



400 W Modified Sine Wave DC-AC Power Inverter

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 outlines the design, performance, appearance, and validation requirements for a 400 W Modified Sine Wave DC-AC Power Inverter. This assembly shall allow the user to power devices continuously up to 400 W in 120 V_{AC} at 60 Hz or 225 V_{AC} at 50 Hz appliances. This assembly shall consist of the power inverter and attachment provisions. Unless otherwise specified, requirements described herein shall apply to the power inverter assembly using production intent connectors and hardware.

1.2 Applicability. The GM Worldwide corporate common component 400 W Modified Sine Wave DC-AC Power Inverter is intended to provide the user with AC output power as a convenience feature. The assembly shall contain the ability to provide sufficient AC power for 400 W and lower power devices. The power inverter will have an output of 125 V_{AC} at 60 Hz or 225 V_{AC} at 50 Hz depending on regional requirements.

This document provides specifications for the 400 W Modified Sine Wave DC-AC Power Inverter, in the areas of performance, reliability and customer perception.

1.3 Remarks. The following is a specific classification of the assembly described in this document.

The 400 W Modified Sine Wave DC-AC Power Inverter will contain one each of the following:

- Inverter Module
- Attachment Provision

1.3.1 Limitations. This standard should not prevent the manufacturer from suggesting alternative approaches which would result in an improved or a more cost effective product. The manufacturer is encouraged to pursue such changes with the appropriate GM Design Release Engineer and Purchasing Agent.

It should be noted that the tests described herein generally produce stresses in excess of those found under normal customer usage. They are designed to provide an evaluation of product performance and durability in a time span considerably less than the expected life of the product. Furthermore, severe stresses are often applied to identify product design limits to ensure a significant margin of safety. Therefore, interpretation of these results must be made with care. Failure of any such test does not imply a likelihood of failure in the field.

2 References

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

2.1 External Standards/Specifications.

ISO 1431-1

2.2 GM Standards/Specifications.

GM1829	GMW3059	GMW3089	GMW3091
GMW3097	GMW3103	GMW3104	GMW3110
GMW3113	GMW3116	GMW3172	GMW3191
GMW3232	GMW4710	GMW8287	GMW8739
GMW14082	GMW14241	GMW14334	GMW14573
GMW15010	GMW15841	GMW15862	TLE-050046

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3 Requirements

The following sections describe in detail the specific functional, physical and electrical capabilities required to satisfy this specification.

3.1 System/Subsystem/Component/Part Definition. The DC-AC Inverter, which is mounted in the interior compartment or trunk, shall be used to provide AC output power for AC appliances. The subsystem integration must comply with TLE-050046.

3.1.1 Appearance. The inverter appearance shall reflect quality design and shall not have scratches, cracks, nicks, sink marks, knit lines, blisters or other abnormalities reflecting poor workmanship.

3.1.2 Content. The required physical and functional content for the assembly is the described in the following paragraphs.

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

3.1.2.1.1 Inverter Assembly. The inverter assembly contains the DC to AC power control electronics, integral connector(s) (for DC input, AC output and remote power switch) and heat dissipation packaging.

3.1.2.1.2 Inter-Connect. The inverter assembly shall have connectors integral to the respective package. The supplier and General Motors Corporation shall jointly agree upon a suitable connection system. Connection interfaces shall comply with GMW3191 Connector Test and Validation Specification and GMW3172 General Specification for Electrical/Electronic Components. Pin-outs shall be specified on the released product drawing. Pin-outs cannot be changed without written authorization of GM Engineering.

3.1.2.2 Functional Content. The AC Inverter Assembly shall be used to operate the functions stated below.

3.1.2.2.1 Inverter Function Overview. The inverter assembly shall provide the following features:

3.1.2.2.1.1 The inverter shall be capable of continuously powering AC loads that require power within 400 W and providing necessary surge power, as described in paragraph 3.2.1.4 Surge Power, to start such loads.

3.1.2.2.1.2 The inverter shall output a modified sine wave AC output.

3.1.2.2.1.3 The inverter shall provide a safety feature to allow for an external activate signal (separate from DC input power) to allow start up and shut down from an input vehicle ignition status. An AC control switch shall be considered to activate the inverter AC output power function. More details are described in paragraph 3.1.2.2.2 Electrical Mechanization.

3.1.2.2.1.4 The inverter shall provide occupant shock protection via incorporation of galvanic isolation between the DC input and AC output portions of the power electronic circuit. Additionally, an isolation fault protect function shall disable AC output when AC current is diverted from the intended circuit via a fault path.

3.1.2.2.1.5 The inverter shall provide a GMLAN LOW Speed Serial Data Interface. GM LAN is a bi-directional communication. Please refer to the GMLAN specifications for device implementation in LSGMLAN GMW14241, GMW3110, GMW3104 and GMW3089.

3.1.2.2.1.6 The Inverter shall store and provide Diagnostic information to the test tool via serial data connection according to GMW3110, such as

- Input Voltage Level
- Output Voltage level
- Output Active Flag
- Load Shedding Active (True/False)
- Micro Switch Error Diagnosis
- Electrical Load status in %
- Hardware failures (DTCs tbd.)
- Internal failures:
 - Controller error,
 - A/D converter error,
 - Boost Error,
 - Relay Error,
 - Operating temperature exceeded

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- External failures
Overload and or short circuit
Input Voltage high,
Input Voltage Low,
Residual Current detected
- Lost Communication

The data shall be available via the diagnostic link. A CPID for Inverter Shut Off shall be defined.

3.1.2.2.1.6.1 Signal Definition for Diagnosis.

DC/AC_PIDs Version 3.0

PID NUMBER	Name	SHORT NAME	DATA TYPE	BYTE LENGTH	BIT DESCRIPTION	SCALING	ENG. UNIT	RESOLUTION	OFFSET	RANGE	MODULE	ARCHITECTURE
4407	Load Shed Level Feedback	LdShLevFdbk	ENM	1	N/A	\$00 = None \$01 = Level 1 \$02 = Level 2 \$03 = Level 3	N/A	N/A	N/A	N/A	DC/AC Converter	Global A
4408	High Voltage Inverter Output Voltage	HVinVOutVlt	UNIM	1	N/A	E = N	Volts	1	0	0 to 255	DC/AC Converter	Global A
4409	High Voltage Inverter System Status	HVinVStat	BITPKD	1	B6 to B7: Reserved B5: High Voltage Output Enable Switch Closed B4: Main Relay Active B3: High Voltage Inverter Active B2: Stabilization Mode Active B1: Output 2 Enabled B0: Output 1 Enabled	B6 to B7: Undefined B5: 1 = True 0 = False B4: 1 = True 0 = False B3: 1 = True 0 = False B2: 1 = True 0 = False B1: 1 = True 0 = False B0: 1 = True 0 = False	N/A	N/A	N/A	N/A	DC/AC Converter	Global A
440A	High Voltage Inverter Temperature	HVinVTemp	UNIM	1	N/A	E = N - 40	°C	1	-40	-40 to 215	DC/AC Converter	Global A
440B	High Voltage Inverter Output Power	HVinVOutPwr	UNIM	2	N/A	E = N	Watts	1	0	0 to 65535	DC/AC Converter	Global A
440C	High Voltage Inverter Input Voltage	HVinVInpVlt	UNIM	1	N/A	E = N * 0.05 * 6	Volts	0.05	6	6 to 18.75	DC/AC Converter	Global A
8002	System Power Mode	SysPwrMd	ENM	1	N/A	\$00 = Off \$01 = Accessory \$02 = Run \$03 = Crank request \$04 to \$FF = Reserved	N/A	N/A	N/A	N/A		Common Arch.
90F8	Battery Running State of Charge	BattRunSOC	UNIM	2	N/A	E = N * 0.0030517578125	%	0.003051758	0	0 - 199.9969482421875	BCM	Global A

3.1.2.2.1.6.2 Diagnostic Address and CAN IDs.

Diagnostic Address: \$CF
Diagnostic Request CAN Id: \$243
Diagnostic Response CAN Id - UUDT: \$543
Diagnostic Response CAN Id - USDT: \$643

Rationale: The Diagnostic CAN IDs are already assigned to the Auxiliary Gage Control ECU. This ECU is only used on the Camaro. In the event that the Camaro needs to add this DCAC, it will require managing the CAN IDs for this one vehicle (AGC or DCAC would have to use a different Id based upon the superset of ECUs used for the Camaro) rather than for multiple vehicles.

3.1.2.2.1.7 The Inverter shall read in serial data information coming from the BCM, which is necessary to decide on when the DC/AC needs to be disabled or not. This includes the consideration of Load Shed levels and /or the evaluation of the engine speed as shutoff criteria.

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3.1.2.2.1.7.1 Communication Signal Definition.

			Rx Signals						
GMLAN Frame	Tx	Rx	Signal Long Name	Short Name	Signal Type	Bit Length	Data States/Range	Conversion	Periodic Interval (ms)
\$0C9 (HSGMLAN)	ECM	Need BCM to receive and gate to LSGMLAN to DC/AC	Engine 12 Volt Starter Motor Commanded On	Eng12vStrtrMtrCmdOn	BLN	1	0 = False; 1 = True		100
\$10240040 (LSGMLAN)	BCM	Add DC/AC as receiver	System Power Mode	SysPwrMd	ENM	2	0 = Off; 1 = Accessory; 2 = Run; 3 = Crank Request		500
\$10248040 (LSGMLAN)	BCM	Add DC/AC as receiver	Battery State of Charge	BatSOC	UNM	8	0% - 100.000035%	E=N*0.392157[%]	500
\$10248040 (LSGMLAN)	BCM	Add DC/AC as receiver	Energy Management Load Shedding Request	EngMgtLdShdRq	ENM	4	\$0 = No Load Shedding; \$1 = Load Shed Level 1; \$2 = Load Shed Level 2; \$3 = Load Shed Level 3; \$4 = Load Shed Level 4		500
\$102CA040 (LSGMLAN)	BCM	Add DC/AC as receiver	Engine Speed	EngSpd	UNM	16	0rpm - 16383.75rpm	E=N*0.25[rpm]	100
\$102CC040 (LSGMLAN)	BCM	Add DC/AC as receiver	Engine Run Active	EngRunAtv	BLN	1	0 = False; 1 = True (equals True during Auto Stop and when ICE is running)		250
\$1A3 (HSGMLAN)	ECM	Need BCM to receive and gate to LSGMLAN to DC/AC	Engine Running	EngRunng	BLN	1	0 = False; 1 = True (equals True when ICE is running)		100

Note: The signals might change during product development.

Internal Load Shed Behavior. See Table 1.

Table 1: Internal Load Shed Behavior

Component	Load Shed Level #1	Load Shed Level #2	Load Shed Level #3
Engine "ON"	400 W DC/AC Inverter "enabled"	400 W DC/AC Inverter "disabled"	400 W DC/AC Inverter "disabled"
Engine "OFF"	400 W DC/AC Inverter "disabled"	400 W DC/AC Inverter "disabled"	400 W DC/AC Inverter "disabled"
Comments: a) Possibly look for different calcs, if we must maintain it during Engine "OFF" b) Load shed behavior could be defined according to electrical load			

Diagnostic Services: Data Identifiers (DIDs). The DIDs listed in this section are required for AVG and Service and Parts Operations to perform assembly plant testing, flash programming, configuration, diagnosis and repair of vehicles.

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Table 2: DID Summary List

DID #	DID Specification Location	DID Description
\$90	GMW3110	Vehicle Identification Number
\$92	GMW3110	System Supplier Id
\$98	GMW3110	Repair Shop Code Or Tester Serial Number
\$99	GMW3110	Programming Date
\$9A	GMW3110	Diagnostic Data Identifier
\$9F	GMW3110	Previous Stored Repair Shop Code Or Tester Serial Numbers
\$A0	GMW3110	Manufacturers Enable Counter (MEC)
\$AB	GMW3110	Compressed Vehicle Partitioning and Product Structure
\$B0	GMW3110	ECU Diagnostic Address
\$B3	GMW3110	Data Universal Numbering System Identification
\$B4	GMW3110	Manufacturing Traceability Characters
\$B5	GMW3110	GM Broadcast Code
\$C0	GMW3110	Boot Software Part Number
\$C1	GMW3110	Software Module Identifier 1
\$C2	GMW3110	Software Module Identifier 2
\$CB	GMW3110	End Model Part Number
\$CC	GMW3110	Base Model Part Number
\$D0	GMW3110	Boot Software Part Number Alpha Code
\$D1	GMW3110	Software Module Identifier 1 Alpha Code
\$D2	GMW3110	Software Module Identifier 2 Alpha Code
\$DB	GMW3110	End Model Part Number Alpha Code
\$DC	GMW3110	Base Model Part Number Alpha Code
\$DE	GMW3110	GMLAN Identification Data

Table 3: Error Messages for Diagnostics

Error messages DC/AC-Inverter					
Subject	Error Message	DTC	DTC Descriptor	FTB	FTB Descriptor
CAN Communication (LS_CAN)	Invalid Data	U0140	Lost Communication With Body Control Module	00	---
	Lost Communication	U0422	Invalid Data Received From Body Control Module	00	---
DC/AC Output Voltage	Short to ground	B1445	Control Module Voltage Output Circuit	02	
	Voltage High (U _A >110% U _{nominal})	B1445	Control Module Voltage Output Circuit	07	voltage above threshold
	Voltage Low (U _A <90% U _{nominal})	B1445	Control Module Voltage Output Circuit	03	voltage below threshold
	Overload (P _A > 400W, t > 5s)	B1445	Control Module Voltage Output Circuit	08	current above threshold
DC/AC Input Voltage	Voltage Low (U _{BAT} < 11V)	B1325	Control Module Power Circuit	12	voltage below threshold
	Voltage Low (U _{BAT} < 9V)	B1325	Control Module Power Circuit	03	voltage below threshold
	Voltage High (U _{BAT} >16V)	B1325	Control Module Power Circuit	07	voltage above threshold
Internal Failure	Boost failure	B101D	Electronic Control Unit Hardware	39	Internal Malfunction
		B101D	Electronic Control Unit Hardware	34	RAM Malfunction
		B101D	Electronic Control Unit Hardware	35	ROM Malfunction
		B101D	Electronic Control Unit Hardware	36	EEPROM Performance/Malfunction
	Main Relay (Open Circuit)	B151E	Accessory AC/DC Power Control Module Relay Circuit	04	
					Add FTBs as needed!

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ACC (Accessory)
 CAN_A (LS_CAN, Single Wire)
 Batt+ (switched via Main Relay)
 Outlet 1 Enable
 Outlet 2 Enable *
 AC_N1 (Output, Return 1)
 AC_N2 (Output, Return 2) *
 AC_L1 (Output 1)
 AC_L2 (Output 2) *
 Main Relay Control
 GND (Input)
 GND (Screen, Protection)

Note: Signals marked with an asterisk (*) are optional for dual outlet application.

3.1.2.2.1.8 The inverter shall incorporate the following user and device protections via electronic control that interrupts AC output power under the following circumstances:

- Isolation Fault Protection detects fault path;
- Over load of inverter output via short circuit or from AC appliance;
- Over voltage of DC input beyond $16.0 V_{DC}$;
- Under voltage of DC input below $11.0 V_{DC}$.

The restart shall be possible only upon fault removal.

For faults described in items a, b and c the restart can be manual, cycling of Activate Signal by AC control switch described in paragraph 3.1.2.2.2 Electrical Mechanization.

For fault described in item **d)**, the restart will be automatic, with no required customer action, if conditions described in Table 4 are attended. Otherwise, the restart can be manual.

Table 4: Minimum Input Voltage and Maximum Fault Duration to Guarantee Automatic Restart

DC Input Voltage	Fault Duration	Restart Type
$< 11 V_{DC}$	$\leq 4 \text{ s}$	Automatic
$< 10 V_{DC}$	$\leq 3 \text{ s}$	Automatic
$< 9 V_{DC}$	$\leq 1 \text{ s}$	Automatic

3.1.2.2.2 Electrical Mechanization. The electrical mechanization for the Inverter and AC Receptacle Assembly is shown in Figure 1 and Figure 2. Wiring harness team shall define when AC line shielding is needed. Additionally there can also be the need for twisted “high voltage” wires to be able to reduce radiation effects. The decision shall be made by the EMC team in alignment with the harness team.

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DC/AC Assembly



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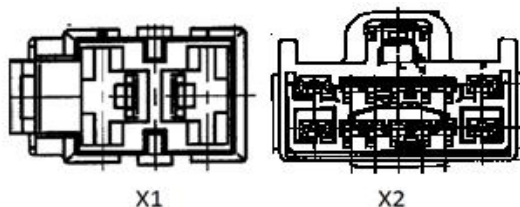
Table 5: Connector Pins and Load Assignment

ID	Pin #	Wire Cross diameter (mm ²)	Pin Dimensions	Signal Description	Nominal Load (230 V)	Nominal Load (120 V)	Peak Load
X1 (2Pin)	tbd	4 to 6	9.5 mm	Battery Plus (+). switched via main relay	43 A	43 A	tbd
X1 (2Pin)	tbd	4 to 6	9.5 mm	Input Ground (Battery Minus)	43 A	43 A	tbd
X2 (14Pin)	tbd	0.5 to 0.75	1.5 mm	Accessory input	10 mA	10 mA	20 mA
X2 (14Pin)	tbd	0.5 to 0.75	1.5 mm	Low Speed CAN. Serial Bus	10 mA	10 mA	20 mA
X2 (14Pin)	tbd	0.5 to 0.75	tbd	Reserved	tbd	tbd	tbd
X2 (14Pin)	tbd	0.75	1.5 mm	External Main Relay Control Output	200 mA	200 mA	300 mA
X2 (14Pin)	tbd	0.5 to 0.75	1.5 mm	Outlet Voltage Enable Input 1	10 mA	10 mA	20 mA
X2 (14Pin)	tbd	0.75	2.8 mm	High AC Voltage Output 1	1.85 A	3.7 A	see definition
X2 (14Pin)	tbd	0.75	2.8 mm	High AC Voltage Return 1	1.85 A	3.7 A	see definition
X2 (14Pin)	tbd	0.5 to 0.75	1.5 mm	Outlet Voltage Enable Input 2	10 mA	10 mA	20 mA
X2 (14Pin)	tbd	0.75	2.8 mm	High AC Voltage Output 2	1.85 A	3.7 A	see definition
X2 (14Pin)	tbd	0.75	2.8 mm	High AC Voltage Return 2	1.85 A	3.7 A	see definition
X2 (14Pin)	tbd	n.a.	1.5 mm	Ground. AC Wire Screen (EMC Protection)	n.a.	n.a.	n.a.
X2 (14Pin)	tbd	n.a.	1.5 mm	Ground. AC Wire Screen (EMC Protection)	n.a.	n.a.	n.a.

Connector Proposal, 120 V AC Version. See Table 6.

Table 6: Connector Proposal, 120 V AC Version

Connector Designation	GM Connector Part Number	In GM Global Connector Catalog?	Connector System Supplier	Supplier Connector Part Number
X1 (2 pin)	13581072	Y	Yazaki	7123-4123-30
X2 (14 pin)	tbd.	Y	Yazaki	7283-6447-40



Connector Proposal, 230 V AC Version. See Table 7:

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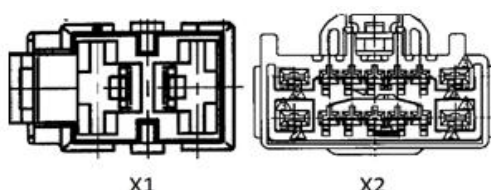
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Table 7: Connector Proposal, 230 V AC Version

Connector Designation	GM Connector Part Number	In GM Global Connector Catalog?	Connector System Supplier	Supplier Connector Part Number
X1 (2 pin)	13581072	Y	Yazaki	7123-4123-30
X2 (14 pin)	13581064	Y	Yazaki	7283-5623-30



3.1.2.2.3 Variants dependent on Technical Requirements. 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 shall 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.

3.1.3 Ambient Environment. This paragraph defines the environmental conditions that the vehicle may experience during its intended life within its target market. Unless otherwise specified, the inverter assembly shall meet the performance requirements specified herein and operate without physical damage or functional degradation when exposed to the following ambient and operating environmental conditions. The validation of these requirements is defined in paragraph 4 Validation. The code letter to check environment requirements according to GMW3172 General Specification for Electrical/Electronic Components is **ZGCDBIP5K3**.

3.1.3.1 Temperature. The inverter assembly shall adhere to the following thermal environmental conditions.

3.1.3.1.1 Operating Temperature Range. The environmental temperature of operation is defined as the temperature range at which the inverter assembly functions are intended. Normal operating temperature shall be designated at +23 °C. The requirements are as follows:

3.1.3.1.1.1 Inverter assembly components (electrical and mechanical) shall function as described herein while exposed to a temperature range of (-40 to +85) °C.

3.1.3.1.1.2 Inverter shall be capable of delivering rated AC Power over a temperature range of (-40 to +50) °C as defined in paragraph 3.2.1.3 Continuous Output Power.

3.1.3.1.2 Storage Temperature Range. The assembly shall operate without damage or performance degradation when subjected to a storage temperature of (-40 to +95) °C.

3.1.3.2 Humidity. The inverter assembly shall meet the requirements of Humid Heat Cyclic (HHC) and Humid Heat Constant (HHCO) from GMW3172 with a 200 W resistive load.

3.1.3.3 Frost. The inverter assembly shall meet the requirements of GMW3172 with 200 W resistive load.

3.1.3.4 Vibration with Thermal Cycling. The inverter assembly shall be immune to vibration that occurs in the vehicle meeting requirements of GMW3172.

3.1.3.5 Thermal Shock. The inverter assembly shall resist cracking and crazing of encapsulated compounds, opening of case seams or changes in electrical or mechanical characteristics due to component displacement or rupture, upon completion of Thermal Shock Air-to-Air and Power Temperature Cycle according to GMW3172.

3.1.3.6 Chemical Loads. The inverter assembly shall withstand exposure to the following fluids:

3.1.3.6.1 Coffee or soft drinks: when tested according to Sugar Water Function Impairment from GMW3172.

3.1.3.6.2 Cleaning agents for interior: when tested according to Chemical Resistance to Fluids from GMW14334 using fluids classified with the code A.

3.1.3.7 Free Fall. The inverter assembly shall meet the requirements of GMW3172.

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