GM WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW16858

12 V 400W DC/DC - Converter

1 Introduction 2
1.1 Purpose 2
1.1.1 Document Change Authority 2
1.2 Applicability 2
1.3 Remarks 3
2 References 3
2.1 External Standards/Specifications 3
2.2 GM Standards/Specifications 3
2.3 Additional References 3
3 Requirements 3
3.1 System/Subsystem/Component/Part Definition 3
3.1.1 Mounting Surfaces 3
3.1.2 Housing Top View (prototype part) 4
3.1.3 Appearance & ME Requirements 4
3.1.4 Finish 4
3.1.5 Content 4
3.1.6 DC/DC Converter Voltage Support 5
3.1.7 Operating Modes 12
3.1.8 Design Guidelines 12
3.1.9 Ambient Environment 12
3.1.4 Interfaces 12
3.1.5 Usage Definition 12
3.2 Product Characteristics 12
3.3 Design and Construction 12
3.3.1 Materials, Processes and Parts Selection Guidelines 12
3.3.2 Design Guidelines and Constraints 13
3.3.3 Identification and Marking 13
3.3.4 Mechanical Requirements 14
3.3.5 Serial Interface 14
3.3.6 Diagnostics 15
3.3.7 Electrical Connection Requirements 16
3.3.8 General Voltage Stabilization Requirements 29

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3.3.9 Conditions 30
3.9.10 Test Conditions 30
3.10 Service Requirements 31
3.10.1 Serviceability 31
4 Validation 35
4.1 Validation Test Plan 35
4.2 A/D/V Plan and VCRI 35
4.3 Facility Information 35
4.4 EMC 35
4.5 Power Temperature Cycling and Thermal Shock 35
4.6 Software Validation Test 36
4.7 Highly Accelerated Life Test (HALT) 36
4.8 DFMEA, DRBFM and DRBTR 36
4.9 Test Reports 36
4.10 Continued Compliance 37
5 Provisions for Shipping 37
5.1 ESD Immunity 37
5.2 Physical Integrity 37
6 Notes 37
6.1 Glossary 37
6.2 Acronyms, Abbreviations, and Symbols 37
7 Additional Paragraphs 37
8 Coding System 37
9 Release and Revisions 37

1 Introduction

Note: Nothing in this standard supersedes 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.

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

1.2 Applicability. 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.

Note: Micro pulse solution will be available with Model Year 2016 and beyond.

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

- Converter Module
- Attachment Provision

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1.3 Remarks. The DC/DC converter provides continuous power to all infotainment and communication facilities to achieve “crack free” 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.

2 References

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

2.1 External Standards/Specifications.

AIAG QS-9000	SAE J1962
ISO 11469	SAE J1979
ISO/IEC 17025	QS9000

2.2 GM Standards/Specifications.

GM1829	GMW3110	GMW3232	GMW14334
GMW3059	GMW3116	GMW4710	GMW15010
GMW3091	GMW3122	GMW8287	GMW15862
GMW3097	GMW3172	GMW14082	GMW16331
GMW3103	GMW3191	GMW14241	

2.3 Additional References.

GM J1962

GM J2602-2

GMSAE156

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.

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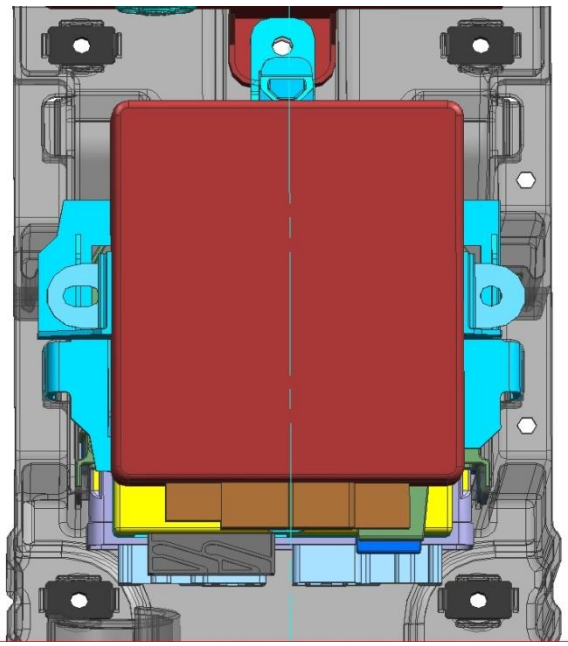
3.1.2 Housing Top View (prototype part). See Figure 1.

Figure 1: 400 W DC/DC Prototype with Bracket (D2xx)



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.

The DC/DC converter bracket mounting hole sizes shall accommodate 7.0 mm size, weld studs, or screws.

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

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, the HS-CAN vehicle 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. The DC/DC characteristic electrical behavior shall be able of being modified without being obliged to hardware changes
c. Dependent on technical requirements different part numbers shall be provided. The usage of different part numbers for production and Aftersales is specified by the GGSE Infrastructure document, which requires different values for the MEC. The MEC needs to be set to **$FE** for production parts and to **$00** for service parts. This drives two different part numbers due to different values for DID $A0.

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

The short term input current (P = 480 W, t ≤ 200 ms) 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 %. For standard Stop/Start applications (P = 400 W, t ≤ 2 s), the input current is 78 A (2 x 39 A) at 6.0 V input voltage.

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.

a. The DC/DC Converter shall be capable to provide a stabilized output voltage during cranking, which requires a maximum power of 480 W (200 ms maximum).
b. A flash controller shall provide internal signal controlling, diagnostics and the HS-CAN bus.
c. The DC/DC Converter shall have a reduced quiescent current consumption during sleep mode (100 µA).
d. The efficiency of the Boost converter shall be > 85 % over the entire operation input voltage range.
e. The converter shall stop the stabilization mode immediately if the input voltage level goes < 6.0 V.
f. The software shall be the same for all different hardware variants as long as different functionality is not requested by the GM engineer.
g. The DC/DC converter shall be easily integrated into all existing GM electrical architectures.
h. The DC/DC converter connection system shall be designed to GMW3191.
i. The DC/DC converter shall be capable of a minimum of 10 installation/cycles without any degradation or loss of performance.
j. The DC/DC converter shall diagnose internal faults and interface faults.
k. The DC/DC converter shall communicate with other devices on the vehicle using the HS_CAN serial data bus.
l. The DC/DC converter shall provide self diagnosis.
m. 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 infotainment 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 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.

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.

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e. The DC/DC Converter shall not be damaged due to shorts in output circuitry.
f. The DC/DC Converter shall protect the Outputs electronically against overload in stabilization mode and return to normal functionality again.
g. The relay must be robust against short circuits during the “Bridged Mode” (Fuse Capability: 40 A for each input).
h. 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). An electronic shutoff shall be considered to protect the power electronics from short circuits

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 ($\Delta U = \pm 0.5$ V maximum)
- Cold start functionality shall be inhibited by using the ACC and the Ignition input signal or by software
- Low input voltage levels < 6.5 V shall disable the stabilization function to avoid electrical network instability and help limiting the input current
- The unit shall meet vibration requirements according to GMW3172
- The DCDC 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
- Failure monitoring information shall be delivered via High Speed CAN

3.1.6.4 Power Output Cycle Timing.

a. The voltage stabilization has to start by being triggered through CAN Bus Signals from the ECM or hardwired 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”.
Assumption: A normal crank procedure is finished ≈ < 800 ms.
c. The DCDC 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 DCDC 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 DCDC shall switch from “stabilization mode” to the “bridged mode” (see Figure 2).

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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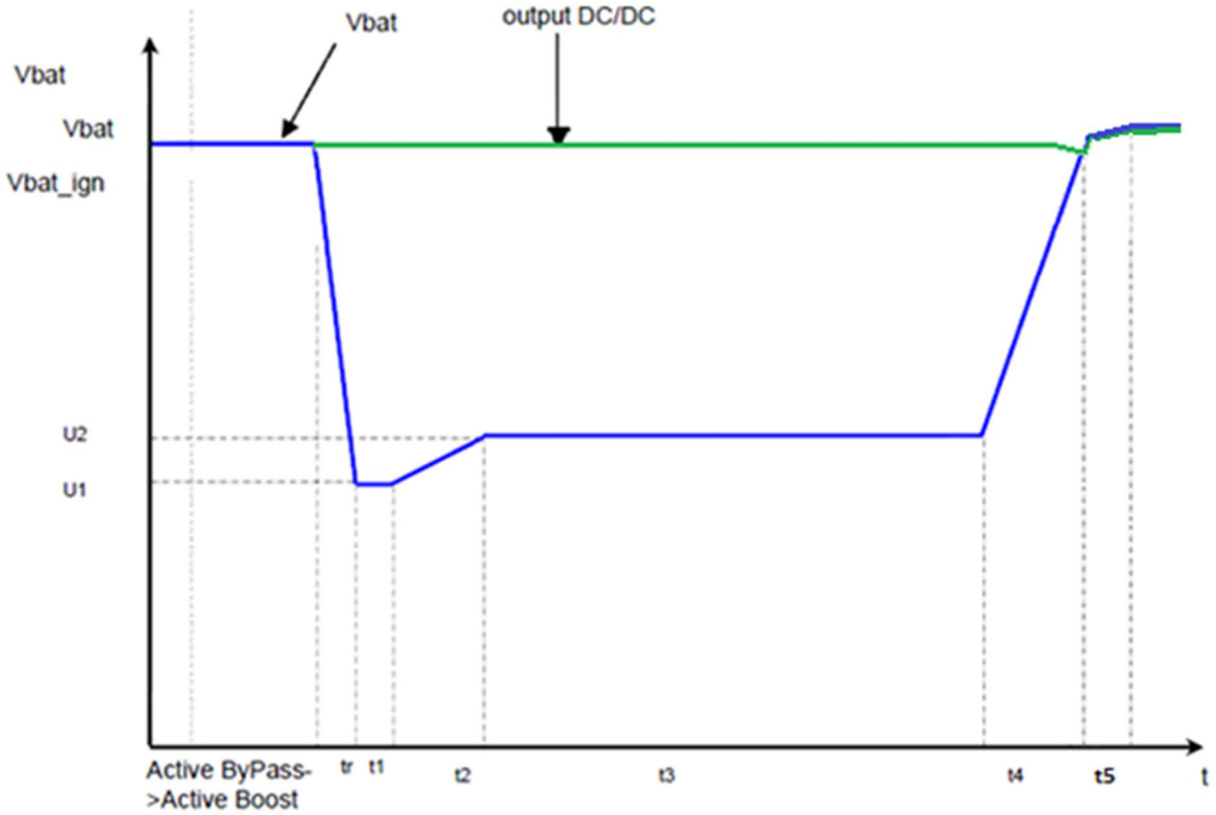
Figure 2: Ramping Function



3.1.6.6 Output Voltage Levelling 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 provide the stabilized output voltage by < 11 ms after crank trigger being received.

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_{DCDC} and U_{BAT} have a difference within a tolerance of 0.4 V (U_{DCDC} shall always be < U_{BAT})
- During the leveling Phase the necessary energy shall be taken from the battery via Booster.
- 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 (6.0 to 16) V_{DC} (see Table 1).

Note: This applies also to the CAN bus 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	6.0 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 2 “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.

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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.

Table 3: Operating Voltage - Functional Requirements

Range	Subsystem Requirements when in this operating voltage range (Functional)
VR_H	a. No function is required.
VR1	<u>VR1a – (18 to 26) V</u> a. All functions shall be in control (including diagnostics), and shall be functional or disabled. Diagnostics are allowed to run normally, but it is expected that faults which are set are legitimate and are not due to the higher voltage level. b. Upon returning to the VR2 range, the DC/DC Converter shall resume normal operation within 100 ms. <u>VR1b – (16 to 18) V</u> c. All functions shall be in control (including diagnostics), and shall be functional or disabled. Diagnostics are allowed to run normally, but it is expected that faults which are set are legitimate and are not due to the higher voltage level. d. Upon returning to the VR2 range, the DC/DC Converter shall resume normal operation within 100 ms. e. The DC/DC Converter shall maintain normal operation for 10 minutes minimum
VR2	a. Full specified operation shall be required.
VR4	a. All functions shall be in control (including diagnostics), and shall be functional or disabled. Diagnostics are allowed to run normally, but it is expected that faults which are set are legitimate and are not due to the lower voltage level. Minimum voltage level: 6.5 V
VR5	a. Same as VR4
VR_L	a. No function is required.

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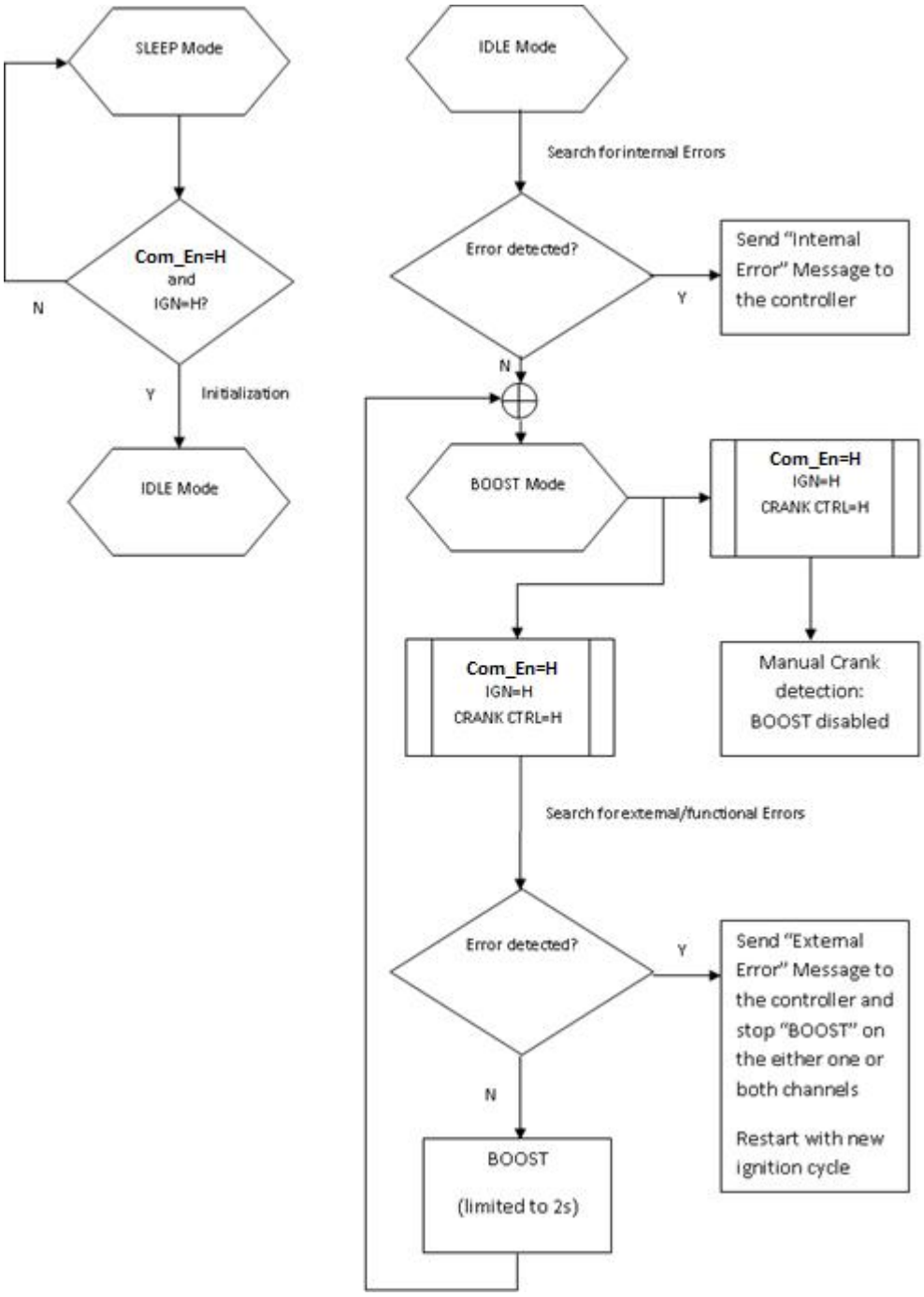
3.1.6.7 Function Transition Diagram. The desired behavior of the DC/DC Converter (features/functions), which shall meet functional requirements and its relationship to the consumers are graphically reflected in this section using Function Transition Diagrams.

Figure 3: Function Transition Diagram (Overview)



3.1.6.8 Watchdog Timer Functionality. The DC/DC Converter shall provide a Watchdog Timer function to supervise the microcontroller functionality.

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3.1.6.9 Configuration. The DC/DC Converter shall provide configuration by software changes for

1. Output Current limitation (Electronic Fusing during stabilization)
2. Information being provided for diagnostics

3.1.7 Operating Modes. The DCDC converter shall operate in one of the following power modes:

1. Low Power Mode (Sleep) – A low power mode is entered to reduce parasitic current draw when immediate processing is not required. The DCDC converter shall remain in this mode until a wake-up input is asserted or a reset occurs. The terms sleep and low power mode are interchangeable.
2. Boost Mode (Awake) – While in full power mode the processor continues to execute its normal set of operational software instructions and supports all module functions. The DCDC converter shall remain in this mode until forced into low power mode

3.1.7.1 Wake-Up Mode. The DCDC converter shall wake up when communication on the HS-CAN is detected and reacts on the system powermode transmitted by the BCM on the HS CAN.

Additionally a separate hardwired powermode RUN/Com_En signal shall be foreseen for waking up the DCDC converter.

3.1.7.2 Sleep Mode. The DCDC converter shall enter Low Power Consumption Mode when HS CAN sending is stopped AND hardwired powermode RUN signal is “LOW”.

3.1.7.3 Auto Start Mode. If AutoStop is active, the DCDC converter shall supply the output channels during automatic cranking with stabilized output voltage for 2 s maximum. If input voltage goes down below the minimum operating voltage (6.0 V minimum at 400 W output power) the DCDC converter shall go into the Bypass Mode (= Bridged Mode) for supplying the consumers directly from the Battery.

3.1.8 Design Guidelines. Not applicable.

3.1.9 Ambient Environment. Not applicable.

3.1.4 Interfaces.

3.1.4.1.1 The Converter assembly shall interface with the vehicle electrical system through a wiring harness per GMW14082.

3.1.5 Usage Definition. Not applicable.

3.2 Product Characteristics. Not applicable.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines.

3.3.1.1.1 Requirements for materials used in the DC/DC Converter are:

a. The materials shall satisfy the recycling requirements of GMW3116.
b. The materials must meet the flammability requirements according to GMW3232.
c. The materials must provide chemical resistance to fluids according to GMW14334.
d. The materials shall not contain PVC > 1 % by mass.
e. All parts that are mounted on the PCB shall be selected to be compatible with the manufacturing process.

3.3.1.1.2 Marking of Recyclable Materials. The material identification for the DCDC converter shall be as indicated by ISO 11469, and shall be approved by GM Engineering. Consideration should be given to the use of multiple identical markings on large or complex shaped parts. The marking shall be in a visible location during the assembly process.

The detail drawing shall carry the following note:

- Legible plastic compound identification symbol per ISO 11469 shall appear on the surface, raised or depressed 0.3 to 0.4.

The label shall not affect appearance, function, or assembly. Omission requires GM approval.

3.3.1.1.3 Global General Motors Lead-Free Electronics. General Motors is working to eliminate Lead (Pb) from electrical and electronic assemblies beginning with 2009 model year vehicles.

GMW3172 provides the appropriate validation criteria.

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