiliaries inverter (DC/AC) output phase current (RMS)

Comment: Current is RMS phase current. Current out is positive.
SLOT Name: SAEec01
Data Length: 2 bytes
Resolution: 0.05 A/bit, -1600 A offset
Data range: -1600 to 1612.75 A
Type: Measured
PGN reference:
Refresh rate: 100 ms

Req-ID	GEN-008
Requirement	The following information of the Auxiliaries inverter (DC/DC) shall be as <u>minimum</u> available on a communication network: <ul style="list-style-type: none"> - Auxiliaries DC/DC converter information <ul style="list-style-type: none"> o Auxiliaries DC/DC converter input voltage o Auxiliaries DC/DC converter input current o Auxiliaries DC/DC converter output voltage o Auxiliaries DC/DC converter output current o Auxiliaries DC/DC converter state o Auxiliaries DC/DC converter error information
Rationale	Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

SPN X+94 Auxiliaries DC/DC converter input voltage

Comment: If not specified, the input is the high voltage side (= main DC bridge) of the converter.

SLOT Name: SAEev05

Data Length: 2 bytes

Resolution: 0.05 V/bit, 0 V offset

Data range: 0 to 3212.75 V

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+95 Auxiliaries DC/DC converter input current

Comment: If not specified, the input is the high voltage side (=main DC bridge) of the converter. Current in is negative.

SLOT Name: SAEec01

Data Length: 2 bytes

Resolution: 0.05 A/bit, -1600 A offset

Data range: -1600 to 1612.75 A

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+96 Auxiliaries DC/DC converter output voltage

Comment: If not specified, the output is the low voltage side of the converter.

SLOT Name: SAEev05

Data Length: 2 bytes

Resolution: 0.05 V/bit, 0 V offset

Data range: 0 to 3212.75 V

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+97 Auxiliaries DC/DC converter output current

Comment: If not specified, the output is the low voltage side of the converter. Current out is positive

SLOT Name: SAEec01

Data Length: 2 bytes

Resolution: 0.05 A/bit, -1600 A offset

Data range: -1600 to 1612.75 A

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+98 Auxiliaries DC/DC converter state

SLOT Name: SAEbc02

000 Init

001 Enabled

010 After run

011-101 Reserved

110 Error

111 Not available or not installed

Data Length: 3 bits

Resolution: 8 states/2bit, 0 offset

Data range: 0 to 7

Type: Status

PGN reference:

Refresh rate: 1 s

Req-ID	GEN-006
Requirement	<p>The following information of the AUX Drive (AUX) system shall be as <u>minimum</u> available on a communication network:</p> <ul style="list-style-type: none"> - AUX + inverter (DC/AC) information <ul style="list-style-type: none"> ○ AUX nominal/continuous reference torque ○ AUX maximal/peak reference torque ○ AUX Maximum Momentary Max. Torque Time Limit ○ AUX torque set point ○ AUX actual torque ○ AUX momentary max. available motoring torque ○ AUX momentary max. available regenerating torque ○ AUX percent nominal torque at zero speed point 1 ○ AUX percent nominal torque at (base) speed point 2a ○ AUX percent nominal torque at speed point 3 ○ AUX percent nominal torque at speed point 4 ○ AUX percent nominal torque at max. speed point 5 ○ AUX percent maximal torque at zero speed point 1 ○ AUX percent maximal torque at (base) speed point 2b ○ AUX percent maximal torque at speed point 3 ○ AUX percent maximal torque at speed point 4 ○ AUX percent maximal torque at max. speed point 5 ○ AUX speed at point 2a (base speed at nominal torque) ○ AUX speed at point 2b (base speed at maximal torque) ○ AUX speed at point 3 ○ AUX speed at point 4 ○ AUX speed at point 5 (max. speed) ○ AUX speed set point ○ AUX actual speed ○ ○ AUX nominal/continuous reference power ○ AUX maximal/peak reference power ○ AUX Maximum Momentary Max. Power Time Limit ○ AUX power set point ○ AUX actual power ○ AUX momentary max. available motoring power ○ AUX momentary max. available regenerating power ○ Actual max. available DC power ○ AUX actual DC inverter voltage ○ AUX actual DC inverter current ○ AUX internal inverter temperature ○ AUX Temperature at intake ○ AUX Temperature at outlet ○ AUX Temperature of inverter at intake ○ AUX Temperature of inverter at outlet ○ AUX winding temperature
Rationale	Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

Analogue to PGN number 65291, the map of the AUX is defined as is done for the internal combustion engine. As shown in Figure 2, 5 points are defined per set for nominal torque (blue) and maximal torque (red line). The speed is given in absolute values, the torque as a percentage of the corresponding reference torque. This is done for the first quadrant; when the sign of speed and torque points is considered, the map can be expanded to the other quadrants.

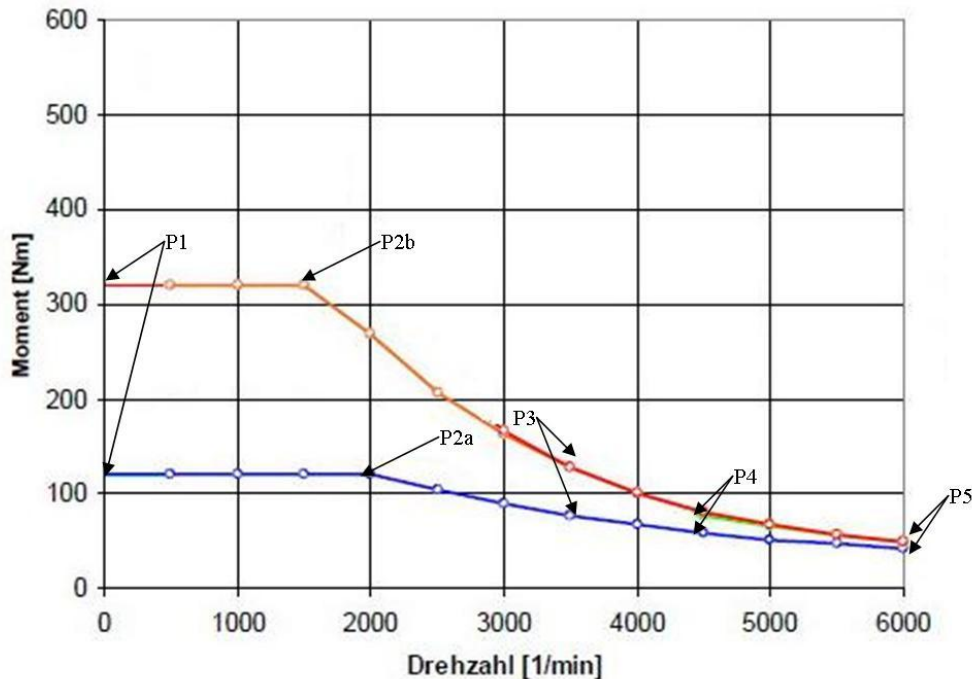


Figure 4 Auxiliary motor configuration map mode

SPN X+99 AUX Nominal/Continuous Reference Torque

Comment: Maximum value for the AUX torque at which the AUX is able to deliver the torque *continuously* (in general).

Slot Name: SAEtq02
Data Length: 2 bytes
Resolution: 1 Nm/bit
Data range: 0 Nm to 64255 Nm
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+100 AUX Maximal/Peak Reference Torque

Comment: Maximum value for the AUX torque at which the AUX is able to deliver the torque *temporarily* (in general). The corresponding time limit is given in 'AUX Momentary Max. Torque Time Limit'

Slot Name: SAEtq02
Data Length: 2 bytes
Resolution: 1 Nm/bit
Data range: 0 Nm to 64255 Nm
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+101 AUX Momentary Max. Torque Time Limit

Comment: Time limit in which the AUX is able to deliver/absorb maximum torque as specified in the map. Relates to SPN 100.

Slot name: SAEtm04

Data Length: 1 byte

Resolution: 0.25 s/bit

Data range: 0 to 62.5 s

0s = no overload allowed

255s = not applicable (no time restriction)

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+102 AUX torque set point

Comment: Value indicated as percentage of AUX maximal/peak reference torque

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % to 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+103 AUX actual torque

Comment: Value indicated as percentage of AUX maximal/peak reference torque.
Measured torque at current moment.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+104 AUX momentary max. available motoring torque

Comment: Value indicated as percentage of AUX maximal/peak reference torque.
Maximum value for the AUX torque at which the AUX is able to deliver (motor mode) the torque *at current moment*.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+105 AUX momentary max. available regenerating torque

Comment: Value indicated as percentage of AUX maximal/peak reference torque.
Maximum value for the AUX torque at which the AUX is able to regenerate
(generator mode) the torque *at current moment*.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+106 AUX percent nominal torque at zero speed point 1

Comment: Value indicated as percentage of AUX Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+107 AUX percent nominal torque at (base) speed point 2a

Comment: Value indicated as percentage of AUX Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+108 AUX percent nominal torque at speed point 3

Comment: Value indicated as percentage of AUX Nominal/Continuous Reference Torque

SLOT Name: SAEpc03

Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset

Data range: 0 to 100%

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+109 AUX percent nominal torque at speed point 4

Comment: Value indicated as percentage of AUX Nominal/Continuous Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+110 AUX percent nominal torque at max. speed point 5

Comment: Value indicated as percentage of AUX Nominal/Continuous Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+111 AUX percent maximal torque at zero speed point 1

Comment: Value indicated as percentage of AUX Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+112 AUX percent maximal torque at (base) speed point 2b

Comment: Value indicated as percentage of AUX Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+113 AUX percent maximal torque at speed point 3

Comment: Value indicated as percentage of AUX Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+114 AUX percent maximal torque at speed point 4

Comment: Value indicated as percentage of AUX Maximal/Peak Reference Torque
SLOT Name: SAEpc03

Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+115 AUX percent maximal torque at max. speed point 5

Comment: Value indicated as percentage of AUX Maximal/Peak Reference Torque
SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100%
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+116 AUX speed at point 2a (base speed at nominal torque)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+117 AUX speed at point 2b (base speed at maximal torque)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+118 AUX speed at point 3

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+119 AUX speed at point 4

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+120 AUX speed at point 5 (max. speed)

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM Operational range: 0 – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+121 AUX speed set point

Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+122 AUX actual speed

Comment: Measured speed at current moment
Slot Name: Nav
Data Length: 2 bytes
Resolution: 1 RPM/bit, -32000 RPM offset
Data range: -32000 RPM to – 32255 RPM
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+123 AUX nominal/continuous reference power

Comment: Maximum value for the AUX power at which the AUX is able to deliver/absorb the power *continuously* (in general).
Slot Name: Nav
Data Length: 2 bytes
Resolution: 100 W/bit, -3200 kW offset
Data range: -3200 – 3225.5 kW
Type: Status
PGN reference:
Refresh rate: 5 s

SPN X+124 AUX maximal/peak reference power

Comment: Maximum value for the AUX power at which the AUX is able to deliver/absorb the power *temporarily* (in general). The corresponding time limit is given in 'AUX Momentary Max. Power Time Limit'

Slot Name: Nav

Data Length: 2 bytes

Resolution: 100 W/bit, -3200 kW offset

Data range: -3200 – 3225.5 kW

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+125 AUX Momentary Max. Power Time Limit

Comment: Time limit in which the AUX is able to deliver/absorb maximum power (in general). Relates to SPN 124.

Slot name: SAEtm04

Data Length: 1 byte

Resolution: 0.25 s/bit

Data range: 0 to 62.5 s

0s = no overload allowed

255s = not applicable (no time restriction)

Type: Status

PGN reference:

Refresh rate: 5 s

SPN X+126 AUX power set point

Comment: Value indicated as percentage of AUX maximal/peak reference power

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % to 132.02 %

Type: Status

PGN reference:

Refresh rate: 100 ms

SPN X+127 AUX actual power

Comment: Value indicated as percentage of AUX maximal/peak reference power. Measured power at current moment.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % to 132.02 %

Type: Measured

PGN reference:

Refresh rate: 100 ms

SPN X+128 AUX momentary max. available motoring power

Comment: Value indicated as percentage of AUX maximal/peak reference power. Maximum value for the AUX power at which the AUX is able to deliver (motor mode) the power *at current moment*.

Slot Name: SAEpc09

Data Length: 2 bytes

Resolution: 0.004 %/bit, -125 % offset

Data range: -125 % – 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+129 AUX momentary max. available regenerating power

Comment: Value indicated as percentage of AUX maximal/peak reference power.
Maximum value for the AUX power at which the AUX is able to absorb
(generator mode) the power *at current moment*.

Slot Name: SAEpc09
Data Length: 2 bytes
Resolution: 0.004 %/bit, -125 % offset
Data range: -125 % – 132.02 %
Type: Status
PGN reference:
Refresh rate: 100 ms

SPN X+130 AUX Actual DC Inverter Voltage

SLOT Name: SAEev05
Data Length: 2 bytes
Resolution: 0.05 V/bit, 0 V offset
Data range: 0 to 3212.75 V
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+131 AUX Actual DC Inverter Current

SLOT Name: SAEec01
Data Length: 2 bytes
Resolution: 0.05 A/bit, -1600 A offset
Data range: -1600 to 1612.75 A
Type: Measured
PGN reference:
Refresh rate: 100 ms

SPN X+132 AUX winding temperature

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+133 AUX Temperature at intake

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+134 AUX Temperature at outlet

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+135 AUX internal inverter temperature

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+136 AUX Temperature of inverter at intake

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+137 AUX Temperature of inverter at outlet

SLOT Name: SAEtp01
Data Length: 1 byte
Resolution: 1°C/bit, -40 °C offset
Data range: -40 to 210 °C
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+138 AUX Status

SLOT Name: SAEbc02
000 Init
001 Enabled
010 After run
011-101 Reserved
110 Error
111 Not available or not installed

Data Length: 3 bits
Resolution: 8 states/2bit, 0 offset
Data range: 0 to 7
Type: Status
PGN reference:
Refresh rate: 1 s

Req-ID	GEN-010
Requirement	The following information of simple smart actuators shall be as <u>minimum</u> available on a communication network for up to 10 actuators: <ul style="list-style-type: none"> ○ ON/ OFF status actuator ○ Position request actuator ○ actual position actuator ○ Speed request actuator ○ actual speed actuator ○ Diagnosis communication
Rationale	- It should be possible to use several valves or fans or similar actuators Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

SPN X+139 ON/OFF status actuator

00	ON
01	OFF
10	Reserved
11	Don't care/take no action

SLOT Name: SAEbc02
Data Length: 2 bits
Resolution: 4 states/2bit, 0 offset
Data range: 0 to 3
Type: Status
PGN reference:
Refresh rate: 1 s

SPN X+140 Position request actuator

SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100% of full scale output value
Type: Status
PGN reference:
Refresh rate: 1 s

SPN X+141 Actual position actuator

SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100% of full scale output value
Type: Measured
PGN reference:
Refresh rate: 1 s

SPN X+142 Speed request actuator

SLOT Name: SAEpc03
Data Length: 1 byte

Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100% of full speed
Type: Status
PGN reference:
Refresh rate: 1 s

SPN X+143 Actual speed actuator

SLOT Name: SAEpc03
Data Length: 1 byte
Resolution: 0.4 %/bit, 0 offset
Data range: 0 to 100% of full speed
Type: Measured
PGN reference:
Refresh rate: 1 s

Req-ID	GEN-011
Requirement	The following information of simple actuators shall be as <u>minimum</u> available on a communication network for up to 10 actuators: <ul style="list-style-type: none"> ○ On/off request
Rationale	- It should be possible to use several relays or on/of fans or valves etc. Information is needed in a central control unit that does control the complete energy management of the vehicle
Priority	High

SPN X+144 ON/OFF status request

00	ON
01	OFF
10	Reserved
11	Don't care/take no action

SLOT Name: SAEbc02

Data Length: 2 bits

Resolution: 4 states/2bit, 0 offset

Data range: 0 to 3

Type: Status

PGN reference:

Refresh rate: 1 s

5.1 Recommendations:

5.1.1 New standard slot names to be specified

SLOT (Scaling, Limit, Offset, and Transfer Function) are also defined in the SAE J1939-71 document. This permits data consistency to be maintained as much as possible between parameters of a given type (temperature, pressure, speed, etc.). Each SLOT is intended to provide a range and resolution suitable for most parameters within a given type. When necessary, a different scaling factor or offset can be used. All SLOTS should be based on a power of 2 scaling from another SLOT. This will minimize the math required for any internal scaling and reduce the opportunity for misinterpreted values. New standard slot names have to be defined for the new added SPN's.

New standard slot names to be specified:

SLOT Name: SAEfv02
 SLOT Type: Flow rate, liquid
 Scaling: 0.02 ltr./min per bit
 Range: -600 to 642.55 ltr./min
 Offset: -600 ltr./min
 Length: 2 bytes
 SLOT identifier:

SLOT Name: SAEpw04
 SLOT Type: Power, Real
 Scaling: 100 W/bit
 Range: -3200 to 3225.5 kW
 Offset: -3200 kW
 Length: 2 bytes
 SLOT identifier:

SLOT Name: SAEtq05
 SLOT Type: Power, Real
 Scaling: 0.01 Nm per bit
 Range: -320 to 322.55 Nm
 Offset: -320 Nm
 Length: 2 bytes
 SLOT identifier:

SLOT Name: SAEvr07
 SLOT Type: Velocity, Rotational
 Scaling: 1 RPM per bit
 Range: -32000 to 32255 RPM
 Offset: -32000 RPM
 Length: 2 bytes
 SLOT identifier:

SLOT Name: SAEtp03
 SLOT Type: Temperature
 Scaling: 2 °C .per bit
 Range: -40 to 460 °C
 Offset: -40 °C
 Length: 1 byte
 SLOT identifier:

SLOT Name: SAEeC01
 Data Length: 2 bytes
 Resolution: 0.1 Ah/bit
 Data range: 0 to 6425.5 Ah
 Type: Status
 PGN reference:
 Refresh rate: 5 s

6 PGN definitions

The SPNs are grouped in the PGNs with respect to the following requirements

- combine SPNs from or to one component
- Optimize message length to 64 bits.
- Same transmission rate (sometimes an SPN with a lower transmission rate, is combined with SPN's with a higher transmission rates. This is done to save busload, and make optimal use of the 64 bit message length.

PGNs are relative to the already existing PGNs defined in the J-1939 document
 The numbering should start at a certain number X which still must be defined

6.1 PGN definitions ESS

6.1.1 PGN 001 *Temperatures of cooling medium at positions X*

Refresh rate: 1 sec

SPN X+1	1 byte	Temperature of cooling medium at position X1
SPN X+1	1 byte	Temperature of cooling medium at position X2
SPN X+1	1 byte	Temperature of cooling medium at position X3
SPN X+1	1 byte	Temperature of cooling medium at position X4
SPN X+1	1 byte	Temperature of cooling medium at position X5
SPN X+2	4bits	Position of temperature measurement X1
SPN X+2	4bits	Position of temperature measurement X2
SPN X+2	4bits	Position of temperature measurement X3
SPN X+2	4bits	Position of temperature measurement X4
SPN X+2	4bits	Position of temperature measurement X5

6.1.2 PGN 002 *Enabling or disabling ESS*

Refresh rate: 0.1 sec

SPN X+5	ESS dis-/enable request
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6.1.3 PGN 003 *ESS actual message 1*

Refresh rate: 0.1 sec

SPN X+8	2 byte	ESS Actual Current
SPN X+14	2 byte	ESS Momentary max. Charge Current
SPN X+15	2 byte	ESS Momentary max. Discharge Current
SPN X+16	2 byte	ESS Actual Voltage

6.1.4 PGN 004 *ESS actual message 2*

Refresh rate: 0.1 sec

SPN X+25	2 byte	ESS Actual Torque
SPN X+31	2 byte	ESS Actual Power
SPN X+36	2 byte	ESS momentary max. Charge Power
SPN X+37	2 byte	ESS momentary max. Discharge Power

6.1.5 PGN 005

ESS actual message 3

Refresh rate: 0.1 sec

SPN X+19	2 byte	ESS Actual Flow
SPN X+22	2 byte	ESS Actual Pressure
SPN X+27	2 byte	ESS Actual Speed

6.1.6 PGN 006

ESS status and temperatures

Refresh rate: 1 sec

SPN X+40	1 byte	ESS maximum system temperature
SPN X+41	1 byte	ESS minimum system temperature
SPN X+42	1 byte	ESS Actual average system temperature
SPN X+43	1 byte	ESS Actual lowest system temperature
SPN X+44	1 byte	ESS Actual highest system temperature
SPN X+3	3 bits	ESS Status

6.1.7 PGN 007

ESS type and status

Refresh rate: 5 sec

SPN X+6	1 byte	ESS State Of Health (SOH)
SPN X+7	1 byte	ESS State Of Charge (SOC)
SPN X+8	1 byte	ESS Actual Electric Capacity
SPN X+10	2 byte	ESS Nominal/Continuous Charge Current
SPN X+11	2 byte	ESS Nominal/Continuous Discharge Current
SPN X+4	2 bits	ESS Type

6.1.8 PGN 008

ESS information 1

Refresh rate: 5 sec

SPN X+12	2 byte	ESS Maximal/Peak Charge Current
SPN X+13	2 byte	ESS Maximal/Peak Discharge Current
SPN X+17	2 byte	ESS max. Voltage
SPN X+18	2 byte	ESS min. Voltage

6.1.9 PGN 009

ESS information 2

Refresh rate: 5 sec

SPN X+20	2 byte	ESS max. Flow
SPN X+21	2 byte	ESS min. Flow
SPN X+23	2 byte	ESS max. Pressure
SPN X+24	2 byte	ESS min. Pressure

6.1.10 PGN 010

ESS information 2

Refresh rate: 5 sec

SPN X+28	2 byte	ESS max. Speed
SPN X+29	2 byte	ESS min. Speed
SPN X+26	2 byte	ESS max. Torque
SPN X+30	2 byte	ESS Power Reference

6.1.11 PGN 011

ESS information 3

Refresh rate: 5 sec

SPN X+32	1 byte	ESS Nominal/Continuous Charge Power
SPN X+33	1 byte	ESS Nominal/Continuous Discharge Power
SPN X+34	1 byte	ESS Maximal/Peak Charge Power
SPN X+35	1 byte	ESS Maximal/Peak Discharge Power

SPN X+38	1 byte	ESS Momentary Max. Charge Rate Time Limit
SPN X+39	1 byte	ESS Momentary Max. Discharge Rate Time Limit

6.2 PGN definition EGM specification

6.2.1 PGN 012 EGM specification

Refresh rate: 5 sec

These signals represent the specifications which have to be provided by the manufacturer. They define the operating range of the EGM.

Analogue to PGN number 65291, the map of the EGM is defined as is done for the internal combustion engine. As shown in Figure 3, 5 points are defined per set for nominal torque (blue) and maximal torque (red line). The speed is given in absolute values, the torque as a percentage of the corresponding reference torque. This is done for the first quadrant; when the sign of speed and torque points is considered, the map can be expanded to the other quadrants.

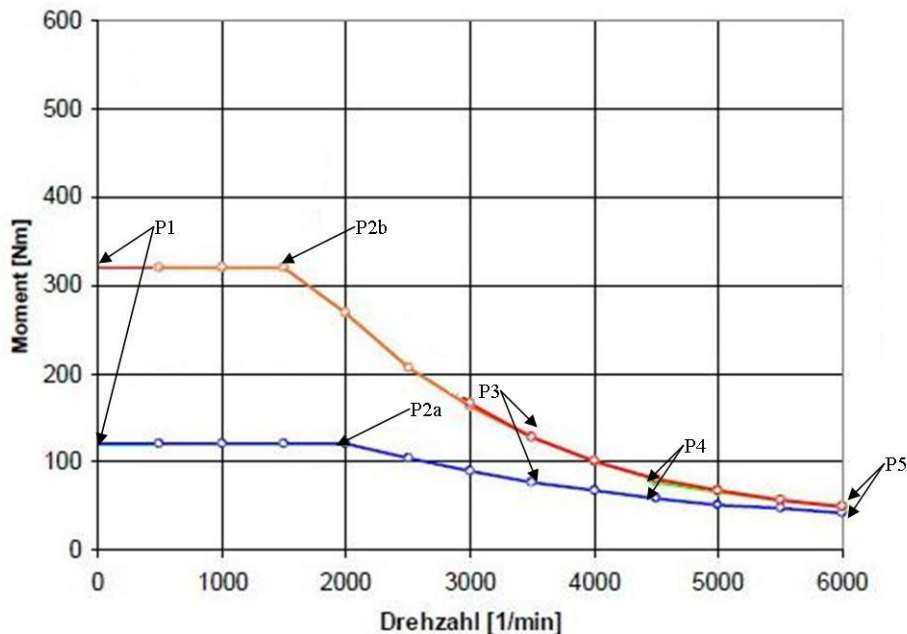


Figure 5 Electric Generator Motor configuration map mode

SPN X+45	2 bytes	EGM Nominal/Continuous Reference Torque
SPN X+46	2 bytes	EGM Maximal/Peak Reference Torque
SPN X+47	1 byte	EGM Momentary Max. Torque Time Limit
SPN X+52	1 byte	EGM percent nominal torque at zero speed point 1
SPN X+53	1 byte	EGM percent nominal torque at (base) speed point 2a
SPN X+54	1 byte	EGM percent nominal torque at speed point 3
SPN X+55	1 byte	EGM percent nominal torque at speed point 4
SPN X+56	1 byte	EGM percent nominal torque at max. speed point 5
SPN X+57	1 byte	EGM percent maximal torque at zero speed point 1
SPN X+58	1 byte	EGM percent maximal torque at (base) speed point 2b
SPN X+59	1 byte	EGM percent maximal torque at speed point 3
SPN X+60	1 byte	EGM percent maximal torque at speed point 4
SPN X+61	1 byte	EGM percent maximal torque at max. speed point 5
SPN X+62	2 bytes	EGM speed at point 2a (base speed at nominal torque)

SPN X+63	2 bytes	EGM speed at point 2b (base speed at maximal torque)
SPN X+64	2 bytes	EGM speed at point 3
SPN X+65	2 bytes	EGM speed at point 4
SPN X+66	2 bytes	EGM speed at point 5 (max. speed)
SPN X+69	2 bytes	EGM nominal/continuous reference power
SPN X+70	2 bytes	EGM maximal/peak reference power
SPN X+71	1 byte	EGM Momentary Max. Power Time Limit

6.2.2 PGN 013

EGM dynamic signals 1

Refresh rate: 100 ms

SPN X+48	2 bytes	EGM torque set point
SPN X+67	2 bytes	EGM speed set point
SPN X+72	2 bytes	EGM power set point

6.2.3 PGN 014

EGM dynamic signals 2

Refresh rate: 100 ms

SPN X+49	2 bytes	EGM actual torque
SPN X+50	2 bytes	EGM momentary max. available motoring torque
SPN X+51	2 bytes	EGM momentary max. available regenerating torque
SPN X+68	2 bytes	EGM actual speed

6.2.4 PGN 015

EGM dynamic signals 3

Refresh rate: 100 ms

SPN X+73	2 bytes	EGM actual power
SPN X+74	2 bytes	EGM momentary max. available motoring power
SPN X+74	2 bytes	EGM momentary max. available regenerating power

6.2.5 PGN 016

EGM dynamic signals 4

Refresh rate: 100 ms

SPN X+76	2 bytes	EGM Actual DC Inverter Voltage
SPN X+77	2 bytes	EGM Actual DC Inverter Current

6.2.6 PGN 017

EGM temperatures and status

Refresh rate: 5s

SPN X+78	1 byte	EGM winding temperature
SPN X+79	1 byte	EGM Temperature at intake
SPN X+80	1 byte	EGM Temperature at outlet
SPN X+81	1 byte	EGM internal inverter temperature
SPN X+82	1 byte	EGM Temperature of inverter at intake
SPN X+83	1 byte	EGM Temperature of inverter at outlet
SPN X+84	3bits	EGM Status

6.3 Auxillaries Inverter (DC/AC) specifications

6.3.1 PGN 018

AUX Inverter(DC/AC) inverter enable/disable command

Refresh rate: 100 ms

SPN X+85	2 bits	Auxiliaries inverter (DC/AC) system state
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6.3.2 PGN 019

AUX Inverter(DC/AC) Dynamic signals

Refresh rate: 100 ms

SPN X+89	2 bytes	Auxiliaries connected
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SPN X+91	2 bytes	Auxiliaries inverter (DC/AC) input current
SPN X+92	2 bytes	Auxiliaries inverter (DC/AC) output phase voltage (RMS)
SPN X+93	2 bytes	Auxiliaries inverter (DC/AC) output phase current (RMS))

6.3.3 PGN 020 *AUX Inverter(DC/AC) state and temperature signals*

Refresh rate: 1 s

SPN X+85	3 bits	Auxiliaries inverter (DC/AC) system state
SPN X+86	1 bytes	Actual Auxiliaries inverter (DC/AC) temperature
SPN X+87	1 byte	Maximum Auxiliaries inverter (DC/AC) temperature

6.4 *Auxillaries Inverter (DC/DC) specifications*

6.4.1 PGN 021 *AUX Inverter(DC/DC) state*

Refresh rate: 1 s

SPN X+98	3 bits	Auxiliaries DC/DC converter state
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6.4.2 PGN 022 *AUX Inverter(DC/DC) state*

Refresh rate: 100 ms

SPN X+94	2 bytes	Auxiliaries DC/DC converter input voltage
SPN X+95	2 bytes	Auxiliaries DC/DC converter input current
SPN X+96	2 bytes	Auxiliaries DC/DC converter output voltage
SPN X+97	2.bytes	Auxiliaries DC/DC converter output current

6.5 *Auxiliaries drive specification*

6.5.1 PGN 023 *AUX drive specification*

Refresh rate: 5 sec

These signals represent the specifications which have to be provided by the manufacturer. They define the operating range of the AUX.

Analogue to PGN number 65291, the map of the AUX is defined as is done for the internal combustion engine. As shown in Figure 4, 5 points are defined per set for nominal torque (blue) and maximal torque (red line). The speed is given in absolute values, the torque as a percentage of the corresponding reference torque. This is done for the first quadrant; when the sign of speed and torque points is considered, the map can be expanded to the other quadrants.

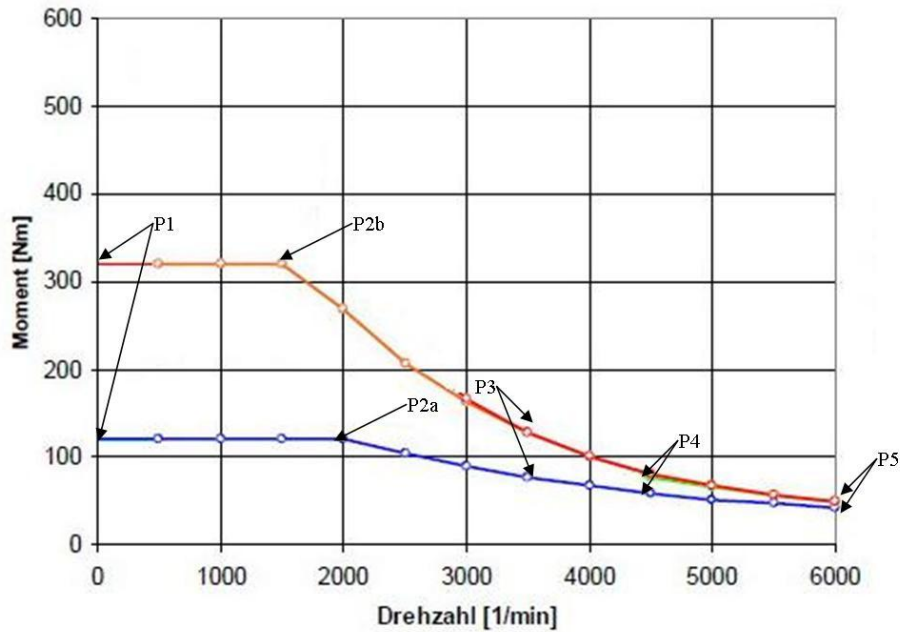


Figure 6 Auxiliary Motor configuration map mode

SPN X+99	2 bytes	AUX Nominal/Continuous Reference Torque
SPN X+100	2 bytes	AUX Maximal/Peak Reference Torque
SPN X+101	1 byte	AUX Momentary Max. Torque Time Limit
SPN X+106	1 byte	AUX percent nominal torque at zero speed point 1
SPN X+106	1 byte	AUX percent nominal torque at (base) speed point 2a
SPN X+108	1 byte	AUX percent nominal torque at speed point 3
SPN X+109	1 byte	AUX percent nominal torque at speed point 4
SPN X+110	1 byte	AUX percent nominal torque at max. speed point 5
SPN X+111	1 byte	AUX percent maximal torque at zero speed point 1
SPN X+112	1 byte	AUX percent maximal torque at (base) speed point 2b
SPN X+113	1 byte	AUX percent maximal torque at speed point 3
SPN X+114	1 byte	AUX percent maximal torque at speed point 4
SPN X+115	1 byte	AUX percent maximal torque at max. speed point 5
SPN X+116	2 bytes	AUX speed at point 2a (base speed at nominal torque)
SPN X+117	2 bytes	AUX speed at point 2b (base speed at maximal torque)
SPN X+118	2 bytes	AUX speed at point 3
SPN X+119	2 bytes	AUX speed at point 3 AUX speed at point 4
SPN X+120	2 bytes	AUX speed at point 5 (max. speed)
SPN X+123	2 bytes	AUX nominal/continuous reference power
SPN X+124	2 bytes	AUX maximal/peak reference power
SPN X+125	1 byte	AUX Momentary Max. Power Time Limit

6.5.2 PGN 024

AUX drive setpoints

Refresh rate: 1s

SPN X+102	2 bytes	AUX torque set point
SPN X+121	2 bytes	AUX speed set point
SPN X+126	2 bytes	AUX power set point

6.5.3 PGN 025

AUX drive dynamic signals1

Refresh rate: 100 ms

This set handles mostly the actual status/measured signals, which are valid at the current moment.

SPN X+102	2 bytes	AUX torque set point
SPN X+122	2 bytes	AUX actual speed
SPN X+127	2 bytes	AUX actual power

6.5.4 PGN 026 *AUX drive dynamic signals2*

Refresh rate: 100 ms

This set handles mostly the actual status/measured signals, which are valid at the current moment.

SPN X+130	2 bytes	AUX Actual DC Inverter Voltage
SPN X+131	2 bytes	AUX Actual DC Inverter Current

6.5.5 PGN 027 *AUX drive dynamic signals3*

Refresh rate: 100 ms

SPN X+104	2 bytes	AUX momentary max. available motoring torque
SPN X+105	2 bytes	AUX momentary max. available regenerating torque
SPN X+128	2 bytes	AUX momentary max. available motoring power
SPN X+129	2 bytes	AUX momentary max. available regenerating power

6.5.6 PGN 028 *AUX drive Temperatures and status*

Refresh rate: 1 s

SPN X+132	1 byte	AUX winding temperature
SPN X+133	1 byte	AUX Temperature at intake
SPN X+134	1 byte	AUX Temperature at outlet
SPN X+135	1 byte	AUX internal inverter temperature
SPN X+136	1 byte	AUX Temperature of inverter at intake
SPN X+137	1 byte	AUX Temperature of inverter at outlet
SPN X+138	3bits	AUX Status

6.6 *Simple smart actuators information*

6.6.1 PGN 029 *Simple smart actuators request*

Refresh rate: 1 s

SPN X+144	2 bits	ON/OFF status request
SPN X+140	1 bytes	Position request actuator
SPN X+142	1.bytes	Speed request actuator

6.6.2 PGN 030 *Simple smart actuator status*

SPN X+139	2 bits	ON/OFF status actuator
SPN X+141	1 bytes	Actual position actuator
SPN X+143	1 bytes	Actual speed actuator

6.7 *Simple actuators information*

6.7.1 PGN 031 *Simple Actuator request*

SPN X+144	2 bits	ON/OFF status request
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7 Conclusion and recommendation

With a relatively small set of messages it is possible to cover all known configurations of hybrid electric vehicles. The set of messages presented in this report covers all currently known configurations and is prepared for possible future configurations. The vehicle configuration is application and vehicle manufacturer specific. Therefore it is not useful to list all possible configurations within the scope of this document.

Acceptance of this document by the vehicle manufacturers is required to get this standardization accepted. Sharing this document with vehicle manufacturers and the SAE organisation is beneficial for acceptance.