GM	WORLDWIDE ENGINEERING STANDARDS	General Specification Electrical/Electronic	GMW8763

Platform to Powertrain Electrical Interface Specification Power and Ground Subsystem

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 Scope. The platform shall provide power and ground from the charging and energy storage subsystem to all powertrain components, as defined in this general specification.

1.2 Mission/Theme. Not applicable.

1.3 Classification. This specification applies to all vehicles.

1.4 Applicability. The **GMW8762** Platform to Powertrain Electrical Interface (PPEI) Standard Specification includes: General Information, On-Board Diagnostics and Electrical Requirements and GM Local Area Network (GMLAN) Serial Data Signal Definitions and Framing for the following nineteen PPEI subsystems standard specifications:

- **GMW8763** Power and Ground
- **GMW8764** Four Wheel Drive/All Wheel Drive Controls
- **GMW8765** Displays and Gauges
- **GMW8766** Engine Power Management
- **GMW8767** Starter Control
- **GMW8768** Vehicle Theft Deterrent
- **GMW8769** Cruise Control
- **GMW8770** Cooling Fan Control
- **GMW8771** Air Conditioning Compressor Control
- **GMW8772** Serial Data Architecture
- **GMW8773** Brakes and Traction Control
- **GMW8774** Enhanced Evaporative Emissions and Fuel
- **GMW8775** Exhaust After-Treatment
- **GMW8776** Suspension Control
- **GMW8777** Transmission
- **GMW8778** Generator Control
- **GMW8779** Post Collision Operation
- **GMW8780** Power Take-Off and Fast Idle Control
- **GMW8781** Vehicle Speed and Rough Road Sensing

Each of the 19 PPEI subsystem standard specifications contains the hardware, serial data, algorithms and calibrations for the named subsystem.

The master PPEI document and all 19 PPEI subsystem standard specifications are required to define the complete set of PPEI requirements.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3059	GMW8772
GMW3097	GMW8773
GMW8762	GMW8774
GMW8764	GMW8775
GMW8765	GMW8776
GMW8766	GMW8777
GMW8767	GMW8778
GMW8768	GMW8779
GMW8769	GMW8780
GMW8770	GMW8781
GMW8771	

2.3 Additional References.

SSTS-EICC-80.201.01

3 Subsystem Requirements

3.1 Functional Overview. Powertrain components shall receive system voltage from the Platform using continuous and switched battery. Components connected directly to battery shall minimize standby current. If regulated voltage is required for a powertrain component, Powertrain

will be responsible for providing it, either as part of the component design or from another powertrain component, such as the Engine Control Module (ECM).

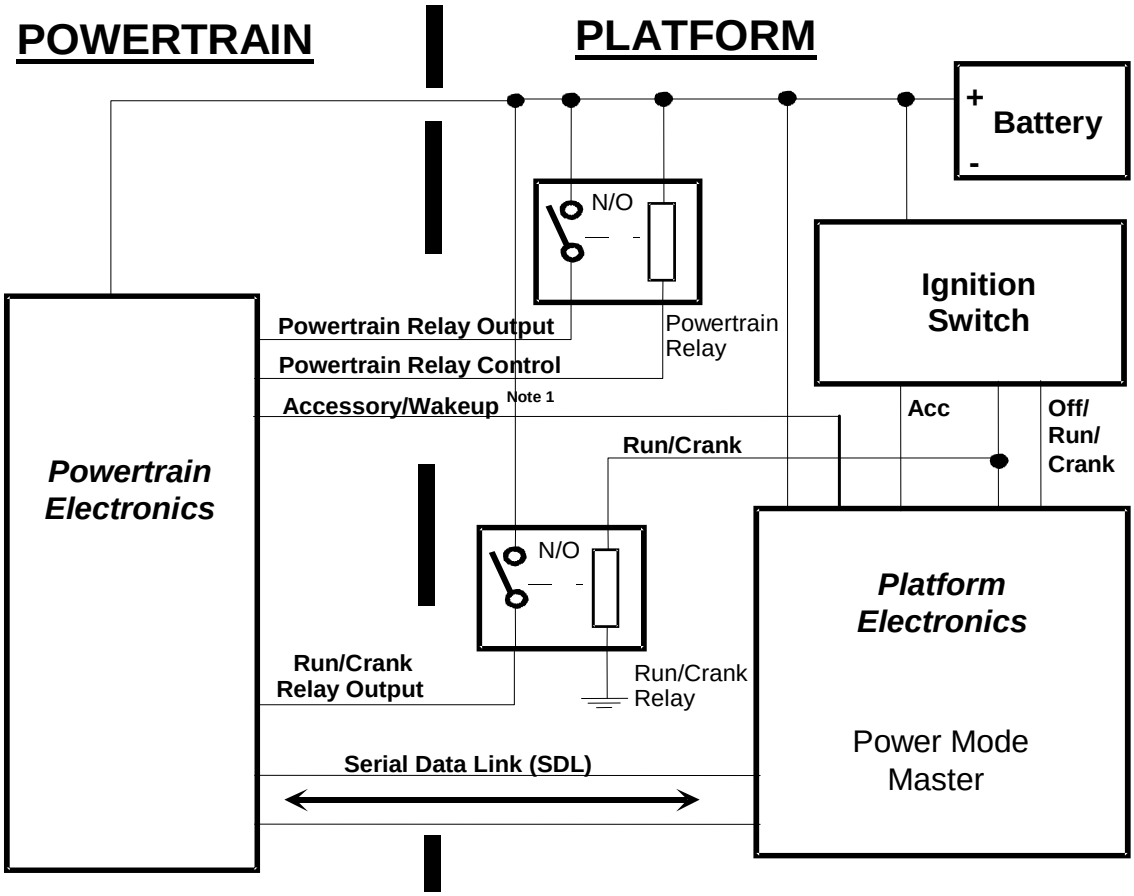
The Powertrain electronics require battery voltage, switched battery voltage, and ground from the vehicle electrical system. The Powertrain electronics utilize these inputs to generate regulated power as a source for certain internal circuits and as a source to power or control certain external loads. The switched battery input, typically in conjunction with a software turn-off delay, controls Powertrain electronics use of unswitched battery power, except for a small amount of power needed for keep-alive memory functions.

3.2 Hardware Overview. The hardware involved includes powertrain electrical components and the vehicle electrical system. The vehicle electrical system includes such items as generator, battery, vehicle wiring harnesses, relays, fuses, and ignition switch.

All Platforms shall provide an Accessory/Wakeup switched battery input to Powertrain. All Platforms shall provide a Run/Crank relay and a Powertrain relay. The Powertrain relay provides switched battery power, engine shutdown management, and reverse battery protection for some powertrain components. Powertrain shall provide circuit partitioning requirements to Platform.

3.2.1 Power Moding Block Diagram.

3.2.1.1 Ignition Key Switch. The following block diagram (Figure 1) depicts the typical mechanization for an Ignition Key switch. The electrical interface between Powertrain and Platform is the only standard defined.



Note 1: The Accessory/Wakeup line may be connected directly to the Accessory signal from the ignition switch if this signal is not driven by the platform electronics to provide wakeup in the OFF power mode (i.e., signal is only active in Accessory).

Figure 1: Ignition Key Switch Block Diagram

3.2.1.2 Easy Key. The following block diagram (Figure 2) depicts the typical mechanization for Easy Key. The electrical interface between Powertrain and Platform is the only standard defined. Refer to the Easy Key Subsystem Technical Specification.

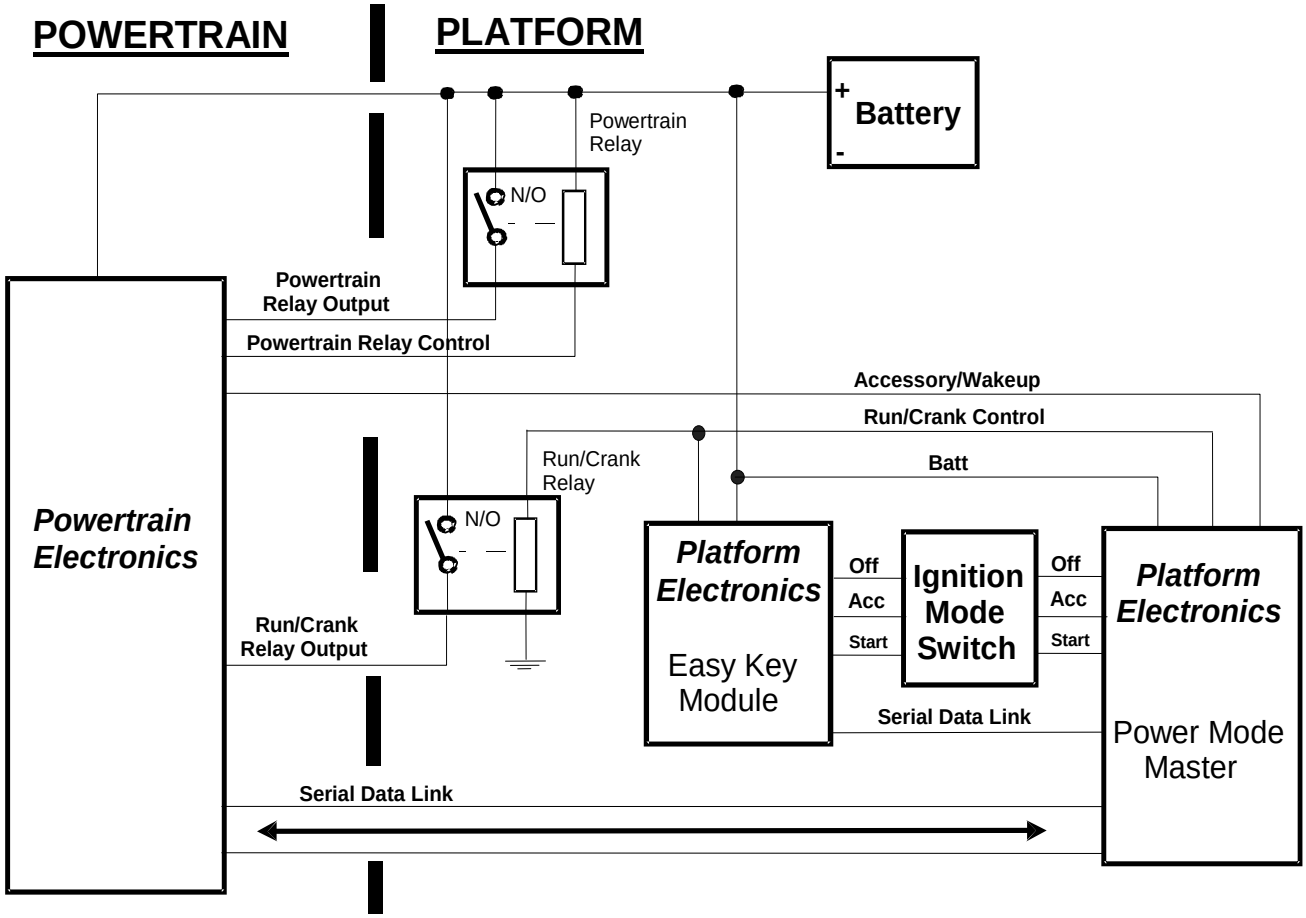
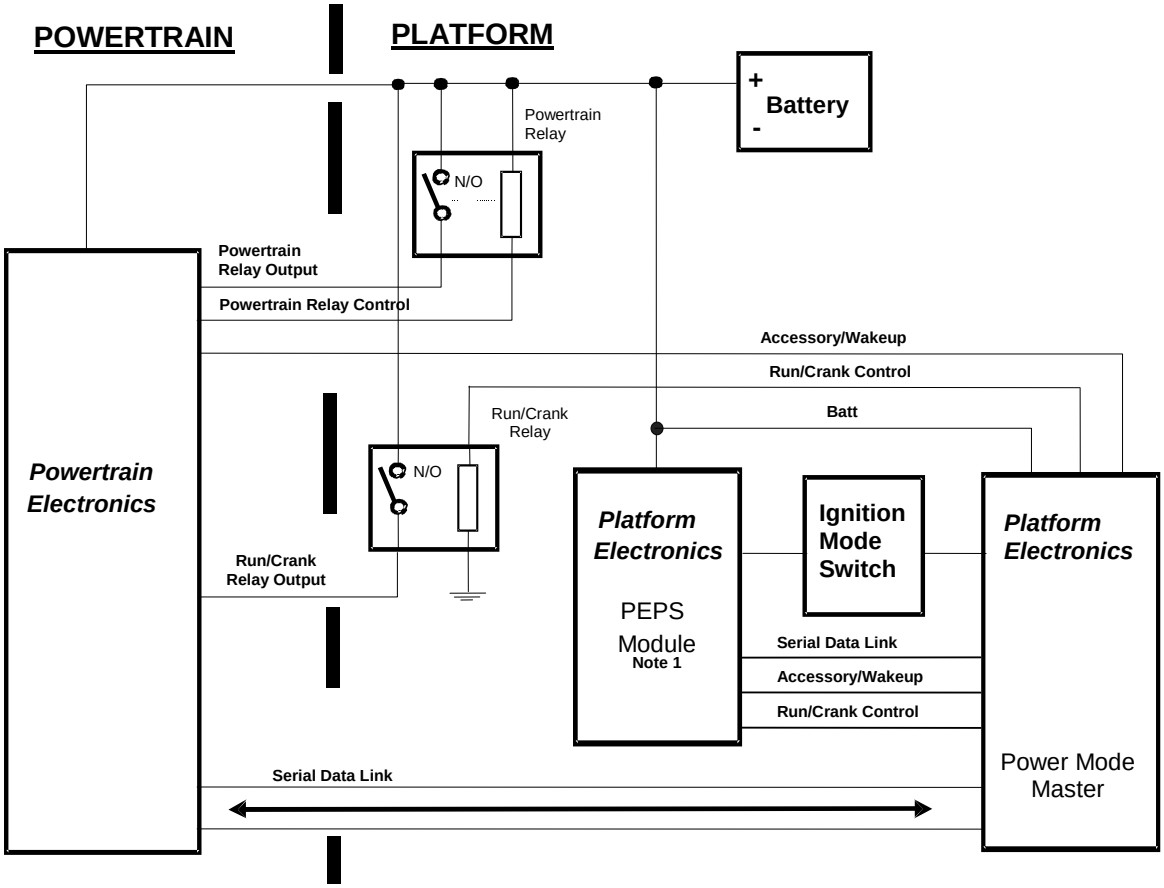


Figure 2: Easy Key Block Diagram

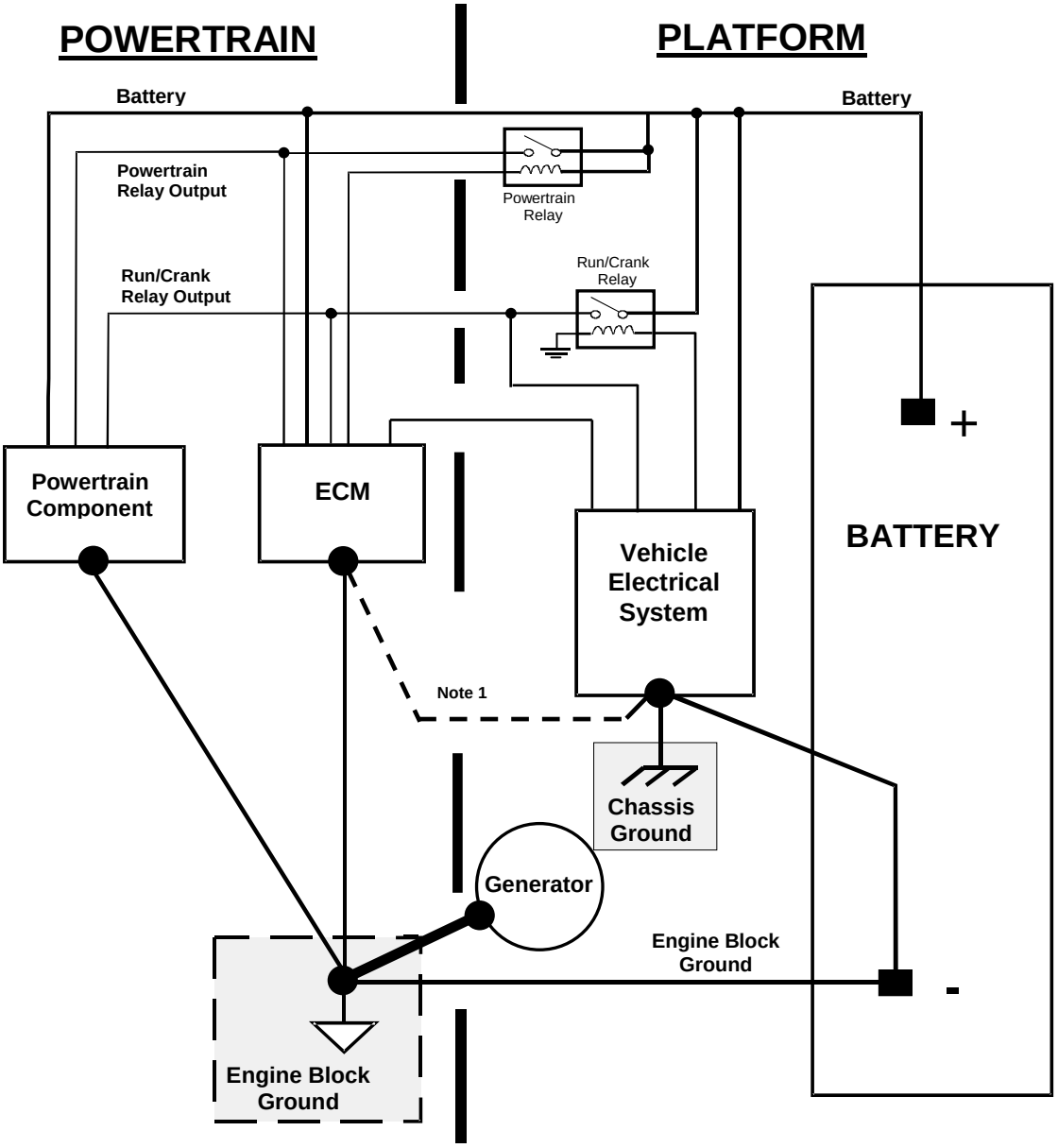
3.2.1.3 Passive Entry Passive Start (PEPS) The following block diagram (Figure 3) depicts the typical mechanization for the Passive Entry Passive Start (PEPS). The electrical interface between Powertrain and Platform is the only standard defined. Refer to the PEPS Subsystem Technical Specification.



Note 1: For manual transmissions, PEPS system requires a Clutch Pedal Position (CPP) sensor. Refer to GMW8777.

Figure 3: PEPS Block Diagram

3.2.2 Power and Signal Distribution Block Diagram. The following block diagram (Figure 4) is for illustrative purposes only.



DEFINITIONS:

Terminal Component Ground

This symbol is the generic Vehicle System Ground that could be physically connected to the Engine Block or Chassis Ground. This symbol is used throughout the document.

Note 1: Refer to paragraph 3.3.7.

Figure 4: Power and Signal Distribution Block Diagram

3.2.3 Power and Signal Distribution Requirements. Powertrain current requirements will be negotiated for each application, along with the fusing and other distribution needs.

The "Engine Run Critical" fuse(s) shall include components that must be powered to operate the engine.

The "Emission Critical" fuse(s) shall include components required for emission control, but are not required for engine operation.

3.2.4 Power Distribution Requirements. In order to enable common power distribution wiring designs (e.g., relay centers) the following components (if used) shall be partitioned to the specified power source below (See Table 1). Those devices partitioned to the Powertrain relay were considered for reverse battery activation prevention, requirements to operate after key-off, reverse battery protection and/or diagnostic consistency.

Table 1: Power Distribution Requirements [Note 1]

Powertrain Relay	Run/Crank Relay	Battery
Air Injection Reaction (AIR) Pump Relay Coil	Four Wheel Drive (4WD) Control Module	AIR Pump Relay Contacts
AIR Valve	4WD Secondary Axle Assembly	AIR Valve Relay Contacts
AIR Valve Relay Coil	4WD Switch Displays	ECM Battery Input
Cam Phaser Solenoids	ECM Run/Crank Input	Engine Cooling Fan Relay Contacts
Compressor Control Relay Coil		
Engine Cooling Fan Relay Coil	Fuel Pump Control Module	Starter Relay Contacts
Electronic Traction Control (ETC) Motors Via ECM	Transmission Control Module (TCM) Run/Crank Input	TCM Battery Input
Fuel Injectors	Top of Travel Clutch Switch	Turbo Cooling Fan Relay Contacts
Ignition Coils	Transmission Solenoids	
Mass Air Flow Sensor	Vent solenoid (non Engine Off Natural Vacuum (EONV))	Vent Solenoid (EONV)
O2 Heaters	Malfunction Indicator Lamp (MIL)	MIL
Overrun Air Solenoid		
Purge Solenoid		
Turbo Cooling Fan Relay Coil		
Variable Intake Solenoid		
Wastegate Solenoid		

Note 1: Exceptions to above:

- Fuel Pump Relay contacts may be sourced to either Run/Crank or Battery
- Fuel Pump Control Module may be sourced to the Powertrain Relay on Saab vehicles with Saab powertrains
- Hardwired MIL display may be sourced to Accessory Wake/Up, Run/Crank Relay Output or Battery
- Hardwired Brake Pedal Apply switch may be sourced to either Run/Crank or Battery

3.3 Interface Description. North American applications shall follow the GMNA Power Moding Specification Version 3.1 or later applicable version.

3.3.1 Serial Data Link. Reference GMW8762 Section 4 PPEI GMLAN Signal Definitions and Framing for definitions of signals listed in Table 2.

Table 2: Power and Signal Distribution Serial Data Signals

Signal Name	Transmitter	Notes
Backup Power Mode Master Virtual Device Availability	Platform	Required
Engine Run Active	Powertrain	Required
Power Mode Master Accessory Terminal Status	Platform	Required
Power Mode Master Run Crank Terminal Status	Platform	Required
System Backup Power Mode	Platform	Required
System Backup Power Mode Enabled	Platform	Required
System Power Mode	Platform	Required

3.3.2 Accessory/Wakeup. All Platforms shall provide an Accessory/Wakeup switched battery input to Powertrain.

The Powertrain electronics shall have a logic input that connects to the Accessory/Wakeup signal. This input shall be used for detecting wake-up.

For ignition key switch mechanizations, switched battery voltage shall be applied to the Accessory/Wakeup signal in the ACCESSORY and RUN ignition switch positions. For Easy Key mechanizations, a high side drive output from the Power Mode Master shall activate the Accessory/Wakeup signal in the ACCESSORY and RUN power modes. PEPS (only) can also drive the Accessory/Wakeup signal in the ACCESSORY and RUN power modes For any mechanization, Accessory/Wakeup may also be activated if communication is required in the OFF power mode.

The Accessory/Wakeup signal shall be deactivated in the Crank Request power mode and reactivated upon return to RUN to provide a hardwire signal to exit Crank Request power mode and to allow backup start capability. The Powertrain electronics shall use this signal to perform required Platform functions (i.e., communication of oil life reset and transmission mode information via the serial data link) in the ACCESSORY or OFF power modes.

3.3.3 Run/Crank Relay Output. The Powertrain electronics shall have an input that connects to the Run/Crank relay output. This input shall be used for detecting wake-up.

For ignition key switch mechanizations, the Run/Crank relay shall be controlled by the ignition switch and shall be energized when the switch is in the Run and Start positions. This is the power source for some powertrain components. On vehicles with Remote Vehicle Start (RVS), the Platform Electronics shall also control the Run/Crank relay. The Run/Crank relay may be energized for the RVS system when the switch is any key position.

For Easy Key and PEPS switch mechanizations, the Platform Electronics (e.g., Power Mode Master and either the Easy Key module or PEPS module) shall energize the Run/Crank Relay in the RUN and CRANK power modes. A single point failure within the Platform Electronics shall not cause the Run/Crank relay to disengage in the RUN power mode. The Run/Crank relay may also be energized in other power modes for the RVS system.

When the Run/Crank relay output is not active, the Powertrain electronics shall ensure that the output control solenoids and systems indicator lamps are not energized. An exception to this can exist if the Run/Crank relay transitions from active to inactive. In this case, the ECM may remain energized under software control in order to perform some additional functions prior to the controller powering down.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information On-Board Diagnostics Requirements for platform design guidelines.

3.3.4 Powertrain Relay Control. This signal is a discrete low-side driver output of the powertrain electronics intended to drive the powertrain relay. The relay coil shall be powered from a fused battery power source. The Powertrain electronics shall pull the output low for engagement of the relay.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information On-Board Diagnostics Requirements for platform design guidelines.

3.3.5 Powertrain Relay Output. This switched battery signal shall be an input to the ECM and other powertrain components.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information On-Board Diagnostics Requirements for platform design guidelines.

3.3.6 Battery. The Battery signal from the Platform to the Powertrain provides the electrical power for certain powertrain actuators (starter, etc.) and for powertrain internal power sources that provide regulated voltages.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information On-Board Diagnostics Requirements for platform design guidelines.

3.3.7 Engine Block Ground. The Platform shall provide a ground path from the battery negative terminal to the engine block. On some applications, EMC testing may dictate that a ground strap from the engine block to chassis (body) is also required.

The gasoline ECM shall be grounded to the engine block (an internal Powertrain connection). Diesel applications may ground the ECM to the body/chassis ground instead of the engine block ground. To make use of this grounding strategy, the body chassis ground must be wired directly to the battery negative terminal.

The Powertrain electronics case(s) may either be grounded or isolated from vehicle ground depending on the controller design. If there is a direct current (DC) connection between the electronics and the case, the case shall be isolated from the other ground planes to avoid DC sneak circuits. If the controller is mounted on the engine block, then a DC connection may be allowed to the engine block.

Powertrain shall provide these requirements for each individual application.

3.4 Failure Modes and Diagnostics.

3.4.1 System Protection. Powertrain components must provide internal protection against all traditional battery, switched battery, and ground transients per GMW3097GS General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility (EMC), Requirements.

Battery and switched battery circuits to the Powertrain shall be over-current protected by the platform to protect the wiring harness, so that disruption of vehicle operation is minimized. The number of protected circuits allocated shall minimize failure effects. To reduce walk-home type electrical failures, circuits essential to Powertrain operations shall be protected separately from circuits that are non-essential, except for functions addressed in legislated objectives (example - odometer security).

The Platform shall avoid undesired component operation due to loss of ground paths (i.e., sneak paths).

3.5 Electrical Characteristics.

3.5.1 Operating Ranges. The powertrain electronics shall operate in the following steady state voltage ranges:

Low Voltage Range	$6.0 \leq VDC \leq 11.0$
Normal Voltage Range	$11.0 < VDC \leq 16.0$
High Voltage Range	$16.0 < VDC \leq 18.0$

Voltages are referenced to component terminals.

In the low voltage range, the engine control module and critical platform items (e.g., starter control relay, fuel pump, fuel pump relay) shall be able to provide sufficient control to run the engine. Refer to 3.5.2 for specific voltage requirements for starting.

In the normal voltage range, all vehicle functions shall perform as designed.

In the high voltage range, degraded operation may occur. All electrical components shall be able to withstand system voltages between 16.0 and 18.0 VDC for 60 minutes. All OBD II diagnostics must operate properly and sufficient functionality must be present to allow the engine to start and run for the time period specified.

All electrical components shall be able to withstand system voltages up to 26.5 VDC for one (1) minute without damage. There is no requirement for the engine to start or for the electronics to operate above 18.0 V.

All electrical components shall be able to withstand system voltages up to 26.5 VDC for one (1) minute without damage. There is no requirement for the engine to start or for the electronics to operate above 18.0 V.

For specific high-speed Controller Area Network (CAN) system operating voltage ranges, refer to GMW8772, PPEI Serial Data Architecture Diagnostic Connector Requirements.

3.5.2 Voltage Requirements for Starting.

3.5.2.1 System Voltage. The system shall provide the voltage waveform shown below in Figure 5, at worst, to the powertrain electronics Battery and Run/Crank terminals as referenced to the component ground terminal(s), during the cold start event. The cold start event, as defined in a typical Vehicle Technical Specification (VTS), is at -29°C with the battery at 80% state of charge. This voltage waveform is simplified to show average voltage level during the event. Short duration transients of less than 1.0 ms are not reflected.

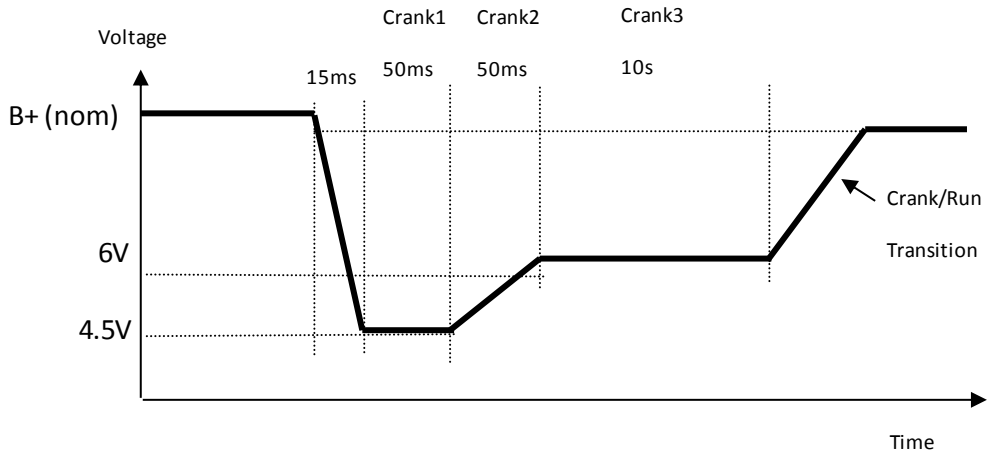


Figure 5: System Voltage Waveform

3.5.2.2 Powertrain Electronics. The powertrain electronics shall be capable of providing sufficient control to start the vehicle under these conditions with the voltage waveform shown in 3.5.2.1. The ECM microprocessor shall not reset during the cranking event. This waveform applies for both assisted and unassisted starting.

The voltage drop in the starter relay coil drive circuit within the powertrain electronics under the low voltage conditions described in the waveform above shall be < 0.9 V.

The voltage drop in the starter relay coil drive circuit within the powertrain electronics under the low voltage conditions described in the waveform above shall be < 0.9 V. The driver electronics shall be capable of supplying up to 100 mA under this low voltage condition.

3.5.2.3 Starter Relay. The system shall provide, at worst, a voltage waveform across the starter relay coil terminals during the event described in 3.5.2.1 which is 1.0 V less than the voltage shown in the waveform for the ECM terminals. A voltage drop of 0.9 V is allocated within this 1.0 V for the drive circuitry within the ECM as described in 3.5.2 2.

The starter relay, once pulled in, shall not drop out during any part of this worst-case voltage waveform. The starter relay shall have a minimum resistance of 50 Ω at -40°C.

3.5.2.4 Powertrain Relay. The system shall provide, at worst, a voltage waveform across the powertrain relay coil terminals during the event described in 3.5.2.1 which is 1.0 V less than the voltage shown in the waveform for the ECM terminals. A voltage drop of 0.9 V is allocated within this 1.0 V for the drive circuitry within the ECM as described in 3.5.7.

The powertrain relay, once pulled in, shall not drop out during any part of this worst case voltage waveform. The powertrain relay shall have a minimum resistance of 50 Ω at -40°C.

3.5.2.5 Platform Electronics. The Accessory/Wakeup output from platform shall function as specified in 3.3.2 down to a voltage of 6.0 V, referenced to the Battery and Run/Crank terminals at the ECM. The minimum "high" level voltage under low voltage conditions shall be 5.0 V.

3.5.3 Voltage Drop Requirements. The vehicle wiring system shall meet and may exceed the requirements specified in this section. The requirements for the wiring system shall be dictated by the Power and Signal Distribution Subsystem Technical Specification (e.g., GMNA SSTS EICC-80.201.01).

To ensure proper system performance, the platform shall meet the following requirements during normal engine run. For transient

performance requirements, refer to GMW3097GS General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility (EMC), Requirements.

Special requirements apply to the Run/Crank supply and common return circuit due to the need to determine vehicle system operating voltage from within the ECM. Due care shall be taken in designing the Power and Signal Distribution System (PSDS) such that the resulting voltage drop in the PSDS between the ECM and the Battery shall not exceed a cumulative total of 0.75 V at normal mode (non-cranking) operating currents for both the Run/Crank supply from the battery and the common negative return from the ECM to the battery. A total value of 0.75 V is allocated to the ECM for controller voltage read error and the reserve margin required for system stability.

This ECM specific requirement above overrides the general voltage drop requirements below in 3.5.3.1 and 3.5.3.2.

3.5.3.1 Positive Side. The maximum potential difference between the battery positive terminal and the powertrain shall be less than 0.75 V.

The maximum potential difference between the battery input terminals on the following components shall be less than 0.75 V. Special requirements apply to some components during cranking. Refer to 3.5.2.

a. Powertrain Electronics.

b. Platform components that interface with the Powertrain.

3.5.3.2 Ground Path. The maximum potential difference between the following components and the ECM Ground Terminal shall not exceed the values given in the table during normal engine run. DC is defined as frequencies less than 10 Hz. Alternating current (AC) is defined as frequencies between 10 and 200 Hz. All potentials are referenced to the ECM ground terminal. Refer to Table 3 below:

Table 3: Ground Path

Component	Maximum Potential Difference	
	Gasoline and Diesel Engines with Engine Block Ground	**Diesel Engines with Chassis Ground**
Engine Block [Note 1]	-0.5 V DC and AC	Not applicable
Chassis Ground	Not applicable	0.0 to -1.5 V DC and AC
Powertrain Component Ground Terminals	± 0.5 V DC and AC	+0.5 V to -1.5 V DC and AC
Generator	± 0.7 V DC and AC	-1.7 to 0.0 V DC and AC
Platform Components that interface with the ECM	± 1.0 V AC -0.5 to +1.0 V DC	± 0.5 V DC and AC

Note 1: Engine Block is defined as the direct unpainted metal surface contact with the cylinder head(s), the block, or the transmission bell housing.

3.5.4 Parasitic Load Current. Parasitic load current is defined as the average current through a component when in the steady state OFF power mode.

Over the temperature range -40 to +40°C, new Powertrain and Platform designs shall limit parasitic load for the combination of the ECM and TCM to 1 mA maximum. Systems that include a Powertrain released AWD/4WD controller may draw up to 1.5 mA for all powertrain requirements (ECM, TCM, and AWD/4WD). This requirement implies a 0.5 mA maximum per module. The design goal is 300 μA for modules with wake-up, and 100 μA otherwise.

3.5.5 Accessory/Wakeup. This input to powertrain shall have the characteristics of an Input Discrete Low (IDL1) as described in GMW8762, PPEI Electrical Requirements. In addition, this input shall correctly read the signal at low voltages as specified in the Table 4 below. This signal may be used for multiple module inputs and/or to power some logic functions. Powertrain may draw up to 250 mA at 13.5 V total from this signal.

Table 4: Accessory/Wakeup

Parameter	Condition	Minimum	Typical	Maximum
Input High-state U_{ih}	8.0 V ≤ Vs ≤ 11.0 V	5.5 V	V_{nom}	V_S +1.0 V
Input High-state U_{ih}	6.0 V ≤ Vs ≤ 8.0 V	4.5 V	V_{nom}	V_S +1.0 V

3.5.6 Run/Crank Relay Output. Specific Run/Crank voltage, current, and recommended fusing requirements shall be provided by Powertrain. Total Powertrain load on this relay shall not exceed 20 A steady state.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information on On-Board Diagnostics Requirements for platform design guidelines.

3.5.7 Powertrain Relay Control. The output of the powertrain electronics shall have the characteristics of a low-side driver, LSD2, as described in GMW8762, PPEI Electrical Requirements. In addition, in order to assure low voltage start performance, the driver saturation voltage shall be 0.9 V maximum at I_0 = 100 mA at 0°C. This output is not required to be Pulse Width Modulated (PWM) capable. The Powertrain controller shall be designed to deactivate this control under reverse system voltage conditions.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information on On-Board Diagnostics Requirements for platform design guidelines.

3.5.8 Powertrain Relay Output. Specific battery voltage, current, and recommended fusing requirements shall be provided by Powertrain. Total load on this relay shall be compatible with a standard mini-relay; maximum steady state current is 30 A.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information On-Board Diagnostics Requirements for platform design guidelines.

3.5.9 Battery. Powertrain shall specify the total current required on the Battery interface and the circuit protection required shall be jointly negotiated.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information on On-Board Diagnostics Requirements for platform design guidelines.

3.5.10 Ground. Powertrain components may ground directly to the engine block. Specific voltage drop and current requirements will be provided by Powertrain for each application. Powertrain components grounded to the engine block must assure signal level compatibility with inputs of a chassis/body grounded diesel ECM.

This interface may be emissions-related. Refer to GMW8762, PPEI General Information on On-Board Diagnostics for platform design guidelines.

3.5.11 Engine to Platform Ground Connection. The potential difference between the engine block ground and the negative battery terminal (post) shall be within -0.2 and +0.5 V, from 0 to 200 Hz, during engine run with maximum electrical load with high generator output (at least 6000 generator rpm). The potential difference shall not exceed 1.0 V under worst-case conditions during engine crank. All voltages are referenced to the negative battery terminal.

4 Algorithm

Refer to GMW8767, PPEI Remote Vehicle Start Algorithm for related PPEI Power Moding Algorithm Requirements.

5 Provisions for Shipping

Not applicable.

6 Notes

6.1 Glossary. Not applicable.

6.2 Acronyms, Abbreviations, and Symbols.

Refer to GMW8762 Appendix A3.

7 Additional Paragraphs

7.1 All parts or systems supplied to this standard must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts.**

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

GMW8763

9 Release and Revisions

9.1 Release. This standard originated in June 2003. It was first approved by the Global PPEI Core Team in December 2003. It was first published in February 2004, for the Global PPEI Version 3.4.

9.2 Revisions.

Rev	Approval Date	Description (Organization)
C	MAR 2006	Global PPEI Version 3.7 Release.
D	FEB 2010	Global PPEI Version 3.8 Release. (Powertrain Interface GSSLT)

Appendix A

The following are approved Change Requests (CRs) for the Global PPEI Version 3.8 Release that impacted the GMW8763 Power and Ground Subsystem:

Sections Changed	Description Of Changes	Rationale/Authorization
3.2.1.3	Add new block diagram for PEPS system	CR1690
3.2.2	Revise block diagram figure number to Figure 4.	
3.3.2	Revise Acccessory/Wakeup description to include PEPS	
3.3.3	Revise Run/Crank description to include PEPS	
3.5.1	Revise waveform to remove VLo with a value of 4.5 V.	CR355
3.5.2.1	Remove VLo definition.	
3.5.2.3	Remove design goal requirement of 4.5 V.	
3.5.2.4	Remove design goal requirement of 4.5 V.	
Figure 4	Revise block diagram to add ground connection between the ECM and Vehicle Electrical System.	CR3993
3.3.7	Revise second paragraph to include the diesel engine ECMs may be grounded to chassis ground.	
Table 3	Revise table to differentiate gasoline and diesel voltage requirements.	
3.5.10	Revise grounding requirements to include the chassis ground.	