



Platform to Powertrain Electrical Interface (PPEI) Specification Starter Control Subsystem

1 Introduction

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 Control
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
GMW8768	GMW8779
GMW8769	GMW8780
GMW8770	GMW8781
GMW8771	

2.3 Additional References.

None.

3 Subsystem Requirements

3.1 Functional Overview.

The ECM Controlled Start mechanization defined in this section shall be applicable to vehicles equipped with an ignition key switch or push button start (Easy Key). The mechanization supports Power Take Off (PTO) remote start on automatic and manual transmissions and the Remote Vehicle Start (RVS) feature on automatic transmission vehicles only.

Starter Control requirements are captured in the PPEI Starter Control algorithm description in Section 4.1. For information about Easy Key, refer to the Easy Key Subsystem Technical Specification. For information about RVS, refer to the RVS Subsystem Technical Specification. For information about PTO Remote Engine Start, refer

to the Power Take Off Remote Engine Start Subsystem Technical Specification.

The ECM Controlled Start mechanization utilizes a serial data based power mode signal for a driver-initiated crank request. The ECM shall only initiate engine cranking when the value of this signal is CRANK_REQUEST, after previously receiving an indication that the vehicle is in Park/Neutral or that the clutch is determined to be depressed. Clutch status is only used in vehicles with a calibration requiring clutch depression for crank initiation. Upon loss of serial data from the Power Mode Master and the Backup Power Mode Master, the ECM shall use its discrete Run/Crank Relay Output (an input to the ECM) and Accessory Input signals for power moding. In this case, the ECM is unable to receive the CRANK REQUEST power mode signal and shall not use its discrete inputs to initiate engine cranking. The only exception to this criterion is as follows:

EXCEPTION: The ECM can initiate engine cranking based on its discrete input signals **ONLY** when the ECM is in "Post Release Stall" mode operation. The Post Release Stall mode operation requires the following: the ECM has passed Vehicle Theft during the current ignition cycle, the engine has stopped rotating and there is a loss of System Power Mode and System Backup Power Mode signals over serial data.

Only the Ignition Mode Switch can generate the Backup System Power Mode = "Crank Request" on the High Speed GMLAN bus. The conventional Ignition Switch system will not provide System

Backup Power Mode signals to the high speed bus since the Backup Power Mode Master is only enabled upon the loss of low speed communication with the gateway module.

The ECM shall disable engine cranking based on its discrete Run/Crank Relay Output and Accessory input signals, or when the value of the power mode signal is not equal to CRANK_REQUEST. The Power Mode Master will never issue the Crank Request power mode signal when in the Off, Accessory/Wake Up, or Run ignition switch positions during any single point failure of the ignition key switch or Easy Key wires.

3.2 Hardware Overview.

The Accessory/Wake Up and Run/Crank signals are required for starter control and shall be used for detecting wake-up.

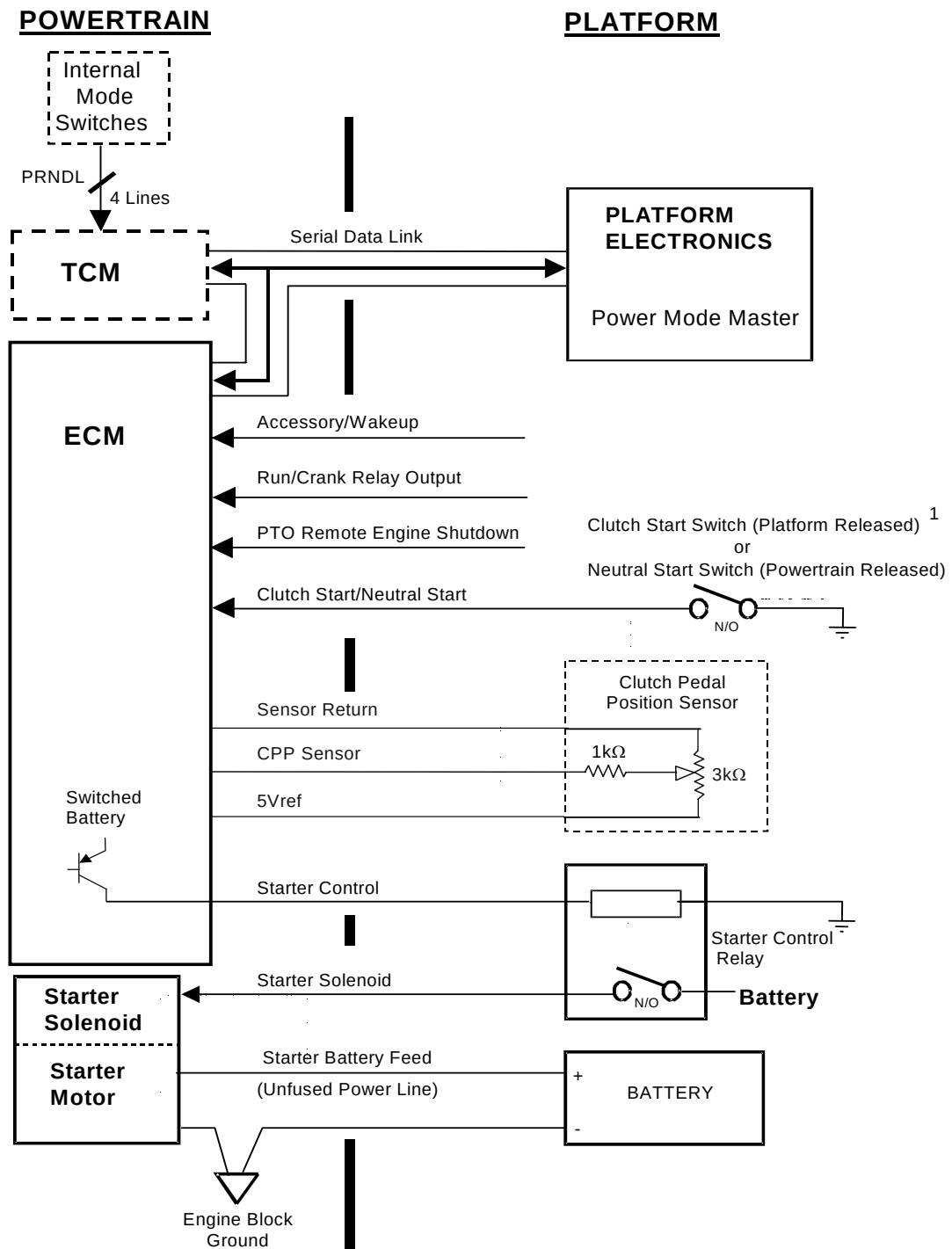
On manual transmissions, Clutch Start information (when required) is communicated to the Powertrain electronics from the Platform. This information is provided by a discrete switch or a sensor. On automatic transmissions, powertrain shall determine park or neutral gear selection with a discrete switch to the ECM.

Vehicle theft password and status, and system power mode are communicated using the serial data link.

The starter solenoid is energized from the battery via the starter control relay. The starter control relay is controlled by the Starter Control output of the powertrain electronics.

3.2.1 Block Diagram.

The following block diagram (Figure 1) depicts the standard mechanization for ECM Controlled Start.



Note:

1. Clutch Start Switch is required for North American and optional for European manual transmissions only. Alternatively, a Clutch Pedal Position (CPP) Sensor may provide this information. Reference GMW8777 Transmission Control for more detail on the CPP Sensor requirements.

Figure 1: Starter Control Subsystem Block Diagram

3.2.2 Power and Ground Requirements.

The cranking circuit power and ground requirements shall be mutually resolved between Platform and Powertrain for each application.

For GMNA applications, refer to the “Cranking Subsystem Technical Specification”.

3.3 Interface Description.

3.3.1 Serial Data Link.

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

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 4.1 PPEI Starter Control Algorithm and Section 4.2 PPEI Remote Vehicle Start Monitor Algorithm for details.

Table 1: Starter Control Serial Data Signals

Signal Name	Transmitter	Notes
Backup Power Mode Master Virtual Device Availability	Platform	Required
Engine Run Active	Powertrain	Required
Platform Engine Speed Command On Switch Active	Platform	Required with PTO
Power Take Off Enable Switch Active	Platform	Required with PTO
Power Take Off Powertrain Run Aborted	Platform	Required with PTO
Power Take Off Remote Engine Shutdown Requested	Platform	Required with PTO
Power Take Off Remote Start Master Engine Start Request	Platform	Required with PTO
Power Take Off Remote Start Master Engine Shutdown Request	Platform	Required with PTO
Powertrain Crank Aborted	Powertrain	Required
Powertrain Crank Active	Powertrain	Required
Powertrain Run Aborted	Powertrain	Required
Remote Vehicle Start Engine Running	Powertrain	Required with RVS
Remote Vehicle Start Request	Platform	Required with RVS
Starting Disabled Indication On	Powertrain	Required
System Backup Power Mode	Platform	Required
System Backup Power Mode Enabled	Platform	Required
System Power Mode	Platform	Required
Wheel Rotational Status Left Driven	Platform	Required With ABS
Wheel Rotational Status Left Non Driven	Platform	Required With ABS
Wheel Rotational Status Right Driven	Platform	Required With ABS
Wheel Rotational Status Right Non Driven	Platform	Required With ABS

Table 2: Starter Control Calibrations

Calibration Name	Location	Owner
K_AccelPedalPct	ECM	Platform
K_AccelPedalPctTime	ECM	Platform
K_ClutchStarterInterlockPresent	ECM	Platform
K_CrankExtend	ECM	Platform/Powertrain
K_CrankExtendFuelLvl	ECM	Platform
K_CrankReqCrankExtendEnblTime	ECM	Platform
K_EngSpdThresh_1	ECM	Platform
K_EngSpdThresh_1_Tme	ECM	Platform
K_EngSpdThresh_2	ECM	Platform
K_EngSpdThresh_2_Tme	ECM	Platform
K_FuelPumpDelay	ECM	Platform
K_LowVoltageCrankExtendThrsh	ECM	Platform
K_LowVoltageCrankExtendTime	ECM	Platform

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K_Max_Starts_Allowed	ECM	Platform
K_MaxCrank	ECM	Platform
K_MinCrank	ECM	Platform
K_PTO_EngShutDwnEnbl	ECM	Platform
K_PwrModeDelay	ECM	Platform
K_RVSPCMBackupTimerFirstStart	ECM	Platform
K_RVSPCMBackupTimerSecondStart	ECM	Platform
K_ShortHighEngRunTime	ECM	Powertrain/Platform

Table 3: Clutch Start/Neutral Start Electrical Characteristics

Maximum Contact Voltage Drop	250 mV DC
Minimum Open Circuit Resistance	50 Kohm
Maximum Contact Chatter Time	7.2 msec
Active State	Closed to ground when clutch is fully disengaged (pedal is depressed)

3.3.3 Clutch Start/Neutral Start.

For automatic transmissions, a normally open Neutral Start switch is required. This input to the powertrain electronics is connected to ground when the Neutral Start switch is closed.

For manual transmission equipped vehicles, Clutch Pedal Apply- Bottom-of-Travel State information is required. See section 3.3.11.

3.3.4 Starter Control.

This signal is a discrete high-side driver output of the Powertrain electronics intended to drive a starter control relay. The starter relay coil shall be connected to ground. The Powertrain electronics shall drive the output high for engagement of the starter relay.

3.3.5 Starter Solenoid.

This input to the starter motor is a power feed from the starter control relay that energizes the starter solenoid. The starter control relay is sourced by battery voltage and is driven by the starter control output of the Powertrain electronics.

3.3.6 Starter Battery Feed.

The Platform shall provide an unfused Battery cable directly to the starter motor.

3.3.7 Engine Block Ground.

Reference GMW8763 Section 3.3.7 PPEI Power and Ground Subsystem.

3.3.8 Accessory/Wake Up.

Reference GMW8763 Section 3.3.2 PPEI Power and Ground Subsystem.

3.3.9 Run/Crank Relay Output.

Reference GMW8763 Section 3.3.3 PPEI Power and Ground Subsystem.

3.3.10 Power Take Off Remote Engine Shutdown.

Reference GMW8780 Section 3 PPEI Power Take Off and Fast Idle Control Subsystem.

3.3.11 Clutch Pedal Apply – Bottom-of-Travel State.

The Bottom-of-Travel State is used to determine if the clutch is disengaged. The engine start subsystem requires the clutch be fully disengaged prior to allowing engine cranking. Therefore, the bottom-of-travel state must not be true until the clutch pedal is deep enough in the pedal travel to ensure disengagement of the clutch. This bottom-of-travel state detection is optional for certain European applications.

Two methods exist to detect clutch pedal apply. One method uses discrete switches. The switches are located at specific positions relative to pedal travel. One of these switches provides an indication of the bottom-of-travel state. The other method uses an analog sensor (Clutch Pedal Position Sensor) to detect the pedal position. This position can then be compared to predefined thresholds to provide information similar to that provided by the discrete switches.

3.3.11.1 Clutch Start Switch

This is a normally-open switch that is connected to ground. This switch provides an indication of whether the clutch is fully disengaged.

3.3.11.2 Clutch Pedal Position 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. The current position can be used along with a specified threshold to provide a positional state similar to Bottom-of-Travel (Clutch Start) switch.

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 Clutch/Neutral discrete input. If a failure is detected, Powertrain shall store a code and utilize serial data gear state information (if available) for subsequent vehicle starts.

Powertrain shall diagnose the starter relay control signal and store a code if a failure is detected.

3.5 Electrical Characteristics.

3.5.1 Clutch Start/Neutral Start.

This input to the ECM shall have the characteristics of the switched-low discrete input described in Section 3.4. This input shall be pulled up to a switched battery source active in the RUN and CRANK REQUEST power modes.

3.5.1.1 Clutch Start Switch.

The (platform released) Clutch Start Switch shall be compatible with the characteristics of the switched-low discrete input as described in GMW8762 Section 3.4 PPEI Electrical Requirements. In addition, the Clutch Start Switch shall have the electrical characteristics defined in Table 3.

3.5.2 Clutch Pedal Position Sensor

Reference GMW8777 Section 3.5.2.2 CPPS Electrical Requirements.

3.5.2.1 5Vref

Reference GMW8777 Section 3.5.2.2.1.1.

3.5.2.2 Sensor Return

Reference GMW8777 Section 3.5.2.2.1.2.

3.5.2.3 CPP Sensor

Reference GMW8777 Section 3.5.2.2.1.3.

3.5.3 Starter Control.

The output of the Powertrain electronics shall have the characteristics of a high-side driver as described in GMW8762 Section 3.2 PPEI Electrical Requirements.

This driver circuit shall be configured so that it will not turn on in a reverse battery condition. This output is not required to have PWM capability. The ECM internal source for the high side driver must be a switched battery source (e.g., Run/Crank or Powertrain relay). If the ECM detects that the driver may be failed "on", then the switched battery source shall be shut down within 250 ms of key-off. (This is inherently accomplished if the Run/Crank input is used.)

3.5.4 Starter Solenoid.

Voltage: Battery Voltage

Solenoid Current: Specific solenoid current is to be supplied by powertrain for each application.

Typical values of solenoid current are:

57 A (sum of pull-in and hold-in coils) for less than 32 msec

12 A hold-in coil

Series Resistance for the relay and wiring from battery to starter solenoid at 27 °C over the life of the vehicle shall be between 0.03 Ω and 0.06 Ω .

3.5.5 Starter Battery Feed.

Reference Section 3.2.2.

3.5.6 Engine Block Ground.

Reference GMW8763 Section 3.5.11 PPEI Power and Ground Requirements and Section 3.2.2 Starter Control Subsystem Requirements.

3.5.7 Accessory/Wake Up.

Reference GMW8763 Section 3.5.5 PPEI Power and Ground Subsystem Requirements.

3.5.8 Run/Crank Relay Output.

Reference GMW8763 Section 3.5.6 PPEI Power and Ground Subsystem Requirements.

3.5.9 Power Take Off Remote Engine Shutdown.

Reference GMW8780 Section 3 PPEI Power Take-Off and Fast Idle Control Subsystem Requirements.

4 Algorithms

4.1 Starter Control Algorithm.

4.1.1 General Overview

Refer to Section 3 for the hardware interface and serial data summary.

The Starter Control algorithm monitors various engine and vehicle operating conditions to determine whether to enable or disable the starter control relay. The algorithm is designed to allow the Powertrain electronics to have full control over the starter.

The Starter Control Algorithm is mainly partitioned to Powertrain. Platform requests a vehicle start through power mode information or by requesting a Remote Start or Power Take Off Remote Start. Starting is inhibited if theft system enable criteria are not met.

For Remote Vehicle Start (RVS), a Remote_Vehicle_Start_Request signal is required from the Platform via serial data. Specific RVS criteria for enabling the start motor are defined in Section 4.1.3.3. For Power Take Off (PTO) Remote Start, a PTO_Remote_Start_Master_Engine_Start signal is required from the Platform via serial data. Specific PTO criteria for enabling the start motor are defined in Section 4.1.3.4.

An additional function of the starter control algorithm is to monitor for a short to power condition on the starter control relay circuit. This is done so that fuel can be disabled in order to prevent the engine from starting.

4.1.2 Context Diagram.

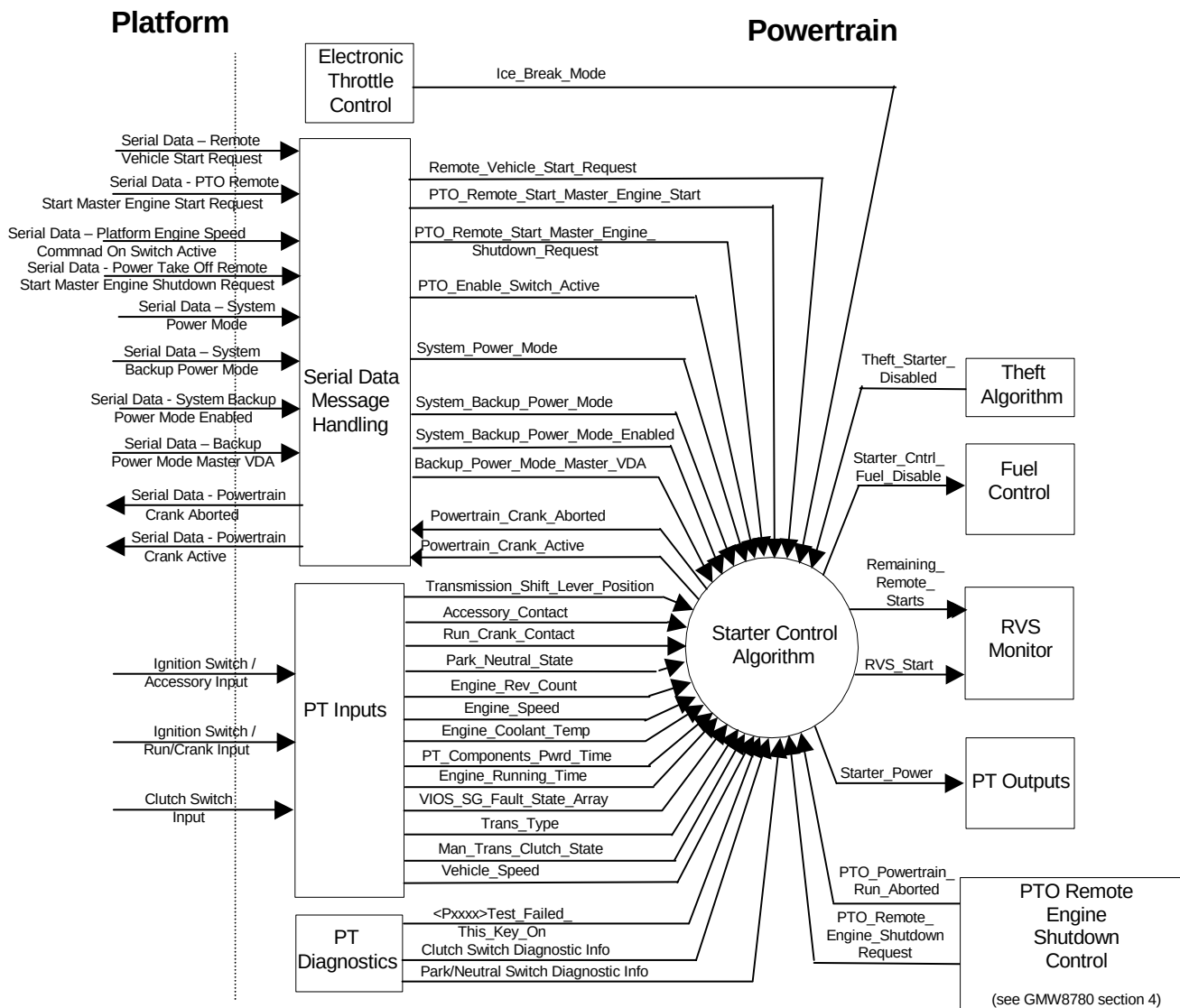


Figure 2: Starter Control Algorithm Context Diagram

4.1.3 Starter Control Algorithm Description.

4.1.3.1 Park/Neutral State Determination.

The variable Park_Neutral_State is used on automatic transmission vehicles to indicate whether the transmission is not in gear. This variable is used throughout the starter control and remote start monitor algorithm.

If the Park/Neutral switch input diagnostic has not failed as described in Section 4.1.6.3 then the Park_Neutral_State is determined from the discrete Park/Neutral switch input. A "True" state occurs when the hardwired input is switched to ground indicating the automatic transmission gear selector is in the Park or Neutral position.

Grey Code PRNDL (from an NSBU Mode Indicator Switches) is not acceptable to use for ECM controlled start applications.

If the Park/Neutral switch input diagnostic has failed as described in Section 4.1.6.3 then the Park_Neutral_State is determined from the GMLAN signal Transmission Shift Lever Position. If the GMLAN signal Transmission Shift lever Position has not been received or Transmission Shift Lever Position Validity = Invalid then Park_Neutral_State shall be set to "False".

4.1.3.2 Starter Enable Criteria.

If the starter is currently disabled, then the starter shall be enabled if **all** of the following conditions are satisfied (once enabled, the starter shall stay enabled until any of the disable criteria defined in Section 4.1.3.5 are met.):

1. Power_Mode is equal to Crank Request for at least K_PwrModeDelay milliseconds.
2. The ignition switch has been cycled out of the Crank position since the starter was last enabled (see Section 4.1.3.2.2).
3. The engine is not rotating (see Section 4.1.3.2.3).
4. Theft algorithms in the powertrain controller have determined starting is allowed based on theft system criteria as follows:
 - Normal Start: When the system is in Pre-Release;
 - Remote Start: When the Remote Start Challenge/Response has been passed.
 - PTO Remote Engine Start: When the Remote Start Challenge/Response has been passed.
5. The delay time for fuel pump priming to expire since the Run/Crank input initially becomes active (Powertrain Optional).
6. The transmission is not in gear (Park/Neutral or Clutch depressed see Section 4.1.3.2.6.2).
7. There are no failures present which require the Powertrain electronics to inhibit starting the vehicle (Powertrain Specific).
8. Ice Break Mode is not active within the Electronic Throttle Control (ETC) algorithm (Powertrain Optional).

The exact requirements (1-8) listed above are further defined in the following sections.

4.1.3.2.1 Power_Mode is equal to Crank Request for at least K_PwrModeDelay milliseconds.

Power_Mode shall be equal to the System_Power_Mode signal received over serial data unless one of the following conditions exists.

- A. **IF** the System_Backup_Power_Mode_Enabled signal is equal to "True"
AND the Backup_Power_Mode_Master_VDA signal is equal to "Available".
THEN Power_Mode shall be equal to the System_Backup_Power_Mode signal.
- B. **IF** the ECM detects that the device transmitting the System Power Mode signal over serial data has failed
(no longer communicating).
THEN the Power_Mode shall be determined from the ECM's
Accessory and Run_Crank_Inputs
- C. **IF** the System_Backup_Power_Mode_Enabled is equal to "True" **AND** the System
Backup_Power_Mode_Master_VDA signal is equal to "Not Available".
THEN the Power_Mode shall be determined from the ECM's
Accessory and Run_Crank_Inputs

Conditions "A" and "C" only occur with Ignition Mode Switch systems.

Condition "B" applies to Ignition Mode Switch and Ignition Switch systems.

ECM Cranking is only initiated via receiving a serial data Crank Request Power Mode except when in Post Release Stall Mode; this is defined in the following:

IF 'B' or 'C' (above) is "True" **AND** the ECM is in Post Release Stall Mode operation

THEN the ECM/PCM shall allow initiation of Cranking if it's Accessory_Input transitions from Active to Inactive and Run_Crank_Input is equal to Active or if the Accessory_input is equal to Inactive and the Run_Crank_Input transitions from Inactive to Active.

Note: The loss of Power Mode Master may result in a transition of the accessory line. This transition will not result in a crank due to the delay in setting the Power Mode Master loss of communication Flag.

The Post Release Stall mode operation requires the following: the ECM Immobilizer is in Post Release state implying that vehicle authentication passed during current ignition cycle and the engine transitioned from rotating to not rotating and there is a loss of System Power Mode and System Backup Power Mode signals over serial data.

4.1.3.2.1.1 Automatic Transmission (GM Global requirement).

While the automatic transmission is not in gear as defined by Section 4.1.3.2.6.1 the Power_Mode state shall transition from a non-Crank_Request state into the Crank_Request state for at least the **K_PwrModeDelay** time before allowing the starter to be enabled. The **K_PwrModeDelay** timer allows for the platform modules to shed loads prior to the engine cranking event.

4.1.3.2.1.2 Manual Transmission (GM North America market requirement for FMVSS).

While the clutch input indicates that the clutch is depressed, the System_Power_Mode state shall transition from a non-CRANK_Request state into the CRANK_Request state for at least the **K_PwrModeDelay** time before allowing the starter to be enabled.

4.1.3.2.1.3 Manual Transmission (GM European market requirement).

The Power_Mode is required to remain equal to Crank Request for at least **K_PwrModeDelay** before allowing the starter to be enabled.

4.1.3.2.2 The ignition switch has been cycled out of the Crank position since the starter was last enabled.

This check requires that the ignition switch be released from the Crank position before cranking is allowed again following a starter disable. The ignition switch is determined to no longer be in the Crank position by Powertrain when the Power_Mode is not equal to Crank.