12 V 400 W OBD2 DC/DC – Converter

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1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard establishes the technical requirements for a 400 W DC/DC boost converter, which shall be integrated into the Global A network architecture especially for OBD2 application.

1.1.1 Document Change Authority. Changes to this standard shall be made using the System Requirements Change (SRC) process.

1.2 Applicability. The DC/DC converter provides continuous power to all infotainment and communication devices to achieve uninterrupted performance from radios, CD players etc. It shall also be used with Navigation systems, which may run into boot mode after engine cranking due to voltage drop effects. Continuously reporting the internal functional and health status to the OBD2 master makes this variant compliant with OBD2 requirements. This change is necessary to be able to give supply to components, which are related to OBD2, like automatic transmissions etc.

1.3 Remarks. This standard is applicable to GM vehicles, which use the Electrical Architecture, produced for sale in the GM North American, Latin American, European, and Asian Pacific regions as early as Model Year 2015.

The 400 W DC-DC Converter will contain one each of the following:

- Converter Module
- Attachment Provision

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ISO 11469	ISO/IEC 17025

2.2 GM Standards/Specifications.

GM1829	GMW3116	GMW8287	GMW15010
GMW3059	GMW3172	GMW14082	GMW15862
GMW3091	GMW3191	GMW14241	GMW16331
GMW3097	GMW3232	GMW14334	
GMW3103	GMW4710	GMW14573	

2.3 Additional References.

AIAG QS-9000

GMSAE156

GM8272

TLE-050046

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3 Requirements

3.1 System/Subsystem/Component/Part Definition. The required physical contents for the Subsystem are identified in the following paragraphs.

12 V StopStart vehicles will require some means of supporting the electrical loads during an AutoStart event to prevent the system voltage from voltage drops, which might produce boot/reset effects on control units or malfunction on mechatronic parts. This unit uses a boost converter circuitry, which allows the direct connection to the vehicle battery. The DC/DC Converter, which is mounted in the interior compartment or trunk, shall be used to provide stabilized DC output power for Stop-/Start appliances. The subsystem integration must comply with TLE-050046.

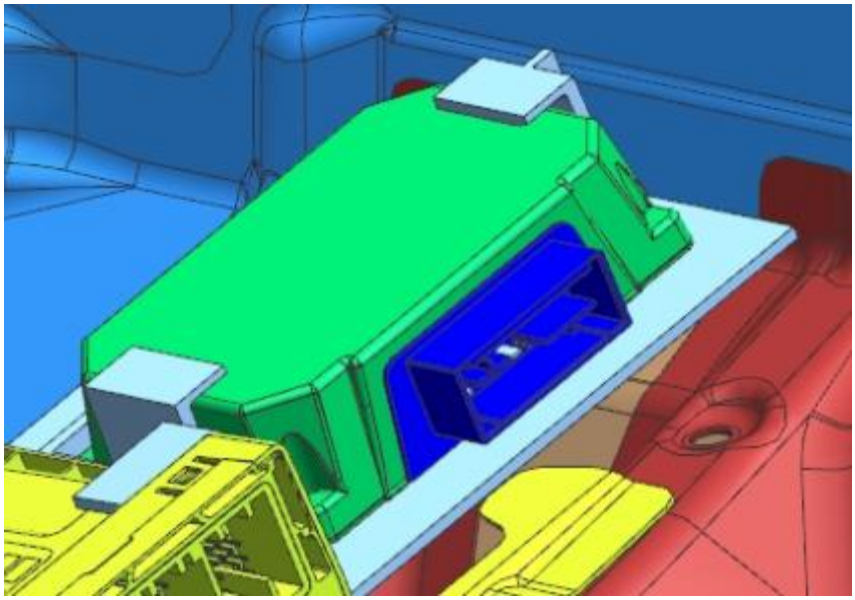
3.1.1 Mounting Surfaces. The DC/DC Converter shall be mounted using an additional bracket in snap in technology. If it is not possible due to mounting surface to ensure a safe mounting (depending on Car Line requirements) also additional fixation features shall be foreseen on the housing.

Mounting holes shall be provided in the packaging envelope dimension, there shall be no external flap or similar. Additional mounting features must meet the housing material to avoid wearing, break or loosing effects.

a. The subsystem components shall mechanically interface with the DC/DC converter.
b. The DC/DC metal case parts shall galvanically be compatible with ferrous and non-ferrous metals and plating and coatings commonly used in automotive structures and fasteners in order to minimize corrosion (no galvanic Effect with other mounting components)
c. If the snap in solution is not applicable, the DC/DC Converter case shall provide four M6 thread holes, which should withstand a torque of (4 ± 1) Nm clamping force without performance degradation or case damage. The holes shall be provided without negative impact on the leak tightness.

3.1.2 Housing View (prototype part). See Figure 1.

Figure 1: 400 W DC/DC Prototype with Bracket (D2Ux)



3.1.3 Appearance & ME Requirements. The DC/DC Converter case shall have no sharp corners.

Plastic Housing: The DC/DC Converter case shall have a non-reflective black, gray, or silver exterior.

Aluminum Housing: The DC/DC Converter aluminum housing shall not be processed (painted, etc.) in any way to have full cooling functionality and keep the aluminum looking.

3.1.3.1 Attachments. Fasteners selected by the platform shall meet the requirement for 20 mm bolt head and tool clearance for tightening.

3.1.4 Finish. The DC/DC converter shall have smooth corners and edges for all exposed surfaces.

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3.1.5 Content.

3.1.5.1 Physical Content. The converter assembly packaging and dimensional requirements shall be specified in the packaging drawing and 3D math data.

The DC/DC Converter consists of the following major items, microcontroller(s), sensing components, PT-Expansion data bus.

a. An identical DC/DC printed circuit board (PCB) shall be used to meet the necessary functionality required by different platforms
b. The DC/DC microcontroller shall come from a family where an upgraded microcontroller with the same footprint but more resources is available and be qualified prior to Integration Vehicle Bench deliveries
c. A bypass shall provide a low impedance connection from Bat+ to consumer Bat+ input

The converter shall provide reverse polarity protection.

3.1.5.1.1 Hardware/Software Variants.

a. The DC/DC Converter shall meet with 3D-reference data coming from GM, if first application was already introduced at GM to be able to provide required electrical interfaces and matching requirements.
b. Dependent on technical requirements different part numbers shall be provided.

3.1.5.1.2 Pre-Fuse. The DC/DC converter requires separate external Pre-Fuses (not included in the DC/DC module!).

Maximum Input continues current is 88 A (2 x 44 A) at 6.5 V input voltage. The input current depends on the battery input voltage assuming a DC/DC efficiency of ≥ 85 % at 200 W (2 s) and < 85 % at 240 W (200 ms).

To avoid load transfer on the supply input, the B+ inputs shall not be connected on the PCB. They always shall be kept as separated signal inputs.

3.1.5.1.3 DC Manufacturing Guidelines. The manufacturing process shall comprehend the following guidelines and constraints:

a. Eliminate PCB re-work operations
b. Eliminate hand soldering of components

The manufacturing process shall comprehend the following guidelines and constraints:

a. Limit / minimize board flexure in PCB separation process
b. Limit / minimize fatigue damage from manufacturing process, e.g. sonic weld; cutting, sawing, routing, etc.
c. Minimize part handling / damage from handling, stacking, etc.
d. Eliminate / reduce potential for ionic contaminates in PCB assembly
e. Assure 100 % coverage in PCB though-holes for solder flux process
f. Control / minimize build variation in manufacture process
g. Consider error-proof methods in manufacture / assembly
h. Avoid wave soldering

3.1.5.2 Functional Content. (See Figure 2).

a. The DC/DC Converter shall be capable to provide a stabilized output voltage during cranking, which requires a maximum power of 480 W for 200 ms at 6.5 V and 400 W for 2 s at 6.0 V.
b. The controller shall provide internal signal monitoring and data transfer via Powertrain Expansion Bus.
c. The DC/DC converter shall not be reprogrammable without disfiguring the device.
d. The DC/DC Converter shall have a reduced quiescent current consumption during sleep mode (100 µA).
e. The efficiency of the Boost converter shall be > 85 % over the entire operation input voltage range
f. The converter hardware shall be protected by electronic fusing against short circuits, high current. High or low voltage events shall not be used for software controlled shutoffs. The DC/DC shall always continue to work within parameters, which are not hazardous to the DC/DC.
g. The DC/DC shall survive cranking voltage transients of T ≤ 2 s duration.

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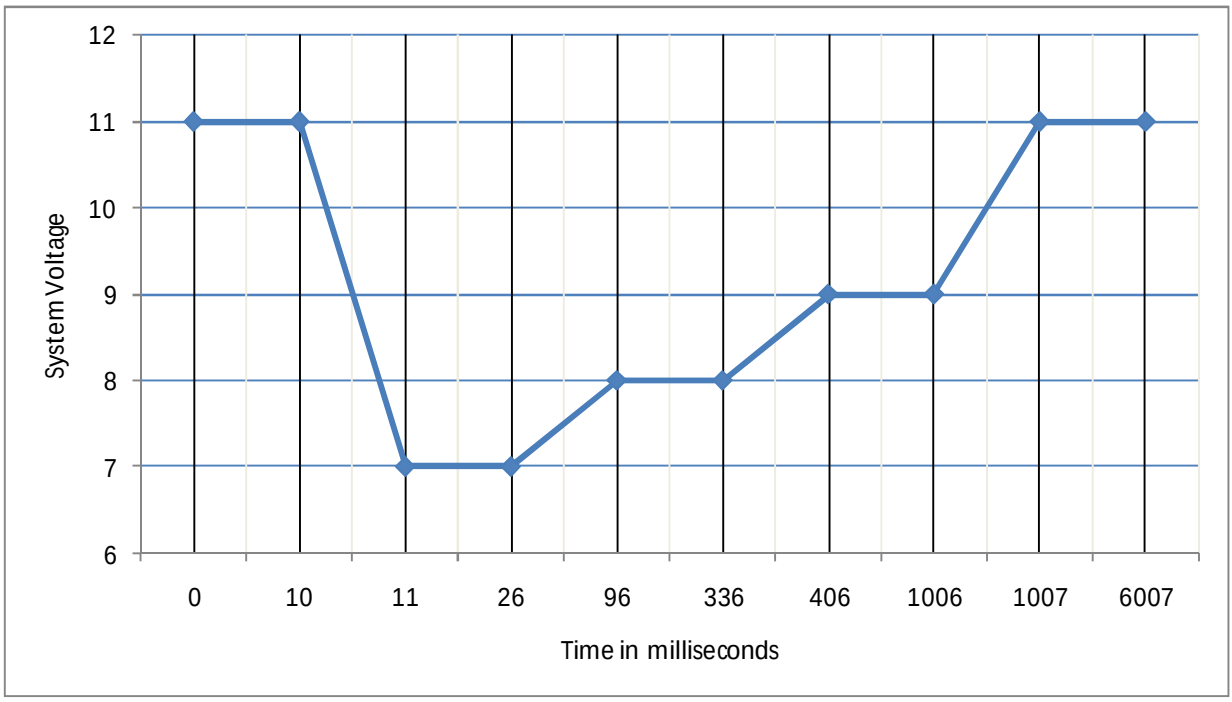
Figure 2: Functional Content



h. The software shall be the same for all different hardware variants as long as different functionality is not requested by the GM engineer.
i. The DC/DC converter shall be easily integrated into all existing GM PPEI architectures.
j. The DC/DC converter connection system shall be designed to GMW3191.
k. The DC/DC converter shall be capable of a minimum of 10 installation/Cycles without any degradation or loss of performance.
l. The DC/DC converter shall provide microprocessor and peripheral health/integrity data to the ECM according to paragraph 3.3.6.
m. The DC/DC converter shall provide un-scaled, un-filtered, raw sensor ADC values to the ECM.
n. The DC/DC converter shall communicate with the ECM via the Powertrain Expansion Bus.
o. The DC/DC shall not interfere with other electronic components by radiation or electromagnetic emissions (EMC).

3.1.6 DC/DC Converter Voltage Support. The DC/DC provides stabilized output voltage level during cranking to allow voltage sensitive functions to operate when battery power drops down for 2 s. To be able to achieve this function, the DC/DC uses a boost circuitry without additional need for charging storage elements, like caps.

3.1.6.1 DC/DC Converter Parasitic Current. The parasitic current during operation shall be < 500 µA as measured with operating voltage of 12.8 V at +25 °C. Parasitic current is defined as the time average value current measured with the external electrical load switched off. The CAN is inactive for that test.

3.1.6.2 DC/DC Converter Overload Protection.

a. All inputs and outputs shall be capable of sustaining an open circuit.
b. All inputs and outputs, except grounds, shall be capable of direct or resistive shorts to battery voltage.
c. Each I/O pin shall be capable of direct or resistive shorts to ground without sustaining damage.
d. Upon removal of any of the fault conditions a through c above the particular input or output shall return to normal behavior within 100 ms (500 ms in Sleep Mode) without requiring any operator action or hardware reset.
e. The DC/DC Converter shall not be damaged due to shorts in output circuitry.
f. When outputs are linked (in the connector or a least very near to the connector), the relay must be robust against short circuits (Fuse Capability: 40 A for each input). The output linked mode requires different software and a new part number.

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g. Polyfuses are not suitable for this technical application, because of the high output current (2 x 17 A nominal (2 x 20 A maximum at 12 V output).

3.1.6.3 Converter Functional Overview.

- The DC/DC converter shall provide a system voltage stabilization for supported components, which are sensitive to voltage drops during an AutoStart event
- The output voltage shall be kept at a constant level during cranking. Specific algorithms ensure, that the customer doesn't take notice of dimming or flickering effects before, during and after the cranking ($\Delta U = \pm 1.0$ V maximum)
- Cold start functionality shall be inhibited by using the Ignition (Run/Crank) and crank control input signals
- The DC/DC shall always attempt to continue to work during low or high input voltages events, taking no protective default actions
- The unit shall meet vibration requirements according to GMW3172.
- The DC/DC shall be capable of supplying power to electrical loads in Accessory, Run and RAP Power Modes as well as parasitic current to loads in Off Power Mode
- Functional and microprocessor/peripheral health monitoring information shall be provided to the ECM via the PT Expansion bus

3.1.6.4 Power Output Cycle Timing.

a. The voltage stabilization shall start by a hardwired trigger using the starter relay control signal coming from the ECM.

b. The duration of the stabilization time shall be calculated to 2 s for the Hardware design. After 2 s stabilization time, the converter shall switch back to the "Bridged Mode", which provides a direct connection to the battery +.
Assumption: A normal crank procedure is finished ≈ < 800 ms.

c. The DC/DC shall be ready for the next stabilization ≥ 10 s after the last stabilization procedure.

3.1.6.5 Ramping Output Voltage Characteristics. To be able to avoid transient effects, like flickering effects, dimming etc., the DC/DC converter shall provide a voltage ramping function as shown in the following graphics. The DC/DC shall store the input voltage level before cranking and use it as starting level for the stabilization process. After the starting process was completed, the stabilized output voltage shall use a voltage ramping function aiming at the input voltage level for equality. As soon as this level has been achieved, the DC/DC shall switch from "stabilization mode" to the "bridged mode" (see Figure 3).

If the cranking process time exceeds 1 s minimum, the ramping function shall be disabled. The output voltage level shall be 14 V maximum.

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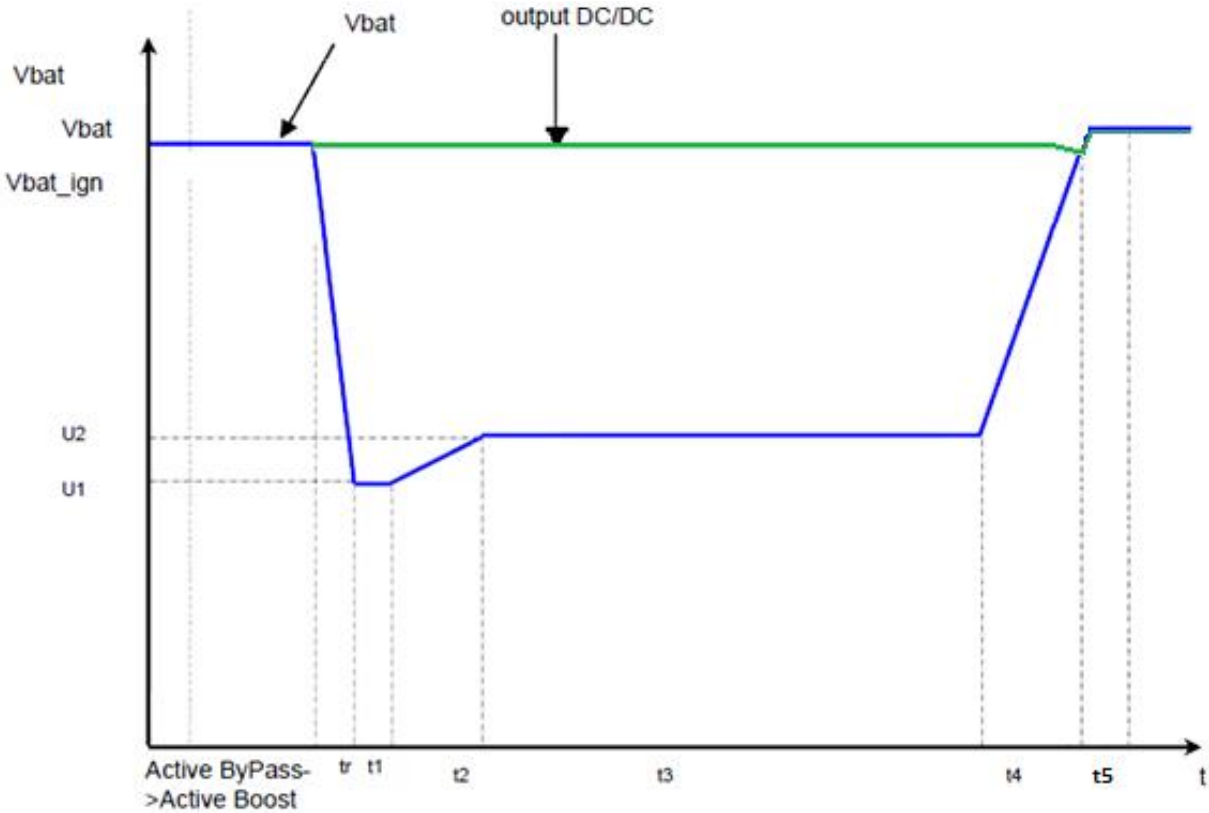
Figure 3: Ramping Function



3.1.6.6 Output Voltage Leveling after Auto Crank.

Assumption:

- Battery voltage range before AutoCrank: (12 to 13) V
- Battery voltage range after AutoCrank: (12 to 15.2) V (minimum last voltage → maximum generator voltage).
- The DC/DC shall be capable of providing the stabilized output voltage in time by using a hardwired crank initialization (crank control signal) being provided 11 ms before the starter activation.

Required action after AutoCrank:

- After AutoCranking the output voltage shall be leveled to the now present Battery voltage up to 14 V maximum before the Bypass shall be activated.
- Below 14 V, the Bypass switching point should be set when $U_{DC/DC}$ and U_{BAT} have a difference within a tolerance of 0.4 V ($U_{DC/DC}$ shall always be < U_{BAT}).
- During the leveling Phase the necessary energy shall be taken from the battery.
- Basic value for programmable voltage leveling slew rate: 0.1 V / 100 ms.

3.1.6.6.1 Operating/Test Voltage. The inverter shall function as specified in this document without interruption within the operating input voltage range of (6.5 to 16) V_{DC} (see Table 1).

Note: This applies also to the PT Expansion interface of the device.

Also, the converter shall be immune of generator output ripple voltage and supply voltage pulses.

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Table 1: Operating Voltage Range

Range Name	Range ID	Limit Name	Specified Limit Value
Max Overvoltage Range	VR_H	Max Voltage Range	26.0 V (1 minute)
Overvoltage Range	VR1	Normal Range Limit High	16.0 V
Normal Operating Range Range not defined in GMW3172, special for DCDC converter	VR2		
		Normal Range Limit Low	6.0 V
Undervoltage Range	VR4	Crank Voltage Limit	6.5 V
		Ground	Ground Reference
Reverse Voltage Range	VR5	Reverse Voltage Limit	-18.0 V
Max Reverse Voltage Range	VR_L		

3.1.6.6.2 Operating Voltage – Hardware Requirements. The Subsystem shall meet the hardware requirements specified in Table 2, when subjected to operating voltage ranges defined earlier.

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Table 2: Operating Voltage, Hardware Requirements

Range	Subsystem Requirements when in this operating voltage range (Hardware)
VR_H	a. Damage to the DC/DC Converter in this range is allowed but the damage shall not result in a thermal event. b. Non-volatile memory or Flash memory shall not be altered, erroneously written, or cleared.
VR1	<u>VR1a – (18 to 26) V</u> a. No damage shall occur for 1 minute at < +50 °C, otherwise meet requirements in VR_H. b. Non-volatile memory or Flash memory shall not be altered, erroneously written, or cleared other than to record valid EDR data. c. The DC/DC Converter shall not disrupt communications (load down the bus with excessive impedance). <u>VR1b – (16 to 18) V</u> d. No damage shall occur to the DC/DC Converter. e. Non-volatile memory or Flash memory shall not be altered, erroneously written, or cleared other than to record valid EDR data. f. The DC/DC Converter shall support continuous (uninterrupted) data communications. g. The DC/DC converter shall not load down the data bus with excessive impedance.
VR2	a. No damage shall occur to the DC/DC Converter.
VR4	a. No damage shall occur to the DC/DC Converter. b. No corruption of non-volatile memory shall occur when traversing in any direction between VR4 (V < reset) and the specified reverse voltage limit or the lower voltage limit in VR5. h. The DC/DC Converter shall support continuous (uninterrupted) data communication function down to the minimum operating voltage for voltage stabilization, meaning data communication interface shall operate as long as voltage stabilization operates. i. During the entire crank waveform (for details see Figure 3 “Ramping Function” in this document) the DC/DC Converter shall support uninterrupted and fault-free transmission of bus messages. c. The DC/DC converter shall not load down the data bus with excessive impedance.
VR5	a. Same as VR4
VR_L	a. Damage is allowed in this range but the damage shall not result in a thermal event. b. Non-volatile memory or Flash memory shall not be altered, erroneously written, or cleared. c. The DC/DC Converter shall not disrupt communications (load down the bus with excessive impedance) upon returning to VR2 range.

3.1.6.6.3 Operating Voltage – Functional Requirements. The Subsystem shall meet the functional requirements specified in Table 3 when subjected to operating voltage ranges defined earlier.

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