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**Electronic Engine Controls, Tier-4 (>130kW) Applications**

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## INTRODUCTION

Description of Technology (See 'Technology' in FT4 and IT4 tables below.):

| Technology* |                |  |               |
|-------------|----------------|--|---------------|
| EWX         | PowerTech E    | Wastegate Turbocharger, No EGR           | DOC/DPF       |
| PWX         | PowerTech Plus | Wastegate Turbocharger                   | DOC/DPF       |
| PWL         | PowerTech Plus | Wastegate Turbocharger                   | DOC + SCR     |
| PVX         | PowerTech Plus | Variable Geometry Turbocharger (VGT)     | DOC/DPF       |
| PSX         | PowerTech Plus | Series Turbochargers (including one VGT) | DOC/DPF       |
| PWS         | PowerTech Plus | Wastegate Turbocharger                   | DOC/DPF + SCR |
| PVS         | PowerTech Plus | Variable Geometry Turbocharger (VGT)     | DOC/DPF + SCR |
| PVL         | PowerTech Plus | Variable Geometry Turbocharger (VGT)     | DOC + SCR     |
| PSS         | PowerTech Plus | Series Turbochargers (including one VGT) | DOC/DPF + SCR |
| PSL         | PowerTech Plus | Series Turbochargers (including one VGT) | DOC + SCR     |

## Final Tier 4 (FT4) Engine Models Covered in this Section:

| Industrial | Generator   | Technology* | ECU Level | Power Range             | Component Technical Manual | Operation and Maintenance |
|------------|-------------|-------------|-----------|-------------------------|----------------------------|---------------------------|
| 3029HFC03  | 3029HFG03   | EWX         | L23       | 37-55 kW (48-74 hp)     | CTM120619                  | OMRG39496                 |
| 4045TFC03  | 4045TFG03   | EWX         |           | 55 kW (74 hp)           | - - -                      | - - -                     |
| 4045HFC04  | 4045HFG04   | PWL         | L34       | 63-104 kW (85-140 hp)   | CTM120119                  | OMRG39498                 |
| 4045HFC06  | 4045HFG06** | PSL         |           | 90-129 kW (121-175 hp)  |                            |                           |
| 4045HFC07  | - - -       | PWS         |           | 93-104 kW (125-140 hp)  |                            |                           |
| 4045HFC09  | 4045HFG09   | PSS         |           | 93-129 kW (125-175 hp)  |                            |                           |
| - - -      | 6068HFG05** | PVL         | L33       | 160-192 kW (214-257 hp) | CTM120019                  | OMRG39499                 |
| - - -      | 6068HFG06** | PSL         |           | 197-241 kW (264-323 hp) |                            |                           |
| 6068HFC08  | 6068HFG08   | PVS         |           | 104-187 kW (140-250 hp) |                            |                           |
| 6068HFC09  | 6068HFG09   | PSS         |           | 168-240 kW (225-322 hp) |                            |                           |
| - - -      | 6090HFG06** | PSL         | L33       | 273-345 kW (366-463 hp) | CTM117719                  | OMRG38997                 |
| 6090HFC09  | 6090HFG09   | PSS         |           | 187-326 kW (250-437 hp) |                            |                           |
| - - -      | 6135HFG06** | PSL         | L32       | 427-473 kW (573-634 hp) | CTM119919                  | OMRG39305                 |
| 6135HFC09  | 6135HFG09   | PSS         |           | 298-473 kW (400-634 hp) |                            |                           |

\*\* Low-idle-capable and Dual-frequency-capable Generator Drive Engines

*Continued - - -*

## Interim Tier 4 (IT4) Engine Models Covered in this Section:

| Industrial             | Generator | Technology* | ECU Level | Power Range             | Component Technical Manual | Operation and Maintenance |
|------------------------|-----------|-------------|-----------|-------------------------|----------------------------|---------------------------|
| 4045HFC92              | 4045HFG92 | PWX         | L23       | 63-102 kW (84-137 hp)   | CTM114619                  | OMRG38827                 |
| 4045HFC93              | 4045HFG93 | PVX         |           | 93-129 kW (125-173 hp)  |                            |                           |
| 6068HFC94<br>6068HFC95 | 6068HFG94 | PVX<br>PSX  | L21       | 138-187 kW (185-250 hp) | CTM104719                  | OMRG38059                 |
| 6090HFC94<br>6090HFC95 | 6090HFG94 | PVX<br>PSX  | L21       | 187-317 kW (250-425 hp) | CTM104819                  | OMRG38038                 |
| 6135HFC95              | 6135HFG95 | PSX         | L22       | 298-448 kW (400-600 hp) | CTM104919                  | OMRG38340                 |

## Safety

Refer to Engine Application Guidelines, "Safety" (AG-02).

## Reference Documents

In light of the fact that the electronic controls guidelines section for IT4 is greatly expanded as compared to prior ECU generations, this document utilizes a substantial number of links to external documents in order to keep the main document simple and concise. It may be wise to download and/or open these linked documents in order to better understand the main document. These links are accessible from the relevant sections of the main document but are listed (and linked) here for quick access if needed. To access, click the link, and then open (double-click) the file from the list that appears.

- [Application\\_Harness\\_L21.xlsx](#)
- [Control\\_Panel\\_Harness\\_Schematic\\_RE542875\\_FT4](#)  
(Refer to Schematics\_L32\_L33\_L34.)
- [Control\\_Panel\\_Harness\\_Schematic\\_RE542875\\_IT4](#)
- [ECU\\_Harness\\_Routing\\_FT4](#)
- [ECU\\_Mounting\\_Requirements.01\\_FT4](#)
- [ECU\\_Pin-Out\\_L21\\_6068\\_6090](#)
- [ECU\\_Pin-Out\\_L22\\_6135](#)
- [ECU\\_Pin-Out\\_L23\\_4045](#)
- [ECU\\_Pin-Out\\_L23\\_4045\\_6068](#)

- [ECU\\_Thermal\\_Guidelines.01\\_FT4](#)
- [ECU\\_Vibration\\_Limits\\_FT4](#)
- [Engine\\_Painting.02\\_FT4](#)
- [ESM\\_Operator\\_Action\\_Information](#)
- [FaultCodes\\_FOR\\_REFERENCE\\_ONLY.xlsx](#)
- [Operator\\_Display\\_PGN-SPN\\_Information\\_FT4](#)
- [Operator\\_Display\\_PGN-SPN\\_Information\\_IT4](#)
- [Quick\\_Reference\\_Guide\\_\(QRG\)\\_FT4](#)
- [Quick\\_Reference\\_Guide\\_\(QRG\)\\_IT4](#)
- [SAE\\_J1939\\_CAN\\_T4.xlsx](#)
- [SAE\\_J1939\\_Engine\\_Start\\_Control](#)
- [Schematic\\_L21\\_6068\\_RE538103](#)
- [Schematic\\_L21\\_6090\\_RE538670](#)
- [Schematic\\_L22\\_6135\\_RE538799](#)
- [Schematic\\_L23\\_3029\\_RE552513](#)
- [Schematic\\_L23\\_4045\\_6068\\_RE542837](#)
- [Schematic\\_L32\\_6135\\_RE563683](#)
- [Schematic\\_L33\\_6068\\_6090\\_RE563704](#)
- [Schematic\\_L34\\_4045\\_RE563710](#)
- [Sensor\\_and\\_Actuator\\_Overview\\_L21\\_IT4\\_6068\\_6090\\_PTPlus](#)
- [Sensor\\_and\\_Actuator\\_Overview\\_L22\\_IT4\\_6135\\_PTPlus](#)
- [Sensor\\_and\\_Actuator\\_Overview\\_L23\\_IT4\\_4045\\_6068\\_PWX\\_PVX](#)
- [Sensor\\_and\\_Actuator\\_Temperature\\_Limits\\_FT4](#)
- [Sensor\\_and\\_Actuator\\_Temperature\\_Limits\\_IT4](#)
- [SJ13312\\_Exhaust\\_Filter\\_Control\\_Switch\\_2015Nov01](#)
- [Speed\\_and\\_Power-constraining\\_Configurations](#)



## **PRINCIPLES OF OPERATION**

### **High Pressure Fuel Injection**

#### **HIGH PRESSURE COMMON RAIL (HPCR) FUEL SYSTEM**

Direct fuel injection is provided by a high pressure common rail fuel system (Denso). The high pressure fuel pump is gear driven at engine speed. The extremely high injection pressures provided by this system reduce particulate emissions. The Engine Control Unit (ECU) calculates the fuel quantity delivered using measured rail pressure, injection duration, and unique flow vs. pressure/duration calibrations for each injector. This control system provides improved consistency in fuel delivery, power and smoothness. Pilot injection under light load conditions provides a significant reduction in combustion noise and harshness.

#### **ELECTRONIC UNIT INJECTOR (EUI) FUEL SYSTEM**

Direct fuel injection is provided by a high pressure electronically controlled camshaft driven unit injectors. The extremely high injection pressures provided by this system reduce particulate emissions. The ECU calculates and controls the injection timing and fuel quantity delivered. This control system provides improved consistency in fuel delivery, power and smoothness. Pilot injection under light load and low to mid speed conditions provides a significant reduction in combustion noise and harshness.

#### **Temperature Limits and Compensation**

The ECU will compensate if needed for a wide range in fuel temperature in order to maintain the desired quantity of fuel injected. This feature is utilized on the EUI fuel system but is not needed on HPCR fuel systems due to the inherent pressure control.

#### **FUEL LUBRICITY AND SULFUR CONTENT**

The very high pressures and tight tolerances between moving parts requires the use of quality fuels that meet the minimum lubricity specification. Additionally, use of fuel with greater than 15-20 parts per million sulfur content will poison the catalytic elements of the exhaust filtration. In general, Jet-type fuels are not allowed due to these two requirements.

Refer to Application Guidelines, "Fuels, Diesel and Alternative" (AG-18).

### **Calibrated Injectors**

Each injector has a compensation code to provide nominal fuel flow rate. This prevents cylinder-to-cylinder imbalance and also provides a more consistent engine-to-engine power level. The compensation code is programmed into ECU as well as the injector location (cylinder number). The ECU calibration codes must be reprogrammed via Service ADVISOR™ when nozzles are changed or relocated. This calibration programming can not be done via Custom Performance Programmer (CPP). Refer to the component technical manual for more details.

### **Variable injection Timing and Pressure Control**

The injection nozzles are electronically controlled for both the start and end of injection. The quantity of fuel delivered is a function of injection duration and injection pressure. The injection pressure may be increased or decreased (on HPCR systems) in order to control emissions. In addition, pilot injection may be used during warm-up or light load for emission and/or noise control.

### **Exhaust Gas Recirculation (EGR) and Variable Turbine Geometry (VTG)**

#### **FUNDAMENTALS**

Exhaust gas recirculation (EGR) and variable turbine geometry (VTG) turbocharger are both performance and emissions control features. During starting, warm-up, low speed, and light-load conditions, exhaust gases are not recirculated. The ECU controls the amount of exhaust gas to be mixed with intake air through the VTG and EGR valve. The VTG has adjustable vanes in the turbine housing. The VTG vane position is closed loop controlled by the ECU using the water-cooled Smart Remote Actuator (SRA). The vanes are opened or closed to provide the necessary pressure differential (between the exhaust and intake manifold) to achieve the desired level of exhaust gas recirculation. When EGR is desired, the ECU sets the appropriate VTG and EGR valve positions. Some of the exhaust gas then passes through a cooler that is connected to the exhaust and intake manifold. Engine coolant cools the exhaust gases. The exhaust gases then pass through the EGR valve and combine with intake air in the mixer portion of the intake manifold, before entering the combustion chamber. The percentage of EGR is calculated by the ECU using intake air temperature and pressure, EGR gas temp and calculated pressure, fixed gas temp and pressure, and known thermodynamic properties of the gases. It is also measured using a pressure differential across a venturi-style orifice. Under some conditions, as much as 40% of the intake charge entering the combustion chamber is recirculated exhaust gas. The cooled exhaust gas in the intake charge reduces peak in-cylinder temperature and pressure, resulting in lower NOx emissions. This allows optimized injection calibration, resulting in reduced fuel consumption, increased power output and reduced emissions.

## COMPONENTS AND CONTROLS

### EGR Valve

The EGR valve is a throttle-like device controlled by the ECU. The valve is located between the EGR cooler and intake manifold. The position of the valve can turn the EGR flow on or off and has influence on flow rate.

### EGR Cooler

The EGR cooler is a corrosion-resistant shell-and-tube heat exchanger that uses engine coolant to reduce the temperature of the recirculated exhaust gas. The coolant flow rate is thermostatically controlled. Cooling the exhaust gas helps control the in-cylinder temperature and exhaust emissions.

**NOTE: Controlling coolant temperature is a fundamental part of the emission control of the engine. Application reviews test data submitted with a coolant temperature below the activation temperature will be rejected. See AG-04, Application Review for more information.**

### EGR Thermostat

The EGR cooler thermostat has an activation point of 85 degrees C and a full-open point of 92-95 degrees C. The thermostatic control of the coolant temperature in the EGR loop helps prevent condensation in the EGR system.

**NOTE: Controlling coolant temperature is a fundamental part of the emission control of the engine. Application reviews test data submitted with a coolant temperature below the activation temperature will be rejected. See AG-04, Application Review for more information.**

### Turbochargers

The type of turbocharging used depends upon engine performance. On engines above 130 kW a Variable Turbine Geometry (VTG) type turbocharger is used. VTG technology is utilized to control exhaust pressure and maximize overall engine performance. In some cases a second turbocharger ("fixed-geometry") is used in series with the VTG. This configuration is called, "Series Turbocharging." This is done in order to maximize performance at low engine speeds.

### Venturi (New for IT4)

A venturi with pressure sensors is used to measure the mass flow rate of the EGR before it enters the intake manifold. This is a new feature for IT4 engines. (Tier-3 engines used temperature and pressure information only and then calculated a mass flow rate.)

### Charge-Air Cooling

Lowering the intake manifold temperature lowers the in-cylinder combustion temperature and thereby reduces exhaust emissions. The restriction of this device also affects EGR flow rates.

### Maximum and Minimum Restrictions

On engines equipped with EGR, exhaust backpressure and charge air cooler restriction play a fundamental role in the EGR flow rate control. Increasing restriction on both the charge air cooler and exhaust system allow for maximum EGR flow rates at a minimum total air flow. Consequently, adversely low restrictions may cause the engine (via turbo-charger vane position) to increase total air flow to rebalance the pressures.

**The lowest heat rejection will be achieved at the maximum allowable restriction for both charge air cooling and the exhaust system.**

A maximum and minimum value is provided on the performance curve. The minimum value is the limit at which the engine can compensate to achieve desired EGR rates. An application designed to operate at the minimum will encounter higher than specified boost pressures, air flows, charge air cooler heat rejection, and coolant heat rejection. Application s designed with restrictions lower than the minimum will not be accepted. For more information, see Application Review (AG-04).

### Tri-CAN Sensor

The Tri-CAN sensor is located in the compressor inlet adaptor and is used to measure temperature, humidity, and pressure. The sensor contains its own processor and the information is sent back to the engine via the Controller Area Network (CAN). The parameters measured by the Tri-CAN may be valuable to the OEM and/or the operator (via a CAN-based control panel). The compressor inlet temperature is available on CAN as "Engine Air Inlet Temperature" (SPN 172, PGN 65269 "Ambient Conditions"). The pressure is used to calculate air cleaner restriction which is also available on CAN (SPN 107 "Engine Air Filter 1 Differential Pressure," PGN 65270 "Inlet/Exhaust Conditions"). The availability of this restriction and the ECU management of its faults can effectively replace traditional "external/mechanical restriction indicators." For more information on air restriction and related diagnostic trouble codes, refer to Air Intake System (AG03).

**EGR CONTROLS DURING WARM-UP OR ENGINE PROTECTION**

It is permissible for the ECU to deviate from the normal engine emission control strategy in order to warm up the engine to normal operating condition, for transient load or speed conditions, and for engine protection. The ECU managed engine warm-up control features are active at coolant temperatures less than or equal to 60°C. This is done to prevent smoke, mis-fire, and EGR cooler and/or intake manifold condensation. EGR is not used in warm-up mode. Similarly, at intake manifold temperatures less than or equal to 15°C, EGR is not needed for emission control and it is turned off to prevent EGR cooler and/or intake manifold condensation. Additionally, EGR is deactivated at light-load and low speed conditions where condensation is more likely (due to lower air flow). In the previously mentioned conditions, the use or (lack thereof) EGR will be transparent to the operator. EGR may also be deactivated in severe over-temperature conditions (coolant or air). In these conditions a fault code will be generated for the suspect condition, an engine derate (reduction in maximum power at the current speed) will occur, and a fault code indicating the derate will also occur.

**Additional IT4 Controls  
For Exhaust Filtration Management**

In addition to the controls and devices for the basic emission control, the engine is equipped with an exhaust filter which is comprised of an oxidation catalyst and a particulate filter. These devices are described in greater detail in the Exhaust System (AG-17) section. In order to manage the cleaning of the catalyst and filter, the engine is equipped with the following devices:

**AIR THROTTLE (New for IT4)**

The air intake throttle can be used for temperature management. When exhaust filter cleaning is necessary, the ECU will utilize the air intake throttle to decrease air flow in order to increase exhaust temperature. This facilitates the light-off condition of the oxidation catalyst. For more information on cleaning, see Exhaust System (AG-17).

**VARIABLE SPEED FAN DRIVE (VSF)**

The (optional) variable speed fan drive may be included on IT4 engine technology and above in order to maintain the charge air cooler temperature at levels desirable for emission control, as well as to manage the exhaust temperature during exhaust filter cleaning. The speed of the fan drive during normal operation is determined at a minimum by charge air cooler as well as coolant temperatures. Additional auxiliary temperature inputs can be configured to drive the fan as well, but are not required. The variable speed fan can be controlled by two different fan drive types:

**Electro Viscous Fan Drive**

- The fan drive is supplied by John Deere.
- It is operated by a closed loop system which is monitored/driven by fan speed.
- It can also be used to control the temperatures of other heat exchanger fluids such as transmission coolers, hydraulic coolers, and air conditioning systems.
- The fan clutch is controlled by the ECU through a PWM driver.

**Hydraulic Fan Drive**

- The fan drive is supplied by the customer.
- It is operated by an open loop system which is monitored/driven by temperature set points.
- It can also be used to control the temperatures of other heat exchanger fluids such as transmission coolers, hydraulic coolers, and air conditioning systems.
- The fan clutch is controlled by the ECU through a PWM driver that supports a maximum load current of 2.5 Amps. Based on this requirement, the driver is capable of a maximum PWM frequency of 1710 Hz with a 95% maximum duty cycle limit.
- Under certain conditions (such as when an inlet screen or cooling system is plugged with debris), the ability to reverse the fan direction may be desired. This (optional) fan reversing feature is only available with a hydraulic fan drive. The reversing clutch is controlled by the ECU through a relay driver that supports a maximum load current of 4 Amps with these requirements:
  - o In a 12V system, system voltage must be greater than 3 Watts.
  - o In a 24V system, system voltage must be greater than 6 Watts.

The activation of these secondary control mechanisms is achieved during the ECU programming via Trim Options. A desired condition is programmed for each fluid or state (a temperature may be desired for a fluid but a state may be defined for other conditions such as A/C compressor engaged). The status of these control conditions may be given to the ECU via analog or digital sensors (direct pin-out from the ECU) and optionally they can be communicated via the SAE J1939 Controller Area Network (CAN) For more details, refer to Trim Options. The fan speed may also be increased during an exhaust filter cleaning event as part of engine load and exhaust temperature management strategy.

**HYDROCARBON DOSING PUMP AND INJECTION NOZZLE**

A hydrocarbon dosing pump and injection nozzle is included on the engine. The dosing pump is fundamentally a low pressure fuel pump that is dedicated to the exhaust filter cleaning. The dosing pump has its own microchip and control of the dosing pump is done via SAE J1939 Controller Area Network (CAN) communication. The injection nozzle is located between turbine housings on a series turbocharger equipped engine and is located on the turbine outlet tube on a single turbocharger engine. (For engines less than 130 kW, the dosing pump and injector are omitted and hydrocarbon injection for exhaust filter cleaning is achieved instead by a supplemental injection from the main engine injectors.)

**TEMPORARILY ELEVATED (OFFSET) LOW IDLE SPEED  
(New for IT4)**

This feature is optional and is chosen at the time of programming. For more information, see Trim Options. The engine may increase the low idle in order to achieve the appropriate air flow for the combustion of hydrocarbon in the oxidation catalyst.

The idle speed will not be "moved" until the engine is already operating at a speed above the offset threshold. Upon engine deceleration, the new temporary offset will be active.

Applications where the minimum throttle (low idle) speed is permanently set to 1200 RPM or higher will not use this feature. The permanently programmed offset is adequate to fulfill this feature. For more information, see IT4 Exhaust System and Interface.

**EXHAUST TEMPERATURE CONTROL MODE**

As partially defined in the air throttle and VSF description, the engine control may change in order to elevate the oxidation catalyst temperature to a "light-off" state.

For more information, see Exhaust System (AG-17).

**ECU PROGRAMMING****Refer to John Deere Custom Performance (Trim Options)**

The OEM software is highly configurable through the trim option pages. While production OEM ECUs will be programmed at the engine factory, the engines will come preprogrammed with default Trim Options selected. Final programming (Custom Performance) or Service programming (Service ADVISOR™) is usually required to select and configure Trim Options for a specific end user's application needs. To program an engine, the user must have a computer meeting the minimum specification, interface hardware (John Deere Electronic Data Link (EDL)), interface software (John Deere Custom Performance Programmer or Service ADVISOR™), access to the internet, and a special "license" installed on the computer.

Premium Trim Software offers further engine integration into OEM equipment or vehicles by providing the capability to control machine functions with the engine ECU, potentially eliminating the need for additional controllers. However, with this new capability comes the potential for troubleshooting difficulties as well as unintended machine operation.

**Troubleshooting Support**

Requirements for Premium Trim document submittal in the Pictures and Files tab in Application Review Depot:

1. Wiring diagrams / schematic of the circuit
2. Flow / control diagram
3. Design diagram
4. Short description of the specific system definition and its intent.
5. Include a copy of the trim page from the example engine.

**Product Safety - Fault or Failure Analysis**

Distributors and OEM's must use proper failure analysis techniques to ensure proper machine operation, especially in the event of wiring malfunctions.

Failure Mode and Effects Analysis (FMEA) is a process that analyzes failure modes and classifies them by severity and likelihood of failure. Unfortunately, FMEA really only considers one fault at a time, instead of analyzing the potential for multiple failures. To identify reference material on this process, an internet search under FMEA can be done. Organizations such as SAE offer training on FMEA methods.

Fault Tree Analysis (FTA) would probably be more effective and easier for the Distributor or OEM to implement. To identify reference material on this process, an internet search under Fault Tree Analysis (or FTA) can be done. Organizations such as SAE offer training on FTA methods.

John Deere University (JDU) offers a product safety DLM for OEM's titled, "Building Safe Products (CSP-18-TW2BB01)." The course is designed to introduce the fundamental concepts of product safety, the main elements of an injury, and basic principles of product safety design. It includes information to identify the steps of the product safety process, which may help reduce injuries in manufactured products, and recognize the importance of performing risk assessments in the design phase. It could also help you establish important product safety planning and implementation processes.

**Note: Original Equipment Manufacturers (OEM's) and Distributors incorporating John Deere engines in their product(s) must conduct a careful review of premium trim control logic and related components, to provide appropriate protection for the safety of personnel involved in the operation or maintenance of products using John Deere engines. This may include review, certification, or compliance with relevant industry recommendations, standards or regulations.**

Here is a non-exhaustive list of recommendations, regulations or standards that may be applicable:

- ISO 14121-1 and 2 Safety of machinery - Risk assessment
- ISO 12100-1 and 2 Safety of machinery- Basic concepts, general principles for design
- IEC 61508-1 thru 7 Functional safety of electrical/electronic/programmable electronic safety-related systems
- ISO 13849- 1 and 2 Safety of machinery - Safety-related parts of control systems
- ISO 25119-1 thru 4 Tractors and machinery for agriculture and forestry - Safety-related parts of control systems
- EN 954 Safety of machinery - Safety-related parts of control systems
- SAE J2948 Keyless Ignition Control
- CSA C22.2 No. 263-09 Fire Pump controllers, includes ignition

Other recommendations, regulations, or standards may apply, depending on the application.

## Exhaust Filter Serial Number (New for IT4)

The Particulate Filter and Oxidation Catalyst are subcomponents of the exhaust filter. Each of these components has a unique serial number that must be entered during the programming process (for new engine initial programming or for service replacement of the exhaust filter).

The serial number can be entered via scanner or manually.

The serial number will be checked for validity.

When the return file is generated (see Return Files) the serial numbers will be loaded into the John Deere server and compared for validity and also checked for duplication. If either of these checks generates an error, the "user" that programmed the engine will be notified and corrective action will be requested.

If a valid serial number is not entered, the engine will not produce full power (derate condition) and will generate a fault code.

## Application Review Number Field in IT4 Custom Performance™ Trim Options

To assist in emissions compliance, a mandatory field for Application Review Number has been added to the IT4 Custom Performance™ Standard and Premium Trim Options pages.

Details are as follows:

- All applications / serial numbers must have an Application Review Number for emissions compliance.
- The input is the 5-digit Application Review Number, or "TBD."
- Reports will be created for follow-up of TBD entries. The John Deere Software Delivery System (SDS) records will need to be updated once the Application Review number is available.
- Units already in production prior to implementation of this Trim field will need this record updated in SDS.
- Send your engine serial number and Application Review number updates (engines programmed before the Trim field release, and TBD entries) to your Application Integration Engineer or Sales Engineer. It is not necessary to reprogram engines in the field with this number as long as the SDS record is updated.
- Trim Option Templates may be used to enter an Application Review Number that corresponds with multiple engine serial numbers in OEM production applications.

- The Application Review number cannot be entered with ServiceADVISOR™.
- This link between engine serial number and Application Review Number will be used by the auditors during Delegated Assembly Audits.
- Customer Support will use this information to assist in diagnosing engine issues.

### Final Programming (Custom Performance Programmer)

The John Deere Custom Performance Programmer can be used to program the ECU, which can allow the approved user to select a different power rating (from a list of available ratings) and can allow the user to open the Trim Options page. After making selections on the Trim Options page, the user can save off the selections as a Trim Template to be used again at a later time. This is especially helpful if programming multiple engines with the same Trim Options. Once the Power Option and Trim Options are selected (either individually or via Trim Template) the final programming may be completed. An electronic record of the programming event (return file) is created on the user's computer. This return file must be uploaded to the John Deere Software Delivery System (SDS) to create a permanent record of the desired programming.

In general, Custom Performance Programmer is:

- Selectable performance ratings
- Selectable Trim Options
- Used by Distributors and Direct Accounts only

### Service Programming (Service ADVISOR™)

The ECU will interact with Service ADVISOR™ for diagnostics and servicing. Service ADVISOR™ can be used to program the ECU, which will allow the user to open and program the Trim Options, without making power adjustments. As with Final Programming, Service Programming return files must be sent to SDS for future servicing and record keeping.

In general, Service Programming is:

- Used by Service Dealers (but is available to Distributors and Direct Accounts)
- Used to program replacement ECU
- Can be used to change a Trim Option setting

### Return Files

As mentioned in both Final Programming and Service Programming, a record of the programming event is created on the technician's computer. This is done in order to create a summary of programming events to be returned to the John Deere Software Delivery System (mainframe).

The return file is stored on the Deere server and it becomes the reference information for the next payload download.

The Trim Options selected in the initial programming event will become the "default" Trim Options on the next payload download. This prevents the end-user from encountering problems on future ECU programming attempts and relieves the technician from the need of contacting Deere or the OEM for the original Trim Options.

### Bench-top Interface Harness

ECU programming can be accomplished on a fully complete application via the application harness diagnostic connector. In the event that programming needs to be completed on a "loose" ECU (not attached to an application harness and power source), a bench-top interface harness and power supply can be used. This interface harness mimics the features of a normal application interface harness but only includes the wiring and connectors necessary to communicate and program the ECU.

Switched power and unswitched power are separate. Do not use unswitched power on a switched power circuit. The ECU operates a managed shut-down process and the unswitched power circuit needs to be maintained long after the switched power has been terminated (up to 30 seconds). This is similar to the shut-down process of modern personal computers.

It is advisable to utilize an "ECU active" indicator by installing a lamp on one of the sensor supply circuits. The sensor supply will be inactive once the ECU has properly completed its shut-down management.

Minimum Power supply is 12-Volt, 7-10 Amp.

A pre-fabricated bench-top interface harness is available from Servicegard / SPX (The source for all dealer tools). The part number for this harness is JDG11243.

## CONSTRAINED OPERATION

The EPA has issued a guidance document for speed and power-constraining configurations. Equipment manufacturers may use the guidance to avoid applying equipment-based constraints (electronic or mechanical) that could be considered tampering, as prohibited by the Clean Air Act.

### **Speed\_and\_Power-constraining\_Configurations**

## ELECTRONIC FEATURES

### Throttle

The engine is capable of interfacing with multiple types of throttles. However, a throttle is not always necessary. The engine is programmed with a "default" throttle in case a throttle is not used or if the throttle becomes invalid. On industrial engines the default is "minimum throttle" (low idle) and on generator drive engines the default is "maximum throttle" (rated speed). The types of allowable throttle include hardware interface types (switches and/or potentiometers) and network requested (via SAE J1939 controller area network). Several throttle inputs are available. There are two analog (potentiometer) throttles, and three types of digital throttles. All throttle inputs must be at low idle for the system to operate at low idle, but in most cases any single throttle input can put the system at fast idle. Only one digital throttle may be chosen but up to two analog throttles may be used (and can be used in conjunction with the digital throttle for a total of three valid hardware-type throttles).

### DIGITAL 2-STATE THROTTLE

A two-position toggle switch selects between defined resistance values. Only "minimum" and "maximum" throttle speeds can be selected. The minimum throttle can be offset from the normal factory "low idle" speed but the maximum throttle speed is not adjustable (factory "rated speed"). The offset for minimum throttle can be set at the time of ECU programming or it can be set using the "bump" and "bump enable" switches of a full-featured control panel. Most 2-state throttle switches are used with "minimum feature" control panels so it is important to consider this fact at the time of programming. There is a limited range to the low idle offset. See Custom Performance Trim Options for more details on this range. See Throttle Hardware for more details on the resistance values.

### DIGITAL 3-STATE THROTTLE

A three-position toggle switch selects between defined resistance values. "minimum" and "maximum" throttle settings are used (similar to 2-state) but a third "intermediate" position is selectable and can be set to a user-defined speed. This speed can be selected at the time of programming or it can be set using the "bump" and "bump enable" switches of a full-featured control panel (similar to the "minimum throttle" offset). There is a limited range to the low idle offset and the intermediate speed offset.

For more details on this range, see Trim Options.

For more details on the resistance values, see Throttle Hardware.

3-state is not available for generator drive engines.

### DIGITAL RAMP THROTTLE

A three-position momentary switch selects between defined resistance values. The positions correspond to "decrease", "maintain", and "increase" speed requests. The minimum throttle speed can be offset during ECU programming. The maximum throttle is not adjustable (remains factory fast idle speed) but the minimum speed may be offset via programming or via switches (the "bump" and "bump enable" switches of a full-featured control panel). The bump and bump enable switches are rarely included with a ramp throttle control panel so consideration to the desired minimum throttle speed should be given at the time of engine programming. Throttle rates are selectable during ECU programming. As an example, a three second rate may be chosen which will accelerate or decelerate the full range of engine speed in three seconds. Please refer to the Trim Options for more details on the allowable selections for throttle rates. See Throttle Hardware for more details on the resistance values.

Ramp is not available for generator drive engines.

### CRUISE CONTROL (DIGITAL)

The Cruise Control is an off-road type that maintains a constant engine RPM under varying load conditions. By comparison, an automotive type cruise control maintains a constant road speed. The Cruise Cancel/Resume function is a one-button, cancel-then-resume function. The first time button contact is made, with Cruise Control active, the Cruise Control disengages and the engine speed drops to idle. If button contact is made again within one minute and with the engine speed above 1300 RPM, the Cruise Control will "Resume." This feature allows the placement of the Cancel/Resume button in a convenient location in the vehicle cab and does not require the use of the normal Cruise controls for momentary interruptions in cruise operation. The Cancel/Resume function is intended for applications like agricultural tractors and sprayers that turn around at the end of each row in a field. This allows the operator to use the throttle and/or brake to turn the vehicle around. When ready to resume field operations, the operator brings the engine speed above 1300 RPM and activates the Cancel/Resume function again to resume cruise speed. An internal timer gives the operator one minute to complete the turnaround maneuver.

The Cruise Control has the normal functions of:

- Cruise Control Power "ON" or "OFF"
- "Set" or "Bump Up" Engine Speed
- "Resume" or "Bump Down" Engine Speed
- Vehicle brake or clutch pedal to disengage cruise Control

These features generally function similar to an automotive cruise control. Refer to the cruise control wiring instructions in Throttle Hardware for more details.

Cruise is not available for generator drive engines.

Cruise will act as an isochronous governor even if the engine is programmed with a droop governor.

### ANALOG THROTTLE

There are two available analog (potentiometer) throttle inputs. Both can use any 2000-Ohm to 15,000-Ohm potentiometer. If one or more analog throttles is selected, one is identified as the primary analog throttle and the other is the secondary analog throttle. Both analog throttle inputs have identical functions and options. Normally, the analog throttles operate between slow idle and fast idle, however, when the adjustable 3-state throttle is used, the analog throttle range will be between the adjustable low idle and the adjustable intermediate speed setting. The John Deere analog throttle is a multi-turn 5000-Ohm potentiometer throttle designed for stationary applications. Many other throttle styles, including various foot pedal throttles, are available from Morse, Williams Controls, and other suppliers. Any potentiometer-style analog throttle will work, as long as total resistance is in the 2,000-15,000-Ohm range. If the analog throttle circuit is enabled (via ECU programming) but not connected, a fault code is generated. The warning lamp illuminates and the system reverts to the secondary analog throttle and/or digital throttle inputs. If no throttle input is present on industrial applications, the system reverts to low idle. If no analog throttle is present on generator applications, the system reverts to rated speed. It is not mandatory to install an analog throttle; it may be disabled via ECU programming if desired. For more details on the allowable resistance values, see Throttle Hardware. For gen-set applications, connection of this circuit is not required. Gen-set ECUs default to rated speed (1800 or 1500 rpm. If the analog throttle is not connected, the engine will run at rated speed (1800 or 1500) only, with no adjustment.

To determine the specific rated speed, refer to the appropriate Engine Performance Curve.

With the "premium option" software package, a third "remote analog" throttle can be chosen.



**Analog Throttle "Auto-calibration" Feature**

Industrial (non-genset) applications also have an Auto-Cal feature that automatically adjusts the ECU expected range to match the installed throttle. This feature is selectable in the trim options. Once the stops are adjusted to limit low and fast idle voltage, the "Auto-Cal" feature of the ECU will check the exact range of the throttle potentiometer and adjust the ECU to that range. However, the initial installation must be within certain resistance limits for the Auto-Cal feature to work. Before plugging it into the wiring harness, adjust the throttle potentiometer using the following procedure:

- With the potentiometer against the slow idle stop, adjust the stop so that the resistance measured between the ground and wiper connections of the potentiometer is between 8% and 21% of overall potentiometer resistance.
- With the potentiometer against the fast idle stop, adjust the stop so that the resistance measured between the power and wiper connections of the potentiometer is also between 8% and 21% of overall potentiometer resistance.
- This does not have to be a precise adjustment. The Auto-Cal feature will make a precise adjustment automatically. Throttles from John Deere, are pre-adjusted at the factory.
- To prevent error codes and unexpected changes in speed, the fast and slow idle stops on the throttle potentiometer must be adjusted so that the voltage on circuit 5915 cannot go below 0.35 volts or above 4.65 volts.

If the auto-calibration feature is not used ("Self" calibration is used), the assumed range for the throttle is 1.0-4.0 volts.

| OCR Low | Self-calibration Range | Default Analog Throttle Range | Self-calibration Range | OCR High |
|---------|------------------------|-------------------------------|------------------------|----------|
| 0%      | 5%                     | 20%                           | 80%                    | 95% 100% |

**Analog Input Range (%)****Combination**

The ECU uses the inputs from all enabled throttles to set the engine speed. The maximum throttle signal of all enabled throttles will control engine speed.

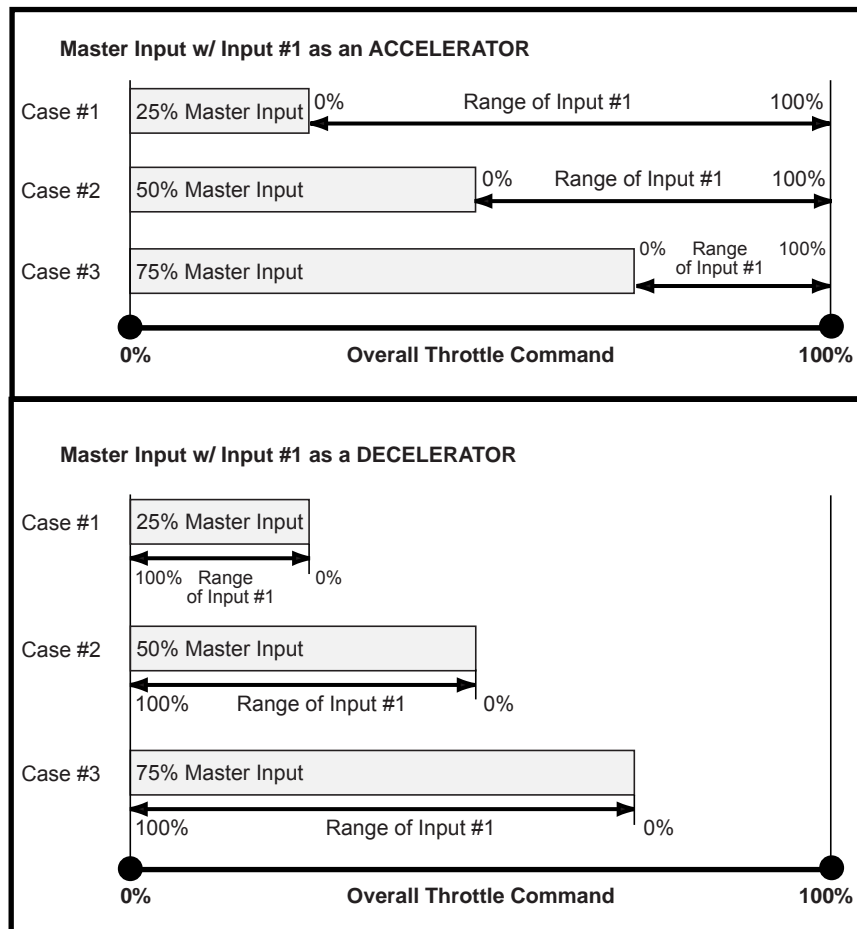
If "Throttle Combination" is enabled, the master input and second input must be selected. One additional throttle, identified as the third input, can also be enabled and a throttle input type selected. Any throttle type (Digital, Primary Analog or Secondary Analog) can be designated as the master input. Each type of throttle can only be selected one time in the throttle combination selections. For example, if the primary analog throttle is selected as the master input, the second input and third input cannot be the primary analog throttle. If throttle combination is enabled for the master input and second input, and the third input is not enabled, the third input throttle will function independently of the combined throttles and the maximum of the combined throttles (master input and second input) and the third input will control engine speed. If all three throttles are enabled in throttle combination, all three throttles will work in combination.

### Throttle Input Type

Throttles are usually accelerator type throttles.

**Accelerator** - An accelerator throttle increases engine speed as the throttle input increases. The master input is always an accelerator type input.

**Decelerator** - A decelerator throttle decreases engine speed as the throttle input increases. The decelerator function is not compatible with the 3-state throttle.



### Combination Throttle Results

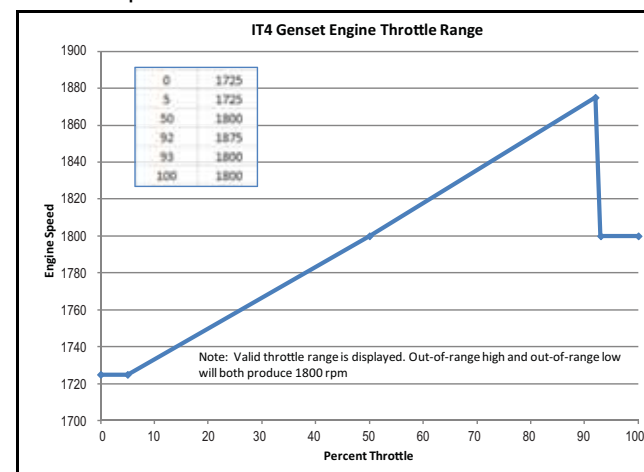
### PRESSURE CONTROL THROTTLE (New for IT4)

A pressure input can be used to control engine speed. This is particularly effective in pumping applications, both gaseous and fluid. An input has to be defined during programming using Trim Options. This input may be a shared ECU pin with another feature and as such may limit some of the other Trim Options. (The same pin can not be used for both features, the user must select which feature will be active). Pressure set points will need to be defined for maximum and minimum throttle and additionally, the type of input needs to be defined. A John Deere sensor must be used if a hard-wired sensor is used. The sensor part number is selected using Trim Options. Alternatively this feature can be run by input from a SAE J1939 Controller Area Network input (the pressure may be given to the ECU via communication with another controller). The pressurized system should have an adequate mechanical relief valve to protect the operator and the electronics.

### GENERATOR THROTTLE (New for IT4)

The generator drive engines will have a limited speed range (1725-1875 rpm). Only the "low idle capable" generator drive engines have the ability to run a low idle speed of 1200 rpm. These "low idle capable" generator drive engines are only available on FT4 No DPF engine options as well as on FT4 3029 generator drive engines. All other generator drive engines are not capable of running any low idle setting.

The run-up rate between initial start-up for no low idle engines (1000 rpm) or low idle capable engines (1200 rpm) to operational speed (1725 rpm) is programmable via Custom Performance (Startup Acceleration Rate). By default it takes approximately 3 seconds (300rpm/sec) to go from 1000 or 1200 rpm to 1725 rpm.



### IT4 Genset Engine Throttle Range

**LOW-IDLE-CAPABLE GENERATOR DRIVE ENGINES (New for FT4)**

The "low-idle-capable" generator drive engines are new to FT4 and are only available for FT4, No-DPF, generator drive engines, and FT4, 3029 generator drive engines. Before the engine will operate at low idle it must be able to reach low idle. This can be accomplished in several ways:

- Torque Speed Control (TSC)
- Hardwire Throttle Control (Analog or Digital Throttles)
- Generator Drive Governor Speed Command by CAN message (Available for only "low-idle-capable" engines)

**DUAL-FREQUENCY-CAPABLE GENERATOR DRIVE ENGINES (New for FT4)**

Dual frequency is also new for FT4 and can only be used in combination with low-idle-capable generator drive engines. Dual frequency offers the ability to run an engine at either 50 Hz (1500 rpm) rated or 60 Hz (1800 rpm) rated based on the application needs and configuration. Several requirements must be met before the engine will operate:

- The ability to select and command a frequency input. This can be accomplished two different ways.
  - 1 Hardwire Switch
    - For this configuration, a 2-position toggle switch (no detent) is required.
    - The ECU will run this switch on a pull-down circuit, therefore configure the switch default state to operate at the safe or desired frequency mode
  - 2 Generator Drive Frequency Selection by CAN message
    - Deere recommends that if this message gets used in combination with the Generator Drive Governor Speed Command that these messages come from the same controller address
- The ability to reach low idle. For details, see "LOW-IDLE-CAPABLE GENERATOR DRIVE ENGINES (New for FT4)" above.

Exhaust Regenerations for low-idle-capable and dual-frequency engines will operate as normal when operating at rated speed. If the engine is operating at low idle and a forced regeneration is required, the engine will verify that a valid interlock has been configured before elevating the engine speed to the requested frequency mode to perform the necessary and required filter cleaning. When completed, the engine will return to the low-idle state.

**OUT-OF-RANGE RECOVERY**

When an expected throttle input signal is outside the expected range, the ECU will assume a desired speed (minimum throttle on industrial engines, maximum throttle on generator drive engines). A fault code will be generated. When the expected throttle signal returns to a valid condition, the ECU will return to one of the following conditions:

- Resume Recovery - returns to the previously desired engine speed. Note: this selection may result in sudden engine speed changes.
- Idle Recovery - the engine maintains the default speed (from when the signal was invalid) but the ECU will respond if the input is returned to "0%" throttle (user may have to "sweep" (analog) or switch (digital) the throttle to regain normal control). Note that while this is called idle recovery, a generator drive engine will run at rated speed instead of idle.
- Locked Recovery - the engine maintains the default speed (from when the signal was invalid) and the ECU will not respond to the throttle regardless of the position (sweeping or switching the throttle will not recover the feature). The engine must be shut off and ECU power off for at least 30 seconds to regain functionality of the throttle.
- The type of recovery can be defined during programming using the Trim Options. Refer to the Trim Options section for more information.

**THROTTLE RATE, RAMP THROTTLE RATE, RAMP THROTTLE STEP**

"Throttle Rate" is how quickly the ECU changes the engine fuel rate in response to a throttle increase signal. The ECU is shipped with the "Maximum" throttle rate selected. Four set rates are available, with the addition of a "Custom" selection that allows the customer to enter in the amount of time they want the ECU to go from minimum throttle to maximum throttle/fast idle. The available selections are as follows:

- Maximum (default)
- Fast
- Medium
- Slow
- Custom

The valid range of values that can be entered in the Custom Throttle Rate box is 5 to 30 seconds

New for IT4, engines will have separate Trim Options for acceleration and deceleration rates. Additionally there will be two acceleration rates that would affect TSC1 speed control (depending upon TSC1 "purpose"). One for "temporary" control (allows immediate speed change) and one for "throttle control" which would limit acceleration or deceleration to the desired rate.

Ramp Throttle Rate (ramp throttle only) - The ramp rate selection sets the rate of change for engine speed increases or decreases when the ramp throttle is active. Four set rates are available, with the addition of a "Custom" selection that allows the customer to enter in the amount of time they want the ECU to go from minimum throttle to maximum throttle/fast idle. The valid range of values that can be entered in the Custom Ramp Rate box is 5 to 30 seconds.

- 3-Second Exponential - Engine speed will start to increase/decrease at a slow rate and will accelerate/decelerate at an increasingly faster rate the longer the switch is held. The engine will go from 0% throttle to 100% throttle in 3 to 5 seconds. This is the default setting.
- 5-second Linear - Engine speed will increase/decrease at a constant rate. With this setting the engine will go from 0% throttle to 100% throttle in 5 seconds.
- 7-second Linear - Engine speed will increase/decrease at a constant rate. With this setting the engine will go from 0% throttle to 100% throttle in 7 seconds.
- 9-second Linear - Engine speed will increase/decrease at a constant rate. With this setting the engine will go from 0% throttle to 100% throttle in 9 seconds.
- Custom - Engine speed will increase/decrease at a constant rate. With this setting the engine will go from 0% throttle to 100% throttle in the amount of time entered in the Custom Ramp Rate box. Valid range for the data entry box is 5 seconds to 30 seconds.

Ramp Throttle Step (ramp throttle only) - Ramp steps or bumps are minor increases or decreases in the percent throttle. When the ramp throttle switch is momentarily held in the "Increase Throttle" or "Decrease Throttle" positions, the percent throttle will increase/decrease a selected percentage of the throttle range. Four ramp step sizes are available.

- 0.4% of throttle range
- 0.8% of throttle range
- 1.6% of throttle range (default)
- 2.8% of throttle range

#### ENVELOPE CALCULATION

A calculator is available that displays the results of the throttle adjustment and governor option selections. This calculator uses information from the engine-specific software payload (such as low idle, rated speed, fast idle) and therefore is presently available for use only through the Custom Performance Programmer. A valid payload is required for use.

#### SAE J1939 Controller Area Network (CAN) Torque/Speed Command (TSC1)

In addition to the hard-wired throttles listed earlier, the engine speed can also be controlled via the Controller Area Network. If this type of control is desired, please review the J1939 standard for more details.

The engine must be programmed to respond to this message. The Trim Options must define whether the feature is intended to be active or inactive and the Source Address of the desired control unit must be declared. The source address must be entered into the Trim Options in decimal form. The source address as broadcast in the CAN message must be in hexadecimal form. See SAE J1939 Standard, Appendix B for more controller source address information.

Failure to follow the standard broadcast rate may result in undesirable engine speed control. If the transmit rate is not followed, the engine may attempt to return to the "default" engine speed between receipt of speed request messages.

The ECU will not respond to a speed request that is outside the defined engine operating envelope (low idle to fast idle). If a speed is requested outside of the operating envelope, the ECU will control to the "default" engine speed.

If the Source Address is incorrectly defined, the engine will not respond to the request and a fault code will be generated. The fault is optional depending upon how the ECU is programmed.

The TSC1 message must contain the source address of the controlling device and also the source address of the desired engine to be controlled. The ECU must be programmed to the corresponding "desired engine" address and also must be programmed to recognize the controlling device.

Abrupt changes in engine speed are possible but not desirable. It is possible to instantaneously request a change in speed from low idle to fast idle. However, it is more desirable to "ramp up" or "ramp down" to control the negative affect on the engine's gear driven accessories and other powered components. This "ramping" feature would have to be built into the software of the controlling device. This affect is offset by the new governor selection. A governor rate can be chosen for temporary control such as transmission shifting or for throttle use. For more information, see Trim Options. Torque can be limited via this same TSC1 message.

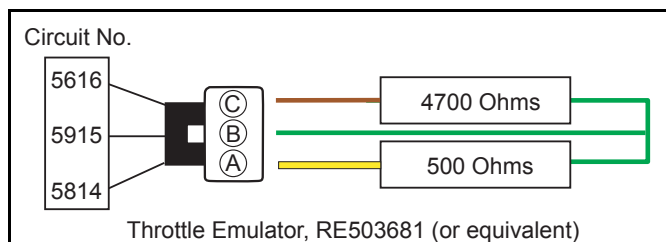
Use of TSC1 speed request may interfere with the ability to accomplish a "stationary" filter cleaning. The engine must be operating on the "low idle governor" in order to initiate a stationary filter cleaning. The low idle governor is defined as the lowest possible engine speed at zero percent throttle. A TSC1-type control panel may be software limiting the effective low idle to a speed higher than the ECU's actual low idle governor.

To avoid this, use the Custom Performance Programmer to set a "low idle offset" to the desired low idle speed for the application (match the ECU's low idle speed to the TSC1 low idle speed).

## Throttle Hardware

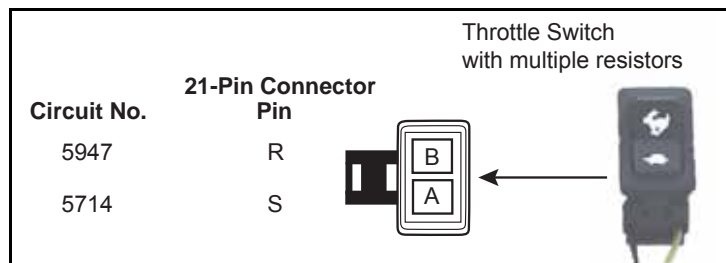
### EMULATOR

An emulator is needed for any throttle that is enabled through the trim settings but not installed (both digital and analog).



**Analog:** Either use the John Deere throttle emulator, or wire an equivalent resistor bridge into the appropriate circuits as defined by the application specific schematic. The exact size of the resistors is not important, as long as total resistance is 2,000-15,000 Ohms, and the small resistor size is 6% to 20% of the large resistor, for slow idle emulator. For fast idle emulator, the resistors are reversed. The throttle can also be emulated for constant speed operation at any speed. A Throttle Emulator Calculator is available in Engine Application Guidelines, Tools (AG-06).

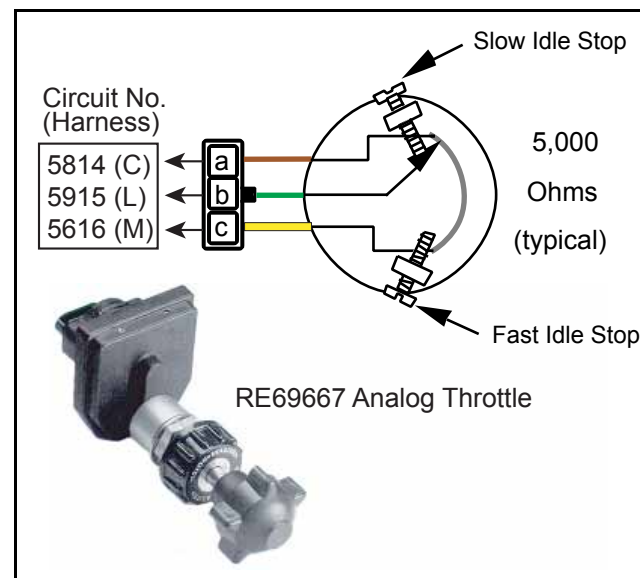
**Digital:** Use a single resistor to achieve the appropriate mode. For resistance values, refer to Digital Throttle Switch.



### Digital Throttle Switch

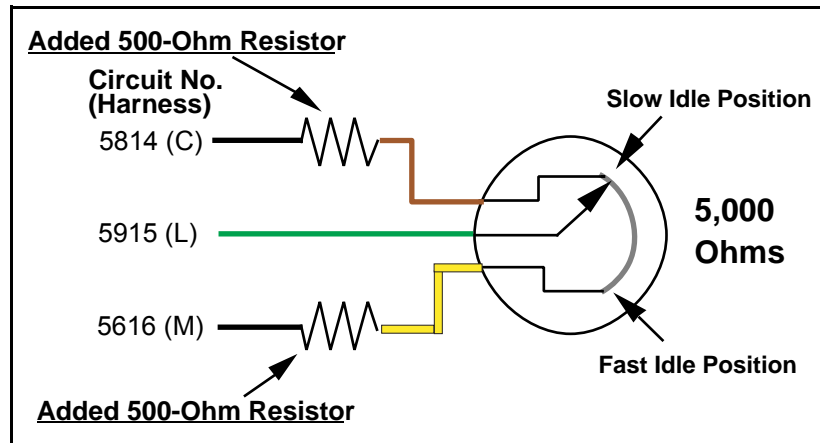
### ANALOG POTENTIOMETER

As partially defined earlier in the feature description, the analog throttle is a potentiometer with a total resistance of not less than 2,000 Ohms and not more than 15,000 Ohms. The throttle stops should be adjusted to a value that achieves 6-20% resistance at the minimum and maximum potentiometer settings.



### ANALOG THROTTLE POTENTIOMETER WITHOUT MECHANICAL ADJUSTMENT STOPS

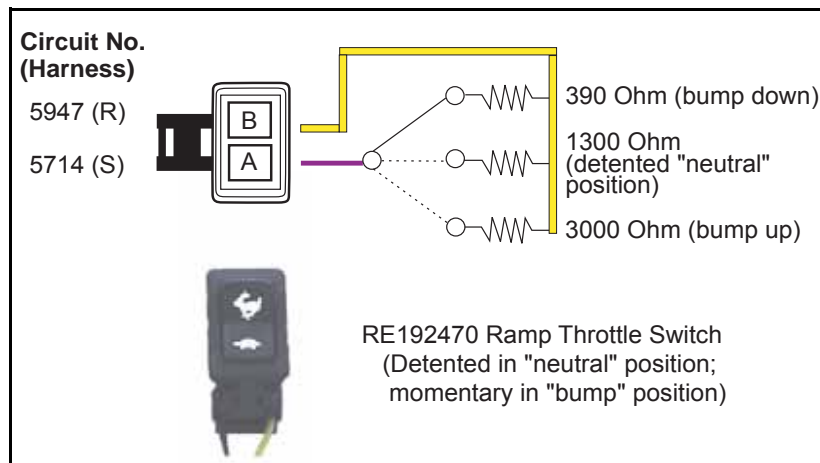
If a potentiometer without fast and slow idle stops is used, additional fixed resistors can be wired in series with the potentiometer to prevent the analog throttle voltage from going outside the upper and lower limits and generating a fault code. For the Auto-Cal system to work properly, each added resistor should be between 9-39% of the nominal throttle potentiometer resistance. Total resistance of the potentiometer and both resistors should be in the range of 2000 to 15,000 Ohms.



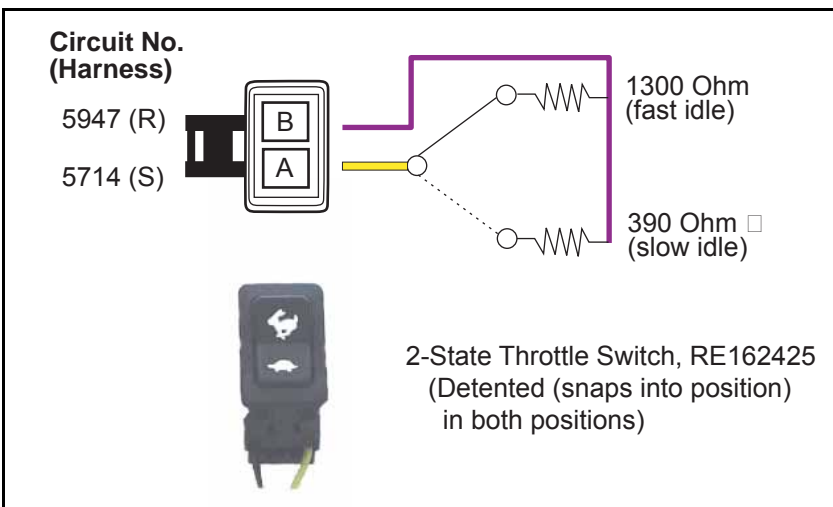
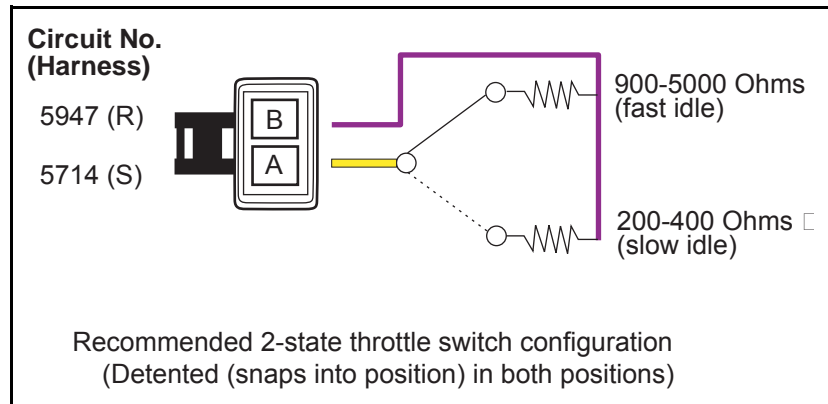
Potentiometer Without Mechanical Adjustment Stops

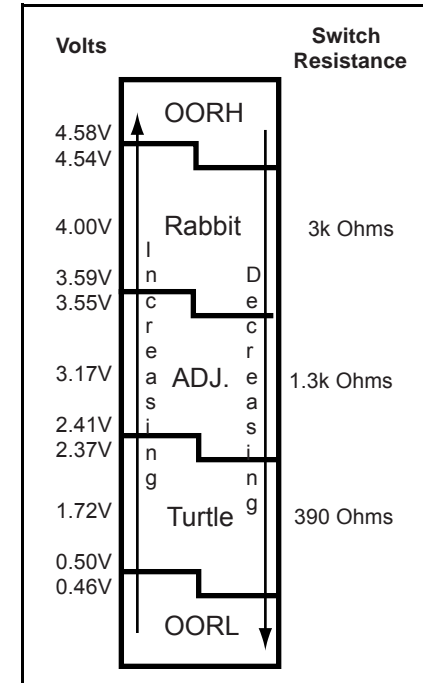
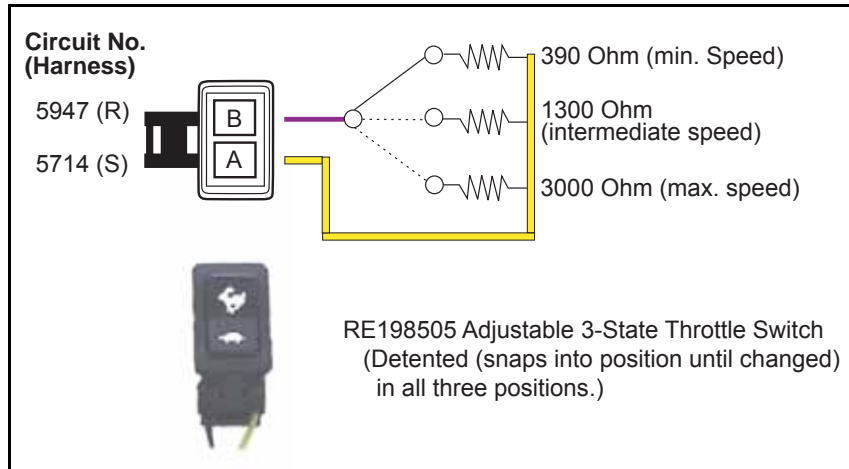
**DIGITAL THROTTLE SWITCH**

The digital throttle switch is either a momentary (Ramp Throttle) or "toggle" (2-State and 3-State) switch that selects between fixed resistance values. Each resistor has an acceptable range.



Ramp Throttle Switch





**3-State Ramp Throttle Breakpoints**

**CRUISE CONTROL**

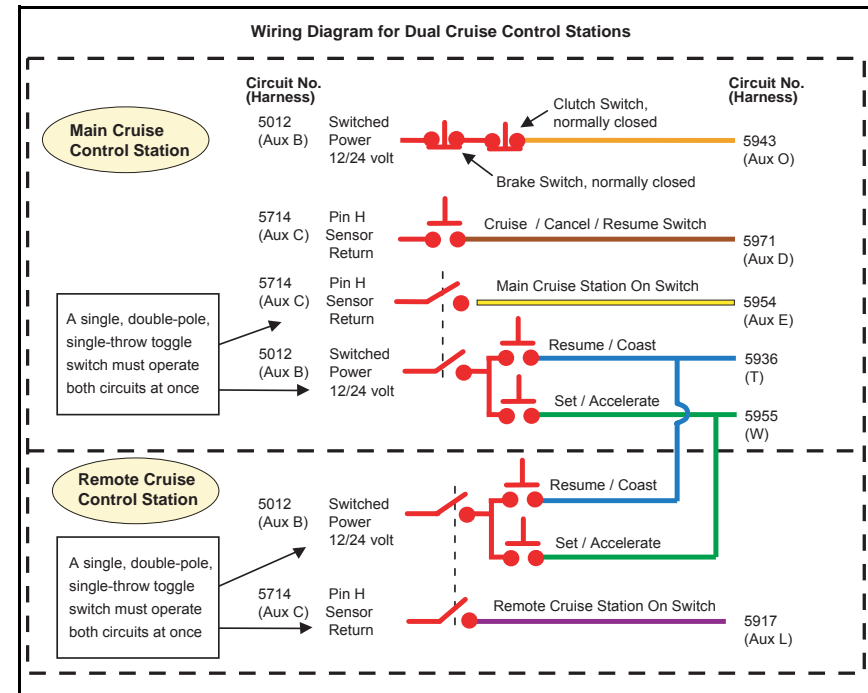
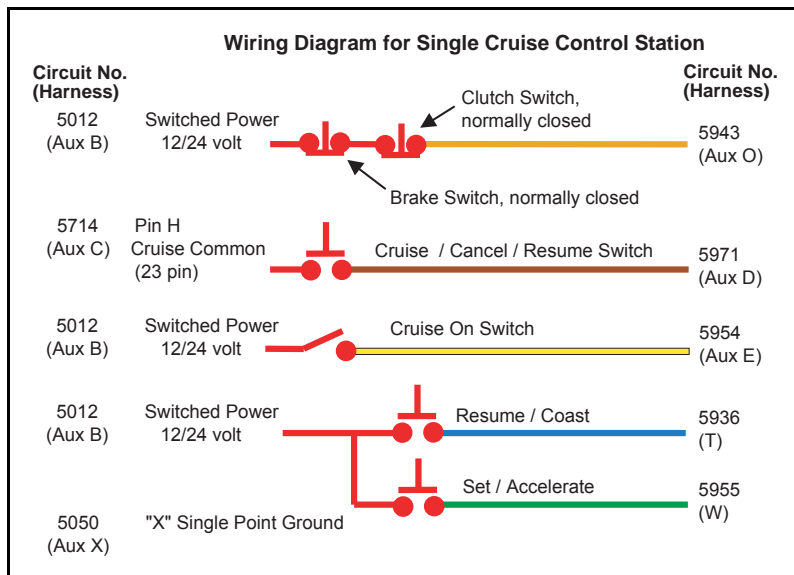
Cruise Control does not require resistors but rather simple toggle and momentary switches.

In the following diagrams, the "Circuit No. (Harness)" letters designate John Deere interface harness connection points. Those designated as "Aux" are on the 23-pin "Auxiliary Connector" (X5020). The remaining pins are on the 21-pin "Control Panel Connector" (X5021).

For additional information, refer to:

**Control\_Panel\_Harness\_Schematic\_RE542875\_FT4**

**Control\_Panel\_Harness\_Schematic\_RE542875\_IT4**





## Governing

Two modes of engine speed governing are available: "isochronous" and "droop." The governing mode can be defined via Trim Options as Droop or Isochronous. It may be switched from droop to isochronous by programming the Trim Options as Harness Selectable or SAE J1939 CAN request (PGN FDC7 "Off Highway Engine Control Selection"). To use the CAN feature, the engine must first be programmed for droop governing. This becomes the default governor and with the CAN request it can be switched to isochronous. If the engine is programmed as isochronous, the feature will not work. Please refer to the J1939 standard for more details. The message byte which controls the feature is "byte 4", "Engine Auxiliary Droop Input State". Refer to the standard for these switch states.

Cruise Control will act as isochronous whether the engine is in droop-mode or not.

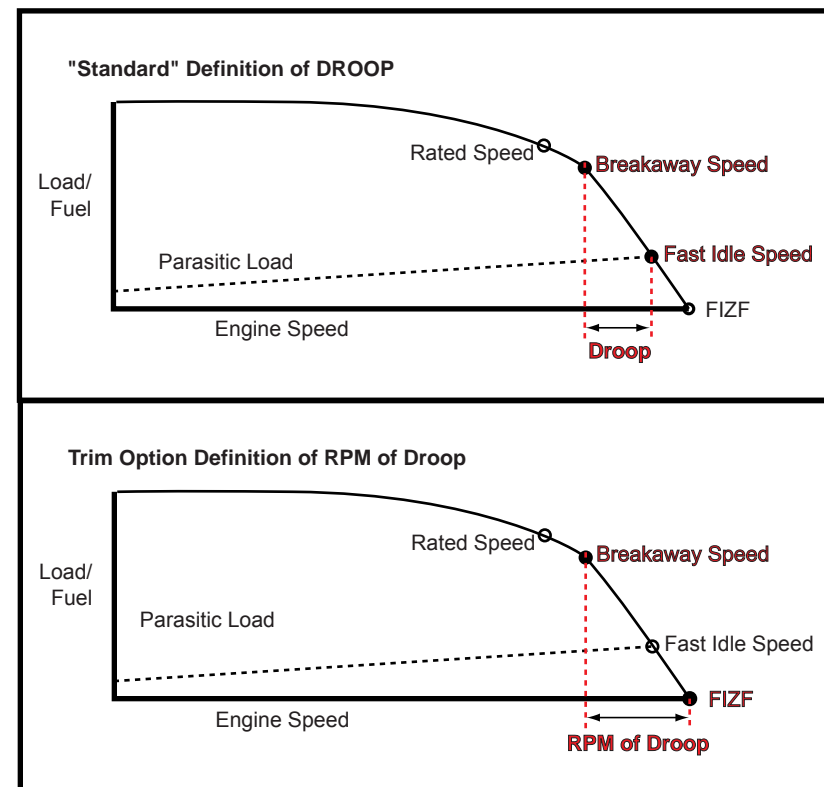
Isochronous control will maintain a consistent desired engine speed regardless of changes in engine load. Significant changes in load will create a temporary change in engine speed and the ECU will compensate the fuel rate to return to the desired speed. If load is increased to the point where the maximum fuel rate is being delivered, speed may change as a result of "pulling down the torque curve."

Droop control will mimic the characteristics of a mechanically controlled governor. Increases in load will cause a decrease in engine speed. Decreases in load will cause an increase in engine speed. The difference in speed between the full-load and no-load point (defined as zero-fuel load) is the RPM of droop.

Harness selectable allows the input to be a hard-wired switch or jumper wire that will allow the end-user to select the governing without reprogramming. Selectable is typically used on generator drive engines and rarely used on industrial engines. Refer to the engine specific schematic to understand which circuits are needed for this feature.

In many cases isochronous governing is perceived as an improvement over droop governing. For example, the application will have a consistent fast idle regardless of engine temperature and parasitic load. In general, this is the preferred governor. In applications where the engine load is operator dependent, a droop governor is preferred. The droop governor allows the operator to notice a change in engine load via the change in engine speed. This allows him to change the controls of the application to prevent lugging down the torque curve or possible engine stalling. Some "load sensing" systems will change application load dependent upon engine speed regardless of operator input. Please discuss the governor selection with the OEM rather than making a random decision. If this is not possible, it is advisable to use the "harness selectable" governor choice in the Trim Options.

The Envelope Calculator in the Trim Options will indicate the Rated Speed, Breakaway, Fast Idle Zero Fuel (FIZF), and RPM of droop. Breakaway is an offset above rated speed where full torque curve fuel is still available. The breakaway offset is included to mimic the typical characteristics of a mechanical governor. The tolerance in mechanical governors required a small additional speed margin to ensure each application could achieve full fuel at the rated speed. On John Deere engines, the breakaway speed is 50-70 rpm higher than rated speed (depending upon engine model). FIZF is not the actual fast idle speed but rather the speed at which the engine will no longer inject fuel. This is at a speed above the application's actual fast idle and the difference is dependent upon the application's parasitic load. Typically, an engine with 125 rpm of defined droop will encounter only 100 rpm of difference between fast idle and breakaway. On isochronous governed engines, FIZF is the same as the breakaway speed (as expected by the fact that there is "zero" rpm of droop).



Definitions of Droop

Additional Governor Settings (applies to part load operation):

- Min-Speed Governor - active when the throttle is at zero percent
- All-Speed Governor - active when the throttle is between zero and 100%
- Max-Speed Governor - This governor is active when the throttle is at 100% (while at part load). For generator drive engines with no throttle connected, this governor will be active.
- These governors can be modified during programming using Trim Options. Do not modify them unless part-load stability issues are apparent. See Trim Options for more details.

## Engine Protection

### FAULT

A fault is an indicator of an undesirable hardware or operating condition. The faults are grouped in categories for the Suspect Parameter Number (SPN) and the Fault Mode Indicator (FMI). The parameter indicates the hardware or condition that is problematic and the fault mode indicator describes the relative issue within that parameter. As an example, a parameter may be "coolant temperature" and the fault mode indicator may be "temperature higher than normal, most severe level." Refer to the full list of SPN/FMI. The indication of the fault gives the operator an opportunity to apply a remedy or at a minimum reduce load and move to safety.

### DERATES

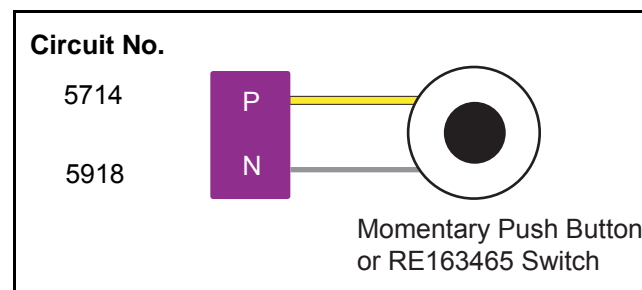
A derate is a temporary reduction in the maximum available fuel rate. A derate is a result of an undesirable engine condition as monitored by the ECU. The derate is used to minimize engine damage and also as an incentive for the operator to take corrective action. If the engine is being operated at light load when the derate occurs, it is quite possible that the application will be unaffected since the active fuel rate may be lower than the yet available fuel rate. An active engine control fault must occur in order for a derate to occur. The actual fault and the derate will both be apparent by the activation of the warning light and their appearance on the diagnostic gauge.

Derates are further defined by categories. Level 1 derates are associated by the fact that the maximum fuel rate has been reduced but no change in emission control management has occurred. Level 1 derates may be "turned off" via Trim Options if desired. If Level 1 derates are turned off, an alternate form of engine protection is required. Level 2 derates are associated by the fact that not only has the maximum fuel rate has been reduced but also the engine controls have further been manipulated to protect the engine at the sacrifice of emission control. Level 2 derates are always active on IT4 applications.

For full description of parameters and their limits, refer to the Derate and Shut-Down section in the appendix.

### SHUT-DOWNS

Shut-down protection is an option that limits engine damage in case of an undesirable engine condition by actively shutting down engine operation. At the time of ECU programming, a selection is available in Trim Options to allow 30 seconds of extended operation or immediate shut-down. This shut-down override can be initiated by the operator to extend the warning for an additional 30 seconds. This extension is not available if "immediate shut-down" has been programmed. There is no option to continuously operate in a shut down condition other than to reset the timer for another 30 seconds via the override button. The override button may be used an unlimited number of times but continuously holding the override button is interpreted as a single 30 second override request. A message can be transmitted to the ECU from another controller via SAE J1939 CAN protocol to enable or disable engine shut-downs. This must be activated at the time of ECU programming via Trim Options. This is the only feature that would allow shut-down protection as "normal" but yet allow a continuous override for emergency situations. The engine protection shut-downs (both standard and optional "external shut-down") should not be used as an emergency shut-down switch. Fault codes will be generated when activated and actual shut-down may be delayed if programmed to do so. Emergency shut-down should be activated by installing a switch in the "ECU switched power" circuit (effectively acting as a key switch override).



**Shutdown Override Switch, RE163465**

### Configurable Derates and Shutdowns (New for IT4)

Derates and Shut-downs may be used in conjunction with application sensors. These sensors must be wired to the ECU or the parameter can be monitored via CAN if there is a valid message on the network. The sensor and/or CAN message must be configured using Trim Options. Refer to Configurable Sensors for more information.

For more information on the subject conditions and derate levels, refer to the Derate and Shut-down section in the appendix. Also, for diagnosis and remedy of an engine protection condition, refer to the component technical manual. The engine protection shut-downs (both standard and optional "external shut-down") should not be used as an emergency shut-down switch. Fault codes will be generated when activated and actual shut-down may be delayed if programmed to do so. Emergency shut-down should be activated by installing a switch in the "ECU switched power" circuit (effectively acting as a key switch override).

### Managed Shut-Down (New for IT4)

A new feature has been added to allow the operator to remove the key switch power but yet allow the engine to automatically idle until stable for shut-down.

The feature uses the "shut-down override" button as an input.

The operator must hold the override button for 30 seconds before removing the switched power to the ECU.

When the engine has reached a stable cool-down temperature, it will automatically turn off.

Alternatively, if the engine must be turned off during "managed shutdown," the operator can press-and-hold the override button to cancel the delay.

### Starter Protection (New for IT4)

This feature prevents the over-cranking of the engine's starting motor. It is available in two types of management. Neither of these types should be considered an "automatic start" feature such as utilized by generator control panels. The threshold speed for disengagement is 600 RPM.

### STARTER OVERSPEED PROTECTION

This method uses conventional key-switch to starter relay wiring but it allows for the installation of an additional ECU controlled relay (in series) to interrupt the normal circuit. The starter is disengaged if cranked for excessive time or if the engine reaches a threshold speed which would allow engine run-up without additional aid. This feature uses only one ECU input/output and does not interfere with other Trim Option selection.

### FULL ECU/STARTER CONTROL

With this feature the starter relay is only wired to the ECU and not to the operator control. The key switch or start button is also wired to the ECU and the ECU interprets the start request and acts to enable the starter relay. The starter is disengaged if cranked for excessive time or if the engine reaches a threshold speed which would allow engine run-up without additional aid. This method of starter controls uses multiple ECU inputs/outputs and may conflict with the ability to activate other Trim Option features (shared ECU pin by both features; only one can be programmed as active).

This feature can also be triggered via SAE J1939 CAN message.

### SAE\_J1939\_Engine\_Start\_Control

### Sensor Configuration (New for IT4)

This feature allows additional sensors to be hard wired to the ECU for simplification of the engine controls and control panel. As an example, the ECU can now monitor transmission temperature, hydraulic temperature, hydraulic pressure, etc. The Trim Option must be defined to allow this use and the sensors name, scale, limit, and offset must also be defined. A CAN message can be selected in order for the ECU to transmit the measured value to other controllers or an electronic control panel.

**Coolant Level / Coolant Loss Sensors (New for IT4)**

A feature has been added to monitor two coolant level switches. One circuit is defined as "Coolant Level" and is monitored when the engine is "keyed on" but not running. The other circuit is "Coolant Loss" and it is monitored as the engine is running. Coolant Level will create a warning if the sensor is triggered. Coolant Loss will create an engine shut-down if triggered. Coolant Level is an optional feature and may be "turned off" using the configurable options at the time of ECU programming. Coolant Loss is a required circuit and must be enabled on all engines. The logic used to monitor Coolant Loss is different depending upon whether the Coolant Level is also enabled (a coolant level check is also included in this single-switch feature). Diagnostic trouble codes (DTC) are activated if either switch is "active."

| <b>Single-Switch Application</b> |   |                                      |  |                      |
|----------------------------------|---|--------------------------------------|--|----------------------|
| <b>DTC</b>                       | <b>Code Description</b>   | <b>Alarm Level</b>                   | <b>Coolant Temp.</b>                         | <b>Controlled by</b> |
| 111.17                           | Engine Coolant Level Information Switch Active                        | Warning (will turn off after 1 min.) | greater than -22 °C (only checked at key on) | Loss Switch          |
| 111.18                           | Engine Coolant Alarm Switch Activated at Moderate Coolant Temperature | Warning                              | -22 °C to -10 °C                             | Loss Switch          |
| 111.01                           | Engine Coolant Alarm Switch Activated at High Coolant Temperature     | Stop                                 | greater than -10 °C                          | Loss Switch          |

| <b>Two-Switch Application</b> |  |                                      |  |                      |
|-------------------------------|--|--------------------------------------|--|----------------------|
| <b>DTC</b>                    | <b>Code Description</b>  | <b>Alarm Level</b>                   | <b>Coolant Temp.</b>                         | <b>Controlled by</b> |
| 111.17                        | Engine Coolant Level Information Switch Active   | Warning (will turn off after 1 min.) | greater than -22 °C (only checked at key on) | Level Switch         |
| 111.18                        | Engine Coolant Alarm Switch Activated at Moderate Coolant Temperature                        | Warning                              | -22 °C to -10 °C                             | Loss Switch          |
| 111.01                        | Engine Coolant Alarm Switch Activated at High Coolant Temperature                            | Stop                                 | greater than -10 °C                          | Loss Switch          |
| 111.07                        | Switches indicate that coolant level is below the loss switch but not below the level switch | Warning                              |  | Loss and Level       |

**Elevated Low Idle**

As previously defined in the Throttle section, a low idle offset is available. But additionally, in conjunction with the exhaust filter management, an elevated low idle is available to aid with exhaust filter cleaning. It is recommended that this feature be active as "default" unless the OEM has operator safety reasons why an elevated idle speed can not be tolerated. The feature would only be active as part of a exhaust filter cleaning event and it would not cause the idle to "jump" from the normal low idle to the elevated setting. Instead the feature would engage while the engine is being operated under normal control above the desired offset speed. As an example, an engine operating at 800 rpm will not be increased. But an engine that is operating at 2000 rpm will not be able to drop to 800 rpm while this feature is active but rather would decelerate only as low as the temporary threshold. This feature is described in more detail in the Exhaust System (AG-17). The typical speed required is 1200 rpm. This feature is not active on generator drive engines.

**Turbo Inlet Temperature Rise (New for IT4)**

The offset between actual ambient temperature and the compressor inlet temperature must be programmed into the ECU. This value should be established in the prototype test phase of the application development and then programmed into the production ECU via Trim Options.

The offset is used in order to give the ECU the ability to calculate the ambient temperature from the input provided by the compressor inlet sensor. The information is used with respect to emission compliance engine control and exhaust temperature management for exhaust filter cleaning.

**NON-TRIMMABLE (“selectable”) FEATURES****Engine Speed Sensor**

Engine speed and crankshaft position are a fundamental part of the engine control system. The crankshaft position sensor is mandatory. Speed is measured by filtering engine crankshaft speed values, which are calculated over one cylinder event. The ECU will broadcast engine speed via standard J1939 CAN protocol (refer to the list of supported CAN messages). The CAN speed message is available as soon as crankshaft rotation starts and the ECU can calculate an estimated speed. However, the calculated speed may not be accurate due to instantaneous crankshaft accelerations at the following cranking speeds.

| Cranking Speed | Minimum Time Threshold |
|----------------|------------------------|
| 100 RPM        | 1200 milliseconds      |
| 150 RPM        | 800 milliseconds       |
| 200 RPM        | 600 milliseconds       |
| 250 RPM        | 480 milliseconds       |

Based on the various engine sizes, the normal cranking speeds can operate anywhere between 150 and 200 rpm. Also, cranking speeds can drop as low as 100 rpm during cold cranking conditions. For this reason, based on the desired cranking speeds and application requirements, the speed message should be filtered or ignored during these critical periods.

This is particularly important in conjunction with generator drive applications due to the auto-start control panels associated with these applications. A one time broadcast of speed over 300 rpm may occur and if the starter control logic does not use a persistence counter, or other filtering, it may result in the inability to start the engine. This problem may not be apparent during application development but rather may occur much later in the product life.

**Remote On / Off Control**

When the ignition switch is in the run position the remote on / off feature can be used as an emergency or remote shut-off. This feature is simply an additional switch wired in series with the key switch. There is no ECU input for this feature and it is not programmable. However, if a John Deere operator interface harness and control panel are used, a connector for this feature is included in the wiring harness.

**Fuel Filter Pressure Sensor**

A fuel filter pressure sensor is standard on the 6068, 6090 and 6135 engines. It is optional on other engine models. A fault code for low fuel pressure is used for engines equipped with this sensor.

**Water-in-Fuel (WIF) Sensor**

A WIF sensor is a standard feature on the 6068, 6090 and 6135 engines. It is not a Trimmable Option. A fault code for water in fuel is provided. This feature is optional and programmable on other engine models.

**Fuel Transfer Pump Control**

The ECU controls the electric fuel transfer pump to provide adequate fuel pressure to the high pressure fuel pump under a wide range of inlet and filter restrictions. This control maximizes filter life and provides for easy filter changes. Transfer pump is powered external from the ECU. This is not a Trimmable Option on the 6.8L and 9.0L. The fuel transfer pump is gear-driven on the 6135 but an electronic transfer pump is also used for priming the fuel system prior to starting.

**Hour Meter**

The ECU keeps and broadcasts, on request, a record of engine run hours. The information is available for retrieval by service tools (i.e. Service ADVISOR™ or PowerView 101). No run time will be lost on a normal power down cycle. When reprogramming the ECU with service tools, the hour meter will be maintained if possible. In situations where the engine hours can not be retrieved, the service tool can be used to set the engine hours to the correct value. Service ADVISOR™ also has the capability to increase (but not decrease) the hours from what is stored in the ECU at anytime.

**Complete List of Engine Sensors Used**

Refer to the Engine Installation Drawing.

**Exhaust Filter Control Interface**

Inputs and indicators are required to allow or control filter cleaning. Refer to “Instrumentation and Controls” and “Operator Interface” sections later in this document.

**DIAGNOSTIC TROUBLE CODES**[Fault\\_Codes\\_FOR\\_REFERENCE\\_ONLY.xlsx](#)**APPLICATION HARNESS PIN-OUT**[Application\\_Harness\\_L21.xlsx](#)**MAX. SURFACE TEMPERATURE FOR SELECT SENSORS**[Sensor\\_and\\_Actuator\\_Temperature\\_Limits\\_FT4](#)[Sensor\\_and\\_Actuator\\_Temperature\\_Limits\\_IT4](#)**CONTROLLER AREA NETWORK (CAN)**[SAE\\_J1939\\_CAN\\_T4.xlsx](#)**ENGINE CONTROL UNIT (ECU)****Operating Range (Voltage)**

The ECU is the same for 12V or 24V systems however 12-volt or 24-volt operation must be specified when ordering the engine. The engine control system has the following voltage requirements:

| 12 Volts DC | 24 Volts DC | Description   |
|-------------|-------------|---|
| 0 to 6.5 V  | 0 to 13 V   | System does not operate; No ECU damage  |
| 6.5 to 10 V | 13 to 20 V  | Cranking Voltage Range; Some features "inactive."   |
| 10 to 16 V  | 20 to 32 V  | Normal Operation; All features "active."  |
| 16 to 24 V  | 32 to 36 V  | Over-voltage, ECU can operate for up to 5 minutes without damage; Some features "inactive." |
| >24 V       | >36 V       | System damage   |

**Operating Range (Internal Temperature)****Storage**

Allowable range is -55 to 105 °C

**Operation**

Recommended range is -35 to 85 °C

Functional "intermittent" range is -40 to 105 °C  
(reduction in ECU component life is expected)

Maximum allowable ambient temperature at ECU 85 °C

ECU temperature must be verified during the application review

(Refer to [ECU\\_Thermal\\_Guidelines.01\\_FT4](#) )

**Speed Range (Cranking)**

The ECU needs to see a minimum crankshaft speed of 60 rpm (average) in order to maintain synchronization between the fuel system and crank position. If instantaneous speed drops below 40 rpm the ECU will "reset". Engine starting can not be accomplished at this speed.

**Mounting**

If the engine is factory supplied (from John Deere) with an engine mounted ECU, it is pre-qualified for orientation, vibration, and water intrusion (splash but not immersion). If the ECU is to be remote mounted or otherwise custom mounted by the OEM, it must be done in accordance with the requirements as outlined in the following documents:

[ECU\\_Mounting\\_Requirements.01\\_FT4](#)[ECU\\_Thermal\\_Guidelines.01\\_FT4](#)[ECU\\_Vibration\\_Limits\\_FT4](#)[ECU\\_Harness\\_Routing\\_FT4](#)

For 'Painting,' refer to "Handling and Startup," AG-22.



## WIRING HARNESS

The engine is supplied with a factory installed harness for control of engine sensors, actuators, etc. This harness utilizes two of the connectors on the ECU. The third ECU connector is dedicated to the application interface harness and can be supplied by John Deere or can be fabricated by the OEM. The John Deere interface harness is intended to be (but not limited to) use with a John Deere control panel. The 21-pin control panel connector and 23-pin auxiliary connector are the same as used on Tier-2 and Tier-3 engines. The purpose of the interface harness has expanded for IT4 and it now also interfaces with the variable speed fan drive and some components of the exhaust filter system.

- ECU Pin Out
  - ECU\_Pin-Out\_L21\_6068\_6090
  - ECU\_Pin-Out\_L22\_6135
  - ECU\_Pin-Out\_L23\_4045
- Schematic

| IT4                             | FT4<br>(Includes Control Panel Harness Schematic) |
|---------------------------------|---|
| Schematic_6135                  | Schematic_L32_6135_RE563683                       |
| Schematic_6090                  | Schematic_L33_6068_6090_RE563704                  |
| Schematic_6068                  | Schematic_L34_4045_RE563710                       |
| Control_Panel_Harness_Schematic |   |

If designing a Control Panel Harness, please refer to "Electronic Engine Harnesses (AG11-H)." This document contains the following information:

- Connector part numbers
- Wire specifications and drawings
- Pin-to-pin connections to meet the FT4 requirements for minimum and premium controls
- FT4 harness options and extensions
- Pin-to-pin connections to meet the IT4 requirements for minimum and premium controls
- Pin-to-pin connections to meet the T3 requirements for minimum and premium controls

### Wire Color and Names

- It is preferred that the same wire colors and numbers are used as indicated on John Deere schematics.
- If alternate colors and numbers are used, OEM must provide to John Deere a schematic for upload into Service ADVISOR™ Dealer Technical Assistance Center (DTAC) system.

## Power to ECU

### UNSWITCHED POWER

**Unswitched power to the ECU must be fused and wired directly to the battery (+) terminal. Wiring to the starter (+) terminal creates a voltage drop that may prevent starting at minimum battery voltage conditions.**

### SWITCHED POWER

Switched power must be available without starting engine. This is typically not an issue with industrial engines and other engines utilizing a normal key switch.

Install a separate momentary switch if needed. Generator-drive engines typically do not have a key switch but rather an auto-start panel. Activating power at the auto-start panel will also engage the starter. This is undesirable for electronic service (programming or diagnostics). A separate "ECU power" switch must be included in the application for this purpose. It may be a momentary or toggle switch as preferred by the OEM. Ideally this switch is located near the diagnostic connector for ease of service.

**NOTE: If this switch is inadvertently left in the "on" position, the normal application "shut-off" switch will have no effect. The ECU will remain powered and the engine will continue to run.**

For this reason it would also be important to wire the emergency stop in a manner that it would interrupt power from both switches.

If ECU switched power can be activated by a separate control system, this is an acceptable alternative to a separate momentary switch. However, activation must be obvious to the service technician. If necessary, a Dealer Technical Assistance Center (DTAC) solution should be submitted to JDPS whereby a technician can find instructions through Service ADVISOR's™ DTAC system

### DIAGNOSTIC CONNECTOR

The Diagnostic connector must have unswitched power. Original Tier-2 and Tier-3 schematics illustrated the diagnostic connector as utilizing "switched" power. This did not allow Service ADVISOR™ to be operational at the time of key-switch activation and important pre-start data could not be monitored or recorded.

All Tier-4 engines must feature "unswitched" power at the diagnostic connector to more fully utilize the power of the diagnostic tools.

## INSTRUMENTATION AND CONTROLS

The minimum allowed interface would include the following:

- Switched power control (key switch or similar)
- Fault lamp and stop lamp
- Wait-to-start lamp (if ECU controlled start aids are used)
- Exhaust filter status indicators
- Exhaust temperature management / exhaust filter cleaning active
- Exhaust filter plugged; Operator-requested exhaust filter cleaning possible
- Exhaust filter plugged; Stationary exhaust filter cleaning required
- Manually request exhaust filter cleaning
- Manually override exhaust filter cleaning
- Machine interlock; safe and ready to clean exhaust filter
- Diagnostic Connector

The interface may be completely electronic (SAE J1939 CAN) with the exception of the diagnostic connector.

### PV101 Diagnostic Gauge for IT4 (DOC/DPF) and FT4 (DOC/DPF) Engines

The PV101 diagnostic gauge has been revised for use with IT4 engines. The diagnostic capability with respect to warnings, shut-downs, wait-to-start, and both active and stored fault codes remain. The hardware is the same as Tier 3 but the software has been updated to fulfill the functionality required for the exhaust filter operator interface. For this reason it is the preferred diagnostic gauge for use on IT4 engines.

**Manual switches and lamps are not needed if the PV101 (or similarly featured SAE J1939 electronic interface) is used.**

The features are as follows

- Engine operating conditions (RPM, hours, temperatures, pressures, etc. Refer to Powerview Brochure.)
- Wait-to-start
- Wait-to-start count-down
- Fault code display
- Clear stored codes
- Warning and shut down lights
- Indication of exhaust filter condition
- Interface to request or override a exhaust filter cleaning event
- Interface to request a "stationary" exhaust filter cleaning (filter condition too severe for normal exhaust filter cleaning - For more details, see Exhaust Filter (AG-17).

An "Interlock" must also be used to indicate the machine is ready and safe for filter cleaning. This feature is not incorporated into the PV101.

Alternate display using SAE J1939 Controller Area Network (CAN) controls can be used for the exhaust filter interface without using a PV101 diagnostic gauge. See "Operator Interface" section later in this document.

**NOTE: The PV101 does not display all of the required symbols and Diesel Exhaust Fluid (DEF) level required for use with FT4 engines using Selective Catalyst Reduction (SCR) (Level 32-34 engine controls)**

### DG14 Diagnostic Gauge for IT4 (DOC/DPF) and FT4 (SCR) Engines

The DG14 diagnostic gauge has been developed especially for the FT4 (SCR) engine with Level 32-34 control systems. However, it is compatible with electronically controlled John Deere engine of all EPA emission tier levels. It fulfills the requirements for on-board diagnostics, emission symbols, exhaust filter controls, and DEF level indicators. It contains all of the features and benefits of the PV101 (listed above) plus the following:

- 3.2-inch backlit LCD display
- Tactile-feel control buttons
- Gauge display - engine parameters displayed by text through form list format or 1-up and/or 4-up display format
- Backwards compatible with PV gauges (Sensor Gauges, Fuel Level Indicator, Dimmer)
- TSC 1 engine speed control with speed adjustment (can replace separate throttle control)
  - o Adjustable "high" and "low" speed limits (via menu)
  - o Adjustable "ramp up" and "ramp down" speed settings (via menu)
  - o Adjustable "bump up" and "bump down" speed settings (via menu)
  - o Password protected (added security feature)
- FT4 symbols for Emission System Malfunction and DEF System Fault (Required for FT4)
- DEF Level Indicator (Required for FT4)
- Service Advisor/CAN Programming Capable (field reprogramming done via Service Advisor)
- Supports up to 3 Digital Inputs
- Supports up to 2 Digital Outputs
- "Offline" Mode Configuration Capable (intended for setting adjustments or field support troubleshooting)



**PV480 Diagnostic Gauge (All Tiers including FT4)**

The PV480 diagnostic gauge has been developed especially for FT4 engines with Level 32-34 control systems. However, it is compatible with electronically controlled John Deere engines of all EPA emission tier levels. It fulfills the requirement for on-board diagnostics, emission symbols, exhaust filter controls, and DEF level indicator. It contains all of the features and benefits of the PV101 (listed above) plus the following:

- 4.3-inch color display
- Tactile-feel control buttons
- Gauge display – engine parameters are displayed in both text and “gauge-like” appearance.
- TSC1 engine speed control with speed adjustment (can replace a separate throttle control)
  - Adjustable “high” and “low” speed limits (via menu)
  - Adjustable “warm-up” and “run” speeds (via menu)
  - “Ramp-Like” Increase/Decrease Speed Control via the PV480’s Integrated Buttons
- Auto-start and Auto-stop
  - Remote Start and Stop
  - Panel-initiated Start and Stop
  - Engine Coolant Temperature-based Start and Stop
  - Clock-based Start and Stop
- FT4 symbols for Emission System Malfunction and DEF System Fault (Required for FT4)
- DEF Level Indicator (Required for FT4)
- Fuel Level Indicator
- Password Protection (Optional security feature)
- USB Connection (Used to re-program the PV480 plus data logging export)
- Data Logging (Records a list of pre-defined parameters to internal memory. Can export the log file to a USB “flash drive”).

**Manual Panel and Indicator Lights for IT4 and FT4 (Level 23) Engines**

Mechanical switches and lamps can be used instead of the CAN exhaust filter cleaning interface.

ECU circuits are provided for use with an analog interface.

Lamps would be used to indicate the condition of the exhaust filter.

Switches would be used to initiate or inhibit the exhaust filter cleaning.

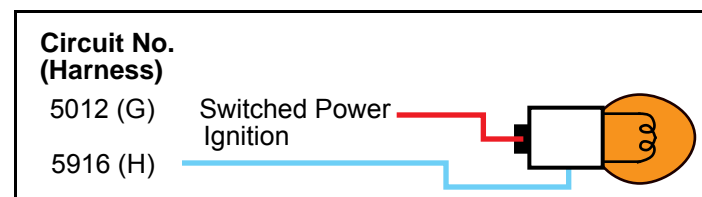
ISO symbols must be used to indicate the lamp and switch function. (Refer to "Tier 4 Engine Emission Symbols.")

The feature must be activated during programming using the Trim Options.

Utilizing the analog interface will limit the number of other "user defined" inputs/outputs. This will prevent the selection of some "other" Trim Options. See Trim Options from more information.

While it may be viewed as simple or cost effective to use analog switches for the interface, the OEM is still required to include a fully functional diagnostic display with warning lights and display of active and stored fault codes.

If it is undesirable to install the diagnostic gauge on the main instrument panel, it may be installed in an accessible alternate location as long as there are at least lamps for "stop" and "warning" faults on the main panel.



**Auxiliary Warning Lamp**

## OPERATOR INTERFACE

### Operator Display, General

#### DISPLAY TYPE

Use of the PV101 Diagnostic Gauge, developed by JDPS, fulfills the IT4 requirements in this document, when properly applied (except interlock). Use of the PV480 Diagnostic Gauge, or the DG14 Diagnostic Gauge, developed by JDPS, fulfills the IT4-FT4 requirements in this document, when properly applied (except interlock).

Any alternate operator interface must meet the requirements in this guideline.

**Operator\_Display\_PGN-SPN\_Information\_IT4** (Level 21-23)

**Operator\_Display\_PGN-SPN\_Information\_FT4** (Level 32-34)

(Operator Display PGN-SPN Info FT4.docx)

#### OEM OPERATOR INTERFACE TESTING TOOL

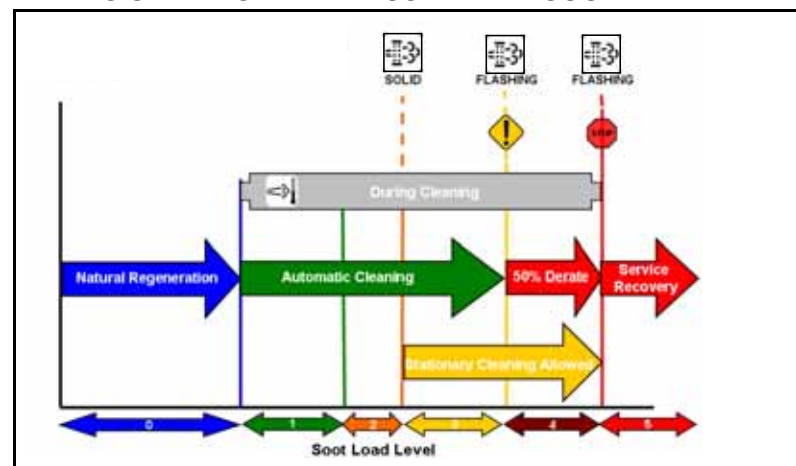
John Deere has developed a tool specifically designed to test any alternate operator interface to the specific John Deere Operator Interface Requirements outlined within this document. For a comprehensive test verification of any alternate operator interface, reference the Engine Application Guidelines, "Engine Application Review - Tier 4 (AG04)."

#### DEFAULT OPERATION

The display device receiving the Exhaust Filter Status CAN message from the engine control unit must perform loss of communication detection and indicate communication failure through a diagnostic trouble code (DTC).

The ECU defaults to 'cleaning disabled' mode if the switch and display are not present and active.

#### CLEANING STRATEGY V. EXHAUST FILTER SOOT LEVEL .



#### Regeneration / Operator Interface Strategy

##### Natural Cleaning

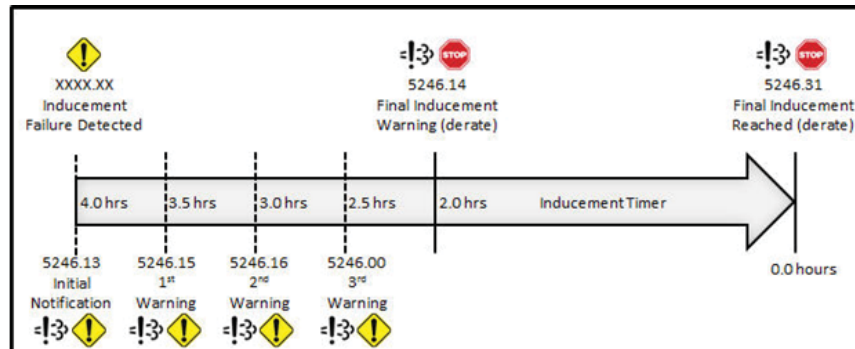
Natural cleaning always occurs during engine operation. The higher the engine load and exhaust temperature, the more soot this type of cleaning will remove. When exhaust temps are high enough, NO is converted in the oxidation catalyst into NO<sub>2</sub>. This is reactive with the soot in the exhaust filter at normal exhaust temperatures. This type of cleaning requires no action by the engine, operator, or operator interface and cannot be disabled. No symbol will be displayed. Natural cleaning alone will eventually result in some soot build up in the EF and will eventually require automatic or manual cleaning.

##### Ash Removal

When ash removal is needed, the operator interface will display a fault code. To clean the ash, the exhaust filter must be removed from the machine. Expected interval for ash cleaning, when appropriate fuel and engine oil is used, is in excess of 5000 hours.

### SCR-EQUIPPED ENGINE FAILURE DEFAULT OPERATION

It is important to note that for all applications using and operating SCR devices, the time until final inducement will vary between EPA and EU (European Union) emission compliant countries. The SCR inducements for the EPA will operate at a maximum of four hours until final inducement has been reached, whereas the inducements for the EU will operate longer than four hours until final inducement has been reached. The figure below is how John Deere handles the EPA inducements.



Inducement Timeline with Expected Fault Indications

### Inducement Derate Settings

The engine performance at the final inducement warning and the final inducement reached stages will operate in accordance to the "trimmed on" inducement engine protection settings. The engine protection settings will be different between industrial and genset applications. If desired, further engine protection can be implemented by customer displays.

There are three inducement engine protection settings for industrial applications that can be "trimmed on:"

- **Low Idle** - The engine will derate to the application low idle speed.
- **Custom Low Idle** - The engine will derate to an idle speed different than low idle. This must be approved through the application review process before selected.
- **Shutdown** - The engine will shut down within 30 seconds.

There are two inducement engine protection settings for genset applications that can be "trimmed on:"

- **Rated Speed** - The engine will operate at rated speed, but a heavy torque derate will be applied.
- **Shutdown** - The engine will shut down within 30 seconds.

## Required Elements for the Operator Interface

### ENGINE EMISSIONS SYSTEM MALFUNCTION INDICATOR (EESMI)


In the following table, this symbol is displayed to notify the operator that the engine emissions are outside the allowable range and that corrective action needs to occur immediately.

This symbol will be displayed when the engine emissions are outside the normal operating range or when there is an engine emissions system fault.

The engine emissions system malfunction indicator (EESMI) must have a dedicated space on either the primary or secondary display. This symbol is only applicable for applications with SCR systems. The EESMI is recommended for use by OEM customers, but is not required as long as sufficient notification is given to the operator indicating that the engine is in an inducement. This can be accomplished either by displaying the EESMI or providing the operator clear communication through fault codes, stop and/or warning indicators. Any additional preventative measures can be taken, outside what is listed here, by the vehicle manufacturer regarding engine emissions system failures.

The EESMI is not driven by an indicator or lamp status message. Therefore alternate ways of detections must be accounted for. The EESMI will need to be driven by bit states 1 through 6 of the suspect parameter number (SPN) 5246. All other states should not drive the EESMI to illuminate. Proper adjustments must be made to the display devices to correctly display the EESMI. For additional information, refer to:

#### Operator\_Display\_PGN-SPN\_Information\_FT4

| Title / Symbol  | Description  | Placement  | Color  |
|---|--|--|--|
|  | <p>Active when:</p> <p>Aftertreatment emissions systems faults or failures are detected. Alerts operator that system fault will result in derate.</p> <p>Recommended for use by OEM customers.</p> | Not required on primary display, but must be at least on secondary display | Consistent with machine's warning / derate indicators. |

### Engine Emissions System Malfunction Indicator (EESMI)


If the EESMI has been implemented on display devices and is active, the operator should take corrective action immediately. The time of operation after the occurrence of the indicator will be limited until the problem has been resolved.

### DIESEL EXHAUST FLUID LEVEL INDICATOR (DEFLI)

In the following table, this symbol is displayed so that the operator will know when the Diesel Exhaust Fluid (DEF) tank is below a measureable level and needs to be refilled. This symbol will only be displayed when the DEF tank level reaches less than 10% of measurable volume.

The DEFLI must have a dedicated space on either the primary or secondary display. This symbol is only applicable for applications with SCR and DEF systems.

It is recommended that some visual notification of the actual DEF tank level is present at all times, however it is required that when the DEF tank level has reached less than 10% of measurable volume, an indicator of DEF tank level is visible to the operator. This can be accomplished either through the display device or by an external DEF tank level gauge.

| Title / Symbol  | Description  | Placement  | Color   |
|---|--|--|---|
|  | <p>Active when:</p> <p>DEF tank level is below measureable level or when poor quality DEF is detected by the DEF Quality Sensor</p> <p>If low, Refill DEF tank</p> | Not required on primary display, but must be at least on secondary display | Consistent with machine's fuel indicator gauge. May be backlit to act as low DEF level warning. |

### Diesel Exhaust Fluid Level Indicator (DEFLI)

In applications where an operator is present and able to distinguish sound in the operating environment, the warning level indication (10% remaining DEF) should also include an audible component.

**EXHAUST FILTER CLEANING INDICATOR (EFCI)**

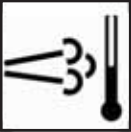
This symbol is displayed so that the operator will know when the exhaust filter system is being cleaned and can expect filter outlet exhaust gas temperatures to be elevated.

This symbol will be displayed during elevated idle operation and when the EF outlet temperatures are above normal operating levels.

The exhaust filter cleaning indicator must have a dedicated space on the display in the normal viewing mode.

If the Engine Emission System Temperature status message is not received from the engine control unit (ECU), the device receiving the status indicates this through a diagnostic trouble code (DTC) and the EFCI symbol is displayed.

To assist in successful cleaning, engine idle speed may be elevated during a cleaning event. The elevated speed will be implemented during a return to idle only; engine speed will not be actively increased. Elevated idle is strongly recommended, but may be "trimmed off" if conditions are met. This symbol will notify the operator that elevated idle is active.

| Title / Symbol  | Description  | Placement  | Color   |
|---|--|--|---|
| Exhaust Filter Cleaning Indicator<br> | Active when:<br>1. Elevated Idle is active<br>2. Dosing is Active<br>3. Exhaust Filter outlet gas temperature is high (>550°C) | Dedicated indicator on primary display – is a dedicated display space that is always available | Consistent with machine's status indicator.<br><br>Not Red or Amber |

**Exhaust Filter Cleaning Indicator (EFCI)**

Elevated Idle speed (1200rpm) during regeneration is strongly recommended as an improvement in EF durability. (Turning this 'off' will be a trim option.)


Conditions for trimming off elevated idle are:

- Demonstrated operational requirement for idle speed <1200rpm.
- Demonstrated ETM capability at slow idle with vehicle parasitics and coldest expected use environment. EF must be able to clean at idle in vehicle at lowest expected temperature.

**EXHAUST FILTER INDICATOR (EFI)**

This symbol is displayed to notify the operator that EF cleaning is needed, due to soot loading, exceeding a pre-determined threshold. As the need for cleaning increases, additional measures will be used, including engine derates to encourage automatic or stationary cleaning.

The Exhaust Filter indicator is recommended to have a space on the display in the normal viewing zone. At a minimum, a space on a secondary screen is required.

| Title / Symbol  | Description  | Placement   | Color  |
|---|--|---|--|
| Exhaust Filter Indicator<br> | Active when:<br>Soot level in the exhaust filter indicates need for an active cleaning.<br>Progressive levels used for stationary and service only levels<br>Identifies the control that starts active cleaning of the exhaust filter. | Not required on primary display, but must be at least on secondary display, regular re-occurrence | Consistent with machine's status indicator combined with Stop/Warning Alarm<br>or<br>Amber/Red dependant on soot level |

**Exhaust Filter Indicator (EFI)**

**Solid Exhaust Filter Indicator (EFI)** in soot level 3 indicates a stationary cleaning can be done. Automatic cleaning is preferred over stationary cleaning when possible, because it uses less fuel.

When the solid EFI is displayed, the operator should:

- Perform a stationary cleaning as soon as it is convenient and safe to do so.
- Turn 'off' cleaning disable (if conditions are favorable for cleaning) so that automatic cleaning can occur.
- Change operating conditions (increase load and speed) so that automatic cleaning can occur.

If cleaning has not been disabled, conditions have not resulted in a successful auto cleaning. If the maximum number of cleaning attempts is reached without a complete cleaning cycle, the EFI symbol will be displayed.

If cleaning has been inhibited, enough soot has accumulated for a stationary cleaning.

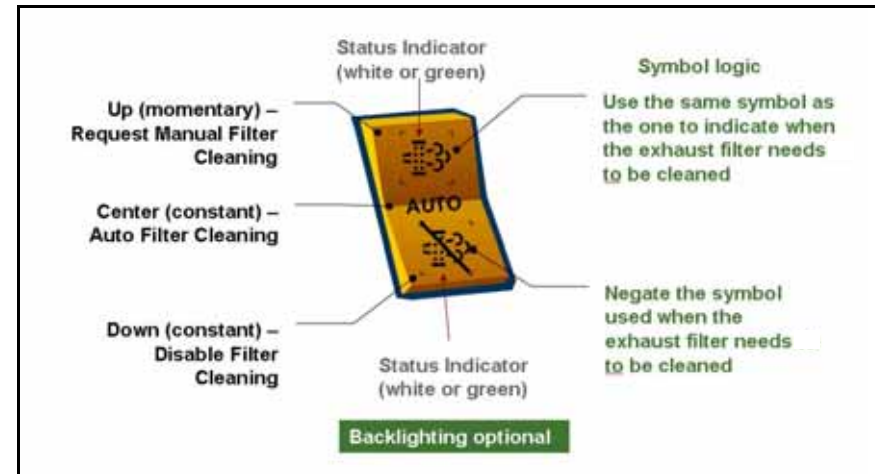
**EFI flashing with yellow warning** (soot level 4) indicates 50% derate and stationary cleaning should be done as soon as it is safe to do so.

**EFI flashing with red stop** in soot level 5, means only service cleaning can be done. Service recovery can be conducted on the machine; It can be initiated through Service Advisor. The 'stop' symbol turns off when service recovery is started.

## CLEANING CONTROL SWITCH

A 3-position switch (or virtual equivalent) that allows the operator to interact with the cleaning system is required.

This switch allows the operator to prevent cleaning when conditions are not favorable. It allows the operator to request stationary cleaning when enough soot has accumulated and the machine is in a condition where elevated exhaust temperatures are acceptable.



## Cleaning Control Switch (Analog)

If a mechanical cleaning control switch is used, the JDPS approved switch, SJ13312 (or equivalent), is recommended. For the dimensions, connector, wiring, and function of this switch, please refer to:

### SJ13312\_Exhaust\_Filter\_Control\_Switch\_2015Nov01

A CAN virtual switch will take precedence over a hardwired switch. Both should never be provided.

For either a mechanical or a virtual cleaning control switch, the following features are required.

- An automatic mode must be provided so that regeneration can occur without need for operator interaction.
- A method must be provided to request manual cleaning to occur.
- A method to stop or disable cleaning from occurring is required. When cleaning is disabled, there must be clear feedback to the operator.

The switch is a normally closed, 3-position toggle switch. Switch failure will result in cleaning disabled operation.



**QUICK REFERENCE GUIDE (QRG)**

A quick reference guide for the operator interface using a Murphy Power-view PV101 is available:

**Quick\_Reference\_Guide\_(QRG)\_IT4**

This PV101 guide also applies to FT4 engines with Level 23 electronic controls.

A quick reference guide for the FT4 operator interface (Level 32-34), using a Murphy Powerview PV480, is available:

**Quick\_Reference\_Guide\_(QRG)\_FT4**

This guide (or similar) is highly recommended to be visible in the machine's operator station in a permanent form to help the machine operators understand the Exhaust Filter operator interface.

If an instrument panel other than a PV101 or PV480 is used, an appropriate QRG should be developed and provided in the operator's station.

**Operating Modes****CLEANING DISABLED**

When Automatic or Manual cleaning is enabled, the exhaust temperature may be high under no-load or light-load conditions at certain times during the exhaust filter cleaning cycle.

**Disable exhaust filter cleaning in conditions where it may be unsafe for elevated exhaust temperatures.**

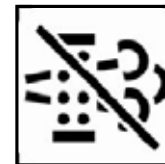
Cleaning Disabled is only recommended when absolutely necessary.

Cleaning Disabled will always be available for the operator to decide on its use. For some machines this feature may be on a second or third menu to avoid accidental inhibit.

Disabled mode may result in stationary cleanings being needed. This means worse fuel economy and loss of use of the machine.

To disable cleaning, the switch position must be placed in the disable cleaning position. The regeneration will be disabled immediately as soon as the switch is moved into the disable/inhibit position.

The ECU will drive a lamp in the switch indicating that the ECU received and stored the disable command. If a virtual switch is used, the cleaning disabled symbol will be displayed:



Exhaust filter cleaning will not occur when disable is 'on.'

No exhaust temperature management (ETM), idle speed changes, or HC dosing will occur in the disable status, but natural cleaning will still occur.

If the disable is left selected continuously and no action is taken, the EF will eventually become heavily loaded with soot and require a service recovery.

Continued operation with the EFI red flashing stop indicator will lead to very high exhaust back pressure and possible engine or exhaust filter damage.

**AUTOMATIC CLEANING**

The Automatic Cleaning mode is recommended because it normally provides the best fuel economy and machine up-time.

To allow automatic cleaning, the switch must be in the middle position, or no cleaning disabled symbol displayed.

This can be achieved by bumping the switch out of disable or out of requested cleaning. In Automatic Cleaning mode:

- Exhaust filter cleaning will occur automatically based on need and opportunity.
- Exhaust temperature management and HC dosing will be active, as needed.
- Elevated idle speed (return to) may be active.

**MANUAL CLEANING**

The exhaust filter symbol must be present to request cleaning. This indicates the soot level is high enough to conduct a Manual Cleaning (PMC).

To request cleaning, the switch must be held in the requested cleaning position for three seconds, continuously.

The ECU will acknowledge this request by illuminating the EFI indicator in the switch or panel.

Exhaust Filter cleaning will occur when "stationary" conditions are met. These conditions must be defined by the OEM, in trim; Examples are:

- Transmission in Neutral or Park
- PTO not engaged
- All Hydraulic functions "Off"
- Throttle at Idle\*

\* Idle setting with respect to the engine programming. Ensure that the low idle offset is programmed to be in alignment with the TSC1 low idle speed if TSC1 is being used as the throttle control.

At least one OEM provided interlock is always required. This can be a CAN message or a hardwired switch set up in trim.

During manual cleaning, engine speed will be increased by the ECU to 1800 rpm. This is different than the elevated return to idle during automatic cleaning. The operator must remain "hands off" or manual cleaning will abort. Change in state of any interlock or throttle will result in an aborted manual cleaning.

**SERVICE CLEANING**

Service Cleaning is not a normal operating mode. It is not the same as Stationary Cleaning. Reaching soot level 5 is a strong indication that something is wrong with the system or inhibit has been left on and warnings have been ignored. Service Cleaning can take several hours to complete and must be followed by a stationary cleaning.

Service Cleaning can be initiated through Service ADVISOR or Service ADVISOR Remote (see CTM). Some instrument panels can also initiate service recovery. If the PV101 is used, a request can be input to initiate Service Cleaning. Simultaneously pressing the left and right arrows on the "exhaust filter service cleaning required" screen will initiate Service Cleaning. This request procedure is in the CTM, but is not published in the operator's manual or Quick Reference guide.

The use of an instrument panel other than PV101 should not allow Service cleaning as part of the normal machine operation. If service cleaning is accessible through the instrument panel, initiating service cleaning instructions should only be available through a service dealer.



**GLOSSARY**

**2-State Throttle** - A digital throttle with 2 operating positions; minimum throttle and fast idle.

**3-State Throttle** - A digital throttle with 3 operating positions; minimum throttle, maximum throttle, and fast idle.

**Accelerator** - A throttle that increases engine speed as the throttle is advanced.

**Analog Throttle** - A throttle that provide a 0 volt to 5 volt signal to the ECU.

**Application Guidelines** - John Deere Engine Application Guidelines are published to guide in the proper installation and application of John Deere engines.

**Breakaway** - The intersection point of the governor curve and the torque curve.

**Bump Switches** - An unlock switch and a raise/lower switch used for adjusting minimum and maximum throttle speeds.

**CAN Bus** - SAE J1939 Controller Area Network standard. A 2-wire network for communication between controllers.

**Cruise Control** - The software feature that controls engine speed to an adjustable set point.

**Decelerator** - A throttle that decreases engine speed as the throttle is advanced.

**Digital Throttle** - A throttle input controller by multi-position switches.

**Disabled** - Opposite of enabled, when a feature's enable box is not checked.

**Droop Governor** - Governor control that drops engine speed the selected RPM of Droop as the engine load increases from 0% to 100% load.

**ECU** - Engine Control Unit.

**Enabled** - Selecting a feature by checking the enable box. This makes the feature active, as long as it is not incompatible with another feature.

**External Derate** - The selectable feature will accept external application conditions (on/off) to signal the engine to derate.

**External Derate Input** - The switched signal for the external derate. The switch can be either a normally open or normally close circuit.

**External Derate Rate** - The speed selected for the engine to reduce power when the external derate circuit is active.

**External Shutdown** - The feature allows an application condition to shut down the engine when a pre-set condition is reached.

**External Shutdown Input** - The signal for engine shutdown through the wiring harness. It is either a normally open or normally closed circuit.

**External Shutdown Timer** - The time delay amount from when the external shutdown circuit switches (reaches the pre-set shutdown limit) and the engine is shut down.

**Fast Idle** - The maximum engine speed that can be reached when there is no external engine load. It is factory pre-set and cannot be adjusted.

**Fault Code** - An abnormal operating condition detected by the ECU and communicated by CAN message.

**Governor** - The ECU control that maintains engine speed on a selected droop curve as engine load varies.

**Harness Selectable Governor** - The wiring harness feature that allows the customer to select (or switch) between droop governor and isochronous governor operation.

**Isochronous Governor** - A governor droop control that has 0 RPM of droop, or maintains the same engine speed independent of the load on the engine.

**John Deere Custom Performance™** - The program used to load engine software into the ECU and select different user options.

**Low Idle** - The factory pre-set minimum engine speed. It cannot be adjusted.

**Low Idle Warm Up** - The feature that allows the low idle speed to be temporarily increased by 200 rpm for two minutes to warm up a cold engine. The low idle warmup feature is always enabled, though the effects of the low idle warm up will not be seen if a customer uses a minimum speed offset greater than 200 rpm.

**Master Input** - The throttle signal that is the chose baseline signal to which the second and third signals are applied in Throttle Combination.

**Maximum Throttle** - The maximum engine speed at 100% throttle (analog and/or digital) condition. Factory pre-set at fast idle, it can be set using the maximum throttle offset or by using the bump switches.

**Maximum Throttle Offset** - The rpm reduction below fast idle for maximum (100%) throttle.

**Minimum Throttle** - The minimum engine speed at 0% throttle(analog and/or digital) condition. Factory pre-set at low idle, it can be set using the minimum throttle offset or by using the bump switches.

**Minimum Throttle Offset** - The rpm selection above low idle for minimum (0%) throttle speed.

**Normally Closed Switch** - A switch that is closed under normal operating conditions.

**Normally Open Switch** - A switch that is open under normal operating conditions.

**Override Shutdown Timer** - The standard shutdown feature that allows a customer to select the time delay between when a shutdown condition occurs and the ECU shuts the engine down.

**Percent Throttle** - The percent throttle value broadcast on the CAN bus describing speed from minimum to maximum throttle.

**Primary Analog Throttle** - One of the two analog throttle input circuits in the engine wiring harness.

**Ramp Rate** - The maximum rate the percent throttle can change. Only affects the ramp throttle.

**Ramp Step** - The selectable feature selecting the size of the step percent throttle change when the ramp switch is held in the speed increase (rabbit) or speed decrease (turtle) position for less than 0.4 seconds.

**Ramp Throttle** - The digital throttle option that uses a switch to increase or decrease engine speed between minimum and maximum throttle values.

**Restricted Options** - Features/Options that cannot be selected at the same time. May still show a check mark in the check box or a dot in the radio button, but will be grayed out.

**Resume** - One of the 6 switches in the cruise control feature; initiates the resume function.

**RPM of Droop** - The amount of rpm the engine will slow down at a given throttle setting as the load is increased from 0% fuel delivery (theoretical frictionless no load condition) to 100% fuel delivery (torque curve fuel delivery).

**SAE J1939** - The SAE standard which defines the digital messages on the CAN bus.

**Second Input** - The throttle signal from the second throttle used in Throttle Combination.

**Secondary Analog Throttle** - One of the two analog throttle input circuits in the engine wiring harness.

**Self-Calibration** - The ECU software feature that monitors the analog throttle voltage input and adjusts the 0% throttle and 100% throttle voltage levels to maximize use of the analog throttle range and to minimize the mechanical deadband.

**Shutdown Timer** - The ECU software function that turns the engine off when a shutdown condition is present.

**Shutdown Override Switch** - The switch in the standard override function that can reset the standard override timer to 30 seconds to allow the machine to be taken out of harm's way.

**Source Address** - The electrical name (decimal number) of the electronic controller sending a Torque Speed Control message on the CAN bus.

**Standard Derate** - The derate software in the ECU that monitors engine operating conditions and derates the engine when pre-set thresholds are exceeded.

**Standard Shutdown** - The shutdown software in the ECU that monitors engine operating conditions and shuts down the engine when pre-set thresholds are exceeded.

**Tachometer Output** - An output signal from the ECU that can be set for 0.5, 27, 30, or 60 pulses per engine revolution.

**Third Input** - The throttle signal from the third throttle used in Throttle Combination.

**Throttle Range** - The engine speed range in which the engine will operate between minimum throttle and maximum throttle.

**Throttle Rate** - The selectable feature that limits the maximum rpm/second change for sudden throttle command changes. Affects only increasing throttle commands, not decreasing.

**Throttle Signal** - The digital or analog signal from a throttle circuit providing a throttle voltage or throttle input to the ECU.

**Torque Speed Control (TSC)** - The CAN bus message sent to the ECU that sets operating conditions and limits.

**Wait-to-Start** - The software feature that can be enabled to send the digital signal on the CAN bus to indicate the operator should wait for the air heater. Usually indicated on an instrument panel.

**Wait-to-Start Lamp** - The engine wiring harness and instrumentation circuit that is energized when the wait-to-start circuit is closed.

## History of Changes

| Date         | Section Owner   | EIB | Page(s)                                 | Description of Change(s)  |
|--------------|-----------------|-----|---|---|
| 2010 Aug 24  | Todd Loes       |     | All                                     | New "Draft" section added.  |
| 2010 Oct 12  | Todd Loes       |     | All                                     | "Finished" section replaced "Draft" section.  |
| 2010 Nov 23  | Todd Loes       |     | pp. 23-28                               | New text added, "Operator Interface."   |
| 2011 Mar 03  | Todd Loes       |     | pp. 2, 19, 22, 23                       | Reference document link added ( <b>Operator Display PGN-SPN Information</b> ) on <b>page 2 and 23</b> ; Revised text added.   |
| 2011 Apr 05  | Todd Loes       |     | pp. 2, 20                               | Links to referenced documents have been connected.  |
| 2011 May 03  | Todd Loes       |     | p.12<br>p. 28                           | <ul style="list-style-type: none"> <li>Text added to TSC1 section; See last paragraph.)</li> <li>Footnote added for Throttle at Idle.</li> </ul>  |
| 2011 July 27 | Todd Loes       |     | p. 1<br>p. 7<br>p. 10<br>p. 17<br>p. 18 | <ul style="list-style-type: none"> <li>Text added to Contents, "Constrained Operation, p. 7."</li> <li>"Constrained Operation" section added, with link to additional text.</li> <li>Text added to "Pressure Control Throttle." See last sentence.</li> <li>Text added to "Shut-Downs." See last three sentences.</li> <li>Text added to "Configurable Derates and Shutdowns (New for IT4)." See last three sentences.</li> </ul> |
| 2011 Sep 01  | Jeff Eagan      |     | p. 2                                    | Links reformatted for new Web Portal.   |
| 2012 Jan 04  | Curt Ritter     |     | p. 6                                    | Text added: "Application Review Number Field in IT4 Custom Performance Trim Options." (Following pages re-paginated.)   |
| 2012 Feb 24  | Todd Loes       |     | p. 20                                   | New section added, "Coolant Level / Coolant Loss Sensors (New for IT4)."  |
| 2012 Nov 08  | Todd Loes       |     | p. 2<br>p. 2<br>p. 20                   | <ul style="list-style-type: none"> <li>To "Introduction" and "Safety," references to 4.5L engines added.</li> <li>Four new Reference Documents added (relative to Level 23).</li> <li>In table for Two-switch Application, line added for 111.07.</li> </ul>  |
| 2012 Dec 06  | Curt Ritter     |     | p. 6                                    | Text added, relative to "Premium Trim Software." (Following pages re-paginated.)  |
| 2013 May 03  | Todd Loes       |     | All                                     | References added throughout the document for FT4 engines. This document, AG11_Tier4, replaces AG11_IT4.   |
| 2014 Feb 20  | Todd Loes       |     | p. 5                                    | New material added, "Tri-CAN Sensor."   |
| 2015 Aug 19  | Jeff Salasek    |     | Attachments                             | Revised attachment, "SAE_J1939_CAN_Messages_T4.xlsx."   |
| 2015 Aug 31  | Andrew Bushanam |     | p. 6<br>p. 22-23<br>p. 28               | <ul style="list-style-type: none"> <li>Text added to "Variable Speed Fan" to include configuration setup and requirements.</li> <li>Text added to "Engine Speed Sensor" to include CAN message processing requirements based on cranking speed.</li> <li>New section added, "DG14 Diagnostic Gauge . . ." to include product specifications and features.</li> </ul>  |
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|              |                 |     |   | <b>Continued - - -</b>  |

## History of Changes - - - Continued

| Date        | Section Owner   | EIB      | Page(s)  | Description of Change(s)   |
|-------------|-----------------|----------|--|--|
| 2015 Nov 3  | Andrew Bushanam |          | p. 2<br>p. 14-15<br>Attachments<br>Attachments | <ul style="list-style-type: none"> <li>The FT4 engine model numbers and descriptions reference chart was updated to include Gen 1.5 applications.</li> <li>New material added, requirements for dual-frequency-capable and low-idle-capable generator drive engines.</li> <li>Revised attachment, "SAE_J1939_CAN_T4_2015Oct23.xlsx" to include a complete and supported list of CAN messages.</li> <li>Revised attachment, "FaultCodes_FOR_REFERENCE_ONLY.xlsx" to include a complete and updated fault list for FT4 and below engines.</li> </ul> |
| 2015 Nov 3  | Todd Loes       |          | Attachments                                    | Revised attachment, "SJ13312_Exhaust_Filter_Control_Switch_2015Nov01.xlsx."  |
| 2015 Nov 11 | Andrew Bushanam |          | p. 30<br>p. 31<br>Attachments                  | <ul style="list-style-type: none"> <li>New material added, "SCR Equipped Engine Failure Default Operation."</li> <li>New material added, "Engine Emissions System Malfunction Indicator (EESMI)," and "Diesel Exhaust Fluid Level Indicator (DEFLI)."</li> <li>Revised attachment, "Operator_Display_PGN-SPN_Information_FT4."</li> <li>Revised attachment, "SAE_J1939_CAN_T4_2015Nov02.xlsx"</li> </ul>   |
| 2016 Mar 03 | Andrew Bushanam |          | p. 30  | New material added, "OEM Operator Interface Testing Tool."   |
| 2016 May 20 | Andrew Bushanam | EIB16-13 | p. 27<br>Attachments                           | <ul style="list-style-type: none"> <li>New material added, "Control Panel Harness Design."</li> <li>Revised attachment, "Sensor_and_Actuator_Temperature_Limit_FT4_2016-May20.pdf."</li> </ul>   |
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