



**Platform to Powertrain Electrical Interface (PPEI) Specification
Air Conditioning Compressor Control Subsystem**

1 Introduction

This section identifies the Air Conditioning Compressor Control electrical interface between Platform and Powertrain.

1.1 Applicability.

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

1. **GMW8763** Power and Ground
2. **GMW8764** Four Wheel Drive/All Wheel Drive Controls
3. **GMW8765** Displays and Gauges
4. **GMW8766** Engine Power Management
5. **GMW8767** Starter Control
6. **GMW8768** Vehicle Theft Deterrent
7. **GMW8769** Cruise Control
8. **GMW8770** Cooling Fan Control
9. **GMW8771** Air Conditioning Compressor Control
10. **GMW8772** Serial Data Architecture
11. **GMW8773** Brakes and Traction Control
12. **GMW8774** Enhanced Evaporative Emissions and Fuel
13. **GMW8775** Exhaust After-Treatment
14. **GMW8776** Suspension Control
15. **GMW8777** Transmission
16. **GMW8778** Generator Control
17. **GMW8779** Post Collision Operation
18. **GMW8780** Power Take-Off and Fast Idle Control
19. **GMW8781** Vehicle Speed and Rough Road Sensing

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

The master PPEI document and all nineteen 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.

GMW3001	GMW8772
GMW3059	GMW8773
GMW8762	GMW8774
GMW8763	GMW8775
GMW8764	GMW8776
GMW8765	GMW8777
GMW8766	GMW8778
GMW8767	GMW8779
GMW8768	GMW8780
GMW8769	GMW8781
GMW8770	

2.3 Additional References.

GMPT GMLAN Diagnostic Test Mode Configuration Specification.

3 Subsystem Requirements

3.1 Functional Overview.

This section applies for all vehicles equipped with air conditioning.

The ECM, on all HVAC systems, shall have primary responsibility for the HVAC compressor activation/de-activation on clutch based systems, or the permission to activate/de-activate on Electrically Controlled Variable Displacement (ECVD) systems.

On clutch based A/C systems, the A/C relay is required by the ECM to control rapid vehicle acceleration and deceleration conditions, and to address OBD diagnostics situations. If an A/C compressor relay is required, the relay control

driver is provided by the ECM. In OBD II markets, the A/C Compressor Relay is always required.

If the A/C compressor relay is not required, Powertrain provides permission via serial data to Platform to activate or request de-activation for normal operation, compressor protection and vehicle performance reasons.

In ECVD systems, the compressor control driver is provided by the Platform HVAC controller. The HVAC controller has the responsibility for algorithms to control the compressor based on inputs from its own subsystem as well as inputs it receives from Powertrain over serial data.

On all A/C systems, Powertrain has the primary responsibility for algorithms to protect the compressor components based on inputs from its own subsystem as well as inputs it receives from Platform over serial data.

3.1.1 Platform Functions.

Platform shall be responsible for executing the following portions of the air conditioning compressor control functions:

- a. On Electronically Controlled Variable Displacement (ECVD) applications, provide the stroke control output.
- b. Provide the electrical interface and process A/C information from any optional sensors necessary to support the HVAC algorithms. See Section 4.1.2.
- c. The HVAC subsystems may request an increased engine idle speed from Powertrain via the GMLAN signal Platform Minimum Idle Boost Level Request to enhance/improve HVAC performance. Reference GMW8766 Engine Power Management Section 3.1.3 Platform Idle Boost Functional Requirements and Section 4.2 Platform Idle Boost Calibrations. (Platform Optional).
- d. Process non-emission related service tool requests for HVAC diagnostic information. See Section 4.1.2.
- e. Provide the A/C compressor control relay (if required).

3.1.2 Powertrain Functions.

Powertrain shall be responsible for executing the following portions of the air conditioning compressor control functions:

- a. Control the compressor control relay (if present) for engine performance and emissions diagnostic purposes.
- b. Perform compressor minimum off timer if required.
- c. Activate the compressor control relay during crank, if required, in order to remove any liquid refrigerant (slug) from the compressor based on engine coolant temperature and engine intake air temperature. See Section 4.1.3.
- d. Provide "engine off timer" function to support A/C slugging algorithm (if required).
- e. Process A/C refrigerant high side pressure transducer data and transmit via serial data to Platform to support HVAC algorithms. See Section 4.1.3.
- f. On any kind of A/C system, manage the system protections. See Section 4.1.3.
- g. Provide an indication via serial data to Platform when the compressor is disabled by Powertrain for compressor protection or high coolant temperature. See GMW8765 Section 3 PPEI Displays and Gauges Subsystem Requirements and GMW8771 Section 4.

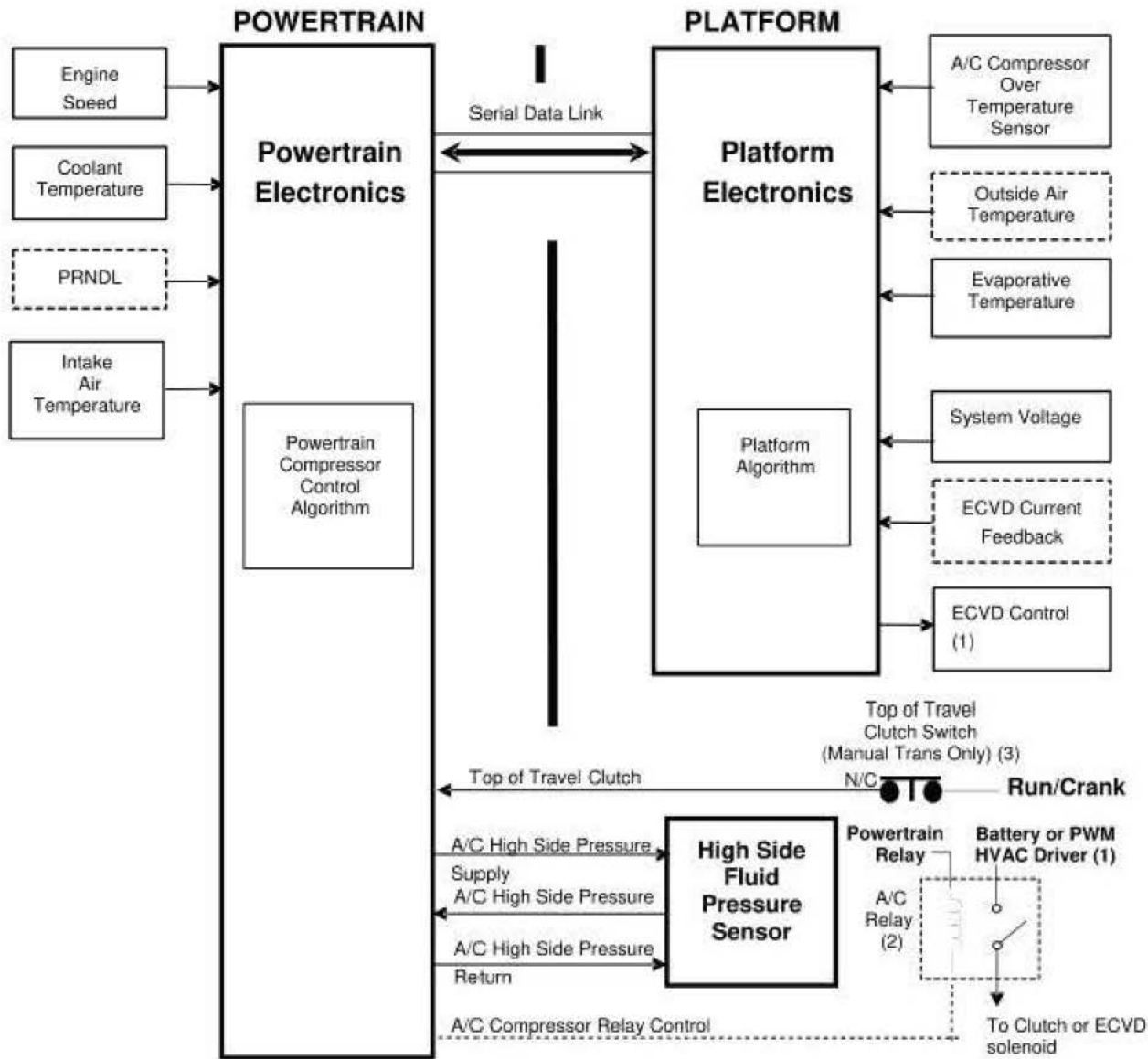
3.2 Hardware Overview.

The only hardware interfaces required in this subsystem are the High Speed GMLAN and the (optional) Top of Travel Clutch switch input. The details for both these interfaces are described in other parts of this document.

3.2.1 Block Diagram.

The following block diagram (Figure 1) depicts a typical mechanization for a compressor. The electrical interface between Powertrain and Platform is the only standard defined.

3.2.1.1 Block Diagram – Air Conditioning Compressor Control



Notes:

- (1) Compressor Control relay contacts are feed from either Battery or the HVAC Control Head.
- (2) A/C Compressor Control Relay is not required for ECVD applications in non-OBD II markets.
- (3) Alternatively a Clutch Pedal Position Sensor may provide this information. Reference GMW8777 for more details.

Figure 1: Air Conditioning Compressor Control Block Diagram

3.3 Interface Description.

3.3.1 Serial Data Link.

Reference GMW8771 Section 4 and GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing for definitions of signals listed below in Table 1.

Table 1: Air Conditioning Compressor Control Serial Data Signals

Signal Name	Transmitter	Notes
Air Conditioning Compressor Command	Powertrain	Required
Air Conditioning Compressor Failed On	Platform	Required (1)
Air Conditioning Compressor Mode Request	Platform	Required
Air Conditioning Compressor Normalized Load	Platform	Required (1)
Air Conditioning Compressor Normalized Load Validity	Platform	Required (1)
Air Conditioning Compressor Normalized Load Gradient Allowed	Powertrain	Required (1)
Air Conditioning Compressor System Virtual Device Availability	Platform	Required
Air Conditioning Compressor Type	Platform	Required
Air Conditioning Off Indication On	Powertrain	Required
Air Conditioning Refrigerant High Side Fluid Pressure	Powertrain	Required
Air Conditioning Refrigerant High Side Fluid Pressure Validity	Powertrain	Required
Engine Coolant Temperature	Powertrain	Required
Engine Coolant Temperature Validity	Powertrain	Required
Engine Intake Air Temperature	Powertrain	Required
Engine Intake Air Temperature Validity	Powertrain	Required
Engine Speed	Powertrain	Required
Notes:		
<ol style="list-style-type: none"> Signal is required for ECVD compressor system, but is not required for fixed displacement, Clutch based, or Hydraulically Controlled Variable Displacement A/C compressor systems. These signal names may change due to development work being done on ECVD systems for GMW8771 release. 		

3.3.2 Calibrations.

The following Table 2 contains calibrations that cross the Platform – Powertrain Electrical Interface (i.e., are located in devices on one side of the interface but controlled by the other side of the interface or driven by variation in the other side of the interface). Refer to Section 4 for details.

Table 2: Air Conditioning Compressor Control Calibration Table

Calibration Name	Location	Owner
K_AC_EngCoolTempDsngc	Powertrain	Platform
K_AC_EngCoolTempEnge	Powertrain	Platform
K_AC_PresSensor_Slope	Powertrain	Platform
K_AC_PresSensor_Offset	Powertrain	Platform
K_AC_VehicleSpeedThrsh	Powertrain	Platform
K_BarometerThreshold	Powertrain	Platform
K_CompressorHiSpdDsblTme	Powertrain	Platform
K_CompressorLoSpdDsblTme	Powertrain	Platform
K_ContinuousGearDsngcOff	Powertrain	Platform
K_ContinuousPN_Dsngc	Powertrain	Platform
K_DiagClutchDelay_CatMon	Platform	Powertrain
K_DiagOverrideOnMax_CatMon	Platform	Powertrain
K_DiagOverrideOnMax_EGR	Platform	Powertrain
K_FullPedDsngc	Powertrain	Platform
K_FullPedEnge	Powertrain	Platform
K_HighPresDsngc	Powertrain	Platform
K_HighPresEnge	Powertrain	Platform
K_HighSpeedGearEngeOff	Powertrain	Platform
K_HighSpeedPN_EngeOff	Powertrain	Platform
K_HighVoltDsngc	Powertrain	Platform
K_HighVoltEnge	Powertrain	Platform
K_HiSpdFullPedDsngc	Powertrain	Platform
K_HiSpdFullPedEnge	Powertrain	Platform
K_LaunchPedPosDsngc	Powertrain	Platform
K_LetOffPedDsblTme	Powertrain	Platform
K_LowAccelDsngc	Powertrain	Platform
K_LowAccelEnge	Powertrain	Platform
K_LowPresDsngc	Powertrain	Platform
K_LowPresEnge	Powertrain	Platform
K_LowSpeedDsngc	Powertrain	Platform

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Calibration Name	Location	Owner
K_LowSpeedEngeOff	Powertrain	Platform
K_LowVehSpdDsng	Powertrain	Platform
K_LowVehSpdEnge	Powertrain	Platform
K_LowVoltDsng	Powertrain	Platform
K_LowVoltEnge	Powertrain	Platform
K_MaxAntiSlugTme	Powertrain	Platform
K_MaxFullPedDsblTme	Powertrain	Platform
K_MinClutchDsblTme	Powertrain	Platform/Powertrain
K_MinCompDsblTme	Powertrain	Platform/Powertrain
K_MinFullPedDsblCycTme	Powertrain	Platform/Powertrain
K_MinFullPedDsblTme	Powertrain	Platform/Powertrain
K_Sensor_Slope	Powertrain	Platform
K_Sensor_Intercept	Powertrain	Platform
K_Sensor_Pressure_Max	Powertrain	Platform
K_ShutdownReqMax (1)	Powertrain	Platform/Powertrain
K_SlugCoolTempThrsh	Platform	Platform/Powertrain
K_SlugIgnVoltThrsh	Platform	Powertrain/Platform
K_SlugKoffMnfdTempThrsh	Platform	Platform/Powertrain
K_SlugMaxRefPulses	Powertrain	Platform
K_SlugMnfdTempThrsh	Platform	Platform/Powertrain
K_SlugUnderPresLmt	Platform	Platform/Powertrain
K_Torq_M_ClitchlessAC_NormTrq	Powertrain	Platform
K_TransientGearDsngOff	Powertrain	Platform
K_TransientPN_DsngOff	Powertrain	Platform

Note:

(1) Calibration is not required for Clutch based A/C compressor control systems.

3.3.3 Top of Travel Clutch.

The Top of Travel Clutch switch and Clutch Pedal Position sensor are optional on manual transmission applications only. The switch or sensor is mandatory for all vehicles equipped with cruise control and also for all North American Applications even if these applications are released in the non North American markets. However, the switch or sensor is optional for non North American applications not equipped with cruise control.

3.3.3.1 Top of Travel Clutch Switch

This switch is a momentary contact normally closed switch to Run/Crank voltage. The Clutch switch opens when the operator depresses the clutch pedal.

3.3.3.2 Clutch Pedal Position (CPP) Sensor.

A potentiometer provides an indication of the clutch pedal position. The ECM uses this input to determine the current pedal position relative to the total range of pedal travel available on a vehicle.

Reference GMW8777 Section 3.3.5 PPEI Transmission Subsystem Requirements.

3.3.4 A/C Compressor Relay Control.

This signal is a discrete low side driver output from the Powertrain Electronics. The output shall be pulled low for compressor engagement on all vehicles with A/C compressor.

This interface may be emission related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.5 A/C High-Side Pressure Supply.

This regulated voltage is supplied by the Powertrain Electronics to the A/C High-Side Pressure Sensor. This may be a shared supply line with other devices.

This interface may be emission related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.6 A/C High-Side Pressure.

The Powertrain Electronics provides an analog input that reads the A/C High-Side pressure sensor output. The sensor has a ratiometric output voltage that is proportional to pressure.

This interface may be emission related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.3.7 A/C High-Side Pressure Return.

This interface may be emission related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

The Powertrain electronics shall provide the algorithm diagnostic to detect an "open" connection of the A/C High-Side Sensor Return hardware signal. The sensor interface shall indicate a sensor voltage out of normal operating range when this condition exists. See Section 4 for algorithm requirements to disable the A/C compressor to protect compressor if AC_Pressure is out of range.

3.4 Failure Modes and Diagnostics.

Reference GMW8772 Section 3.4 PPEI Serial Data Architecture Requirements for serial data failure modes and diagnostic information.

Powertrain shall diagnose the A/C High-Side Pressure Sensor for low voltage and high voltage.

A diagnostic trouble code shall be set for low voltage. A second diagnostic trouble code shall be set for high voltage.

Platform and Powertrain shall provide appropriate diagnostics and failsoft for each of their inputs and outputs. See Section 4.

3.5 Electrical Characteristics.**3.5.1 Top of Travel Clutch.**

Reference GMW8762 Section 3.3.2 PPEI Electrical Requirements.

3.5.1.1 Top of Travel Clutch Switch.

The Top of Travel Clutch Switch is a normally closed switch, sourced by Run/Crank, which opens when the clutch is depressed.

Reference GMW8762 Section 3.3.2 PPEI Electrical Requirements for details.

3.5.1.2 Clutch Pedal Position (CPP) Sensor.

The CPP Sensor shall be a potentiometer with a resistance of 3k Ohm between the CPP Vref and CPP Rtn terminals .

Reference GMW8777 section 3.5.2.2 CPPS Electrical Requirements for details.

3.5.2 A/C Compressor Relay Control.

The output of the Powertrain Electronics shall have the characteristics of a low side driver, LSD2, as described in GMW8762 Section 3.1 PPEI Electrical Requirements.

This interface may be emission related. Refer to GMW8762 Section 1.4 PPEI On-Board Diagnostics Requirements for platform design guidelines.

3.5.3 A/C High-Side Pressure Supply.

Reference GMW8762 Section 3.5 for electrical characteristics.

3.5.4 A/C High-Side Pressure.

Reference GMW8762 Section 3.5 for electrical characteristics.

3.5.5 A/C High-Side Pressure Return.

Reference GMW8762 Section 3.5 for electrical characteristics.

4 Algorithm

4.1 Air Conditioning Compressor Control Algorithm Requirements

4.1.1 General Overview.

The Air Conditioning Compressor algorithm is partitioned between the Platform and Powertrain controllers. This interface applies to clutch based or clutchless designs, which support the following A/C compressor technology types:

- Fixed displacement
- Pneumatically controlled variable displacement
- Electronically controlled variable displacement

Powertrain is responsible for the reading of the A/C high-side refrigerant pressure sensor for all types of systems.

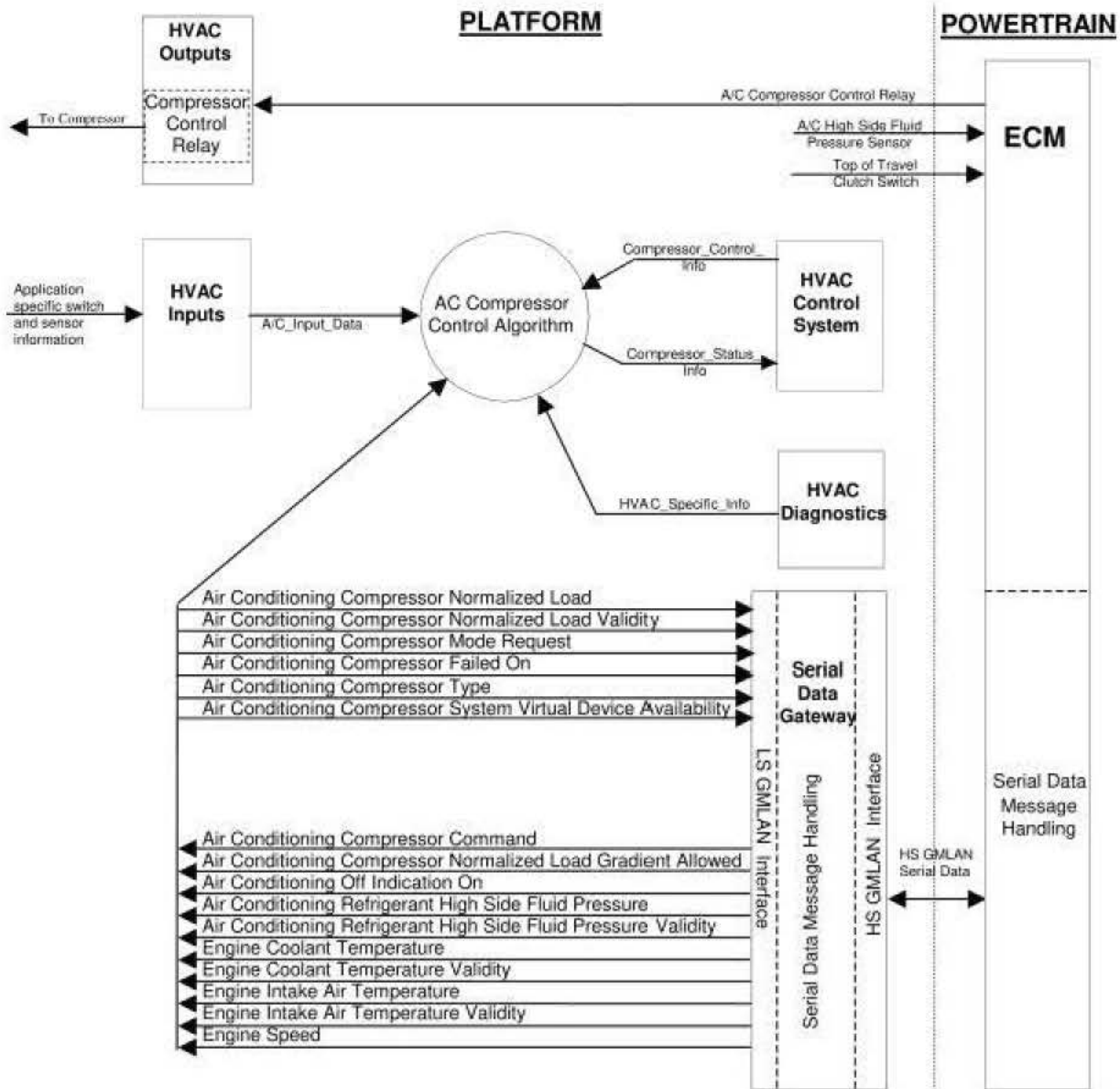
For systems with an A/C Control relay, the Powertrain electronics provides the control algorithm to determine the compressor control relay state. In response to an "A/C request" from Platform, Powertrain will change the state of the A/C control relay when it has adequately prepared for the expected change in A/C load on the engine. At any time while the compressor is engaged, Powertrain has the responsibility of disabling the A/C compressor for compressor protection reasons. Powertrain may also de-activate the A/C compressor relay for acceleration or deceleration events. Powertrain may also control the compressor to a specific state to comply with OBD II requirements for emissions control/diagnostics (e.g. DVT and end of line testing). Note: the A/C Compressor Relay is not required for vehicles sold in non-OBD II compliant markets. The A/C relay may be desired for quicker A/C enable and disable response.

For Fixed Displacement and Pneumatically Controlled Variable Displacement compressors, Powertrain may also energize the A/C compressor relay to enable the compressor during engine cranking to remove A/C refrigerant slug from the compressor.

In systems without an A/C relay (i.e., non-OBD compliant markets, and/or with Electronically Controlled Variable Displacement (ECVD) compressors), the Platform electronics provides the algorithm to control the compressor load directly based on its own inputs and serial data information received from Powertrain. As with A/C relay based systems, an "A/C request" is provided from Platform to Powertrain. Powertrain will in turn respond via serial data with a permission to Platform to engage the A/C compressor load. Fundamental to the Powertrain's ability to maintain engine performance requirements, the Platform shall control the A/C compressor, such that, the gradient of compressor load does not exceed a threshold maximum. This gradient load threshold is provided as a serial data signal from Powertrain and may change dynamically based on engine conditions. At any time while the compressor is engaged, the Powertrain electronics may request Platform to disengage, or delay the engagement/disengagement of the A/C compressor for A/C system protection reasons or for vehicle acceleration/deceleration events. Note: For ECVD engagement means a change of state from "compressor idle" (minimum stroke) to normal operation. ECVD compressor disengagement indicates a change of state from normal operation to "compressor idle" state. Reference Section 4.1.8.3 for an overview of the ECVD compressor operating event sequences.

4.1.2 Platform Algorithm Requirements.

4.1.2.1 Context Diagram



Notes:

1. Required for A/C Fan run-on control due to A/C and cooling fan control based on A/C high-side fluid pressure.
2. Data optionally required by Platform HVAC subsystem.

Figure 2: Air Conditioning Compressor Control Platform Algorithm Requirements Context Diagram

4.1.2.2 Air Conditioning Compressor Type.

Platform shall transmit to Powertrain an indication of the type of A/C compressor system type, via the serial data signal Air Conditioning Compressor Type. The Gateway shall use a state of "None" as a power-up default for this signal. If platform has not determined the presence of an A/C compressor system or if no A/C compressor system is present on the vehicle, Air Conditioning Compressor Type shall be transmitted with this default state. Note: The initial transmissions of this signal may contain the default state during the vehicle power-up sequence. See GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for more information.

4.1.2.3 Platform Minimum Idle Boost Level Request.

HVAC electronics requests to increase engine idle speed for air conditioning and heating will be communicated via the serial data signal Platform Minimum Idle Boost Level Request. The gateway module will send this signal to Powertrain; see GMW8766 Section 3 PPEI Engine Power Management Subsystem Requirements.

4.1.2.4 Air Conditioning Compressor Mode Request.

The Gateway shall determine the value transmitted in the serial data signal Air Conditioning Compressor Mode Request. The value of this signal indicates the A/C state requested by Platform (via the Gateway Module) based on either a hardwire signal or serial data signal received from the low speed data link.

- a. The signal Air Conditioning Compressor Mode Request is transmitted with one of the following states:
 - (1) "Disengage Immediately"
 - (2) "Disengage"
 - (3) "Engage"
- b. Powertrain shall enable or disable the state of the A/C Compressor based on the state of this signal, unless an override condition is detected, as defined in Section 4.1.3.13.
- c. The Gateway shall use a state of "Disengage Immediately" as a power-up default for this signal. If Platform has not determined the presence of an A/C compressor system or if no A/C compressor system is present on the vehicle, Air Conditioning Compressor Mode Request shall be transmitted with this default state. Note: The initial transmissions of this signal may contain the default state during the vehicle power-up sequence.

4.1.2.5 Air Conditioning Compressor Command.

For A/C systems with an A/C compressor relay, the state of this relay is provided by the serial data signal Air Conditioning Compressor Command. See GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for more information.

For ECVD systems, when no A/C relay is present on the vehicle, the Platform electronics shall control the A/C compressor stroke based on the state of Air Conditioning Compressor Command:

- a. In response to Air Conditioning Compressor Command signal state transition from "On" to "Off", the Platform electronics shall take the A/C compressor stroke to its' minimum value. The resulting rate of change in compressor load shall not exceed the load gradient value specified by Air Conditioning Compressor Normalized Load Gradient Allowed.
 - (1) A load gradient value equal to the maximum signal value (i.e., 25.5 dm³/minutes/s) shall be interpreted as an immediate shutdown request of the A/C compressor (i.e., the compressor stroke shall be taken to its' minimum value as quickly as possible).
 - (2) A load gradient value less than the maximum signal value (i.e., <25.5 dm³/min/s) shall be interpreted as a normal shutdown request of the A/C compressor (i.e., the compressor stroke shall be taken to its' minimum value at a rate not to exceed the gradient value).
- b. In response to Air Conditioning Compressor Command signal state transition from "Off" to "On", the Platform electronics shall control the compressor to the minimum possible stroke for initial engagement. The resulting rate of change after the "Off" to "On" transition of the compressor load shall not exceed that specified by Air Conditioning Compressor Normalized Load Gradient Allowed. If possible, A/C compressor system should ramp in the compressor load as slowly as possible during an A/C compressor engagement transition.

4.1.2.6 Air Conditioning Off Indication On.

Air Conditioning Off Indication On is used for display purposes to indicate when Air Conditioning has been turned off by the Powertrain controller even though Platform is commanding the compressor on. The data value "True" shall be interpreted by Platform as an indication that the Powertrain electronics is *commanding* the compressor off.

This signal is only commanded to "True" by Powertrain due to high coolant temperature.

4.1.2.7 Air Conditioning Compressor Failed On.

For ECVD applications, the Platform (Gateway) shall transmit to Powertrain an indication of whether the A/C compressor has failed "On" via the serial data signal Air Conditioning Compressor Failed On. Powertrain internal algorithms may optionally use this signal for protection and diagnostic reasons. The A/C Compressor is failed "On" when, for example, a failure has occurred to the Platform A/C compressor output driver that causes the A/C compressor to be stuck in the "On" state. The HVAC module shall have a related diagnostic trouble code (DTC) set when transmitting this serial data signal as "True".

For applications with an A/C Relay, when the Air Conditioning Compressor Failed On signal is equal to "True", the Platform electronics may optionally take default action to request Powertrain to enable or disable the compressor relay based on the state of Air Conditioning Compressor Mode Request signal. Reference Section 4.1.2.4.

The Gateway shall use a state of "False" as a power-up default for this signal. If Platform has not determined the presence of an A/C compressor system or if no A/C compressor system is present on the vehicle, Air Conditioning Compressor Failed On shall be transmitted with this default state. Note: The initial transmissions of this signal may contain the default state during the vehicle power-up sequence.

4.1.2.8 Air Conditioning Compressor Normalized Load.

For ECVD compressor systems, the Platform electronics shall calculate and transmit to Powertrain via the Platform Gateway the signals Air Conditioning Compressor Normalized Load and Air Conditioning Compressor Normalized Load Validity.

Air Conditioning Compressor Normalized Load value is dependent on the states of Air Conditioning Compressor Mode Request and the Air Conditioning Compressor Command as defined in the following table:

Air Conditioning Compressor Normalized Load [Nm/(kPa *min)]	Air Conditioning Compressor Mode Request	Air Conditioning Compressor Command
$K_AC_LoadScalingFactor$ $\cdot (I_Value_Actual$ $- K_SolenoidCurrentOffset)^{0.5}$ $\cdot (V_Air_Actual$ $+ K_AirSlowOffset)0.5$ See Section 4.1.2.8 (a)	X (don't care)	"On"
0 See Section 4.1.2.8 (b)	"Engage"	"Off"
0 See Section 4.1.2.8 (c)	"Disengage" or "Disengage Immediately"	"Off"

The Platform electronics shall determine the value of **Air Conditioning Compressor Normalized Load** as follows:

- a. **Air Conditioning Compressor Normalized Load** is calculated as follows (reference only, empirical equation between quantities): when the following conditions are present:
 - (1) **Air Conditioning Compressor Command** signal has been received equal to "On", and
 - (2) **Air Conditioning Compressor Mode Request** has been transmitted equal to "Engage".

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$$\text{Air Conditioning Compressor Normalized Load (dm}^3\text{/min)} = \\ K_AC_LoadScalingFactor * (I_Value_Actual - K_SolenoidCurrentOffset)^{0.5} \\ * (V_Air_Actual + K_AirSlowOffset)^{0.5} \text{ [Nm/(kPa *min)]}$$

Where:

I_Value_Actual = A/C solenoid current (Ampere) and shall be greater than $K_SolenoidCurrentOffset$

V_Air_Actual = A/C system air induction air flow across the A/C evaporator (dm³/min)

$K_AC_LoadScalingFactor$ = This is a Platform determined calibration, located in the Platform electronics which represents the A/C compressor load scaling factor. (unitless)

$K_SolenoidCurrentOffset$ = This is a Platform determined calibration, located in the Platform electronics, which value represents the A/C solenoid current offset (Ampere).

$K_AirSlowOffset$ = This is a Platform determined calibration, located in the Platform electronics, which value represents the A/C system air induction air flow offset (dm³/min).

Note: The equation is for reference only and may change with Platform compressor applications.

- b. **Air Conditioning Compressor Normalized Load** shall be transmitted with a value of "0" until it can be calculated by the Platform electronics. During the A/C compressor engagement transition, where the following conditions are present:

- (1) **Air Conditioning Compressor Command** signal has been received equal to "Off", and
- (2) **Air Conditioning Compressor Mode Request** has been transmitted equal to "Engage".

Note: The HVAC controller is not expected to send any value for load anticipation. Powertrain shall manage this transient condition as specified in Section 4.1.3.8.

- c. **Air Conditioning Compressor Normalized Load** shall be set to "0" normalized compressor load when the following conditions are present:

- (1) **Air Conditioning Compressor Command** signal has been received equal to "Off", and
- (2) **Air Conditioning Compressor Mode Request** has been transmitted equal to "Disengage" or "Disengage Immediately".

- d. **Air Conditioning Compressor Normalized Load** variation shall not exceed the load gradient value provided by the signal **Air Conditioning Compressor Normalized Load Gradient Allowed**, when the following conditions are present:

- (1) **Air Conditioning Compressor Command** signal has been received equal to "On", and
- (2) **Air Conditioning Compressor Mode Request** has been transmitted equal to "engage".

- e. **Air Conditioning Compressor Normalized Load** shall be set equal to the default value of 0.0 if any of the following conditions are present:

- (1) HVAC system power-up is in progress, or
- (2) The presence of an A/C compressor system has not been detected, or
- (3) No A/C compressor system is present on the vehicle.

Note: The initial transmissions of this signal may contain the default value during the vehicle power-up sequence.

4.1.2.9 Air Conditioning Compressor Protection.

For all A/C systems, Powertrain is responsible for determining when to disable the compressor for protection reasons. For ECVD systems, the Platform shall disable the compressor immediately based on the following signals received from Powertrain:

- a. The **Air Conditioning Compressor Command** is equal to "Off", and

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- b. The **Air Conditioning Compressor Normalized Load Gradient Allowed** is equal to "maximum". See Sections 4.1.3.13.3, 4.1.3.13.4 and 4.1.3.13.5.

4.1.2.10 Air Conditioning Compressor System Virtual Device Availability.

Air Conditioning Compressor System Virtual Device Availability is transmitted by the Gateway. This signal indicates when the Gateway has detected a supervision failure with the original transmitter (e.g., HVAC module) of the signals **Air Conditioning Compressor Normalized Load**, **Air Conditioning Compressor Normalized Load Validity**, **Air Conditioning Compressor Failed On**, and **Air Conditioning Compressor Mode Request**.

4.1.3 Powertrain Algorithm Requirements.

4.1.3.1 Context Diagram.

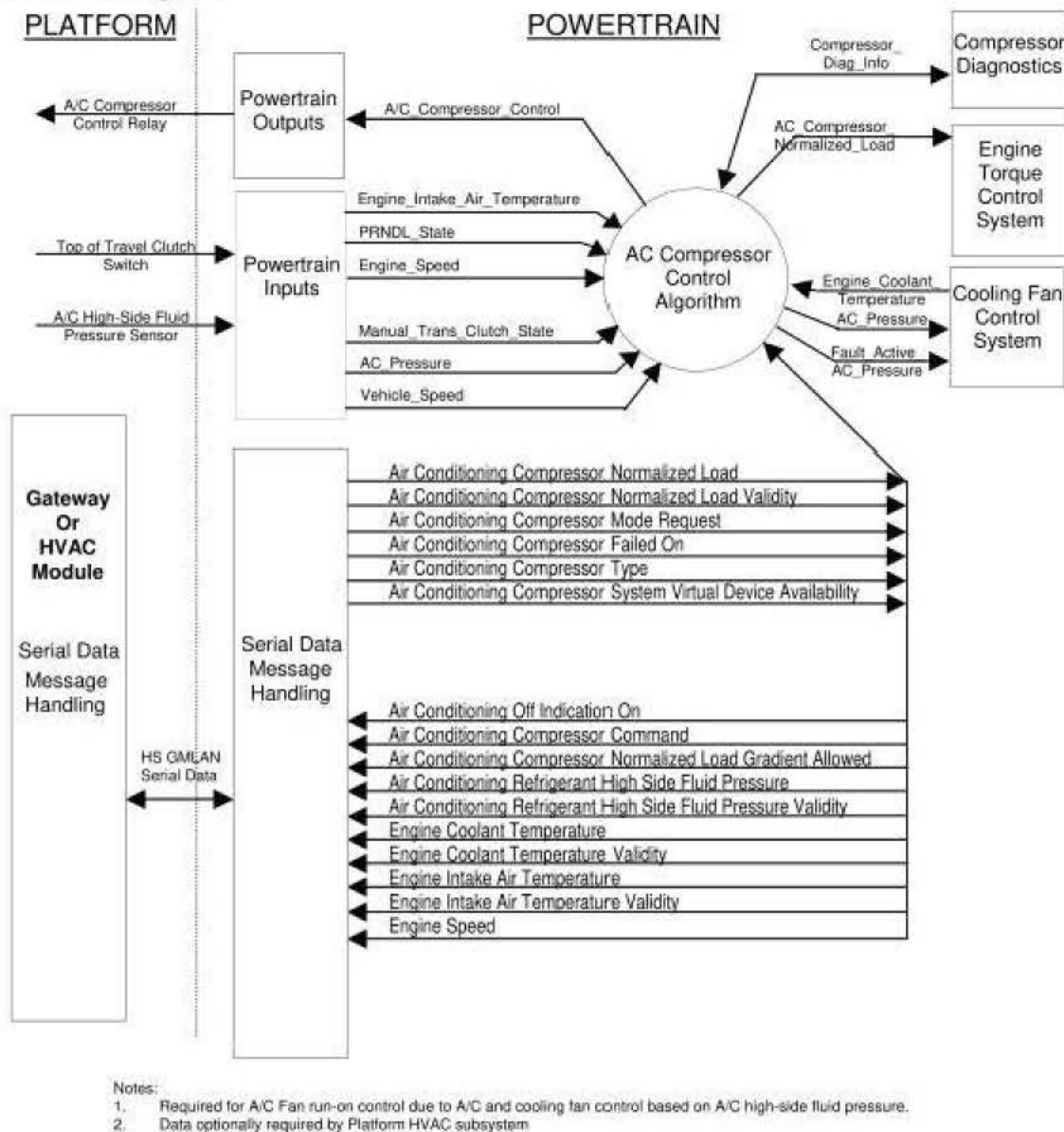


Figure 3: Air Conditioning Compressor Control Powertrain Algorithm Requirements Context Diagram.

4.1.3.2 Air Conditioning Compressor Type.

Powertrain shall determine A/C compressor system type, via the serial data signal ***Air Conditioning Compressor Type*** received from the Gateway. Powertrain shall always assume a default state of "None" for this signal. See GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for more information.

4.1.3.3 Air Conditioning Compressor System Virtual Device Availability.

Air Conditioning Compressor System Virtual Device Availability is received by Powertrain from the Gateway. Powertrain shall use this signal to determine the proper operation (default action) in the event of a failure with the original source of the following signals: ***Air Conditioning Compressor Normalized Load***, ***Air Conditioning Compressor Normalized Load Validity***, ***Air Conditioning Compressor Failed On***, and ***Air Conditioning Compressor Mode Request***.

4.1.3.4 Air Conditioning Refrigerant High Side Fluid Pressure.

Powertrain shall transmit to Platform the current air conditioning refrigerant high side pressure and its associated validity via the serial data signals ***Air Conditioning Refrigerant High Side Fluid Pressure*** and ***Air Conditioning Refrigerant High Side Fluid Pressure Validity***. If there is no air conditioning compressor on the vehicle, these serial data signals shall be transmitted with default values of "0" and "Invalid", respectively. Specific serial data signal requirements are defined in GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements.

The A/C high-side pressure sensor is read by the Powertrain controller as defined per Section 3. See Section 4.1.8.1 for definitions of the related calibrations, ***K_AC_PresSensor_Slope*** and ***K_AC_PresSensor_Offset***, which define the sensor characteristics.

4.1.3.5 Engine Coolant Temperature Requirements.

Powertrain shall provide to Platform engine coolant temperature and its' validity, via the serial data signals ***Engine Coolant Temperature*** and ***Engine Coolant Temperature Validity***.

4.1.3.6 Engine Intake Air Temperature Requirements.

Powertrain shall provide to Platform intake air temperature and its validity, via the serial data signals ***Engine Intake Air Temperature*** and ***Engine Intake Air Temperature Validity***.

4.1.3.7 Idle Air Compensation Control.

For cycling clutch A/C systems, if ***Air Conditioning Compressor Mode Request*** has transitioned from "Engage to Disengage" or "Engage to Disengage Immediately", Powertrain shall prevent adjustment of nominal idle speed to a lower value until vehicle speed has exceeded ***K_AC_VehicleSpeedThrsh***. This action is taken to prevent engine speed surging caused by temporary loss and re-application due to Platform HVAC requests.

4.1.3.8 Air Conditioning Compressor Actual Torque.

The Powertrain electronics receives the signal ***Air Conditioning Compressor Normalized Load*** from the Platform Gateway. This signal is used for engine torque change compensation by idle and engine speed control system for vehicles supporting ECVD A/C compressors only. See GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for more information.

Powertrain shall determine the value of the variable ***AC_Compressor_Actual_Torque*** based on the following equation:

$$\text{AC_Compressor_Actual_Torque} = \text{Air Conditioning Compressor Normalized Load (or K_Torq_M_ClitchlessAC_NormTrq)} * \text{AC_Pressure} / \text{Engine_Speed}$$

Where:

Air Conditioning Compressor Normalized Load = see Section 4.1.2.8. [Nm/(kPa * min)]

K_Torq_M_ClitchlessAC_NormTrq = (replacement) calibration, only used for A/C compressor engagement transition until HVAC is able to calculate and send a value for ***Air Conditioning Compressor Normalized Load*** which is greater than "0" (see Section 4.1.3.9 and Data Dictionary Section 4.1.8.1).

AC_Pressure = A/C Refrigerant High Side Fluid Pressure (see Data Dictionary, Section 4.1.8.2).

Engine_Speed = Engine speed (see Data Dictionary, Section 4.1.8.2).

4.1.3.9 Air Conditioning Compressor Anticipated Torque

The following requirements apply to vehicles supporting ECVD A/C compressors only.

The Powertrain electronics shall provide the calibration **K_Torq_M_ClitchlessAC_NormTrq** in order to calculate an anticipated **AC_Compressor_Actual_Torque** as defined in Section 4.1.3.8. The anticipated AC compressor torque value is required in order to compensate for the initial torque change (inertia and initial pressure build-up) during the transition from the "disengaged" to "engaged" state of the compressor by Powertrain idle and engine speed control systems.

Powertrain shall use the calibration **K_Torq_M_ClitchlessAC_NormTrq** in order to calculate the anticipated **AC_Compressor_Actual_Torque** when the following conditions are satisfied:

- a. **Air Conditioning Compressor Mode Request** has been received by Powertrain equal to "Engage"
- b. **Air Conditioning Compressor Command** is being transmitted by Powertrain equal to "Off".

Following the compressor engagement, i.e., **Air Conditioning Compressor Command** is being transmitted by Powertrain equal to "ON" and as soon as an **Air Conditioning Compressor Normalized Load** signal greater than "0" is received by Powertrain electronics, the calibration **K_Torq_M_ClitchlessAC_NormTrq** shall be replaced by the actual **Air Conditioning Compressor Normalized Load** in order to calculate the actual **AC_Compressor_Actual_Torque**.

4.1.3.10 Air Conditioning Compressor Command.

The serial data signal **Air Conditioning Compressor Command On** transmitted by Powertrain to indicate the command state of the A/C Compressor. Also see Section 4.1.1.1 and GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for Platform requirements related to this signal.

- a. For all A/C systems with an A/C relay, a state of "On" shall indicate the relay is energized, resulting in the closure of the relay output contacts and the A/C compressor being enabled. A state of "Off" shall indicate the relay is de-energized, causing the relay output contacts to open and the A/C compressor is disabled. The state of the Air Conditioning Compressor Command signal shall be set to "Off" any time a failure is detected with the A/C Compressor Relay hardware output. See Section 4.1.3.13.
- b. For A/C systems without an A/C relay (ECVD A/C compressor systems in non-OBD II markets), **Air Conditioning Compressor Command** and **Air Conditioning Compressor Normalized Load Gradient Allowed** shall indicate the "permission" to the Platform electronics to allow engagement or request disengagement of the A/C compressor based on the following (See Section 4.1.3.13):
 - (1) An **Air Conditioning Compressor Command** state of "On" shall indicate that A/C compressor engagement is permitted and that the Powertrain electronics has adequately prepared for the pending change in the compressor load. Powertrain shall send the **Air Conditioning Compressor Load Gradient Allowed** with the maximum value of load gradient the engine can tolerate and still maintain engine performance.
 - (2) An **Air Conditioning Compressor Command** state of "Off" shall indicate that A/C compressor disengagement is being requested (or compressor engagement is no longer permitted).
 - (3) The state of the **Air Conditioning Compressor Command** signal shall be set to "Off" any time the **Air Conditioning Compressor Mode Request** is equal to "Disengage" or "Disengage Immediately".

4.1.3.11 Air Conditioning Off Indication On.

The Powertrain electronics shall transmit **Air Conditioning Off Indication On** set to "True" if the following requirements are satisfied:

- a. **Air Conditioning Compressor Mode Request** is being received equal to "Engage".
- b. **Air Conditioning Compressor Command** is being transmitted with a value of "Off".
- c. The air conditioning compressor is being commanded off due to high coolant temperature.

If any of the above conditions are not satisfied, **Air Conditioning Off Indication On** set to "False".

4.1.3.12 Air Conditioning Compressor Normalized Load Gradient Allowed.

For ECVD compressor applications, Powertrain shall transmit to Platform the serial data signal **Air Conditioning Compressor Normalized Load Gradient Allowed**. This signal shall be normalized as defined in Section 4.1.3.8.

Air Conditioning Compressor Normalized Load Gradient Allowed shall reflect the following information:

Maximum allowed compressor load gradient for the existing powertrain operating conditions, which include the following:

- a. While the signal **Air Conditioning Compressor Command** is equal to "On", Powertrain shall adjust **Air Conditioning Compressor Normalized Load Gradient Allowed** to the maximum value possible, which will not affect engine performance as perceived by the vehicle operator (e.g. idle stability)
- b. When the signal **Air Conditioning Compressor Command** transitions to "Off":
 - (1) Powertrain shall indicate an "Immediate Shutdown" of the A/C Compressor by setting **Air Conditioning Compressor Normalized Load Gradient Allowed** equal to its maximum value (see GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements) as a result of a pending engine stall, fast vehicle launch condition, wide-open throttle condition or protection reason.
 - (2) Powertrain shall indicate a "Controlled Shutdown" of the A/C compressor by setting **Air Conditioning Compressor Load Gradient Allowed** equal to an intermediate value as a result of coolant system faults, compressor failed "On" or serial data faults.

Powertrain shall set and maintain **Air Conditioning Compressor Normalized Load Gradient Allowed** equal to the minimum "engagement" value prior the **Air Conditioning Compressor Command** being set equal to "On".

4.1.3.13 Powertrain A/C Compressor Control.

Powertrain can control the A/C compressor via the following methods:

- a. By an A/C Compressor Relay if present (clutch type compressor or ECVD compressor in OBD II vehicle markets).
- b. By a serial data signal request **Air Conditioning Compressor Command** to the Platform HVAC controller (ECVD compressor in non-OBDII vehicle markets).

Powertrain shall control the A/C Compressor during to the following conditions:

- a. While the engine is cranking, Powertrain may activate the A/C Compressor to remove slug in the refrigerant system. Reference Section 4.1.3.13.1.
- b. An A/C Compressor override maybe requested by a Scan Tool through device control. Reference Section 4.1.3.13.2.
- c. While the engine is running, Powertrain shall determine the A/C Compressor enable/disable state based on the following requirements:
 - (1) The A/C compressor shall be enabled if both of the following conditions are satisfied:
 - (a) The Powertrain electronics has prepared and is ready to manage the addition of the pending A/C compressor load. For ECVD A/C systems the signal Air Conditioning Compressor Normalized Load (see Section 4.1.3.8 and Section 4.1.2.8) provides an indication of the pending compressor load.
 - (b) The **Air Conditioning Compressor Mode Request** (Request (reference Section 4.1.2.4) is equal to "Engage".
 - (2) The A/C Compressor shall be disabled or remain disabled if any of the following conditions are present:
 - (a) The Powertrain electronics is *not* ready to manage the addition of the pending A/C compressor load, or
 - (b) The **Air Conditioning Compressor Mode Request** (reference Section 4.1.2.4) is equal to "Disengage" or "Disengage Immediately":
 - i. If the **Air Conditioning Compressor Mode Request** is equal to "Disengage" Powertrain is allowed to compensate for the change in compressor load prior to disabling the A/C Compressor.

- ii. If the **Air Conditioning Compressor Mode Request** is equal to "Disengage Immediately", Powertrain shall disable the A/C Compressor unconditionally.
- (3) The Powertrain electronics shall control to the enable/disable requirements above, unless one of the following override conditions have occurred (Note: the state of "Disengage Immediately" shall take priority over these conditions):

A/C Compressor disabling conditions:

- (1) Due to protect compressor for engine speed protection reasons. See Section 4.1.3.13.3.
- (2) Due to protect compressor if battery voltage is out of range. See Section 4.1.3.13.4.
- (3) Due to protect compressor if AC_Pressure is out of range. See Section 4.1.3.13.5.
- (4) A/C Compressor enabling is delayed until the A/C Compressor has been disabled for a minimum period of time. See Section 4.1.3.13.6.
- (5) Due to high engine coolant temperature. See Section 4.1.3.13.7.
- (6) To provide all available engine power for maximum vehicle performance. See Section 4.1.3.13.8.
- (7) To improve vehicle launch performance. See Section 4.1.3.13.9.
- (8) For Powertrain specific reasons. See Section 4.1.3.13.10.
- (9) A/C Compressor engagement and disengagement delayed due to Powertrain diagnostics. See Section 4.1.3.13.11.
- (10) Due to compressor failed "On" condition detected by Platform. See Section 4.1.3.13.12.
- (11) Due to detection of a serial data failure. See Section 4.1.3.13.13.

4.1.3.13.1 Enable the A/C Compressor during engine crank to remove slug in the refrigerant system.

The Powertrain controller may enable the A/C Compressor while the engine is cranking to remove slug in the refrigerant system. If required to remove slug, the A/C Compressor Relay shall be engaged until **Engine Reference Pulse Count** is equal to **K_SlugMaxRefPulses** or **K_MaxAntiSlugTme** seconds, whichever occurs first. The A/C Compressor shall be enabled for anti-slugging when all of the following conditions are satisfied:

- a. The engine is cranking as determined by Powertrain.
- b. The air conditioning refrigerant high side fluid pressure as determined by Powertrain is greater than or equal to **K_SlugUnderPresLmt**.
- c. The system voltage as determined by Powertrain is greater than or equal to **K_SlugIgnVoltThrsh**.
- d. The engine coolant temperature as determined by Powertrain is less than **K_SlugCoolTempThrsh**.
- e. The intake air temperature as determined by Powertrain, at the last time when the engine running state was true, is greater than **K_SlugKoffMnfdTempThrsh**.
- f. The intake air temperature as determined by Powertrain, when the Run/Crank input transitions to high, is greater than **K_SlugMnfdTempThrsh**.

4.1.3.13.2 A/C Compressor enable/disable override requested by a Scan tool through device control.

GM corporate device control requirements are documented by the GMPT GMLAN Diagnostic Test Mode Configuration Specification.

4.1.3.13.3 A/C Compressor engage and disengage control to prevent compressor damage and engine stall.

The Powertrain controller shall disable the A/C Compressor if the engine speed is not within an acceptable range to protect the compressor from damage or to prevent engine stall.

- a. The A/C Compressor disable and enable range due to engine speed is shown in Figure 1 below.
- b. All of the calibrations in the figure, with the exception of the engine stall calibration **K_LowSpeedEngOff**, are Platform owned calibrations located in the Powertrain electronics.

- c. PRNDL_State is used to determine Park/Neutral vs. Gear for an automatic transmission.
- (1) If a Clutch Switch is available for a manual transmission, "Park/Neutral" will be indicated when **Manual_Trans_Clutch_State** is equal to "Depressed".
 - (2) If a clutch switch is not available for a manual transmission application, "In Gear" shall be assumed.

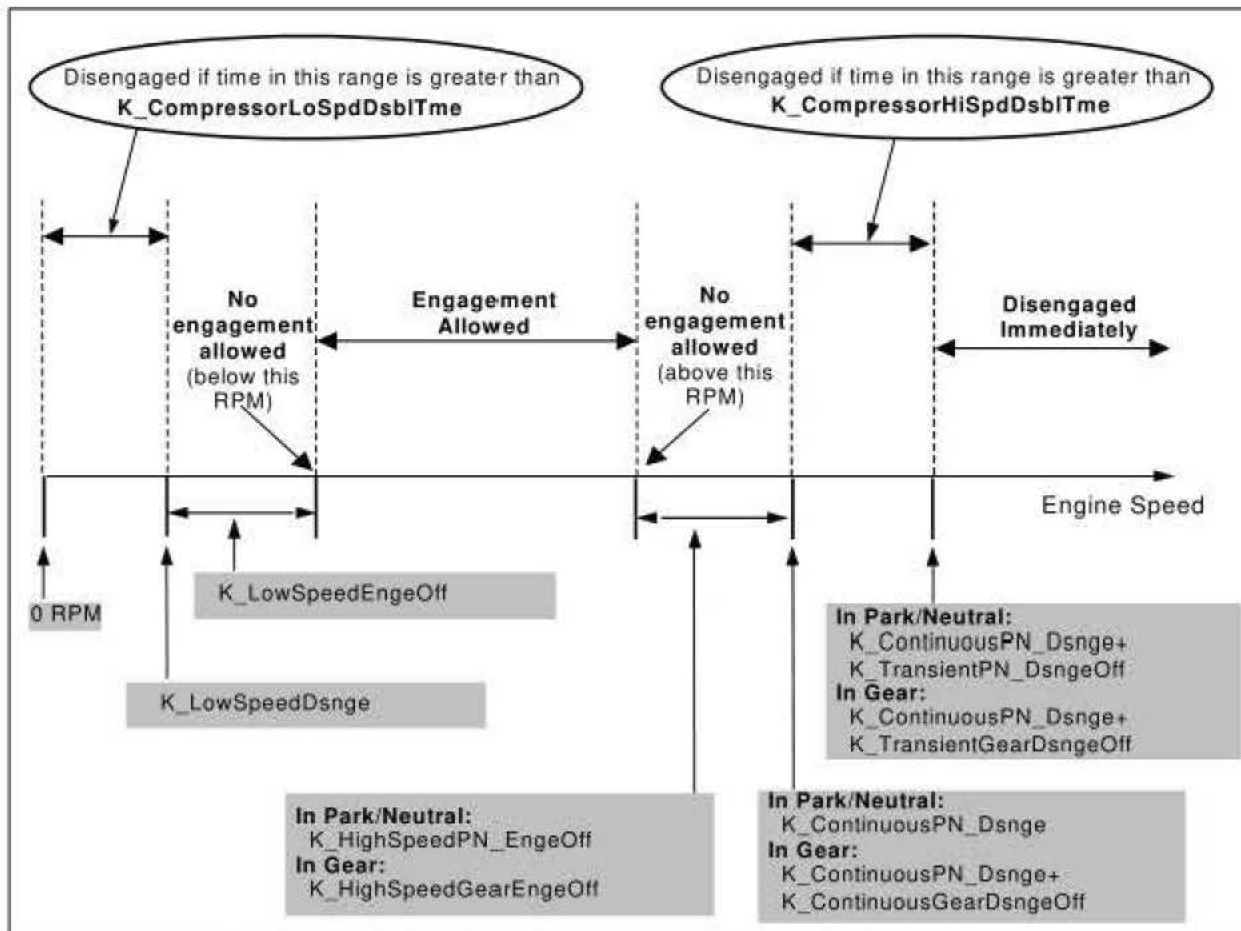


Figure 4 - A/C Compressor Disabled/Enable Range for Engine Speed Protection

Figure 4 Notes:

- "Engagement Allowed" defines the band of engine speed where the powertrain controller is not prevented from enabling the A/C Compressor.
- "Disengage Immediately" defines the range of engine speed where the powertrain controller shall disable the A/C Compressor as fast as possible due to compressor speed protections.
- "No Engagement Allowed" defines the band of engine speed where the powertrain controller is prevented from enabling the A/C Compressor due to engine stall and compressor speed protections.

4.1.3.13.4 A/C Compressor disabled to protect Compressor Components if battery voltage is out of range.

The Powertrain controller shall disable the A/C Compressor as fast as possible if either of the following conditions is satisfied:

- Run/Crank voltage is greater than **K_HighVoltDsngc** with **K_HighVoltEnge** (platform owned calibrations) acting as a hysteresis pair.
- Run/Crank voltage is less than **K_LowVoltDsngc** with **K_LowVoltEnge** (platform owned calibrations) acting as a hysteresis pair.

4.1.3.13.5 A/C Compressor disabled to protect Compressor if AC_Pressure is out of range.

The Powertrain controller shall disable the A/C Compressor as fast as possible if any of the following conditions are satisfied:

- AC_Pressure** is greater than **K_HighPresDsngc** with **K_HighPresEnge** (platform owned calibrations) acting as a hysteresis pair.
- AC_Pressure** is less than **K_LowPresDsngc** with **K_LowPresEnge** (platform owned calibrations) acting as a hysteresis pair.
- A fault (**Fault_Active_AC_Pressure** = True) is detected.

4.1.3.13.6 A/C Compressor enable delayed until A/C Compressor has been disabled for a minimum period of time.

The Powertrain controller shall delay enabling the A/C Compressor until it has been disabled for at least **K_MinCompDsblTme** (platform owned calibration) seconds. This delay is bypassed for device control overrides by a Scan tool. This minimum disable time does not apply to A/C Compressor enable/disable events during engine cranking (see Section 4.1.3.13.1).

4.1.3.13.7 A/C Compressor disabled due to high engine coolant temperature

The Powertrain controller shall disable the A/C Compressor when **Engine_Coolant_Temperature** is greater than **K_AC_EngCoolTempDsngc** and shall not re-enable the compressor until **Engine_Coolant_Temperature** is less than **K_AC_EngCoolTempEnge**.

4.1.3.13.8 A/C Compressor disengaged to provide all available engine power for maximum vehicle performance.

The Powertrain controller shall disengage the A/C Compressor during wide-open throttle maneuvers for increased vehicle performance. The A/C Compressor shall be disabled immediately for a minimum time period of **K_MinFullPedDsblTme** seconds if ALL of the following conditions are satisfied:

- The accelerator pedal position is greater than **K_FullPedDsngc**, with **K_FullPedEnge** as a hysteresis.
- The engine speed is lower than **K_HiSpdFullPedDsngc**, with **K_HiSpdFullPedEnge** as a hysteresis.
- Ambient_Air_Pressure** is greater than **K_BarometerThreshold**.
- A minimum time period of **K_MinFullPedDsblCycTme** seconds has elapsed since the end of the last wide open throttle A/C Compressor disable event.
- To avoid a short A/C Compressor engagement during a gear shift, the clutch shall continue to be disabled after leaving condition (a) for the time period of **K_LetOffPedDsblTme** seconds.
- The A/C Compressor will continue to be disabled as long as the wide-open throttle condition exists up to a maximum time period of **K_MaxFullPedDsblTme** seconds.

Note: All calibrations in this section are Platform owned calibrations located in the Powertrain electronics.

4.1.3.13.9 A/C Compressor disabled to improve vehicle launch performance.

The Powertrain controller may disable the A/C Compressor during a heavy launch condition. A heavy launch is defined for high road grade or "fast drive-away" vehicle operation when all of the following conditions are met:

- The accelerator pedal is depressed further than **K_LaunchPedPosDsngc** as a function of engine speed.
- The vehicle speed is below **K_LowVehSpdDsngc** with the hysteresis **K_LowVehSpdEnge**.
- Vehicle acceleration is less than **K_LowAccelDsngc** with the hysteresis **K_LowAccelEnge**.

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The A/C Compressor shall continue to be disabled after leaving condition (a) for the time period of **K_LetOffPedDsblTme** seconds.

Guideline for this calibration: In hot weather and on a level road, the A/C Compressor shall stay enabled during a "normal drive-away".

Note: All calibrations in this section are Platform owned calibrations located in the Powertrain electronics.

4.1.3.13.10 A/C Compressor disabled for Powertrain reasons (Powertrain Optional).

- a. The Powertrain controller may immediately disable or delay enabling the A/C Compressor for Powertrain specific reasons, which include, but are not limited to the following:
 - (1) Engine load management
 - (2) Transmission shift events
 - (3) Engine stall prevention
 - (4) Engine speed stabilization for a start
 - (5) Transition to closed throttle
- b. Powertrain shall limit the duration that the A/C Compressor is disabled to **K_ShutdownReqMax** seconds, except for service device control or Crank Angle Sensing Error (CASE) Learn during Dynamic Vehicle Test.

4.1.3.13.11 A/C Compressor Engagement and Disengagement delayed due to Powertrain Diagnostics (Powertrain optional).

The Powertrain controller may delay engagement or disengagement of the A/C Compressor when requested by Powertrain diagnostics. The Catalyst Monitor Diagnostic and the EGR (Exhaust Gas Recirculation) Quick Test Diagnostic may require the A/C Compressor to remain engaged or disengaged in order to stabilize conditions, allowing the diagnostics to run and avoid any OBD-II non-compliance issues. Diagnostics will only be allowed to override Platform A/C control to remain engaged if none of the A/C Compressor Protection Immediate shutdown conditions are present. The A/C Compressor Immediate Shutdown Conditions are defined (refer to Section 4.1.3.11.c) as Engine Speed Protection, Battery Voltage Out of Range, the A/C High Side Pressure Out of Range and if the **Air Conditioning Compressor Mode Request** is received as "Disengage_Immediately". No priority scheme is required for diagnostic overrides since the EGR Diagnostic Request and the Catalyst Monitor Diagnostic Request operate in mutually exclusive regions.

4.1.3.13.11.1 A/C Compressor engagement and disengagement delayed due to Catalyst Monitor Diagnostic Override.

When A/C compressor is disengaged the Catalyst Monitor Diagnostic can request that the air conditioning compressor remain off for up to **K_DiagClutchDelay_CatMon** seconds. When the A/C Compressor is engaged the Catalyst Monitor Diagnostic can request that the air conditioning compressor remain engaged for up to **K_DiagOverrideOnMax_CatMon** seconds.

4.1.3.13.11.2 A/C Compressor engagement and disengagement delayed due to EGR Diagnostic Override.

When A/C clutch is disengaged or engaged the EGR Diagnostic can request that the air conditioning compressor state change be delayed up to **K_DiagOverrideOnMax_EGR** seconds.

4.1.3.13.12 A/C Compressor enabled when compressor failed "On" detected by Platform.

For ECVD compressor systems only, which support an A/C compressor control relay, the Powertrain electronics may de-energize the A/C compressor relay when the serial data signal Air Conditioning Compressor Failed On is received equal to "True".

4.1.3.13.13 A/C Compressor disable due to serial data failure detected.

- a. The Powertrain electronics shall command "Off" (disabled) the A/C Compressor Relay if any of the following serial failures have occurred:
- b. **Air Conditioning Compressor Normalized Load Validity** is equal to "Invalid" (ECVD systems only).
- c. The value of any of the following serial data signals cannot be determined due to serial data link failure:
 - (1) **Air Conditioning Compressor Mode Request**, default value = "Disengage Immediately".
 - (2) **Air Conditioning Compressor Failed On**, default value = "False" (ECVD systems only)

- (3) **Air Conditioning Compressor Normalized Load**, default value = "0.0"
- d. **Air Conditioning Compressor System Virtual Device Availability** is equal to "Virtual Device Unavailable" or cannot be determined due to serial data link failure (default value = "Virtual Device Unavailable").
- e. The Powertrain electronics has determined that the serial data bus has failed.

4.1.4 Execution/Activation Requirements.

Table 5: Air Conditioning Compressor Control Execution Requirements

Algorithm Section	Platform Maximum Execution Interval	Powertrain Maximum Execution Interval
Air Conditioning Compressor Control	28 ms	28 ms

4.1.5 Diagnostic Requirements.

Powertrain shall monitor the following sensors and set the validity bit to "Invalid" in the corresponding serial data signal when a fault is detected and the corresponding DTC has been set:

- A/C Refrigerant High Side Pressure (AC_Pressure)
- Air Intake Temperature Sensor
- Coolant Temperature Sensor

4.1.6 On-Vehicle Communications/Serial Data Interaction Requirements.

Table 6: Serial Data Interface Requirements

Signal Name	Transmitter
Air Conditioning Compressor Command	Powertrain
Air Conditioning Compressor Failed On	Platform
Air Conditioning Compressor Mode Request	Platform
Air Conditioning Compressor Normalized Load	Platform
Air Conditioning Compressor Normalized Load Gradient Allowed	Powertrain
Air Conditioning Compressor Normalized Load Validity	Platform
Air Conditioning Compressor System Virtual Device Availability	Platform
Air Conditioning Compressor Type	Platform
Air Conditioning Off Indication On	Powertrain
Air Conditioning Refrigerant High Side Fluid Pressure	Powertrain
Air Conditioning Refrigerant High Side Fluid Pressure Validity	Powertrain
Engine Coolant Temperature	Powertrain
Engine Coolant Temperature Validity	Powertrain
Engine Intake Air Temperature	Powertrain
Engine Intake Air Temperature Validity	Powertrain
Engine Speed	Powertrain

4.1.7 Off-Vehicle Communications / Serial Data Interaction Requirements.**4.1.7.1 PIDs.**

Powertrain shall provide to Platform the last eight reasons why it has requested that no change be made to the air conditioning compressor torque or that the air conditioning compressor be shutdown. See Corporate Common PID Database for further details.

4.1.8 Data Dictionary.**4.1.8.1 Calibrations.**

K_AC_EngCoolTempEnge, K_AC_EngCoolTempDsng = Hysteresis calibration pairs of the maximum engine coolant temperature which the A/C Compressor shall be allowed to operate.

Minimum Range: -40 to 150 °C.

Minimum Resolution: 1 °C.

Typical Value: 110, 115 °C.

Location: Powertrain

Owner: Platform

K_AC_PresSensor_Slope = Calibration defines the slope of the A/C pressure sensor transfer function. See Section 3.

Minimum Range: 0.000000-0.002046 volts/kPa

Minimum Resolution: 0.000001 volts/kPa

Typical Value: 0.000273 (GMNA Corporate Common Sensor)

Location: Powertrain

Owner: Platform

K_AC_PresSensor_Offset = Calibration defines the sensor offset voltage of the A/C pressure sensor transfer function. See Section 3.

Minimum Range: 0.0000-0.2046 volts

Minimum Resolution:

Typical Value: 0.0228 volts (GMNA Corporate Common Sensor)

Location: Powertrain

Owner: Platform

K_AC_VehicleSpeedThrsh = Upon a change in state of the Air Conditioning Compressor Mode Request serial data signal from engaged to either disengage or disengage immediately, Powertrain shall prevent adjustment of nominal idle speed to a lower value until vehicle speed has exceeded this calibration.

Minimum Range: 0-255 KPH

Minimum Resolution: 1 KPH

Typical Value: 10 KPH

Location: Powertrain

Owner: Platform

K_BarometerThreshold = Minimum ambient air pressure to enable wide-open throttle disable function.

Minimum Range: 0 to 100 kPa

Minimum Resolution: 1 kPa

Typical Value: 85 kPa

Location: Powertrain

Owner: Platform

K_CompressorHISpdDsblTme = Time that the engine speed is allowed to be between the continuous high speed and transient high speed thresholds before disable of the A/C Compressor is commanded by the Powertrain controller.

Minimum Range: 0 to 15 s

Minimum Resolution: 0.5 s

Typical Value: 5 s

Location: Powertrain

Owner: Platform

K_CompressorLoSpdDsblTme = Time that the engine speed is allowed to be below K_LowSpeedDsngc before disable of the A/C Compressor is commanded by the Powertrain controller.

Minimum Range: 0 to 15 s

Minimum Resolution: 0.5 s

Typical Value: 5 s

Location: Powertrain

Owner: Platform

K_ContinuousGearDsngcOff = Engine speed offset above K_ContinuousPN_Dsngc, above which the compressor is only allowed to remain engaged for a calibratable time, after which it is disabled.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 0 RPM

Location: Powertrain

Owner: Platform

K_ContinuousPN_Dsngc = Engine speed, when the transmission is in Park/Neutral, above which the compressor is only allowed to remain engaged for a calibratable time, after which it is disabled.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 4600 RPM

Location: Powertrain

Owner: Platform

K_DiagClutchDelay_CatMon = Maximum amount of time the compressor control system is allowed to delay engagement of the A/C compressor for Powertrain Catalyst Monitor diagnostic algorithms. (Powertrain owned and optional)

Minimum Range: 0 to 25.5 s.

Minimum Resolution: 0.1 s.

Typical Value: 5 s

K_DiagOverrideOnMax_CatMon = Maximum amount of time the compressor control system is allowed to delay disengagement of the A/C compressor for the Powertrain Catalyst Monitor diagnostic algorithms. (Powertrain owned and optional)

Minimum Range: 0 to 25.5 s.

Minimum Resolution: 0.1 s.

Typical Value: 20 s

K_DiagOverrideOnMax_EGR = Maximum amount of time the compressor control system is allowed to delay an A/C compressor state change for the Powertrain EGR diagnostic algorithms. (Powertrain owned and optional)

Minimum Range: 0 to 25.5 s.

Minimum Resolution: 0.1 s.

Typical Value: 4 s

K_FullPedDsng = Accelerator pedal position above which the A/C Compressor shall be disabled.

Minimum Range: 0 to 100%

Minimum Resolution: 1%

Typical Value: 95%

Location: Powertrain

Owner: Platform

K_FullPedEng = Hysteresis to K_FullPedDsng.

Minimum Range: 0 to 100%

Minimum Resolution: 1%

Typical Value: 85%

Location: Powertrain

Owner: Platform

K_HighPresDsng = A/C Pressure above which the A/C Compressor is disabled.

Minimum Range: 0 to 4096 kPa

Minimum Resolution: 14 kPa

Typical Value: 3000 kPa

Location: Powertrain

Owner: Platform

K_HighPresEng = A/C Pressure below which the A/C Compressor may be re-enabled if it had been disabled due to high A/C Pressure.

Minimum Range: 0 to 4096 kPa

Minimum Resolution: 14 kPa

Typical Value: 2300 kPa

Location: Powertrain

Owner: Platform

K_HighSpeedGearEngOff = Engine speed offset from the sum of K_ContinuousPN_Dsng and K_ContinuousGearDsngOff below which re-engagement of the A/C Compressor is allowed while in gear.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 700 RPM

Location: Powertrain

Owner: Platform

K_HighSpeedPN_EngOff = Engine speed offset from K_ContinuousPN_Dsng below which re-engagement of the A/C Compressor is allowed.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 700 RPM

Location: Powertrain

Owner: Platform

K_HiSpdFullPedDsng = Maximum engine speed for Wide Open Throttle which the A/C Compressor shall be disabled.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 3800 RPM

Location: Powertrain

Owner: Platform

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K_HiSpdFullPedEnge = Hysteresis to K_HiSpdFullPedDsngc.

Typical Value: 4000 RPM

Location: Powertrain

Owner: Platform

K_HighVoltDsngc and **K_HighVoltEnge** = Hysteresis pair of calibrations that define the voltage above which the A/C Compressor is disabled.

Minimum Range: 0 to 25.5 volts

Minimum Resolution: 0.1 volts

Typical Value: 16 volts

Location: Powertrain

Owner: Platform

K_LaunchPedPosDsngc = Accelerator pedal position as a function of engine speed, above which the A/C Compressor shall be disabled during a heavy launch condition.

table with 5 calibrateable breakpoints

Minimum Range:	0 to 8192 rpm,	0 to 100%
----------------	----------------	-----------

Minimum Resolution:	32 rpm,	1%
---------------------	---------	----

Typical Values: at idle speed:	55%
--------------------------------	-----

at stall speed auto trans:	80%
----------------------------	-----

Location: Powertrain

Owner: Platform

K_LetOffPedDsbtMe = A/C Compressor continuous disable time for pedal let-off conditions.

Minimum Range: 0-10 s

Minimum Resolution: 0.1 s

Typical Value: 1.5 s

Location: Powertrain

Owner: Powertrain/Platform

K_LowAccelDsngc = Vehicle acceleration below which a heavy launch condition is defined.

Minimum Range: 0 to 2 m/s²

Minimum Resolution: 0.1 m/s²

Typical Value: 0.6 m/s²

Location: Powertrain

Owner: Platform

K_LowAccelEnge = Hysteresis to K_LowAccelDsngc.

Typical Value: 0.9 m/s²

Location: Powertrain

Owner: Platform

K_LowPresDsngc = A/C Pressure below which the A/C Compressor is disabled.

Minimum Range: 0 to 4096 kPa

Minimum Resolution: 14 kPa

Typical Value: 180 kPa

Location: Powertrain

Owner: Platform

K_LowPresEnge = A/C Pressure above which the A/C Compressor may be re-enabled if it had been disabled due to low A/C Pressure.

Minimum Range: 0 to 4096 kPa

Minimum Resolution: 14 kPa

Typical Value: 215 kPa

Location: Powertrain

Owner: Platform

K_LowSpeedDsng = Engine speed below which the A/C Compressor is disabled to protect the compressor from inadequate lubrication.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 450 RPM

Location: Powertrain

Owner: Platform

K_LowSpeedEngeOff = Engine speed offset from K_LowSpeedDsng above which re-engagement of the A/C Compressor is allowed.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 125 RPM

Location: Powertrain

Owner: Platform

K_LowVehSpdDsng = Vehicle speed below which a heavy launch condition is defined.

Minimum Range: 0 to 50 km/h

Minimum Resolution: 1 km/h

Typical Value: 22 km/h

Location: Powertrain

Owner: Platform

K_LowVehSpdEnge = Hysteresis to K_LowVehSpdDsng.

Typical Value: 25 km/h

Location: Powertrain

Owner: Platform

K_LowVoltDsng and **K_LowVoltEnge** = Hysteresis pair of calibrations that define the voltage below which the A/C Compressor is disabled.

Minimum Range: 0 to 25.5 volts

Minimum Resolution: 0.1 volts

Typical Values: 9.5 and 11.0 volts respectively

Location: Powertrain

Owner: Platform

K_MaxAntiSlugTme = Maximum amount of time allowed to engage A/C Compressor for anti-slugging action.

Minimum Range: 100 to 7000 ms.

Minimum Resolution: 100 ms.

Typical Value: 500 ms.

Location: Powertrain

Owner: Platform

K_MaxFullPedDsblTme = Maximum amount of time the A/C Compressor is allowed to be disabled for the wide open throttle disable function. This is a Powertrain-owned calibration.

Minimum Range: 0 to 10 s.

Minimum Resolution: 0.1 s.

Typical Value: 6 s

Location: Powertrain

Owner: Platform

K_MinCompDsblTme = Minimum compressor off time as a function of engine speed (see GMW8762 Section 4 PPEI Serial Data Signal and Definitions and Framing Requirements for usage description).

Minimum Range: 0 to 10 s

Minimum Resolution: 0.1 s

Table Breakpoints: 0 to 8192 RPM; every 512 RPM

Typical Values: 0 RPM = 8 s

1024 RPM = 8 s

Location: Platform

Owner: Platform/Powertrain

K_MinFullPedDsblCycTme = Minimum amount of time before the wide open throttle disable can be activated since the last time the A/C Compressor was disabled for a wide open throttle condition. This is a Powertrain-owned calibration.

Minimum Range: 0 to 10 s.

Minimum Resolution: 0.1 s.

Typical Value: 6 s

Location: Powertrain

Owner: Powertrain

K_MinFullPedDsblTme = Minimum amount of time the A/C Compressor will be disabled due to a wide-open throttle condition.

Minimum Range: 0 to 10 s.

Minimum Resolution: 0.1 s.

Typical Value: 2 s

Location: Powertrain

Owner: Powertrain

K_ShutdownReqMax = The maximum duration that the A/C Compressor can be disabled for Powertrain specific reasons such as engine load management, transmission shift events, engine stall prevention, engine speed stabilization for a start, transition to closed throttle, etc (this excludes service device control or Crank Angle Sensing Error (CASE) Learn during Dynamic Vehicle Test).

Minimum Range: 0 – 25.5

Minimum Resolution: 0.1 s

Typical Value: 5 s (when executing CATMON, "No Change Allowed" overrides this value)

Location: Powertrain

Owner: Platform/Powertrain

K_SlugCoolTempThrsh = Maximum engine coolant temperature to engage anti-slugging action.

Minimum Range: -40 to 150 °C.

Minimum Resolution: 1 °C.

Typical Value: 25 °C.

Location: Powertrain

Owner: Platform

K_SlugIgnVoltThrsh = Minimum vehicle system voltage to engage A/C Compressor for anti-slugging.

Minimum Range: 0 to 25.5 volts

Minimum Resolution: 0.1 volts

Typical Value: 9.5 volts

Location: Powertrain

Owner: Platform

K_SlugKoffMnfdTempThrsh = Maximum Intake air temperature at end of last ignition cycle to enable anti-slugging action.

Minimum Range: -40 to 150 °C.

Minimum Resolution: 1 °C.

Typical Value: 14 °C.

Location: Powertrain

Owner: Platform

K_SlugMaxRefPulses = number of engine reference pulses to engage the A/C Compressor for anti-slugging action during engine crank.

Minimum Range: 0 to 255 pulses

Minimum Resolution: 1 pulse

Typical Value: 15 pulses

Location: Powertrain

Owner: Platform

K_SlugMnfdTempThrsh = Maximum Intake air temperature to enable anti-slugging action.

Minimum Range: -40 to 150 °C.

Minimum Resolution: 1 °C.

Typical Value: 5 °C.

Location: Powertrain

Owner: Platform

K_SlugUnderPresLmt = Minimum A/C high side pressure to enable anti-slugging action.

Minimum Range: 0 to 500 kPa

Minimum Resolution: 14 kPa

Typical Value: 150 kPa

Location: Powertrain

Owner: Platform

K_Torq_M_CltchlessAC_NormTrq = Calibration is not required for Clutch based A/C compressor control systems. This calibration replaces the serial data signal of Air Conditioning Compressor Normalized Load during the off to on sequence (anticipated A/C load).

Minimum Range: 0.00 to 10.00 dm³/minute

Minimum Resolution: 0.1

Typical Value: 3

Location: Powertrain

Owner: Platform

K_TransientGearDsngOff = Engine speed offset above K_ContinuousPN_DsngOff at which the A/C Compressor is immediately disabled when the transmission is in gear, to protect the A/C Compressor.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 750 RPM

Location: Powertrain

Owner: Platform

K_TransientPN_DsngOff = Engine speed offset above K_ContinuousPN_DsngOff at which the A/C Compressor is immediately disabled when the transmission is in Park or Neutral, to protect the A/C Compressor.

Minimum Range: 0 to 8192 RPM

Minimum Resolution: 32 RPM

Typical Value: 750 RPM

Location: Powertrain

Owner: Platform

4.1.8.2 Variables

AC_Pressure = variable reflects the A/C refrigerant high side fluid sensor value as determined from the ECM hardware interface.

Minimum Range: 0 to 3570 kPa

Minimum Resolution: 14 kPa

AC_Compressor_Actual_Torque = See Section 4.1.3.8 for more information).

Engine_Coolant_Temperature = Temperature of the engine coolant as determined by the I/O interface of the Powertrain Controller.

Minimum Range: -40 to +140 °C

Minimum Resolution: 0.2 °C

Engine_Speed = Engine speed as determined by Powertrain. Used to determine A/C Compressor Torque load on the engine.

Minimum Range: 0-8192 RPM

Minimum Resolution: RPM

Fault_Active_AC_Pressure = This flag is set when Powertrain has detected a fault with the AC Pressure Sensor signal. Fault_Active_AC_Pressure shall be set equal to "True" upon detection of an error in the AC_Pressure value. Fault_Active_AC_Pressure shall remain set for the current ignition cycle.

Minimum Range: N/A

Minimum Resolution: True or False

Vehicle_Speed = speed of the vehicle as determined by Powertrain

Minimum Range: 0 – 255 KPH

Minimum Resolution: 1 KPH

4.1.8.3 Compressor Sequence/Event Chart.

Description:

- Yellow cells – Events and signals sent by Platform.
- Blue values – Variable/state change.
- *Engine Load Compensation* indicates what information PowerTrain might use for their estimation.
- TIME / EVENT, no information about how long time/ many frames that passes between the event is considered.

Compressor engagement overview

TIME / EVENT	DEFAULT 1	AC REQ	ECU prep	app. Engagement	Engaged	app. Norm Operation	Norm operation
Air Conditioning Compressor Mode Request	DISENG im	ENABLE	ENABLE	ENABLE	ENABLE	ENABLE	ENABLE
Air Conditioning Compressor Command	OFF	OFF	OFF	ON	ON	ON	ON
Air Conditioning Compressor Normalized Load	0	0	0	0	MIN VALUE	MIN VALUE	OPERATIONAL
Air Conditioning Compressor Normalized Load Validity	VALID	VALID	VALID	VALID	VALID	VALID	VALID
Air Conditioning Compressor normalized Load Gradient Allowed	0.0	0.0	MIN VALUE	MIN VALUE	MIN VALUE	OPERATIONAL	OPERATIONAL
Engine Load Compensation	NONE	NONE	use Calibration	use Calibration	use serial data	use serial data	use serial data

Compressor disengage immediate overview

Requested by Engine

TIME / EVENT	Comp engaged	Im. Shutdown Req	Im. Shutdown	DEFAULT
Air Conditioning Compressor Mode Request	ENABLE	ENABLE	Im Disengage	Im Disengage
Air Conditioning Compressor Command	ON	OFF	OFF	OFF
Air Conditioning Compressor Normalized Load	OPERATIONAL	OPERATIONAL	0	0
Air Conditioning Compressor Normalized Load Validity	VALID	VALID	VALID	VALID
Air Conditioning Compressor normalized Load Gradient Allowed	OPERATIONAL	MAX. VALUE	MAX. VALUE	0.0
Engine Load Compensation	use serial data	use serial data	NONE	NONE

Compressor immediate disengage overview

Requested by HVAC

TIME / EVENT	Comp engaged	Im. Shutdown Req	Im ShutDown App	Im. Shutdown	DEFAULT
Air Conditioning Compressor Mode Request	ENABLE	Im Disengage	Im Disengage	Im Disengage	Im Disengage
Air Conditioning Compressor Command	ON	OFF	OFF	OFF	OFF
Air Conditioning Compressor Normalized Load	OPERATIONAL	OPERATIONAL	OPERATIONAL	0	0
Air Conditioning Compressor Normalized Load Validity	VALID	VALID	VALID	VALID	VALID
Air Conditioning Compressor normalized Load Gradient Allowed	OPERATIONAL	OPERATIONAL	MAX	MAX. VALUE	0.0
Engine Load Compensation	use serial data	use serial data	use serial data	NONE	NONE

Compressor disengage overview

Requested by Engine

TIME / EVENT	Comp engaged	Shutdown Req	Rampdown	Shutdown	Shutdown	DEFAULT
Air Conditioning Compressor Mode Request	ENABLE	ENABLE	Disengage	Disengage	Disengage	Im Disengage
Air Conditioning Compressor Command	ON	OFF	OFF	OFF	OFF	OFF
Air Conditioning Compressor Normalized Load	OPERATIONAL	OPERATIONAL	MIN VALUE	0	0	0
Air Conditioning Compressor Normalized Load Validity	VALID	VALID	VALID	VALID	VALID	VALID
Air Conditioning Compressor normalized Load Gradient Allowed	OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL	0.0	0.0
Engine Load Compensation	use serial data	use serial data	use serial data	use serial data	NONE	NONE

Compressor disengage overview

Requested by HVAC

TIME / EVENT	Comp engaged	Shutdown Req	Rampdown app	Rampdown	Shutdown	Shutdown	DEFAULT
Air Conditioning Compressor Mode Request	ENABLE	Disengage	Disengage	Disengage	Disengage	Disengage	Im Disengage
Air Conditioning Compressor Command	ON	ON	OFF	OFF	OFF	OFF	OFF
Air Conditioning Compressor Normalized Load	OPERATIONAL	OPERATIONAL	OPERATIONAL	MIN VALUE	0	0	0
Air Conditioning Compressor Normalized Load Validity	VALID	VALID	VALID	VALID	VALID	VALID	VALID
Air Conditioning Compressor normalized Load Gradient Allowed	OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL	0.0	0.0
Engine Load Compensation	use serial data	use serial data	use serial data	use serial data	use serial data	NONE	NONE

5 Provisions for Shipping

Not Applicable.

6 Notes**6.1 Glossary**

None.

6.2 Acronyms, Abbreviations, and Symbols.

See GMW8762 Appendix Section A.3

7 Additional Paragraphs

7.1 All materials supplied to this specification must comply with the requirements of GMW3001, **Rules and Regulations for Materials Specifications.**

7.2 All materials supplied to this specification must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts.**

8 Coding System

This specification shall be referenced in other documents, drawings, VTS, CTS, etc. as follows:

GMW8771

9 Release and Revisions

9.1 Release. This general specification originated in June 2003; approved by The Global PPEI Core Team in December 2003 and initially published in February 2004 for the Global PPEI Version 3.4.

9.2 Revisions.

Rev	Approval Date	Description (Organization)
A	Aug 2004	Global PPEI Version 3.5 Release.
B	Jul 2005	Global PPEI Version 3.6 Release.
C	Mar 2006	Global PPEI Version 3.7 Release.

Appendix A

The following are approved Change Requests (CRs) for the Global PPEI Version 3.6 Release that impacted the GMW8771 Air Conditioning Compressor Control Subsystem.

Sections Changed	Description of Change	Rationale/ Authorization
	No changes were made to GMW8771 PPEI Air Conditioning Compressor Control Subsystem Standard for the Global PPEI Version 3.7 Release.	

Deviations

None.

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