



MI-21 SECM70
Calibration for
ISO EN 1175
Compliance

Calibration Manual



General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.



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Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.



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- ToolKit

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- Bosch (Robert Bosch GmbH)

Warnings and Notices

Important Definitions



This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

WARNING

Before Working On Vehicle

Ensure that personnel are fully trained on safe vehicle service procedures prior to attempting to replace or service a MI-21 system.

- Vehicle must be parked on a level surface away from other vehicle traffic
- Vehicle parking brake must be applied, or wheels chocked.
- Load must be fully lowered to the ground.
- Engine must be shut off.
- Hydraulic system pressure must be relieved

All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to engine start. Personnel shall wear appropriate personal protective equipment to minimize the potential for injury due to high voltage, hot exhaust gases, flying debris, exposure to hot surfaces or any moving parts that may be activated and are located in the vicinity of the MI-21 System.

WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- Eye Protection
- Hearing Protection
- Hard Hat
- Gloves
- Safety Boots
- Respirator

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

 **WARNING****Start-up**

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

 **WARNING****Automotive Applications**

On- and Off-Highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

 **WARNING****IOLOCK**

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. *The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.*

- Microprocessor failures will send the module into an IOLOCK state.
- Discrete outputs / relay drivers will be non-active and de-energized.
- Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- Watchdog detected failures
- Microprocessor failure
- PowerUp and PowerDown conditions
- System reset and hardware/software initialization
- PC tool initiated

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

NOTICE**Battery Charging Device**

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual **82715**, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
 - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
 - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
 - Discharge yourself after picking up the cable harness before installing it as a precaution.
 - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

IMPORTANT

Do not touch the pins of the SECM70. Do not open the SECM70 enclosure. There are no user-serviceable parts inside.

Regulatory Compliance

Other European and UKCA Compliance:

ISO EN 1175 is a vehicle-level standard. This document addresses the proper configuration of Woodward engine management system, MI-21, for partial compliance with the standard. It is the responsibility of the vehicle OEM to address full compliance with ISO EN 1175. This includes addressing all safety functions of ISO EN 1175 which pertain to the vehicle type.

This product is designed for safety critical applications and when installed correctly will enable the MI-21 System to meet the Declaration of Incorporation for the ISO EN1175 standard.

Electromagnetic Interference & Compatibility (EMI & EMC):

The MI-21 does not have a function unless it is in a control system. As such, it is a part of the EMI / EMC environment as configured in the system.

The MI-21 has no regulatory marking requirements for EMC or EMI since it is a component of the system.

EMC/EMI Compliance is determined at the package system level by the package OEM system integrator or aftermarket retrofit contractor.

EMC: Electromagnetic Compatibility including emissions and immunity

If the installation guidance for the MI-21 ECM, air/fuel ratio control, sensor, and wiring installation are followed, the control system will not unduly interfere with other devices or be interfered with by other devices in its environment.

Machinery Directive: Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.

EMC Directive: Compliant as an integrated component to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC)

Other UKCA Compliance:

Compliance with the following UKCA regulations or standards does not qualify this product for application of the UKCA Marking:

Machinery: S.I. 2008 No. 1597: Supply of Machinery (Safety) Regulations 2008

EMC: Compliant as an integrated component to S.I. 2016 No. 1091: Electromagnetic Compatibility Regulations 2016 and all applicable amendments.

Special Conditions for Safe Use

Product Variations Declared

The functional safety requirements in this manual apply to MI-21 controllers based on the SECM 70 (P/N 1751-6767 or 1751-6772) with software version **D70210403L007 or later**.

Compliance requires:

- Use of a Bosch brush DC throttle body with redundant analog position sensors (Woodward P/N 6945-5001 or Woodward P/N 6945-5002)
- Use of an operator pedal with redundant analog position sensors and MTTF_d rating of 'High'.

Competence of Personnel

All persons involved in the calibration of the MI-21 firmware, installation and maintenance must have appropriate training. Training and guidance materials include this manual, and the latest revision of the Woodward Application Manual 35187 MI-21 Engine Control System for HMC 2.4L Application / Troubleshooting Manual

Calibration

This document provides requirements for the calibration of safety-related functions as specified by ISO EN 1175. Failure to adhere to these requirements will result in non-compliance with the ISO EN 1175 standard.

Verification

Each Safety Function discussed in the following chapters has been verified by Woodward, Inc. It is strongly recommended that the vehicle OEM repeat the verification process on a representative vehicle following final calibration. Guidelines for verifying each safety function are included in the following chapters.

Failure Modes and Effects Testing

The vehicle OEM shall perform a Failure Modes and Effects Test (FMET) following final calibration and prior to production release of new MI-21 software.

FMET requires the vehicle OEM to obtain a representative vehicle, install the new OEM software with calibration, and induce each of the faults listed in the Appendix of this manual to confirm the following:

- Faults are detected
- Faults are safely managed

It may not be possible to induce all faults (e.g., CPU faults).

Chapter 1.

General Information

Woodward manufactures a family of engine management systems for the Mobile Industrial (MI) market, intended for ride-on counterbalanced lift trucks with Internal Combustion Engines (ICE). Engines may be either dedicated LPG fuel or bi-fuel (switchable between LPG and gasoline). The Woodward engine management system, MI-21, controls engine fuel, ignition spark, and throttle position.

Woodward has been requested to self-certify the MI-21 ECU for compliance with ISO standard EN 1175, Safety of Industrial Trucks – Electrical/Electronic requirements. Certification shall be done by means of a Declaration of Incorporation to be issued by Woodward Inc.

ISO EN 1175 is a type-C standard which deals with detailed safety requirements for a particular machine or group of machines (i.e., Industrial Trucks). As such, it references other standards, including ISO 13849-1, ISO 13849-2 (both type-B standards) and ISO 12100, a type-A standard. ISO EN 1175 specifies safety functions, Required Performance Levels (PLr) and other properties that are then evaluated in accordance with ISO 13849-1 and ISO13849-2.

The Safety Functions specified by ISO EN 1175 apply to the various vehicle systems including:

- Travel Control
- Monitoring of Operating Position
- Brake Control (both service brake and parking brake)
- Load Handling System
- Steering System
- Requirements for high voltage trucks (i.e., battery driven trucks)

MI-21 addresses parts of the Travel Control vehicle system – primarily having to do with the control and delivery of engine torque to the torque converter and transmission.

MI-21 does **not** control any of the following systems:

- Transmission
- Operating Presence Control (OPC)
- Service Brake
- Parking Brake
- Load Handling System (LHS)
- Steering System

Any ISO EN 1175 Safety Functions pertaining to those systems are not embodied by the MI-21 Engine Management System and are the responsibility of the vehicle OEM.

NOTICE

This document provides requirements for the calibration of safety-related functions as specified by ISO EN 1175. Failure to adhere to these requirements will result in non-compliance with the ISO EN 1175 standard.

Chapter 2.

MI-21 Engine Management System

Figure 2-1 presents a schematic representation of the MI-21 Engine Management System.

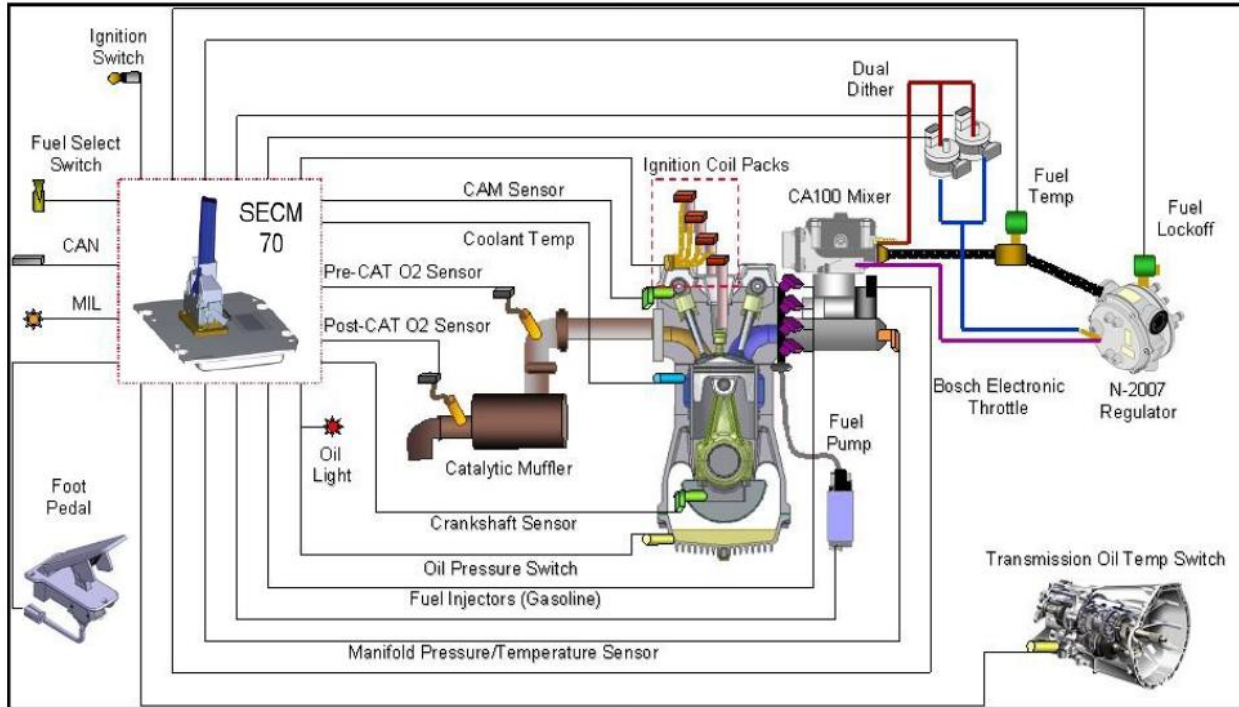


Figure 2-1. MI-21 Bi-Fuel System for 2.4L Hyundai Engine on Certified Systems

The primary MI-21 components which apply to ISO EN 1175 safety functions are:

- SECM 70 microprocessor-based electronic control module with MI-21 embedded software
- Dual Sensor Accelerator Pedal Position (APP) sensor (customer supplied)
- Bosch Electronic Throttle with Brush DC actuator and dual position sensors

The ISO EN 1175 Safety Functions embodied in the SECM 70 are the following:

- Section 4.5.2: Travel Control System: portions applying to engine speed activation
- Section 4.5.5: Automatic Restoration of Drive System
- Section 4.5.6: Deviation from Setpoint -as expressed in section 4.5.6.1
- Section 4.5.6.2: Uncontrolled Acceleration from Standstill on Level Ground
- Section 4.5.6.3: Unintended Truck Behavior While Truck is Moving
- Section 4.5.10: Speed Limitation

These requirements are addressed by the MI-21 Airflow Manager software logic which coordinates and prioritizes several control modes including:

- Operator Accelerator Pedal Position (APP) Control
- Minimum Engine Speed Governor
- Maximum Engine Speed Governor
- Road Speed Governor
- Engine Power Limiter

Operation and calibration of the Safety Functions will be described in the next chapters.

A key portion of ISO EN 1175 is section 4.5.1 which defines 'safe state' as 0 torque, zero or minimum rpm.

ISO EN 1175 4.5.1 General

For the drive system the following are considered as safe and can be used to achieve a safe state e.g., in case of a failure in the drive system:

- no driving torque, on the condition that the truck has an additional braking system which can be activated by the operator.
- automatic braking by the drive system and/or by the braking system till and during standstill.
- automatic speed reduction to a specific limit based on type, application, and condition of the truck so long as the operator has full control and release of the speed control leads to the stopping of powered movement.

Failures of the electrical system leading to behavior as mentioned in a), b) or c) or any combination thereof may be treated as non-safety relevant failures.

NOTE: Control actions to achieve a safe state are only required for safety-related parts of control systems of Category 2 and higher as defined in EN ISO 13849-1.

Chapter 3.

Engine Airflow Management

All of the ISO EN 1175 safety functions discussed in this manual pertain to the MI-21 Airflow Management and throttle control logic.

A simplified view of the Airflow Manager logic is shown below. It illustrates the prioritization of the different control modes:

- Pedal Mode (operator pedal input)
- Road Speed Governor (RSG)
- Max engine speed governor (Max Gov)
- Engine speed idle governor (Min Gov)
- Engine Power Limiter

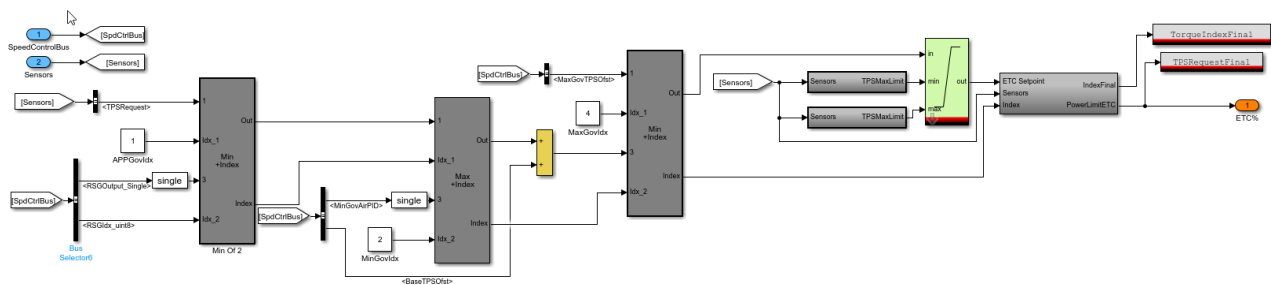


Figure 3-1. Engine Airflow Management Algorithm

Pedal Mode

- Arbitrates the two analog pedal sensor inputs (e.g., if one is bad, use the other). If both are bad, command zero.
- Command zero pedal if pedal is depressed during crank-to-run transition. Restore pedal command following brief return to zero pedal.
- Shapes commanded throttle based on lookup table (function of pedal and rpm) for vehicle driveability.

Calibration of Pedal Mode

Pedal Mode calibration is dependent upon engine, vehicle, pedal design, and customer driveability requirements. As such, this will require involvement of the customer application team. Calibration parameters are located on the following Toolkit pages.

- Sensor – APP: Scaling, Polarity and Adapt configuration
- Engine Control – Run Airflow: Table lookup to convert APPcnt to TPS desired
- Diagnostic – APP Sensor: APP_Sensors_Conflict_Fault configuration
- Diagnostic – APP1 Adapt: APP1 Sensor Adapt Fault configuration
- Diagnostic – APP1 Range: APP1 Sensor Range Fault configuration
- Diagnostic – APP2 Adapt: APP2 Sensor Adapt Fault configuration
- Diagnostic – APP2 Range: APP2 Sensor Range Fault configuration
- Diagnostic – Fault config (A-G): APP OBD faults definitions

Road Speed Governor (RSG)

When vehicle speed approaches the maximum value, a closed-loop PID algorithm will control vehicle speed and override the Pedal command to reduce throttle command if pedal command is greater than PID output

Calibration of Road Speed Governor

Road Speed Governor calibration is dependent upon engine, vehicle, and customer driveability requirements. As such, this will require involvement of the customer application team. Calibration parameters are located on the following ToolKit pages.

- Sensor – Vehicle Speed Input: Road Speed Sensor configuration and scaling
- Engine Control – Run. Road Speed Governor: Enable, setpoint config and PID config

Idle Engine Speed Governor (MinGov)

- When engine speed falls below desired idle speed, a closed-loop PID algorithm will control engine speed and override the Pedal or RSG command to increase throttle command to maintain idle speed.
- Commanded idle speed is a function of Engine Coolant Temperature (ECT) to enhance cold warmup.

Calibration of Idle Engine Speed Governor

Idle Speed Governor calibration is dependent upon engine, vehicle, and customer driveability requirements. As such, this will require involvement of the customer application team. Calibration parameters are located on the following ToolKit pages.

- Speed Control – Air Min Governor 2

Max Engine Speed Governor (MaxGov)

When engine speed approaches the maximum value, a closed-loop PID algorithm will control engine speed and override the Pedal, RSG or Idle command to reduce throttle command if pedal/RSG command is greater than PID output

Calibration of Max Engine Speed Governor

Max Engine Speed Governor calibration is dependent upon engine, vehicle, and customer driveability requirements. As such, this will require involvement of the customer application team. Calibration parameters are located on the following ToolKit pages.

- Speed Control.Max Governor

Engine Power Limiter

- When a fault condition commands a power limiting fault action, a closed-loop PID algorithm will control engine percent power and override all other throttle commands to reduce engine power.
- If the fault action is cleared, the power limit will not be eliminated until the other throttle commands drop below the power limit.

Calibration of Engine Power Limiter

The Engine Power Limiter calibration is dependent upon engine, vehicle, and customer driveability requirements. As such, this will require involvement of the customer application team. Calibration parameters are located on the following ToolKit pages.

- Engine Control – Run.Power Limits

Electronic Throttle Control

- Arbitrates the two analog Throttle sensor inputs (e.g., if one is bad, use the other). If both are bad, feedback 100% (which will close throttle).
- Perform closed-loop PID control of throttle using position command from Airflow Manager and position feedback from arbitrated throttle sensor inputs.

Calibration of Electronic Throttle Control

It is strongly recommended that customers not modify the electronic throttle control calibration provided with the factory settings. Tampering could result in undesirable operating characteristics and premature failure of the throttle

Chapter 4. Sensor and Actuator Faults

Before addressing the more complex diagnostics pertaining to the safety functions, the lower-level diagnostics must be calibrated appropriately. Calibrations include both fault detection and fault management (i.e., fault conditions and fault actions). Fault detection thresholds will be dependent upon the sensor which is selected by the customer.

Accelerator Pedal Position (APP) Faults

Table 4-1. APP Faults

NOTE: Set APP1DfltValue and APP2DfltValue = 0

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|---|---|
| 611 | 91/4 | APP1RangeLow APP1 Voltage Range Low Fault This fault indicates APP1 signal line has shorted to XDRG or ground, or APP1 signal line has opened. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 612 | 29/4 | APP2RangeLow APP2 Voltage Range Low Fault This fault indicates APP2 signal line has shorted to XDRG or ground, or APP2 signal line has opened. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 621 | 91/3 | APP1RangeHigh APP1 Voltage Range High Faults This fault indicates APP1 signal line has shorted to XDRP or power line. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 622 | 29/3 | APP2RangeHigh APP2 Voltage Range High Faults This fault indicates APP2 signal line has shorted to XDRP or power line. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 631 | 91/1 | APP1AdaptLoMin APP1 Low Adapt Min Faults The purpose of this diagnostic is to make sure the APP1 voltage is above a rational low threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |

Table 4-1. APP Faults (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|--------------|-----------------------------|
| 632 | 29/1 | <p>APP2AdaptLoMin APP2 Low Adapt Min Faults The purpose of this diagnostic is to make sure the APP2 voltage is above a rational low threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 641 | 91/16 | <p>APP1AdaptHiMax APP1 High Adapt Max Faults The purpose of this diagnostic is to make sure the APP1 voltage is below a rational high threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 642 | 29/16 | <p>APP2AdaptHiMax APP1 High Adapt Max Faults The purpose of this diagnostic is to make sure the APP2 voltage is below a rational high threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 651 | 91/18 | <p>APP1AdaptHiMin APP1 High Adapt Min Faults The purpose of this diagnostic is to make sure the APP1 voltage is above a rational low threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 652 | 29/18 | <p>APP2AdaptHiMin APP2 High Adapt Min Faults The purpose of this diagnostic is to make sure the APP2 voltage is above a rational low threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 661 | 91/0 | <p>APP1AdaptLoMax APP1 Low Adapt Max Faults The purpose of this diagnostic is to make sure the APP1 voltage is below a rational high threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |

Table 4-1. APP Faults (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|---|---|
| 662 | 29/0 | <p>APP2AdaptLoMax APP2 Low Adapt Max Faults The purpose of this diagnostic is to make sure the APP2 voltage is below a rational high threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure.</p> | TurnOnMIL | Test Failed Since Key Cycle |
| 691 | 91/7 | <p>APP_Sensors_Conflict APP Sensor Conflict Faults The purpose of this diagnostic is to detect a potential situation where the APP1 and APP2 position disagree the Pedal position. The fault can be caused by a failed position sensor or fouling on the traces in the Pedal.</p> | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |


Figures 4-1 through 4-7 below illustrate APP Fault calibration pages from ToolKit.

APP_Sensors_Conflict_Fault

Master Enable

APP_Sensors_Conflict_FaultConfig Enabled ▾

Event Manager

 EventManagerFlag_APP_Sensors_Conflict

Fault Configuration I

Suspected X Limit counts

Suspected Y Limit counts

DriveCycle X Limit counts

DriveCycle Y Limit counts

Fault Configuration II

APP_Sensors_Conflict_EmissionsRelated Not Emissions-Related ▾

APP_Sensors_Conflict_OBD Fault ID

APP_Sensors_Conflict_SPN

APP_Sensors_Conflict_FMI

APP_Sensors_Conflict_Is Permanent Not Permanent ▾

APP_Sensors_Conflict_Fault Test - ▾

FaultAction & Condition

FaultActionRoute1_Action TurnOnMIL ▾

FaultActionRoute1_Condition TestFailedSinceKeyCycle ▾

FaultActionRoute2_Action IdleMode ▾

FaultActionRoute2_Condition TestFailedSinceKeyCycle ▾


FaultActionRoute3_Action Level4PowerLimit ▾

FaultActionRoute3_Condition TestFailedSinceKeyCycle ▾

FaultActionRoute4_Action (None) ▾

FaultActionRoute4_Condition (None) ▾

Enabling Status & Condition

APP_Sensors_Conflict_Enabled Error 

Malfunction Criteria

APP1_APP2_Max_Deviation %

Figure 4-1. APP Sensors Conflict Fault

| APP1AdaptHiMax_Fault | APP1AdaptHiMin_Fault |
|--|--|
| Master Enable APP1AdaptHiMax_FaultConfig <input type="text" value="Disabled"/> | Master Enable APP1AdaptHiMin_FaultConfig <input type="text" value="Disabled"/> |
| Event Manager EventManagerFlag_APP1AdaptHiMax <input checked="" type="checkbox"/> | Event Manager EventManagerFlag_APP1AdaptHiMin <input checked="" type="checkbox"/> |
| Fault Configuration I Suspected X Limit <input type="text" value="100"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="100"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts |
| Fault Configuration II APP1AdaptHiMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP1AdaptHiMax_OBDFaultID <input type="text" value="641"/> APP1AdaptHiMax_SPN <input type="text" value="91"/> APP1AdaptHiMax_FMI <input type="text" value="16"/> APP1AdaptHiMax_IsPermanent <input type="text" value="Not Permanent"/> APP1AdaptHiMax_FaultTest <input type="text" value="-"/> | Fault Configuration II APP1AdaptHiMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP1AdaptHiMin_OBDFaultID <input type="text" value="651"/> APP1AdaptHiMin_SPN <input type="text" value="91"/> APP1AdaptHiMin_FMI <input type="text" value="18"/> APP1AdaptHiMin_IsPermanent <input type="text" value="Not Permanent"/> APP1AdaptHiMin_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition APP1RangeHighAdaptHiMax_Fault_Enabled <input checked="" type="checkbox"/> Error | Enabling Status & Condition APP1RangeHighAdaptHiMin_Fault_Enabled <input checked="" type="checkbox"/> Error |
| Malfunction Criteria APP1ADC <input checked="" type="checkbox"/> Error ADC_counts > APP1Adapt_Hi_Max <input type="text" value="767"/> ADC_counts | Malfunction Criteria APP1ADC <input checked="" type="checkbox"/> Error ADC_counts < APP1Adapt_Hi_Min <input type="text" value="706"/> ADC_counts |

Figure 4-2. APP1 Adapt High Max/Min Faults

| APP1AdaptLoMax_Fault | APP1AdaptLoMin_Fault |
|--|--|
| <p>Master Enable</p> <p>APP1AdaptLoMax_FaultConfig Disabled</p> | <p>Master Enable</p> <p>APP1AdaptLoMin_FaultConfig Disabled</p> |
| <p>Event Manager</p> <p>✖ EventManagerFlag_APP1AdaptLoMax</p> | <p>Event Manager</p> <p>✖ EventManagerFlag_APP1AdaptLoMin</p> |
| <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="100"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> | <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="100"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> |
| <p>Fault Configuration II</p> <p>APP1AdaptLoMax_EmissionsRelated Not Emissions-Related</p> <p>APP1AdaptLoMax_OBDFaultID <input type="text" value="661"/></p> <p>APP1AdaptLoMax_SPN <input type="text" value="91"/></p> <p>APP1AdaptLoMax_FMI <input type="text" value="0"/></p> <p>APP1AdaptLoMax_IsPermanent Not Permanent</p> <p>APP1AdaptLoMax_FaultTest -</p> | <p>Fault Configuration II</p> <p>APP1AdaptLoMin_EmissionsRelated Not Emissions-Related</p> <p>APP1AdaptLoMin_OBDFaultID <input type="text" value="631"/></p> <p>APP1AdaptLoMin_SPN <input type="text" value="91"/></p> <p>APP1AdaptLoMin_FMI <input type="text" value="1"/></p> <p>APP1AdaptLoMin_IsPermanent Not Permanent</p> <p>APP1AdaptLoMin_FaultTest -</p> |
| <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute2_Action (None)</p> <p>FaultActionRoute2_Condition (None)</p> <p>FaultActionRoute3_Action (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> | <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute2_Action (None)</p> <p>FaultActionRoute2_Condition (None)</p> <p>FaultActionRoute3_Action (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> |
| <p>Enabling Status & Condition</p> <p>APP1RangeHighAdaptLoMax_Fault_Enabled Error ✖</p> | <p>Enabling Status & Condition</p> <p>APP1RangeHighAdaptLoMin_Fault_Enabled Error ✖</p> |
| <p>Malfunction Criteria</p> <p>APP1ADC ✖ Error ADC_counts</p> <p>> APP1Adapt_Low_Max <input type="text" value="102"/> ADC_counts</p> | <p>Malfunction Criteria</p> <p>APP1ADC ✖ Error ADC_counts</p> <p>< APP1Adapt_Low_Min <input type="text" value="61"/> ADC_counts</p> |

Figure 4-3. APP1 Adapt Low Max/Min Faults

| APP1RangeHigh_Fault | APP1RangeLow_Fault |
|---|--|
| <p>Master Enable</p> <p>APP1RangeHigh_FaultConfig Enabled</p> | <p>Master Enable</p> <p>APP1RangeLow_FaultConfig Enabled</p> |
| <p>Event Manager</p> <p> EventManagerFlag_APP1RangeHigh</p> | <p>Event Manager</p> <p> EventManagerFlag_APP1RangeLow</p> |
| <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="95"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> | <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="95"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> |
| <p>Fault Configuration II</p> <p>APP1RangeHigh_EmissionsRelated Not Emissions-Related</p> <p>APP1RangeHigh_OBDFaultID <input type="text" value="621"/></p> <p>APP1RangeHigh_SPN <input type="text" value="91"/></p> <p>APP1RangeHigh_FMI <input type="text" value="3"/></p> <p>APP1RangeHigh_IsPermanent Not Permanent</p> <p>APP1RangeHigh_FaultTest -</p> | <p>Fault Configuration II</p> <p>APP1RangeLow_EmissionsRelated Not Emissions-Related</p> <p>APP1RangeLow_OBDFaultID <input type="text" value="611"/></p> <p>APP1RangeLow_SPN <input type="text" value="91"/></p> <p>APP1RangeLow_FMI <input type="text" value="4"/></p> <p>APP1RangeLow_IsPermanent Not Permanent</p> <p>APP1RangeLow_FaultTest -</p> |
| <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute2_Action IdleMode</p> <p>FaultActionRoute2_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute3_Action (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> | <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute2_Action IdleMode</p> <p>FaultActionRoute2_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute3_Action Level4PowerLimit</p> <p>FaultActionRoute3_Condition TestFailedSinceKeyCycle</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> |
| <p>Enabling Status & Condition</p> <p>APP1RangeHigh_Fault_Enabled Error </p> | <p>Enabling Status & Condition</p> <p>APP1RangeLow_Fault_Enabled Error </p> |
| <p>Malfunction Criteria</p> <p>APP1InputHiFitPos <input type="text" value="1013"/> ADC_counts</p> <p>> APP1ADC Error ADC_counts</p> | <p>Malfunction Criteria</p> <p>APP1InputLoFitPos <input type="text" value="10"/> ADC_counts</p> <p>< APP1ADC Error ADC_counts</p> |

Figure 4-4. APP1 Voltage Range High/Low Faults

| APP2AdaptHiMax_Fault | APP2AdaptHiMin_Fault |
|--|--|
| Master Enable APP2AdaptHiMax_FaultConfig <input type="text" value="Enabled"/> | Master Enable APP2AdaptHiMin_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager ❌ EventManagerFlag_APP2AdaptHiMax | Event Manager ❌ EventManagerFlag_APP2AdaptHiMin |
| Fault Configuration I Suspected X Limit <input type="text" value="100"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="100"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts |
| Fault Configuration II APP2AdaptHiMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP2AdaptHiMax_OBDFaultID <input type="text" value="642"/> APP2AdaptHiMax_SPN <input type="text" value="29"/> APP2AdaptHiMax_FMI <input type="text" value="16"/> APP2AdaptHiMax_IsPermanent <input type="text" value="Not Permanent"/> APP2AdaptHiMax_FaultTest <input type="text" value="-"/> | Fault Configuration II APP2AdaptHiMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP2AdaptHiMin_OBDFaultID <input type="text" value="652"/> APP2AdaptHiMin_SPN <input type="text" value="29"/> APP2AdaptHiMin_FMI <input type="text" value="18"/> APP2AdaptHiMin_IsPermanent <input type="text" value="Not Permanent"/> APP2AdaptHiMin_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition APP2RangeHighAdaptHiMax_Fault_Enabled <input type="text" value="Error"/> ❌ | Enabling Status & Condition APP2RangeHighAdaptHiMin_Fault_Enabled <input type="text" value="Error"/> ❌ |
| Malfunction Criteria APP2ADC <input type="text" value="Error"/> ❌ ADC_counts > APP2Adapt_Hi_Max <input type="text" value="769"/> ADC_counts | Malfunction Criteria APP2ADC <input type="text" value="Error"/> ❌ ADC_counts < APP2Adapt_Hi_Min <input type="text" value="708"/> ADC_counts |

Figure 4-5. APP2 Adapt High Max/Min Faults

| APP2AdaptLoMax_Fault | APP2AdaptLoMin_Fault |
|--|--|
| <p>Master Enable</p> <p>APP2AdaptLoMax_FaultConfig <input type="text" value="Enabled"/></p> | <p>Master Enable</p> <p>APP2AdaptLoMin_FaultConfig <input type="text" value="Enabled"/></p> |
| <p>Event Manager</p> <p> EventManagerFlag_APP2AdaptLoMax</p> | <p>Event Manager</p> <p> EventManagerFlag_APP2AdaptLoMin</p> |
| <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="100"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> | <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="100"/> counts</p> <p>Suspected Y Limit <input type="text" value="100"/> counts</p> <p>DriveCycle X Limit <input type="text" value="0"/> counts</p> <p>DriveCycle Y Limit <input type="text" value="0"/> counts</p> |
| <p>Fault Configuration II</p> <p>APP2AdaptLoMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/></p> <p>APP2AdaptLoMax_OBDFaultID <input type="text" value="662"/></p> <p>APP2AdaptLoMax_SPN <input type="text" value="29"/></p> <p>APP2AdaptLoMax_FMI <input type="text" value="0"/></p> <p>APP2AdaptLoMax_IsPermanent <input type="text" value="Not Permanent"/></p> <p>APP2AdaptLoMax_FaultTest <input type="text" value="-"/></p> | <p>Fault Configuration II</p> <p>APP2AdaptLoMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/></p> <p>APP2AdaptLoMin_OBDFaultID <input type="text" value="632"/></p> <p>APP2AdaptLoMin_SPN <input type="text" value="29"/></p> <p>APP2AdaptLoMin_FMI <input type="text" value="1"/></p> <p>APP2AdaptLoMin_IsPermanent <input type="text" value="Not Permanent"/></p> <p>APP2AdaptLoMin_FaultTest <input type="text" value="-"/></p> |
| <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/></p> <p>FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/></p> <p>FaultActionRoute2_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute2_Condition <input type="text" value="(None)"/></p> <p>FaultActionRoute3_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute3_Condition <input type="text" value="(None)"/></p> <p>FaultActionRoute4_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute4_Condition <input type="text" value="(None)"/></p> | <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/></p> <p>FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/></p> <p>FaultActionRoute2_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute2_Condition <input type="text" value="(None)"/></p> <p>FaultActionRoute3_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute3_Condition <input type="text" value="(None)"/></p> <p>FaultActionRoute4_Action <input type="text" value="(None)"/></p> <p>FaultActionRoute4_Condition <input type="text" value="(None)"/></p> |
| <p>Enabling Status & Condition</p> <p>APP2RangeHighAdaptLoMax_Fault_Enabled <input type="text" value="Error"/> </p> | <p>Enabling Status & Condition</p> <p>APP2RangeHighAdaptLoMin_Fault_Enabled <input type="text" value="Error"/> </p> |
| <p>Malfunction Criteria</p> <p>APP2ADC Error ADC_counts</p> <p>> APP2Adapt_Low_Max <input type="text" value="123"/> ADC_counts</p> | <p>Malfunction Criteria</p> <p>APP2ADC Error ADC_counts</p> <p>< APP2Adapt_Low_Min <input type="text" value="82"/> ADC_counts</p> |

Figure 4-6. APP2 Adapt Low Max/Min Faults

| APP2RangeHigh_Fault | APP2RangeLow_Fault |
|--|--|
| Master Enable APP2RangeHigh_FaultConfig <input type="text" value="Enabled"/> | Master Enable APP2RangeLow_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_APP2RangeHigh <input type="checkbox"/> | Event Manager EventManagerFlag_APP2RangeLow <input type="checkbox"/> |
| Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts DriveCycle X Limit <input type="text" value="0"/> counts DriveCycle Y Limit <input type="text" value="0"/> counts |
| Fault Configuration II APP2RangeHigh_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP2RangeHigh_OBDFaultID <input type="text" value="622"/> APP2RangeHigh_SPN <input type="text" value="29"/> APP2RangeHigh_FMI <input type="text" value="3"/> APP2RangeHigh_IsPermanent <input type="text" value="Not Permanent"/> APP2RangeHigh_FaultTest <input type="text" value="-"/> | Fault Configuration II APP2RangeLow_EmissionsRelated <input type="text" value="Not Emissions-Related"/> APP2RangeLow_OBDFaultID <input type="text" value="612"/> APP2RangeLow_SPN <input type="text" value="29"/> APP2RangeLow_FMI <input type="text" value="4"/> APP2RangeLow_IsPermanent <input type="text" value="Not Permanent"/> APP2RangeLow_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="IdleMode"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute3_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition APP2RangeHigh_Fault_Enabled <input type="text" value="Error"/> | Enabling Status & Condition APP2RangeLow_Fault_Enabled <input type="text" value="Error"/> |
| Malfunction Criteria APP2ADC <input type="text" value="Error"/> ADC_counts > APP2InputHiFltPos <input type="text" value="1013"/> ADC_counts | Malfunction Criteria APP2ADC <input type="text" value="Error"/> ADC_counts < APP2InputLoFltPos <input type="text" value="10"/> ADC_counts |

Figure 4-7. APP2 Voltage Range High/Low Faults

Throttle Position Sensor (TPS) Faults

Table 4-2. TPS Faults

NOTE: Set TPS1DfltValue and TPS2DfltValue = 100

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|-------------------------------|--|
| 221 | 51/4 | TPS1RangeLow TPS1 Voltage Range Low Fault This fault indicates TPS1 signal line has shorted to XDRG or ground, or TPS1 signal line has opened. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 222 | 3673/4 | TPS2RangeLow TPS2 Voltage Range Low Fault This fault indicates TPS2 signal line has shorted to XDRG or ground, or TPS2 signal line has opened. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 231 | 51/3 | TPS1RangeHigh TPS1 Voltage Range High Faults This fault indicates TPS1 signal line has shorted to XDRP or power line. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 232 | 3673/3 | TPS2RangeHigh TPS2 Voltage Range High Faults This fault indicates TPS2 signal line has shorted to XDRP or power line. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 241 | 51/1 | TPS1AdaptLoMin TPS1 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS1 voltage is above a rational low threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 242 | 3673/1 | TPS2AdaptLoMin TPS2 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS2 voltage is above a rational low threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 251 | 51/16 | TPS1AdaptHiMax TPS1 High Adapt Max Faults The purpose of this diagnostic is to make sure the TPS1 voltage is below a rational high threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |

Table 4-2. TPS Faults (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|-------------------------------|--|
| 252 | 3673/16 | <p>TPS2AdaptHiMax TPS1 High Adapt Max Faults The purpose of this diagnostic is to make sure the TPS2 voltage is below a rational high threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 271 | 51/18 | <p>TPS1AdaptHiMin TPS1 High Adapt Min Faults The purpose of this diagnostic is to make sure the TPS1 voltage is above a rational low threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 272 | 3673/18 | <p>TPS2AdaptHiMin TPS2 High Adapt Min Faults The purpose of this diagnostic is to make sure the TPS2 voltage is above a rational low threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 281 | 51/0 | <p>TPS1AdaptLoMax TPS1 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS1 voltage is below a rational high threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 282 | 3673/0 | <p>TPS2AdaptLoMax TPS2 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS2 voltage is below a rational high threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 291 | 51/7 | <p>TPS_Sensors_Conflict TPS Sensor Conflict Faults The purpose of this diagnostic is to detect a potential situation where the TPS1 and TPS2 position disagree the throttle position. The fault can be caused by a failed position sensor or fouling on the traces in the throttle.</p> | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table 4-2. TPS Faults (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--------------|-----------------------------|
| 292 | 51/2 | TPS_Intermittent TPS Intermittent Faults The purpose of this diagnostic is to monitor all the suspected or Failed TPS faults. The fault can be caused by TPS1 or TPS2 sensor drifting, throttle mechanical failure, short to ground/5V, or open TPS conditions. | TurnOnMIL | Test Failed Since Key Cycle |

Figures 4-8 through 4-14 below illustrate TPS Fault calibration pages from ToolKit.

| TPS_Intermittent_Fault | TPS_Sensors_Conflict_Fault |
|--|--|
| Master Enable TPS_Intermittent_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS_Sensors_Conflict_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_TPS_Intermittent <input checked="" type="checkbox"/> | Event Manager EventManagerFlag_TPS_Sensors_Conflict <input checked="" type="checkbox"/> |
| Fault Configuration I Suspected X Limit <input type="text" value="5"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS_IntermittentDriveCycleXLimit <input type="text" value="0"/> counts TPS_IntermittentDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS_Sensors_ConflictDriveCycleXLimit <input type="text" value="0"/> counts TPS_Sensors_ConflictDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II Emissions Related <input type="text" value="Not Emissions-Related"/> TPS_Intermittent_OBDFaultID <input type="text" value="292"/> TPS_Intermittent_SPN <input type="text" value="51"/> TPS_Intermittent_FMI <input type="text" value="2"/> TPS_Intermittent_IsPermanent <input type="text" value="Not Permanent"/> TPS_Intermittent_FaultTest <input type="text" value="-"/> | Fault Configuration II Emissions Related <input type="text" value="Not Emissions-Related"/> TPS_Sensors_Conflict_OBDFaultID <input type="text" value="291"/> TPS_Sensors_Conflict_SPN <input type="text" value="51"/> TPS_Sensors_Conflict_FMI <input type="text" value="7"/> TPS_Sensors_Conflict_IsPermanent <input type="text" value="Not Permanent"/> TPS_Sensors_Conflict_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="(None)"/> FaultActionRoute2_Condition <input type="text" value="(None)"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="CutThrottle"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS_Intermittent_Enabled <input type="text" value="Error"/> | Enabling Status & Condition TPS_Sensors_Conflict_Enabled <input type="text" value="Error"/> |
| Malfunction Criteria SuspectedMarquee <input type="text" value="Error"/> | Malfunction Criteria { Abs (TPS1Percent - <input type="text" value="Error"/> Error TPS2Percent) <input type="text" value="Error"/> Error > TPS1_TPS2_Max_Deviation } <input type="text" value="15"/> % |

Figure 4-8. TPS Intermittent and TPS Sensors Conflict Faults

| TPS1AdaptHiMax_Fault | TPS1AdaptHiMin_Fault |
|---|---|
| Master Enable TPS1AdaptHiMax_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS1AdaptHiMin_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_TPS1AdaptHiMax | Event Manager EventManagerFlag_TPS1AdaptHiMin |
| Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS1AdaptHiMaxDriveCycleXLimit <input type="text" value="0"/> counts TPS1AdaptHiMaxDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS1AdaptHiMinDriveCycleXLimit <input type="text" value="0"/> counts TPS1AdaptHiMinDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II TPS1AdaptHiMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1AdaptHiMax_OBDFaultID <input type="text" value="251"/> TPS1AdaptHiMax_SPN <input type="text" value="51"/> TPS1AdaptHiMax_FMI <input type="text" value="16"/> TPS1AdaptHiMax_IsPermanent <input type="text" value="Not Permanent"/> TPS1AdaptHiMax_FaultTest <input type="text" value="-"/> | Fault Configuration II TPS1AdaptHiMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1AdaptHiMin_OBDFaultID <input type="text" value="271"/> TPS1AdaptHiMin_SPN <input type="text" value="51"/> TPS1AdaptHiMin_FMI <input type="text" value="18"/> TPS1AdaptHiMin_IsPermanent <input type="text" value="Not Permanent"/> TPS1AdaptHiMin_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS1RangeHighAdaptHiMax_Fault_Enabled <input type="text" value="Error"/> | Enabling Status & Condition TPS1RangeHighAdaptHiMin_Fault_Enabled <input type="text" value="Error"/> |
| Malfunction Criteria TPS1ADC <input type="text" value="Error"/> > TPS1Adapt_Hi_Max <input type="text" value="1000"/> ADC_counts | Malfunction Criteria TPS1ADC <input type="text" value="Error"/> < TPS1Adapt_Hi_Min <input type="text" value="760"/> ADC_counts |

Figure 4-9. TPS1 High Adapt Max/Min Faults

| TPS1AdaptLoMax_Fault | TPS1AdaptLoMin_Fault |
|---|---|
| Master Enable TPS1AdaptLoMax_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS1AdaptLoMin_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager ✘ EventManagerFlag_TPS1AdaptLoMax | Event Manager ✘ EventManagerFlag_TPS1AdaptLoMin |
| Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS1AdaptLoMaxDriveCycleXLimit <input type="text" value="0"/> counts TPS1AdaptLoMaxDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS1AdaptLoMinDriveCycleXLimit <input type="text" value="0"/> counts TPS1AdaptLoMinDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II TPS1AdaptLoMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1AdaptLoMax_OBDFaultID <input type="text" value="281"/> TPS1AdaptLoMax_SPN <input type="text" value="51"/> TPS1AdaptLoMax_FMI <input type="text" value="0"/> TPS1AdaptLoMax_IsPermanent <input type="text" value="Not Permanent"/> TPS1AdaptLoMax_FaultTest <input type="text" value="-"/> | Fault Configuration II TPS1AdaptLoMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1AdaptLoMin_OBDFaultID <input type="text" value="241"/> TPS1AdaptLoMin_SPN <input type="text" value="51"/> TPS1AdaptLoMin_FMI <input type="text" value="1"/> TPS1AdaptLoMin_IsPermanent <input type="text" value="Not Permanent"/> TPS1AdaptLoMin_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS1RangeHighAdaptLoMax_Fault_Enabled <input type="text" value="Error"/> ✘ | Enabling Status & Condition TPS1RangeHighAdaptLoMin_Fault_Enabled <input type="text" value="Error"/> ✘ |
| Malfunction Criteria TPS1ADC ✘ Error > TPS1Adapt_Low_Max <input type="text" value="115"/> ADC_counts | Malfunction Criteria TPS1ADC ✘ Error < TPS1Adapt_Low_Min <input type="text" value="50"/> ADC_counts |

Figure 4-10. TPS1 Low Adapt Max/Min Faults

| TPS1RangeHigh_Fault | TPS1RangeLow_Fault |
|---|---|
| Master Enable TPS1RangeHigh_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS1RangeLow_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_TPS1RangeHigh | Event Manager EventManagerFlag_TPS1RangeLow |
| Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS1RangeHighDriveCycleXLimit <input type="text" value="0"/> counts TPS1RangeHighDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS1RangeLowDriveCycleXLimit <input type="text" value="0"/> counts TPS1RangeLowDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II TPS1RangeHigh_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1RangeHigh_OBDFaultID <input type="text" value="231"/> TPS1RangeHigh_SPN <input type="text" value="51"/> TPS1RangeHigh_FMI <input type="text" value="3"/> TPS1RangeHigh_IsPermanent <input type="text" value="Not Permanent"/> TPS1RangeHigh_FaultTest <input type="text" value="-"/> | Fault Configuration II TPS1RangeLow_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS1RangeLow_OBDFaultID <input type="text" value="221"/> TPS1RangeLow_SPN <input type="text" value="51"/> TPS1RangeLow_FMI <input type="text" value="4"/> TPS1RangeLow_IsPermanent <input type="text" value="Not Permanent"/> TPS1RangeLow_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="CutThrottle"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="CutThrottle"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> |
| FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS1RangeHigh_Fault_Enabled <input type="text" value="Error"/> | Enabling Status & Condition TPS1RangeLow_Fault_Enabled <input type="text" value="Error"/> |
| Malfunction Criteria TPS1ADC <input type="text" value="Error"/> > TPS1InputHiFltPos <input type="text" value="1010"/> ADC_counts | Malfunction Criteria TPS1ADC <input type="text" value="Error"/> < TPS1InputLoFltPos <input type="text" value="10"/> ADC_counts |

Figure 4-11. TPS1 Voltage Range High/Low Faults

| TPS2AdaptHiMax_Fault | TPS2AdaptHiMin_Fault |
|---|---|
| Master Enable TPS2AdaptHiMax_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS2AdaptHiMin_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_TPS2AdaptHiMax <input checked="" type="checkbox"/> | Event Manager EventManagerFlag_TPS2AdaptHiMin <input checked="" type="checkbox"/> |
| Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS2AdaptHiMaxDriveCycleXLimit <input type="text" value="0"/> counts TPS2AdaptHiMaxDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="40"/> counts Suspected Y Limit <input type="text" value="50"/> counts TPS2AdaptHiMinDriveCycleXLimit <input type="text" value="0"/> counts TPS2AdaptHiMinDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II TPS2AdaptHiMax_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS2AdaptHiMax_OBDFaultID <input type="text" value="252"/> TPS2AdaptHiMax_SPN <input type="text" value="3673"/> TPS2AdaptHiMax_FMI <input type="text" value="16"/> TPS2AdaptHiMax_IsPermanent <input type="text" value="Not Permanent"/> TPS2AdaptHiMax_FaultTest <input type="text" value="-"/> | Fault Configuration II TPS2AdaptHiMin_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS2AdaptHiMin_OBDFaultID <input type="text" value="272"/> TPS2AdaptHiMin_SPN <input type="text" value="3673"/> TPS2AdaptHiMin_FMI <input type="text" value="18"/> TPS2AdaptHiMin_IsPermanent <input type="text" value="Not Permanent"/> TPS2AdaptHiMin_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute2_Action <input type="text" value="Level4PowerLimit"/> FaultActionRoute2_Condition <input type="text" value="FailedLastDriveCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS2RangeHighAdaptHiMax_Fault_Enabled <input checked="" type="checkbox"/> Error | Enabling Status & Condition TPS2RangeHighAdaptHiMin_Fault_Enabled <input checked="" type="checkbox"/> Error |
| Malfunction Criteria TPS2ADC <input checked="" type="checkbox"/> Error > TPS2Adapt_Hi_Max <input type="text" value="1000"/> ADC_counts | Malfunction Criteria TPS2ADC <input checked="" type="checkbox"/> Error < TPS2Adapt_Hi_Min <input type="text" value="760"/> ADC_counts |

Figure 4-12. TPS2 High Adapt Max/Min Faults

| TPS2AdaptLoMax_Fault | TPS2AdaptLoMin_Fault |
|--|--|
| <p>Master Enable</p> <p>TPS2AdaptLoMax_FaultConfig Enabled</p> | <p>Master Enable</p> <p>TPS2AdaptLoMin_FaultConfig Enabled</p> |
| <p>Event Manager</p> <p>✘ EventManagerFlag_TPS2AdaptLoMax</p> | <p>Event Manager</p> <p>✘ EventManagerFlag_TPS2AdaptLoMin</p> |
| <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="40"/> counts</p> <p>Suspected Y Limit <input type="text" value="50"/> counts</p> <p>TPS2AdaptLoMaxDriveCycleXLimit <input type="text" value="0"/> counts</p> <p>TPS2AdaptLoMaxDriveCycleYLimit <input type="text" value="0"/> counts</p> | <p>Fault Configuration I</p> <p>Suspected X Limit <input type="text" value="40"/> counts</p> <p>Suspected Y Limit <input type="text" value="50"/> counts</p> <p>TPS2AdaptLoMinDriveCycleXLimit <input type="text" value="0"/> counts</p> <p>TPS2AdaptLoMinDriveCycleYLimit <input type="text" value="0"/> counts</p> |
| <p>Fault Configuration II</p> <p>TPS2AdaptLoMax_EmissionsRelated Not Emissions-Related</p> <p>TPS2AdaptLoMax_OBDFaultID <input type="text" value="282"/></p> <p>TPS2AdaptLoMax_SPN <input type="text" value="3673"/></p> <p>TPS2AdaptLoMax_FMI <input type="text" value="0"/></p> <p>TPS2AdaptLoMax_IsPermanent Not Permanent</p> <p>TPS2AdaptLoMax_FaultTest -</p> | <p>Fault Configuration II</p> <p>TPS2AdaptLoMin_EmissionsRelated Not Emissions-Related</p> <p>TPS2AdaptLoMin_OBDFaultID <input type="text" value="242"/></p> <p>TPS2AdaptLoMin_SPN <input type="text" value="3673"/></p> <p>TPS2AdaptLoMin_FMI <input type="text" value="1"/></p> <p>TPS2AdaptLoMin_IsPermanent Not Permanent</p> <p>TPS2AdaptLoMin_FaultTest -</p> |
| <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition FailedLastDriveCycle</p> <p>FaultActionRoute2_Action Level4PowerLimit</p> <p>FaultActionRoute2_Condition FailedLastDriveCycle</p> <p>FaultActionRoute3_Action (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> | <p>FaultAction & Condition</p> <p>FaultActionRoute1_Action TurnOnMIL</p> <p>FaultActionRoute1_Condition FailedLastDriveCycle</p> <p>FaultActionRoute2_Action Level4PowerLimit</p> <p>FaultActionRoute2_Condition FailedLastDriveCycle</p> <p>FaultActionRoute3_Action (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute3_Condition (None)</p> <p>FaultActionRoute4_Action (None)</p> <p>FaultActionRoute4_Condition (None)</p> |
| <p>Enabling Status & Condition</p> <p>TPS2RangeHighAdaptLoMax_Fault_Enabled Error ✘</p> | <p>Enabling Status & Condition</p> <p>TPS2RangeHighAdaptLoMin_Fault_Enabled Error ✘</p> |
| <p>Malfunction Criteria</p> <p>TPS2ADC ✘ Error</p> <p>> TPS2Adapt_Low_Max <input type="text" value="115"/> ADC_counts</p> | <p>Malfunction Criteria</p> <p>TPS2ADC ✘ Error</p> <p>< TPS2Adapt_Low_Min <input type="text" value="50"/> ADC_counts</p> |

Figure 4-13. TPS2 Low Adapt Max/Min Faults

| TPS2RangeHigh_Fault | TPS2RangeLow_Fault |
|--|--|
| Master Enable TPS2RangeHigh_FaultConfig <input type="text" value="Enabled"/> | Master Enable TPS2RangeLow_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager ✘ EventManagerFlag_TPS2RangeHigh | Event Manager ✘ EventManagerFlag_TPS2RangeLow |
| Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS2RangeHighDriveCycleXLimit <input type="text" value="0"/> counts TPS2RangeHighDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="95"/> counts Suspected Y Limit <input type="text" value="100"/> counts TPS2RangeLowDriveCycleXLimit <input type="text" value="0"/> counts TPS2RangeLowDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II TPS2RangeHigh_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS2RangeHigh_OBDFaultID <input type="text" value="232"/> TPS2RangeHigh_SPN <input type="text" value="3673"/> TPS2RangeHigh_FMI <input type="text" value="3"/> TPS2RangeHigh_IsPermanent <input type="text" value="Not Permanent"/> TPS2RangeHigh_FaultTest <input type="text" value="-"/> | Fault Configuration II TPS2RangeLow_EmissionsRelated <input type="text" value="Not Emissions-Related"/> TPS2RangeLow_OBDFaultID <input type="text" value="222"/> TPS2RangeLow_SPN <input type="text" value="3673"/> TPS2RangeLow_FMI <input type="text" value="4"/> TPS2RangeLow_IsPermanent <input type="text" value="Not Permanent"/> TPS2RangeLow_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="CutThrottle"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="CutThrottle"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition TPS2RangeHigh_Fault_Enabled <input type="text" value="Error"/> ✘ | Enabling Status & Condition TPS2RangeLow_Fault_Enabled <input type="text" value="Error"/> ✘ |
| Malfunction Criteria TPS2ADC ✘ <input type="text" value="Error"/> > TPS2InputHiFltPos <input type="text" value="1010"/> ADC_counts | Malfunction Criteria TPS2ADC ✘ <input type="text" value="Error"/> < TPS2InputLoFltPos <input type="text" value="10"/> ADC_counts |

Figure 4-14. TPS2 Voltage Range High/Low Faults

Sense Volt Faults

Table 4-3. Sense Volt Faults

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|------------------------------------|--|
| 551 | 1079/4 | SensVoltRangeLow XDRP 5V sensor power voltage lower than expected This fault indicates overload on XDRP line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 561 | 1079/3 | SensVoltRangeHigh XDRP 5V sensor power voltage higher than expected This fault indicates ECU internal circuit failure or short circuit to system power line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Figure 4-15 below illustrates Sense Volt Fault calibration pages from ToolKit.

| SensVoltRangeHigh_Fault | SensVoltRangeLow_Fault |
|--|--|
| Master Enable SensVoltRangeHigh_FaultConfig <input type="text" value="Enabled"/> | Master Enable SensVoltRangeLow_FaultConfig <input type="text" value="Enabled"/> |
| Event Manager EventManagerFlag_SensVoltRangeHigh <input checked="" type="checkbox"/> | Event Manager EventManagerFlag_SensVoltRangeLow <input checked="" type="checkbox"/> |
| Fault Configuration I Suspected X Limit <input type="text" value="45"/> counts Suspected Y Limit <input type="text" value="50"/> counts SensVoltRangeHighDriveCycleXLimit <input type="text" value="0"/> counts SensVoltRangeHighDriveCycleYLimit <input type="text" value="0"/> counts | Fault Configuration I Suspected X Limit <input type="text" value="45"/> counts Suspected Y Limit <input type="text" value="50"/> counts SensVoltRangeLowDriveCycleXLimit <input type="text" value="0"/> counts SensVoltRangeLowDriveCycleYLimit <input type="text" value="0"/> counts |
| Fault Configuration II Emissions Related <input type="text" value="Not Emissions-Related"/> SensVoltRangeHigh_OBDFaultID <input type="text" value="561"/> SensVoltRangeHigh_SPN <input type="text" value="1079"/> SensVoltRangeHigh_FMI <input type="text" value="3"/> SensVoltRangeHigh_IsPermanent <input type="text" value="Not Permanent"/> SensVoltRangeHigh_FaultTest <input type="text" value="-"/> | Fault Configuration II Emissions Related <input type="text" value="Not Emissions-Related"/> SensVoltRangeLow_OBDFaultID <input type="text" value="551"/> SensVoltRangeLow_SPN <input type="text" value="1079"/> SensVoltRangeLow_FMI <input type="text" value="4"/> SensVoltRangeLow_IsPermanent <input type="text" value="Not Permanent"/> SensVoltRangeLow_FaultTest <input type="text" value="-"/> |
| FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="DelayedEngineShutdown"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> | FaultAction & Condition FaultActionRoute1_Action <input type="text" value="TurnOnMIL"/> FaultActionRoute1_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute2_Action <input type="text" value="DelayedEngineShutdown"/> FaultActionRoute2_Condition <input type="text" value="TestFailedSinceKeyCycle"/> FaultActionRoute3_Action <input type="text" value="(None)"/> FaultActionRoute3_Condition <input type="text" value="(None)"/> FaultActionRoute4_Action <input type="text" value="(None)"/> FaultActionRoute4_Condition <input type="text" value="(None)"/> |
| Enabling Status & Condition SensVoltRangeHigh_Fault_Enabled <input type="text" value="Error"/> <input checked="" type="checkbox"/> | Enabling Status & Condition SensVoltRangeLow_Fault_Enabled <input type="text" value="Error"/> <input checked="" type="checkbox"/> |
| Malfunction Criteria SysVoltADC <input checked="" type="checkbox"/> Error ADC_counts > SensVoltInputHiFltPos <input type="text" value="531"/> ADC_counts | Malfunction Criteria SysVoltADC <input checked="" type="checkbox"/> Error ADC_counts < SensVoltInputLoFltPos <input type="text" value="500"/> ADC_counts |

Figure 4-15. Sensor Power Voltage High/Low Faults

MAP Sensor Faults

Table 4-4. MAP Sensor Faults

NOTE: Fault Calibrations: Fault thresholds dependent upon sensor characteristics

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|--|--|
| 371 | 105/4 | IATRangeLow Engine IAT Sensor voltage too Low. Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed. | TurnOnMIL | Test Failed Since Key Cycle |
| 381 | 105/3 | IATRangeHigh Engine IAT Sensor voltage too High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the ECU or shorted to power. | TurnOnMIL | Test Failed Since Key Cycle |
| 391 | 105/2 | IAT_IR_Fault IAT lower than expected Normally set if IAT sensor is not responding to changes in actual temperature. | TurnOnMIL | Test Failed Since Key Cycle |
| 331 | 102/17 | MAPTimeRangeLow Manifold Absolute Pressure Sensor Voltage is Low Normally set if the TMAP pressure signal wire has been disconnected or shorted to ground | TurnOnMIL | Test Failed Since Key Cycle |
| 332 | 102/4 | MAPRangeLow Manifold Absolute Pressure Sensor Voltage is Low Normally set if the TMAP pressure signal wire has been disconnected or shorted to ground | TurnOnMIL DelayedEngi neShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 341 | 102/15 | MAPTimeRangeHigh Manifold Absolute Pressure Sensor Voltage is High Normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, or the TMAP has failed | TurnOnMIL | Test Failed Since Key Cycle |
| 342 | 102/3 | MAPRangeHigh Manifold Absolute Pressure Sensor Voltage is High Normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, or the TMAP has failed | TurnOnMIL DelayedEngi neShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 351 | 102/0 | MAP_IR_HI Manifold Absolute Pressure sensor indicates higher pressure than expected | TurnOnMIL | Test Failed Since Key Cycle |

Table 4-4. MAP Sensor Faults (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|--------------|-----------------------------|
| 352 | 102/1 | MAP_IR_LO Manifold Absolute Pressure sensor indicates lower pressure than expected | TurnOnMIL | Test Failed Since Key Cycle |
| 353 | 102/2 | MAP_STICKING Manifold Absolute Pressure sensor not changing as expected | TurnOnMIL | Test Failed Since Key Cycle |

Figures 4-16 through 4-19 illustrate Map Sensor Fault calibration pages from ToolKit.

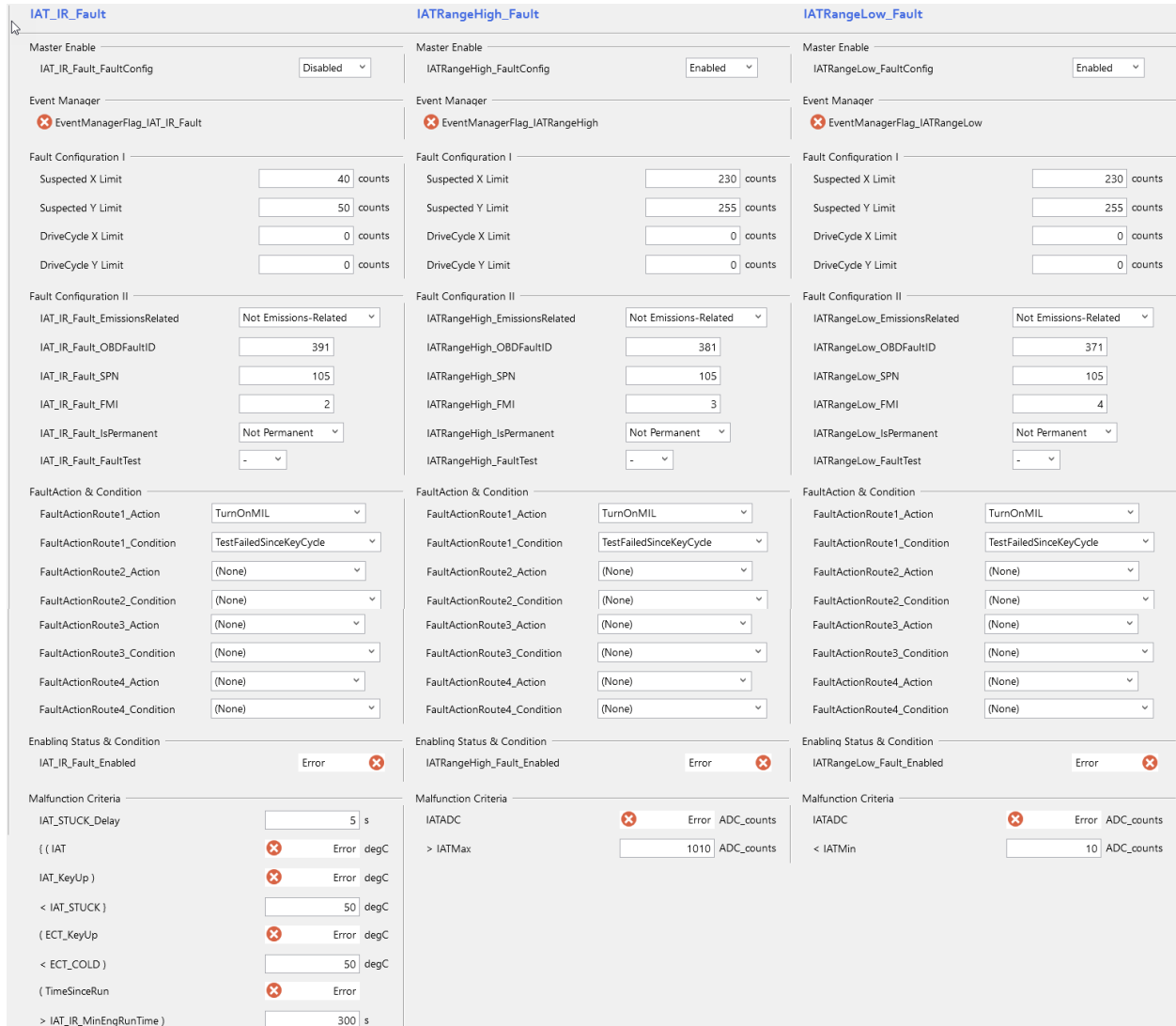


Figure 4-16. IAT Faults

| MAP_IR_HI_Fault | MAP_IR_LO_Fault | MAP_STICKING_Fault |
|--|--|--|
| Master Enable MAP_IR_HI_FaultConfig: Enabled | Master Enable MAP_IR_LO_FaultConfig: Enabled | Master Enable MAP_STICKING_FaultConfig: Disabled |
| Event Manager EventManagerFlag_MAP_IR_HI | Event Manager EventManagerFlag_MAP_IR_LO | Event Manager EventManagerFlag_MAP_STICKING |
| Fault Configuration I Suspected X Limit: 400 counts Suspected Y Limit: 500 counts MAP_IR_HI_DriveCycleXLimit: 0 counts MAP_IR_HI_DriveCycleYLimit: 0 counts | Fault Configuration I Suspected X Limit: 400 counts Suspected Y Limit: 500 counts MAP_IR_LO_DriveCycleXLimit: 0 counts MAP_IR_LO_DriveCycleYLimit: 0 counts | Fault Configuration I Suspected X Limit: 400 counts Suspected Y Limit: 500 counts MAP_STICKING_DriveCycleXLimit: 0 counts MAP_STICKING_DriveCycleYLimit: 0 counts |
| Fault Configuration II MAP_IR_HI_EmissionsRelated: Not Emissions-Related MAP_IR_HI_OBDFaultID: 351 MAP_IR_HI_SPN: 102 MAP_IR_HI_FMI: 0 MAP_IR_HI_IsPermanent: Not Permanent MAP_IR_HI_FaultTest: - | Fault Configuration II MAP_IR_LO_EmissionsRelated: Not Emissions-Related MAP_IR_LO_OBDFaultID: 352 MAP_IR_LO_SPN: 102 MAP_IR_LO_FMI: 1 MAP_IR_LO_IsPermanent: Not Permanent MAP_IR_LO_FaultTest: - | Fault Configuration II MAP_STICKING_EmissionsRelated: Not Emissions-Related MAP_STICKING_OBDFaultID: 353 MAP_STICKING_SPN: 102 MAP_STICKING_FMI: 2 MAP_STICKING_IsPermanent: Not Permanent MAP_STICKING_FaultTest: - |
| FaultAction & Condition FaultActionRoute1_Action: TurnOnMIL FaultActionRoute1_Condition: TestFailedSinceKeyCycle FaultActionRoute2_Action: (None) FaultActionRoute2_Condition: (None) FaultActionRoute3_Action: (None) FaultActionRoute3_Condition: (None) FaultActionRoute4_Action: (None) FaultActionRoute4_Condition: (None) | FaultAction & Condition FaultActionRoute1_Action: TurnOnMIL FaultActionRoute1_Condition: TestFailedSinceKeyCycle FaultActionRoute2_Action: (None) FaultActionRoute2_Condition: (None) FaultActionRoute3_Action: (None) FaultActionRoute3_Condition: (None) FaultActionRoute4_Action: (None) FaultActionRoute4_Condition: (None) | FaultAction & Condition FaultActionRoute1_Action: TurnOnMIL FaultActionRoute1_Condition: TestFailedSinceKeyCycle FaultActionRoute2_Action: (None) FaultActionRoute2_Condition: (None) FaultActionRoute3_Action: (None) FaultActionRoute3_Condition: (None) FaultActionRoute4_Action: (None) FaultActionRoute4_Condition: (None) |
| Enabling Status & Condition MAP_IR_HI_Enabled: Error | Enabling Status & Condition MAP_IR_LO_Enabled: Error | Enabling Status & Condition MAP_STICKING_Enabled: Error |
| Malfunction Criteria MAP_IR_HI_Delay: 5 s MAP: Error kPa > MAP_IR_HI: 75 kPa TPSPcnt: Error % < MAP_IR_TPS_CL: 15 % | Malfunction Criteria MAP_IR_LO_Delay: 5 s MAP: Error kPa < MAP_IR_LO: 50 kPa TPSPcnt: Error % > MAP_IR_TPS_OP: 70 % | Malfunction Criteria { (BARO: Error kPa - MAP): Error kPa < MAP_STUCK } : 10 kPa MAP_STUCK_Delay: 5 s TPSPcnt: Error % < MAP_TPS_STUCK : 50 % |

Figure 4-17. MAP High/Low and Sticking Faults

| MAPRangeHigh_Fault | MAPRangeLow_Fault |
|--|--|
| Master Enable MAPRangeHigh_FaultConfig: Enabled | Master Enable MAPRangeLow_FaultConfig: Enabled |
| Event Manager EventManagerFlag_MAPRangeHigh: | Event Manager EventManagerFlag_MAPRangeLow: |
| Fault Configuration I Suspected X Limit: 95 counts Suspected Y Limit: 100 counts MAPRangeHighDriveCycleXLimit: 0 counts MAPRangeHighDriveCycleYLimit: 0 counts | Fault Configuration I Suspected X Limit: 95 counts Suspected Y Limit: 100 counts MAPRangeLowDriveCycleXLimit: 0 counts MAPRangeLowDriveCycleYLimit: 0 counts |
| Fault Configuration II MAPRangeHigh_EmissionsRelated: Not Emissions-Related MAPRangeHigh_OBDFaultID: 342 MAPRangeHigh_SPN: 102 MAPRangeHigh_FMI: 3 MAPRangeHigh_IsPermanent: Not Permanent MAPRangeHigh_FaultTest: - | Fault Configuration II MAPRangeLow_EmissionsRelated: Not Emissions-Related MAPRangeLow_OBDFaultID: 332 MAPRangeLow_SPN: 102 MAPRangeLow_FMI: 4 MAPRangeLow_IsPermanent: Not Permanent MAPRangeLow_FaultTest: - |
| FaultAction & Condition FaultActionRoute1_Action: TurnOnMIL FaultActionRoute1_Condition: TestFailedSinceKeyCycle FaultActionRoute2_Action: DelayedEngineShutdown FaultActionRoute2_Condition: TestFailedSinceKeyCycle FaultActionRoute3_Action: (None) FaultActionRoute3_Condition: (None) FaultActionRoute4_Action: (None) FaultActionRoute4_Condition: (None) | FaultAction & Condition FaultActionRoute1_Action: TurnOnMIL FaultActionRoute1_Condition: TestFailedSinceKeyCycle FaultActionRoute2_Action: DelayedEngineShutdown FaultActionRoute2_Condition: TestFailedSinceKeyCycle FaultActionRoute3_Action: (None) FaultActionRoute3_Condition: (None) FaultActionRoute4_Action: (None) FaultActionRoute4_Condition: (None) |
| Enabling Status & Condition MAPRangeHigh_Fault_Enabled: Error | Enabling Status & Condition MAPRangeLow_Fault_Enabled: Error |
| Malfunction Criteria MAPADC: Error ADC_counts > MAPInputHiFitPos: 1013 ADC_counts | Malfunction Criteria MAPADC: Error ADC_counts < MAPInputLoFitPos: 10 ADC_counts |

Figure 4-18. MAP Sensor Voltage High/Low Faults

| MAPTimeRangeHigh_Fault | | MAPTimeRangeLow_Fault | |
|-------------------------------------|-------------------------|------------------------------------|-------------------------|
| Master Enable | | Master Enable | |
| MAPTimeRangeHigh_FaultConfig | Enabled | MAPTimeRangeLow_FaultConfig | Enabled |
| Event Manager | | Event Manager | |
| ✘ EventManagerFlag_MAPTimeRangeHigh | | ✘ EventManagerFlag_MAPTimeRangeLow | |
| Fault Configuration I | | Fault Configuration I | |
| Suspected X Limit | 40 counts | Suspected X Limit | 40 counts |
| Suspected Y Limit | 50 counts | Suspected Y Limit | 50 counts |
| MAPTimeRangeHighDriveCycleXLimit | 0 counts | MAPTimeRangeLowDriveCycleXLimit | 0 counts |
| MAPTimeRangeHighDriveCycleYLimit | 0 counts | MAPTimeRangeLowDriveCycleYLimit | 0 counts |
| Fault Configuration II | | Fault Configuration II | |
| Emissions Related | Not Emissions-Related | Emissions Related | Not Emissions-Related |
| MAPTimeRangeHigh_OBDFaultID | 341 | MAPTimeRangeLow_OBDFaultID | 331 |
| MAPTimeRangeHigh_SPN | 102 | MAPTimeRangeLow_SPN | 102 |
| MAPTimeRangeHigh_FMI | 15 | MAPTimeRangeLow_FMI | 17 |
| MAPTimeRangeHigh_IsPermanent | Not Permanent | MAPTimeRangeLow_IsPermanent | Not Permanent |
| MAPTimeRangeHigh_FaultTest | - | MAPTimeRangeLow_FaultTest | - |
| FaultAction & Condition | | FaultAction & Condition | |
| FaultActionRoute1_Action | TurnOnMIL | FaultActionRoute1_Action | TurnOnMIL |
| FaultActionRoute1_Condition | TestFailedSinceKeyCycle | FaultActionRoute1_Condition | TestFailedSinceKeyCycle |
| FaultActionRoute2_Action | (None) | FaultActionRoute2_Action | (None) |
| FaultActionRoute2_Condition | (None) | FaultActionRoute2_Condition | (None) |
| FaultActionRoute3_Action | (None) | FaultActionRoute3_Action | (None) |
| FaultActionRoute3_Condition | (None) | FaultActionRoute3_Condition_ | (None) |
| FaultActionRoute4_Action | (None) | FaultActionRoute4_Action | (None) |
| FaultActionRoute4_Condition | (None) | FaultActionRoute4_Condition | (None) |
| Enabling Status & Condition | | Enabling Status & Condition | |
| MAPTimeRangeHigh_Fault_Enabled | Error ✘ | MAPTimeRangeLow_Fault_Enabled | Error ✘ |
| Malfunction Criteria | | Malfunction Criteria | |
| MAPTimeADC | ✘ Error ADC_counts | MAPTimeADC | ✘ Error ADC_counts |
| > MAPTimeInputHiFltPos | 1013 ADC_counts | > MAPTimeInputLoFltPos | 10 ADC_counts |

Figure 4-19. MAP Time Range High/Low Faults

ETC Faults

Table 4-5. ETC Faults

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--|--|
| 461 | 3464/7 | <p>ETC_Sticking Throttle Sticking Faults The purpose of this diagnostics is to monitor if the throttle is sticking and not tracking the setpoint. This fault can be caused by mechanical throttle failures, contamination, and debris.</p> | <p>TurnOnMIL IdleMode EngineShutdown</p> | <p>Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle</p> |
| 471 | 3464/5 | <p>ETC_Open_Fault Throttle Open Faults The purpose of this diagnostics is to monitor if the H-Bridge throttle circuit is open, which would result in the loss of throttle control. This fault can be caused by throttle failures or overdriven throttles</p> | <p>TurnOnMIL CutThrottle DelayedEngineShutdown</p> | <p>Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle</p> |
| 481 | 3464/2 | <p>ETCSpringTest Throttle Spring Test Faults The purpose of this diagnostics is to monitor if the internal spring in the throttle closes the throttle when the throttle motor is powered off. This fault can be caused by mechanical throttle failures, contamination, and debris.</p> | <p>TurnOnMIL EngineShutdown</p> | <p>Failed Last Drive Cycle Failed Last Drive Cycle</p> |
| 491 | 3464/6 | <p>HBridgeFault_ETC Throttle Driver H-Bridge Faults The purpose of this diagnostic is to monitor the throttle H-Bridge driver chip condition. The H-Bridge chip senses overtemp condition due to high current outputs. If the H-Bridge chip determines there is a short condition or the HBridge driver current is above a calibratable threshold for a calibratable time period, this fault will set. The fault can be caused by throttle failures or overdriven throttles.</p> | <p>TurnOnMIL CutThrottle DelayedEngineShutdown</p> | <p>Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle</p> |

ETC Fault calibration pages from ToolKit

Figures 4-20 and 4-21 illustrate ETC Fault calibration pages from ToolKit.

The image displays three side-by-side calibration pages for ETC faults. Each page is titled and contains the following sections:

- Master Enable:** A dropdown menu set to 'Enabled'.
- Event Manager:** A red 'X' icon and a label: 'EventManagerFlag_ETC_Open_Fault', 'EventManagerFlag_ETC_Sticking', and 'EventManagerFlag_ETCSpringTest'.
- Fault Configuration I:** Four input fields for 'Suspected X Limit', 'Suspected Y Limit', 'DriveCycle X Limit', and 'DriveCycle Y Limit' with values in counts.
- Fault Configuration II:** A dropdown for 'EmissionsRelated' (set to 'Not Emissions-Related') and five input fields for 'OBDFaultID', 'SPN', 'FMI', 'IsPermanent', and 'FaultTest'.
- FaultAction & Condition:** Four pairs of dropdown menus for 'Action' and 'Condition' for routes 1 through 4.
- Enabling Status & Condition:** A dropdown for 'Enabled' with a red 'X' icon and 'Error' label.
- Malfunction Criteria:** Input fields for 'Delay', 'DutyCycle', '> ETC_OC_MIN', 'Current', and '< ETC_I_MIN' with units and error indicators.

Figure 4-20. Throttle Open, Throttle Sticking, and Throttle Spring Test Faults

HBridgeFault_ETC_Fault

Master Enable
 HBridgeFault_ETC_FaultConfig Enabled

Event Manager
✖ EventManagerFlag_HBridgeFault_ETC

Fault Configuration I

Suspected X Limit counts

Suspected Y Limit counts

DriveCycle X Limit counts

DriveCycle Y Limit counts

Fault Configuration II

HBridgeFault_ETC_EmissionsRelated Not Emissions-Related

HBridgeFault_ETC_OBDFaultID

HBridgeFault_ETC_SPN

HBridgeFault_ETC_FMI

HBridgeFault_ETC_IsPermanent Not Permanent

HBridgeFault_ETC_FaultTest -

FaultAction & Condition

FaultActionRoute1_Action TurnOnMIL

FaultActionRoute1_Condition TestFailedSinceKeyCycle

FaultActionRoute2_Action CutThrottle

FaultActionRoute2_Condition TestFailedSinceKeyCycle

FaultActionRoute3_Action DelayedEngineShutdown

FaultActionRoute3_Condition TestFailedSinceKeyCycle

FaultActionRoute4_Action (None)

FaultActionRoute4_Condition (None)

Enabling Status & Condition

HBridgeFault_ETC_Fault_Enabled Error ✖

Malfunction Criteria

HBridgeFaultState Error ✖ status

Figure 4-21. Throttle Driver H-Bridge Faults

Overspeed Faults

Table 4-6. Overspeed Faults

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--|---|
| 571 | 190/0 | HardOverspeed Engine speed has exceeded first level (1 of 3) of overspeed protection | TurnOnMIL HardRevLimit EngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 572 | 190/16 | MediumOverspeed Engine speed has exceeded second level (2 of 3) of overspeed protection | TurnOnMIL MediumRevLimit DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 573 | 190/15 | SoftOverspeed Engine speed has exceeded third level (3 of 3) of overspeed protection | TurnOnMIL SoftRevLimit | Test Failed Since Key Cycle Test Failed |

The image displays three side-by-side calibration pages for overspeed faults. Each page is titled at the top: **SoftOverspeed_Fault**, **MediumOverspeed_Fault**, and **HardOverspeed_Fault**.

- Master Enable:** SoftOverspeed_FaultConfig (Disabled), MediumOverspeed_FaultConfig (Disabled), HardOverspeed_FaultConfig (Enabled).
- Event Manager:** EventManagerFlag_SoftOverspeed, EventManagerFlag_MediumOverspeed, EventManagerFlag_HardOverspeed.
- Fault Configuration I:** Suspected X Limit (50 counts), Suspected Y Limit (255 counts), SoftOverspeedDriveCycleYLimit (0 counts), SoftOverspeedDriveCycleXLimit (0 counts).
- Fault Configuration II:** Emissions Related (Not Emissions-Related), SoftOverspeed_OBDFaultID (573), SoftOverspeed_SPN (190), SoftOverspeed_FMI (15), SoftOverspeed_IsPermanent (Not Permanent), SoftOverspeed_FaultTest (-).
- FaultAction & Condition:** FaultActionRoute1_Action (TurnOnMIL), FaultActionRoute1_Condition (TestFailedSinceKeyCycle), FaultActionRoute2_Action (SoftRevLimit), FaultActionRoute2_Condition (TestFailed), FaultActionRoute3_Action ((None)), FaultActionRoute3_Condition ((None)), FaultActionRoute4_Action ((None)), FaultActionRoute4_Condition ((None)).
- Enabling Status & Condition:** SoftOverspeed_Enabled (Error), MediumOverspeed_Enabled (Error), HardOverspeed_Enabled (Error).
- Malfunction Criteria:** RPM (Error rpm), > BaseRevLimit (2800 rpm), MediumRevOffset (75 rpm).

Figure 4-22. Overspeed Fault calibration pages from Toolkit

Chapter 5.

Travel Control System

ISO EN 1175 Safety Function: 4.5.2 Travel Control System

The travel control system shall be so arranged that on level ground the truck will start from standstill only when the control(s) for speed and direction are activated. For IC trucks, after engaging direction control, low speed is allowed without activation of the speed control. Means shall be provided to avoid any truck movement when:

- switching on the travel control system
- starting the engine of an IC truck

Any initial activation of the drive system shall only be possible from the neutral position of the speed and/or directional control.

MI-21 Software to Support Safety Function

Under normal operating conditions, the pedal control, air management and throttle control algorithms will prevent unintended vehicle launch. Diagnostic coverage is provided by extensive sensor and actuator fault detection and fault management. In addition, MI-21 logic exists to disable the pedal if it is above idle position during the crank-to-run transition. In this mode, engine rpm is expected to remain close to MinGovSetPt. This reduced rpm set point permits detection of loss of control at a reduced threshold.

A fault, APPLockOverspeedFault, will be triggered when the following conditions exist:

- If pedal is disabled at startup and rpm exceeds a threshold for a fixed period, set fault
- It is expected that the rpm fault threshold can be much lower than the normal overspeed fault to catch rising RPM as early as possible
- The rpm threshold should account for variations in MinGovRPMSetPt due to ECT and ramp rate

The new fault is inhibited when either of the following faults indicate TestFailedSinceKeyCycle

- SensVoltRangeHigh
- SensVoltRangeLow

Both above faults must be enabled, and fault thresholds set. See ToolKit page ‘Sensor – Sens Volt, Sys Volt, MPRD’

The fault ‘APPLockOverspeedFault must be enabled

The following calibration parameters are used to configure the fault:

- APPLockRevLimit: Actual RPM above MinGovSetPt to enable fault detection
- APPLockRevLimitHyst: RPM below APPLockRevLimit to disable fault detection
- APPLockFaultDelay: Delay between fault detection true and OBD fault Set input is true

The following calibration values are required:

Table 5-1. Required Calibration Values

| Parameter | Calibration Value |
|------------------------------|-------------------------|
| FaultConfig.APPLockOverspeed | Enabled |
| FaultActionRoute1Action | IdleMode |
| FaultActionRoute1Condition | TestFailedSinceKeyCycle |
| FaultActionRoute2Action | TurnOnMIL |
| FaultActionRoute2Condition | TestFailedSinceKeyCycle |
| APPLockRevLimit | 200 rpm |
| APPLockRevLimitHyst | 100 rpm |
| APPLockFaultDelay | 1 sec |

Testing to Verify APP Lock Overspeed Fault

Testing of this safety function requires:

- Engaging the APP lock on startup
- Trigger an APP Lock Overspeed condition
- Confirm safe engine shutdown

Test Procedure

1. Key off and let engine stop
2. Turn key on
3. Verify correct calibration values
4. Increase pedal command to >3%
5. Set dyno speed setpoint to 1500 rpm (for vehicle testing, set overspeed Base Rev Limit =1400 rpm)
6. Start engine
7. Engine should idle at min gov setpoint and not respond to increases in pedal
8. Use TPSReq_ovr and TPSReq_new to override throttle setpoint
9. Engine should accelerate, APPLockOverspeedFault should set after one second, MIL light should illuminate, and engine should shut down
10. Clear TPSReq_ovr.
11. Decrease pedal command to 0%
12. Restart engine
13. Engine should idle at min gov setpoint
14. Set 'Test' for APPSLockOverspeed Fault
15. MIL light should illuminate, and engine should shut down
16. restart engine - exercise system, try to induce unintended fault
17. Restore overspeed Base Rev Limit to original value

Required Calibrations

Figure 5-1. illustrates required calibrations.

'APPLockOverspeedFault'

| | | | |
|---|--|---|--|
| Master Enable Enable Fault: <input type="text" value="Enabled"/> | | Malfunction Criteria APP_Mode: <input type="text" value="Error"/> | |
| Event Manager <input checked="" type="checkbox"/> EventManagerFlag_APPLockOverspeedFault | | MinGovBaseRPMSetPt: <input checked="" type="text" value="Error"/> rpm | APPLockRevLimit (added to MinGovBase): <input type="text" value="1500"/> rpm |
| Fault Configuration I Suspected X Limit: <input type="text" value="95"/> counts Suspected Y Limit: <input type="text" value="100"/> counts DriveCycle X Limit: <input type="text" value="0"/> counts DriveCycle Y Limit: <input type="text" value="0"/> counts | | APPLockRevLimitHyst: <input type="text" value="200"/> rpm | APPLockFaultDelay: <input type="text" value="1.5"/> s |
| Fault Configuration II Emissions Related: <input type="text" value="Not Emissions-Related"/> | | APPLockOverspeedFaultTimer: <input checked="" type="text" value="Error"/> s | |
| Fault ID (SFC): <input type="text" value="574"/> SPN: <input type="text" value="190"/> FMI: <input type="text" value="31"/> Permanent: <input type="text" value="Not Permanent"/> Fault Test: <input type="text" value="-"/> | | | |
| FaultAction & Condition Fault Action 1: <input type="text" value="TurnOnMIL"/> Fault Condition 1: <input type="text" value="TestFailedSinceKeyCycle"/> Fault Action 2: <input type="text" value="EngineShutdown"/> Fault Condition 2: <input type="text" value="TestFailedSinceKeyCycle"/> | | | |
| Fault Action 3: <input type="text" value="(None)"/> Fault Condition 3: <input type="text" value="(None)"/> Fault Action 4: <input type="text" value="(None)"/> Fault Condition 4: <input type="text" value="(None)"/> | | | |
| Enabling Status & Condition Fault Enabled: <input type="text" value="Error"/> | | | |

Figure 5-1. APP Lock Overspeed Fault Calibration Pages from ToolKit

Chapter 6.

Automatic Restoration of Drive System

ISO EN 1175 Safety Function: 4.5.5 Automatic Restoration of Drive System

The automatic release of the drive system from a limited mode shall not cause an unsafe movement.

If the truck speed near or equal to zero is caused by a speed limitation and the limitation is exceeding a time specified by the manufacturer, a release of the speed limitation shall be possible only after return to neutral position of the speed control. Speed and time duration can depend on truck type and acceleration rate.

MI-21 Software to Support Safety Function

Analysis of the MI-21 software has shown that only the power limiting feature can limit and then release the drive system. However, if the Power Limiter is active and limiting power, it cannot be released until the cause of the power limit is no longer active and the pedal is decreased to command power less than the limit. After that, the engine power will track the position commanded by the pedal. This will avoid unsafe throttle movement.

In order for Power Limiting mode to be released, the pedal control setpoint must be reduced below the power limit – this precludes a sudden uncontrolled acceleration. This will prevent a sudden release of power limiting with unexpected increase in engine power.

Required Calibration Values

If any fault uses a Power Limit Fault Action (i.e., Level1 PowerLimit, Level2 PowerLimit, Level3 PowerLimit, Level4 PowerLimit) then:

- a) Load, Torque, Power, Work must be calibrated to calculate IndTorque, IndTorquePercent and IndPower using both fuels.
- b) Power Limit Control logic must be properly calibrated to provide accurate, stable control of IndPower

Table 6-1. Required Calibration Values

| Parameter | Calibration Value |
|-----------|-------------------|
| | None required |

Testing to Verify Automatic Restoration of Drive System

Verification of the logic can be achieved as follows:

- Calibrate a fault so that it will trigger a power limit
- Increase engine power with the pedal.
- Set the fault - and expect to see the power limit
- Clear the fault or fix the fault
- Expect the power limit to remain in effect until APP is decreased below the power limit power.

Test Procedure:

1. Stop engine
2. Configure ECTOverTempFault with:
 - a) Fault Action1 = Level1PowerLimit
 - b) Fault Condition1 = Test Failing
 - c) Fault Action2 = TurnOnMIL
 - d) Fault Condition2 = Test Failing
3. Configure Power Limit: Set PowerLimit1 = 40%

4. Set dyno speed limit to approximately 1500 rpm (for vehicle testing, set MaxGovInGearUpperLimit =1500 rpm)
5. Start engine
6. Increase pedal to achieve 1500 rpm and apply engine torque with dyno (for vehicle testing, use hydraulics to apply load – e.g., tilt cylinders against stop)
7. Reduce ECTSensRangeHiThresh below current ECT reading to trip fault
8. MIL lamp should illuminate, and Engine power should be decreased to 40%
9. Restore ECTSensRangeHiThresh to original value. MIL lamp should turn off
10. Engine power should remain at 40%
11. Reduce APP and engine power should decrease with pedal
12. Increase pedal and it should be possible to achieve engine power >40%
13. exercise system, try to induce unintended overspeed/overpower
14. Restore ECTOverTempFault calibrations to original values
15. Restore MaxGovInGearUpperLimit to original value

Required Calibrations

Figure 6-1. illustrates required calibrations.

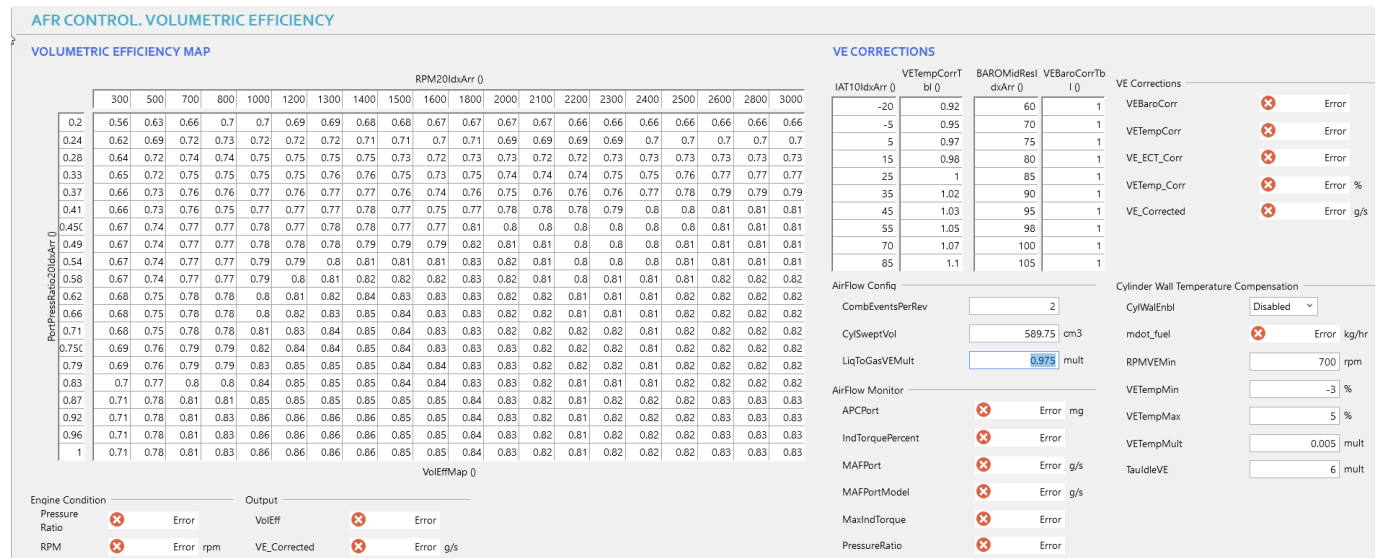


Figure 6-1. Required Calibrations

ENGINE CONTROL. TORQUE & POWER

TORQUE & POWER

TPS <> IndTorque

TPS1ADC Error

IndTorque Error Nm

Torque & Power

RPM Error rpm

IndWorkMax kJ

IndPower Error kW

IndWork Error kJ

| APC_TPS10IdxArr () | IndTorqueTbl (Nm) |
|--------------------|-------------------|
| 42 | 2.03 |
| 104 | 40 |
| 166 | 74.3 |
| 228 | 99.65 |
| 290 | 116.87 |
| 352 | 130.97 |
| 414 | 146.84 |
| 476 | 158.9 |
| 538 | 170.56 |
| 600 | 194.83 |

Indicated Torque

APCPort Error mg

IndTorque Error Nm

MaxIndTorque Error

IndTorquePercent Error

Power Limits

PowerLimitETCSetpoint Error %

PowerLimitActual Error kW

PowerLimitSetpoint Error kW

PowerLimitState Error

Torque Manager

TorqueIndexFinal

TorqueIndexFinalNum Error

TPSRequest Error %

TPSRequestFinal Error %

| NormalizedTorq_RPM10IdxArr () | Normalized_Torque_CurveTbl (%) |
|-------------------------------|--------------------------------|
| 800 | 0.89 |
| 1000 | 0.92 |
| 1200 | 0.95 |
| 1400 | 0.97 |
| 1600 | 0.99 |
| 1800 | 1 |
| 2000 | 0.99 |
| 2200 | 0.98 |
| 2400 | 0.96 |
| 2600 | 0.96 |

ENGINE CONTROL. TORQUE & POWER

TORQUE & POWER

Torque & Power

RPM Error rpm

IndWorkMax kJ

IndPower Error kW

IndWork Error kJ

Indicated Torque

APCPort Error mg

IndTorque Error Nm

MaxIndTorque Error

IndTorquePercent Error

Power Limits

PowerLimitETCSetpoint Error %

PowerLimitActual Error kW

PowerLimitSetpoint Error kW

PowerLimitState Error

POWER LIMIT PID GAINS

Power Limit Gains

PowerLimit_DGain mult

PowerLimit_ErrorGain mult

PowerLimit_IGain mult

PowerLimit_ITermLowerLimit %

PowerLimit_ITermUpperLimit %

PowerLimit_PGain mult

PowerLimit_PIDOutLowerLimit %

PowerLimit_PIDOutUpperLimit %

POWER LIMIT THRESHOLDS

Power Limit Thresholds

EngMax_Power kW

PowerLimit_1 %

PowerLimit_2 %

PowerLimit_3 %

PowerLimit_4 %

POWER LIMIT ERROR MULTIPLIER GAINS

| PowerLimit_SpeedErrorIdxArr (RPM) | PowerLimit_PGainErrorMultTbl (mult) | PowerLimit_SpeedErrorIdxArr (RPM) | PowerLimit_IGainErrorMultTbl (mult) | PowerLimit_SpeedErrorIdxArr (RPM) | PowerLimit_DGainErrorMultTbl (mult) |
|-----------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|-----------------------------------|-------------------------------------|
| 100 | 1 | 100 | 1 | 100 | 1 |
| 200 | 1 | 200 | 1 | 200 | 1 |
| 300 | 1 | 300 | 1 | 300 | 1 |
| 400 | 1 | 400 | 1 | 400 | 1 |
| 500 | 1 | 500 | 1 | 500 | 1 |
| 600 | 1 | 600 | 1 | 600 | 1 |
| 700 | 1 | 700 | 1 | 700 | 1 |
| 800 | 1 | 800 | 1 | 800 | 1 |
| 900 | 1 | 900 | 1 | 900 | 1 |
| 1000 | 1 | 1000 | 1 | 1000 | 1 |

Torque Index

TorqueIndexFinal

Figure 6-2. Engine Control, Torque and Power Calibration Pages from Toolkit

Chapter 7. Deviation from Setpoint

ISO EN 1175 Safety Function: 4.5.6.1 Deviation from Setpoint

The drive system shall be so designed that any deviation from operator setpoint caused by an electrical fault which could result in hazardous truck movement that cannot be controlled by the operator in the normal operating position is prevented.

MI-21 Software to Support Safety Function

Under normal operating conditions, air management and throttle control algorithms will prevent unintended throttle deviation from setpoint. Diagnostic coverage is provided by extensive sensor and actuator fault detection and fault management. In addition, if actual throttle position deviates from commanded throttle position by more than a calibratable threshold for more than a specified duration, a fault will be triggered resulting in engine shutdown. Commanded throttle position, as previously described, reflects the output of the MI-21 airflow manager which coordinates the various modes of operation (e.g., pedal control, max governor, min governor, road speed governor and power limiter).

The following calibration values are required:

Table 7-1. Required Calibration Values

| Parameter | Calibration Value |
|----------------------------|--------------------------|
| ETC_Sticking | Enabled |
| FaultActionRoute1Action | EngineShutdown |
| FaultActionRoute1Condition | TestFailedSinceKeyCycle |
| FaultActionRoute2Action | TurnOnMIL |
| FaultActionRoute2Condition | TestFailedSinceLastClear |
| ETC_StickingThresh | 20% |
| HBridgeFault_ETC | Enabled |
| SensVoltRangeHigh | Enabled |
| SensVoltRangeLow | Enabled |
| ETC_Open_Fault | Enabled |

Testing to Verify Deviation from Setpoint Safety Function

Verification of the logic can be achieved as follows.

- Overriding command to throttle h-bridge
- Confirm sticking fault is set
- Confirm safe engine shutdown and MIL lamp

Test Procedure

1. Configure ETCStickingFault as follows:
 - a. Fault Action1 = Engine Shutdown
 - b. Fault Condition1 = Test Failed Since Key Cycle
 - c. Fault Action2 = TurnOnMIL
 - d. Fault Condition2 = = Test Failed Since Key Cycle
2. Start engine, use app to run at around 1000 rpm
3. Set dyno to limit speed at around 1500 rpm (for vehicle testing, set overspeed Base Rev Limit =1400 rpm)
4. Monitor ETC_DutyCycle and use ETC_ovr and ETC_new to increase PWM duty cycle
5. ETC_Sticking fault should set, MIL should be illuminated and engine should shut down
6. Restart engine - exercise system, try to induce unintended fault
7. Restore ETCStickingFault calibrations to required values
8. Restore overspeed Base Rev Limit to original value

Required Calibrations

Figure 7-1. illustrates required calibrations.

ETC_Sticking_Fault

Master Enable

ETC_Sticking_FaultConfig Enabled ▾

Event Manager

✘ EventManagerFlag_ETC_Sticking

Fault Configuration I

Suspected X Limit counts

Suspected Y Limit counts

DriveCycle X Limit counts

DriveCycle Y Limit counts

Fault Configuration II

ETC_Sticking_EmissionsRelated Not Emissions-Related ▾

ETC_Sticking_OBDFaultID

ETC_Sticking_SPN

ETC_Sticking_FMI

ETC_Sticking_IsPermanent Not Permanent ▾

ETC_Sticking_FaultTest - ▾

FaultAction & Condition

FaultActionRoute1_Action TurnOnMIL ▾

FaultActionRoute1_Condition TestFailedSinceKeyCycle ▾

FaultActionRoute2_Action IdleMode ▾

FaultActionRoute2_Condition TestFailedSinceKeyCycle ▾

FaultActionRoute3_Action EngineShutdown ▾

FaultActionRoute3_Condition TestFailedSinceKeyCycle ▾

FaultActionRoute4_Action (None) ▾

FaultActionRoute4_Condition (None) ▾

Enabling Status & Condition

ETC_Sticking_Fault_Enabled Error ✘

Malfunction Criteria

ETC_StickingThresh %

Figure 7-1. ETC Sticking Fault Calibration Page from ToolKit

Chapter 8.

Uncontrolled Acceleration and Unintended Behavior

ISO EN 1175 Safety Function: 4.5.6.2 Uncontrolled acceleration from standstill on level ground

The drive system shall be so designed that uncontrolled hazardous acceleration from standstill on level ground is prevented

ISO EN 1175 Safety Function: 4.5.6.3 Unintended truck behavior while truck is moving

The drive system shall be so designed that unintended hazardous truck behavior while truck is moving is prevented. This safety function shall be in accordance with the PLr as defined in ISO EN 1175 Table 2. The following behavior caused by an electrical failure is considered hazardous:

- a) no reaction of reverse or neutral travel direction when demanded by the operator.
- b) acceleration unrelated to the operator input and uncontrollable by operator adjustment of speed control (accelerator) during travel operation on level ground that:
 - is higher than 30 % of the maximum acceleration achievable by the truck under no fault condition and/or
 - which results in a speed that exceeds the operator requested speed setpoint by more than 20 % of maximum speed achievable by the truck under no fault condition.

MI-21 Software to Support Safety Function:

Under normal operating conditions, the pedal control, air management and throttle control algorithms will prevent uncontrolled acceleration and unintended behavior. Diagnostic coverage is provided by extensive sensor and actuator fault detection and fault management. In addition, control loss logic exists that will set a diagnostic fault when all three of the following conditions are true:

- APP is close to idle (indicating operator wants idle rpm)
- RPM is above min gov
- Indicated torque is high

The min gov will account for ECT-based changes in speed setpoint and Min Gov Ramp Rate.

The control loss diagnostic fault will be disabled when either ASG or TSC1 is active

Testing to Verify Deviation from Setpoint Safety Function:

Testing of this safety function requires

- Pedal at minimum
- Use override to increase throttle setpoint
- Confirm safe engine shutdown and MIL lamp

Test Procedure

1. Start engine, set app at idle
2. Set dyno to limit speed at around 1200 rpm (for vehicle testing, set overspeed Base Rev Limit =1400 rpm)
3. Use TPSReq_ovr and TPSReq_new to override throttle setpoint. Try 40%
4. ControlLossFault should set, MIL should be illuminated, and engine should shutdown.
5. Set TPSReq_ovr = 0, restore Overspeed Base Rev Limit to original value.
6. Restart engine - exercise system, try to induce unintended fault

Required Calibrations

The following calibration values are required.

Table 8-1. Required Calibration Values

| Parameter | Calibration Value |
|----------------------------|--------------------------|
| AllSpeedGovEnable | Disabled |
| TSC1_Enable | Disabled |
| ControlLossFault | Enabled |
| FaultActionRoute1Action | EngineShutdown |
| FaultActionRoute1Condition | TestFailedSinceKeyCycle |
| FaultActionRoute2Action | TurnOnMIL |
| FaultActionRoute2Condition | TestFailedSinceLastClear |
| ControlLossTPSSetPt | 10% |
| ControlLossRPM | 200 rpm |
| ControlLossTorque | 35% |
| ControlLossFaultDelay | 2 sec |

Figure 8-1. Control Loss Fault Calibration Page from ToolKit

Chapter 9.

Speed Limitation

ISO EN 1175 Safety Function: 4.5.10 Speed Limitation

The electrical system limiting truck speed shall be so designed that the admissible maximum speed on level ground is not exceeded. In the event of an electrical fault the transition to the safe state, as defined (see Chapter 2) shall be initiated.

MI-21 Software to Support Safety Function

Under normal operating conditions, the Road Speed Governor, air management and throttle control algorithms will limit vehicle speed. Diagnostic coverage is provided by extensive sensor and actuator fault detection and fault management. In addition, logic exists to detect failure of the vehicle speed and limit engine rpm to assure safe operation

One means to identify a missing road speed sensor is its absence when it should be present. Under normal conditions, any time the engine is under load and above the min gov speed, there should be a road speed signal present. An exception occurs when the vehicle is stationary, and the operator depresses the pedal while raising the load to increase raise speed. However, this condition should only persist long enough to raise the load. As a result, if the engine is under load and above the min gov speed and road speed is absent for more than about 20-30 seconds, there may be a problem with the Road Speed Sensor. When this occurs, the max governor set speed shall be reduced to avoid exceeding the normal vehicle speed limit. If the road speed reappears, the max governor set speed will be ramped back up to its normal value and the road speed governor will resume its normal operation.

Testing to Verify Deviation from Setpoint Safety Function

Testing of this safety function requires the following:

- Set dyno to 2200 rpm
- Increase pedal to 40% load without VSS
- Engine should run at 2200 rpm for 30 seconds
- RoadSpeedAbsent Fault will set, MIL will illuminate, and rpm will ramp down to 1200 rpm
- Provide vehicle speed of about 10 kph
- Engine speed should ramp back up to 1500 rpm

Test Procedure

1. Start engine
2. Set dyno to limit speed at around 2200 rpm
3. Increase pedal to about 40% load
4. Engine should run at 2200 rpm for 30 seconds
5. RoadSpeedAbsent Fault will set, MIL will illuminate, and rpm will ramp down to 1200 rpm
6. Provide vehicle speed of about 10 kph (on dyno, set RoadSpdInput_Select = 1/RPM Based)
7. Engine speed should ramp back up to 2200 rpm, MIL should turn off

Required Calibrations

The following calibration values are required.

Table 9-1. Required Calibration Values

| Parameter | Calibration Value |
|--------------------------------|-------------------|
| RoadSpeedAbsentFault | Enabled |
| FaultActionRoute1Action | RPMLimit |
| FaultActionRoute1Condition | TestFailing |
| FaultActionRoute2Action | TurnOnMIL |
| FaultActionRoute2Condition | TestFailing |
| VSSLossMin | 2 kph |
| VSSLossRPM | 200 rpm |
| VSSLossHyst | 5 kph |
| VSSLossTorque | 30% |
| VSS_AbsentDelay | 30 sec |
| VSS_PresentDelay | 3 sec |
| RPMLimitFA_RampRateUp | 100 rpm/sec |
| RPMLimitFA_RampRateDn | 500 rpm/sec |
| MaxGovInFaultSetPtCal | 1200 rpm |
| RoadSpdInput_Select_EOL_Select | 0/noEOL |
| RoadSpdInput_Select | 0/disabled |
| RPMtoKPHGain_EOL_Select | 0/noEOL |
| RPMtoKPHGain | 0.01 |

Road Speed Sensor Faults

Figure 9-1. Road Speed Absent Fault

Road Speed Noise Fault

Master Enable
 RoadSpdNoiseFault_FaultConfig Disabled

Event Manager
✘ EventManagerFlag_RoadSpdNoiseFault

Fault Configuration I

Suspected X Limit counts

Suspected Y Limit counts

RoadSpdNoiseFaultDriveCycleXLimit counts

RoadSpdNoiseFaultDriveCycleYLimit counts

Fault Configuration II

RoadSpdNoiseFault_EmissionsRelated Not Emissions-Related

RoadSpdNoiseFault_OBDFaultID

RoadSpdNoiseFault_SPN

RoadSpdNoiseFault_FMI

RoadSpdNoiseFault_IsPermanent Not Permanent

RoadSpdNoiseFault_FaultTest -

FaultAction & Condition

FaultActionRoute1_Action TurnOnMIL

FaultActionRoute1_Condition TestFailedSinceKeyCycle

FaultActionRoute2_Action RPMLimit

FaultActionRoute2_Condition TestFailed

FaultActionRoute3_Action (None)

FaultActionRoute3_Condition (None)

FaultActionRoute4_Action (None)

FaultActionRoute4_Condition (None)

Enabling Status & Condition

RoadSpdNoiseFaultFault_Enabled Error ✘

Malfunction Criteria

RoadSpdDutyClnRange Error ✘

Malfunction Criteria

{ RoadSpd_DC_LowerThresh %

> SPD_DutyCycle < ✘ Error %

RoadSpd_DC_UpperThresh } %

Malfunction Criteria

SPD_Frequency ✘ Error Hz

> RoadSpd_Freq_UpperThresh Hz

Figure 9-2. Road Speed Noise Fault

SENSOR. SPEED INPUT

ROAD SPEED SENSOR

Road Speed Sensor

SPD_PassivePullDirection_PullDirection

RoadSpeedHz Hz

VSpd_ConvConst kph/Hz

VSpd_ConvConst_EOL kph/Hz

VSpdtoKPHGain_EOL_Select

RoadSpd_FiltrConst s

RoadSpeedRaw kph

Override

RoadSpeed_new kph

RoadSpeed_ovr

Road Speed Sensor Status

SPD_TimeoutThresh s

SPD_NewnessStatus

SPD_Timeout

ROAD SPEED INPUT CONFIG

Road Speed Input Configuration

RoadSpeedMode

Road_speed_final kph

RoadSpdInput_Select

RoadSpdInput_Select_EOL

RoadSpdInput_Select_EOL_select

RoadSpd_0_or_100_DC_Delay s

RoadSpd_DC_LowerThresh %

RoadSpd_DC_UpperThresh %

RoadSpd_FiltrConst s

RoadSpd_Freq_UpperThresh Hz

RoadSpdDutyClnRange

Road Speed Override

RoadSpd_kph kph

RoadSpeed_new kph

RoadSpeed_ovr

RPM BASED ROAD SPEED

RPM Based Road Speed

RPM rpm

RPMtoKPHGain kph/rpm

RPMtoKPHGain_EOL kph/rpm

RPMtoKPHGain_EOL_select

RPMtoKPHFiltConst s

RPM_kph kph

Road Speed Sensor Override

SPD_DutyCycle %

SPD_DutyCycle_new %

SPD_DutyCycle_ovr

SPD_Frequency Hz

SPD_Frequency_new Hz

SPD_Frequency_ovr

Figure 9-3. Speed Sensor Input Calibration

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Chapter 10.

Microprocessor Fault Detection

Diagnostic coverage of microprocessor faults improves diagnostic coverage of the MI-21 system.

IMPORTANT

These safety features are factory calibrated by Woodward, Inc. Changes to any of these features without consent by Woodward will invalidate warranty claims.

MI-21 Software to Support Safety Functions

Diagnostics provide coverage for microprocessor faults. The following features are supported.

Reset Cause

- Reset Cause block shall be read once per CPU reset (Typically power cycle)
- If the reset cause is unexpected, > 2, a fault shall be set

Task/Kernel/Interrupt Stack and Heap Margin

- The Task Info block shall be used to read the stack margin and min bytes free for each task
- Min bytes free should be refreshed in CPU idle mode
- A fault shall be set when the min byte free value is less than the margin
- Using non-custom task, the default task names to be supported are:
 - FGNDTask
 - FGNDAngleTask
 - BGNDTask
 - ApplicationInterruptTask
 - MainAppTask
 - SHUTDOWNTask
- The InterruptTask shall follow the same requirements, but the stack information is read using the OS Info block instead of the Task Info block.
- The Kernel Stack min bytes free shall be read via the OS Info block. A calibration shall be used for margin. The Kernel Stack allocation is predefined and fixed in MotoHawk and should never overflow.
- The Heap peak usage, margin, and allocation shall be read via the OS Info block. The min byte free shall be computed and compared to the margin as the above requirements.
- Stack allocations and margins need to be evaluated with each release and each configuration by executing the application in a variety of operating scenarios, such as a Test Stand Procedure (TSP).

CPU Idle Percent

- CPU Idle shall be read using the OS Info block
- A fault shall be set if CPU Idle is less than a calibrated margin (10% default)

EEPROM

- Memory Region based Buffered EEPROM shall be used
- For MY17 SECM70 this is enabled by default

Application CRC (Cyclic Redundancy Check)

- Use the Image Validation Definition to enable Bootloader validation of the application image for DEV and PROD builds.
- Also enable CAL validation for PROD builds
- This enables the bootloader to perform a CRC check on calibration at startup
- Enable Image validation including calibration after flash shall be enabled for both DEV and PROD

- This enables the softboot to validate the entire flash contents have been downloaded correctly and report an error if not

CVN (Calibration Verification Number)

- CVN shall be computed and reported
- Current CVN and status shall be reported via applicable protocols
 - J1939 – DM19
 - ISO15765 – InfoType 0x06 and/or DID 0xF806
 - Probe for XCP based tools and MotoTune
- CVN can be used to determine that the executing application software and calibration are what is intended for the target system

Protected Access for Vector/Matric Indexing

- Protected access shall be enabled for all vector and matrix access via index
- Access error status shall be read
- A combined fault shall be used to report any access error
 - A combined flag can be used or
 - The OBD Fault Set block can be used

Idle Loop Time and Starvation Timeout

- Idle Loop Time shall be read
- Last time shall be used to set a fault if time is greater than a calibrated maximum (default 250ms)
- The Starvation Timer Definition block shall be used to set the starvation timeout, which is the loop time above which the module will reset (300ms)
- Maximum Idle Loop time shall be logged to NV and used to determine appropriate starvation timeout and/or CPU usage

Slip Detection

- Trigger slip detection shall be enabled
- Calibration and Instrumentation shall be enabled for all applicable options.
- Slip Tolerance default shall be set to 100% (indicating a full execute time has been missed)
- Max observed time shall be logged in NV and can be used to make decisions regarding task/trigger scheduling
- A fault shall be set when the max observed time is greater than a calibrated value (default 200% of periodic rate)

Redundant Calibration

- Redundant Calibration shall be enabled using the Redundant Calibration Definition block

Memory ECC faults

- The Memory Fault Definition and Get blocks can be used to provide additional detail when an ECC failure reset occurs.
- The Reset Cause block will report an ECC failure reset, but not the memory type or address

Required Calibrations

Calibration parameters for the Microprocessor faults can be found on the following ToolKit pages:

Diagnostic – CPU Faults – CPU load
Diagnostic – CPU Faults – Memory
Diagnostic – CPU Faults – Slip Detection 1
Diagnostic – CPU Faults – Slip Detection 2
Diagnostic – CPU Faults – Stack Monitor 1
Diagnostic – CPU Faults – Stack Monitor 2

Chapter 11.

Customer Verification of MI-21

Failure Modes and Effects Testing

Vehicle OEM shall perform a Failure Modes and Effects Test (FMET) following final calibration and prior to production release of new MI-21 software.

FMET requires the vehicle OEM to obtain a representative vehicle, install the new OEM software with calibration, and induce the faults listed in the Appendix of this manual to confirm the following:

- Faults are detected
- Faults are safely managed

Faults may be simulated by any of the following means:

- Wiring harness: Can simulate open circuit or short circuit faults
- Calibration: May modify fault thresholds to trigger faults
- Use FaultTest flag (e.g., APP1RangeHigh_FaultTest) to trigger fault

Chapter 12.

Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (EngineHelpDesk@Woodward.com) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full-Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at www.woodward.com/local-partner.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime.

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option, with the exception that the unit will be returned to you in “like-new” condition. This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- return number
- name and location where the control is installed
- name and phone number of contact person
- complete Woodward part number(s) and serial number(s)
- description of the problem
- instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:

- protective caps on any connectors
- antistatic protective bags on all electronic modules
- packing materials that will not damage the surface of the unit
- at least 100 mm (4 inches) of tightly packed, industry-approved packing material
- a packing carton with double walls
- a strong tape around the outside of the carton for increased strength

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- the part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- the unit serial number, which is also on the nameplate

Engineering Services

Woodward's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at www.woodward.com/local-partner.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at www.woodward.com/support, where you may also find the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

| <u>Facility</u> | <u>Phone Number</u> |
|-----------------|---------------------|
| Brazil | +55 (19) 3708 4800 |
| China | +86 (512) 8818 5515 |
| Germany | +49 (711) 78954-510 |
| India | +91 (124) 4399500 |
| Japan | +81 (43) 213-2191 |
| Korea | +82 (32) 422-5551 |
| Poland | +48 (12) 295 13 00 |
| United States | +1 (970) 482-5811 |

Products Used in Engine Systems

| <u>Facility</u> | <u>Phone Number</u> |
|-----------------|---------------------|
| Brazil | +55 (19) 3708 4800 |
| China | +86 (512) 8818 5515 |
| Germany | +49 (711) 78954-510 |
| India | +91 (124) 4399500 |
| Japan | +81 (43) 213-2191 |
| Korea | +82 (32) 422-5551 |
| The Netherlands | +31 (23) 5661111 |
| United States | +1 (970) 482-5811 |

Products Used in Industrial Turbomachinery Systems

| <u>Facility</u> | <u>Phone Number</u> |
|-----------------|---------------------|
| Brazil | +55 (19) 3708 4800 |
| China | +86 (512) 8818 5515 |
| India | +91 (124) 4399500 |
| Japan | +81 (43) 213-2191 |
| Korea | +82 (32) 422-5551 |
| The Netherlands | +31 (23) 5661111 |
| Poland | +48 (12) 295 13 00 |
| United States | +1 (970) 482-5811 |

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.

MI-21 Fault Specifications

Table A-1. MI-21 Fault Specifications

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|---|---|
| 131 | 651/4 | Inj1Fault Fuel Injector 1 open circuit, broken injector 1 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 132 | 652/4 | Inj2Fault Fuel Injector 2 open circuit, broken injector 2 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 133 | 653/4 | Inj3Fault Fuel Injector 3 open circuit, broken injector 3 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 134 | 654/4 | Inj4Fault Fuel Injector 4 open circuit, broken injector 4 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 135 | 655/4 | Inj5Fault Fuel Injector 5 open circuit, broken injector 5 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 136 | 656/4 | Inj6Fault Fuel Injector 6 open circuit, broken injector 6 wire or defective injector | TurnOnMIL DisableLiquidO2Ctrl DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 141 | 110/4 | ECTRangeLow Engine Coolant Temperature Sensor voltage too Low. Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed. | TurnOnMIL Level3PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 151 | 110/3 | ECTRangeHigh Engine Coolant Temperature Sensor voltage too High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the ECU or shorted to power. | TurnOnMIL Level3PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 161 | 110/0 | ECTOverTempFault Engine Coolant Temperature too High. The sensor has measured an excessive coolant temperature typically due to the engine overheating. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|------------------------------------|---|
| 171 | 110/2 | ECT_IR_Fault Engine Coolant Temperature lower than expected Normally set if Coolant Temperature sensor is not responding to changes in actual temperature. | TurnOnMIL | Test Failed Since Key Cycle |
| 181 | 6317/7 | FuelSelectConflict Fuel select switch indicate the both fuel is selected at the same time. Normally set if fuel selection switch wiring harness is shorted to ground. | TurnOnMIL EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 191 | 637/7 | CamEdgesFault CAM Loss Fault The purpose of this diagnostics algorithm is to check CAM Sensor Loss Fault. The fault can be caused by cam sensor failure, unconnected cam sensor, or shorted to ground. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 192 | 637/2 | CamSyncFault CAM Sync Fault The purpose of this diagnostics is to detect CAM Sensor Sync Fault. The fault can be caused by CAM sensor shifting or Crank sensor shifting. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 193 | 636/7 | CrankEdgesFault Crank Loss Fault The purpose of this diagnostics is to detect Crank Sensor Loss Fault. The fault can be caused by crank sensor failure, unconnected crank sensor, or shorted to ground. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 194 | 636/2 | CrankSyncFault Crank Sync Fault The purpose of this diagnostics is to detect Crank Sensor Sync Fault. The fault can be caused by Crank sensor shifting or CAM sensor shifting. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 221 | 51/4 | TPS1RangeLow TPS1 Voltage Range Low Fault This fault indicates TPS1 signal line has shorted to XDRG or ground, or TPS1 signal line has opened. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|-------------------------------|--|
| 222 | 3673/4 | TPS2RangeLow TPS2 Voltage Range Low Fault This fault indicates TPS2 signal line has shorted to XDRG or ground, or TPS2 signal line has opened. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 231 | 51/3 | TPS1RangeHigh TPS1 Voltage Range High Faults This fault indicates TPS1 signal line has shorted to XDRP or power line. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 232 | 3673/3 | TPS2RangeHigh TPS2 Voltage Range High Faults This fault indicates TPS2 signal line has shorted to XDRP or power line. | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 241 | 51/1 | TPS1AdaptLoMin TPS1 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS1 voltage is above a rational low threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 242 | 3673/1 | TPS2AdaptLoMin TPS2 Low Adapt Min Faults The purpose of this diagnostic is to make sure the TPS2 voltage is above a rational low threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 251 | 51/16 | TPS1AdaptHiMax TPS1 High Adapt Max Faults The purpose of this diagnostic is to make sure the TPS1 voltage is below a rational high threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 252 | 3673/16 | TPS2AdaptHiMax TPS1 High Adapt Max Faults The purpose of this diagnostic is to make sure the TPS2 voltage is below a rational high threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure. | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|-------------------------------|--|
| 271 | 51/18 | <p>TPS1AdaptHiMin TPS1 High Adapt Min Faults The purpose of this diagnostic is to make sure the TPS1 voltage is above a rational low threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 272 | 3673/18 | <p>TPS2AdaptHiMin TPS2 High Adapt Min Faults The purpose of this diagnostic is to make sure the TPS2 voltage is above a rational low threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 281 | 51/0 | <p>TPS1AdaptLoMax TPS1 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS1 voltage is below a rational high threshold. This fault can be caused by TPS1 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 282 | 3673/0 | <p>TPS2AdaptLoMax TPS2 Low Adapt Max Faults The purpose of this diagnostic is to make sure the TPS2 voltage is below a rational high threshold. This fault can be caused by TPS2 sensor drifting or throttle mechanism failure.</p> | TurnOnMIL Level4PowerLimit | Failed Last Drive Cycle Failed Last Drive Cycle |
| 291 | 51/7 | <p>TPS_Sensors_Conflict TPS Sensor Conflict Faults The purpose of this diagnostic is to detect a potential situation where the TPS1 and TPS2 position disagree the throttle position. The fault can be caused by a failed position sensor or fouling on the traces in the throttle.</p> | TurnOnMIL CutThrottle | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|------------------------------------|--|
| 292 | 51/2 | TPS_Intermittent TPS Intermittent Faults The purpose of this diagnostic is to monitor all the suspected or Failed TPS faults. The fault can be caused by TPS1 or TPS2 sensor drifting, throttle mechanical failure, short to ground/5V, or open TPS conditions. | TurnOnMIL | Test Failed Since Key Cycle |
| 331 | 102/17 | MAPTimeRangeLow Manifold Absolute Pressure Sensor Voltage is Low Normally set if the TMAP pressure signal wire has been disconnected or shorted to ground | TurnOnMIL | Test Failed Since Key Cycle |
| 332 | 102/4 | MAPRangeLow Manifold Absolute Pressure Sensor Voltage is Low Normally set if the TMAP pressure signal wire has been disconnected or shorted to ground | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 341 | 102/15 | MAPTimeRangeHigh Manifold Absolute Pressure Sensor Voltage is High Normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, or the TMAP has failed | TurnOnMIL | Test Failed Since Key Cycle |
| 342 | 102/3 | MAPRangeHigh Manifold Absolute Pressure Sensor Voltage is High Normally set if the TMAP pressure signal wire has become shorted to power, shorted to the MAT signal, or the TMAP has failed | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 351 | 102/0 | MAP_IR_HI Manifold Absolute Pressure sensor indicates higher pressure than expected | TurnOnMIL | Test Failed Since Key Cycle |
| 352 | 102/1 | MAP_IR_LO Manifold Absolute Pressure sensor indicates lower pressure than expected | TurnOnMIL | Test Failed Since Key Cycle |
| 353 | 102/2 | MAP_STICKING Manifold Absolute Pressure sensor not changing as expected | TurnOnMIL | Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--|---|
| 361 | 18/3 | FuelPressureRangeHigh Fuel pressure sensor voltage above normal operating range | TurnOnMIL DisablePreCatO2Adapt DisablePostCatO2Adapt | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 362 | 18/4 | FuelPressureRangeLow Fuel pressure sensor voltage below normal operating range | TurnOnMIL DisablePreCatO2Adapt DisablePostCatO2Adapt | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 363 | 18/15 | FuelPress_IR_HI Fuel pressure is higher than expectation | TurnOnMIL | Test Failed Since Key Cycle |
| 364 | 18/17 | FuelPress_IR_LO Fuel pressure is lower than expectation | TurnOnMIL | Test Failed Since Key Cycle |
| 371 | 105/4 | IATRangeLow Engine IAT Sensor voltage too Low. Normally set if the coolant sensor wire has shorted to chassis ground or the sensor has failed. | TurnOnMIL | Test Failed Since Key Cycle |
| 381 | 105/3 | IATRangeHigh Engine IAT Sensor voltage too High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the ECU or shorted to power. | TurnOnMIL | Test Failed Since Key Cycle |
| 391 | 105/2 | IAT_IR_Fault IAT lower than expected Normally set if IAT sensor is not responding to changes in actual temperature. | TurnOnMIL | Test Failed Since Key Cycle |
| 421 | 1268/3 | EST1_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 1 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 422 | 1269/3 | EST2_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 2 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|---|---|
| 423 | 1270/3 | EST3_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 3 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 424 | 1271/3 | EST4_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 4 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 425 | 1272/3 | EST5_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 5 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 426 | 1273/3 | EST6_Fault The purpose of this diagnostic is to detect open or short circuit condition for ignition coil 6 primary side. The fault can be caused by open or short circuit for primary coil line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 431 | 84/10 | RoadSpdNoiseFault The vehicle speed sensor duty cycle or frequency is outside expected limits | TurnOnMIL RPMLimit | Test Failed Since Key Cycle Test Failed |
| 432 | 84/2 | RoadSpeedAbsentFault The vehicle speed sensor is reading lower than expected over a period. | TurnOnMIL RPMLimit | Test Failed Test Failed |
| 461 | 3464/7 | ETC_Sticking Throttle Sticking Faults The purpose of this diagnostics is to monitor if the throttle is sticking and not tracking the setpoint. This fault can be caused by mechanical throttle failures, contamination, and debris. | TurnOnMIL IdleMode EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|---|---|
| 471 | 3464/5 | ETC_Open_Fault Throttle Open Faults The purpose of this diagnostics is to monitor if the H-Bridge throttle circuit is open, which would result in the loss of throttle control. This fault can be caused by throttle failures or overdriven throttles | TurnOnMIL CutThrottle DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 481 | 3464/2 | ETCSpringTest Throttle Spring Test Faults The purpose of this diagnostics is to monitor if the internal spring in the throttle closes the throttle when the throttle motor is powered off. This fault can be caused by mechanical throttle failures, contamination, and debris. | TurnOnMIL EngineShutdown | Failed Last Drive Cycle Failed Last Drive Cycle |
| 491 | 3464/6 | HBridgeFault_ETC Throttle Driver H-Bridge Faults The purpose of this diagnostic is to monitor the throttle H-Bridge driver chip condition. The H-Bridge chip senses overtemp condition due to high current outputs. If the H-Bridge chip determines there is a short condition or the HBridge driver current is above a calibratable threshold for a calibratable time period, this fault will set. The fault can be caused by throttle failures or overdriven throttles. | TurnOnMIL CutThrottle DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 521 | 100/1 | LowOilPressureFault Low oil pressure while the engine is running. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 522 | 100/3 | OilPressureRangeHigh Oil pressure sensor voltage above normal operating range | TurnOnMIL Level3PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 523 | 100/4 | OilPressureRangeLow Oil pressure sensor voltage below normal operating range | TurnOnMIL Level3PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 524 | 100/5 | LSDFault_LowOilPLampFault Low Oil Pressure Lamp Driver Line Short or Open Fault This monitor is to detect Low Oil Pressure Lamp open or short Fault. | TurnOnMIL | Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--|---|
| 525 | 175/16 | OilTemperatureHigh High oil temperature while key is on. | TurnOnMIL Level3PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 526 | 175/0 | OilTemperatureSevere Severe oil temperature while key is on. | TurnOnMIL Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 527 | 175/3 | OilTempRangeHigh Oil temperature sensor voltage above normal operating range | TurnOnMIL | Test Failed Since Key Cycle |
| 528 | 175/4 | OilTempRangeLow Oil temperature sensor voltage below normal operating range | TurnOnMIL | Test Failed Since Key Cycle |
| 531 | 158/4 | SysVoltRangeLow Battery Voltage Lower than Expected This fault indicates that the low system voltage supply or battery charging system failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 541 | 158/3 | SysVoltRangeHigh Battery Voltage Higher than Expected This fault indicates that the high system voltage supply or voltage regulator failure. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 551 | 1079/4 | SensVoltRangeLow XDRP 5V sensor power voltage lower than expected This fault indicates overload on XDRP line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 561 | 1079/3 | SensVoltRangeHigh XDRP 5V sensor power voltage higher than expected This fault indicates ECU internal circuit failure or short circuit to system power line. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 571 | 190/0 | HardOverspeed Engine speed has exceeded first level (1 of 3) of overspeed protection | TurnOnMIL HardRevLimit EngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 572 | 190/16 | MediumOverspeed Engine speed has exceeded second level (2 of 3) of overspeed protection | TurnOnMIL MediumRevLimit DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Test Failed Since Key Cycle |
| 573 | 190/15 | SoftOverspeed Engine speed has exceeded third level (3 of 3) of overspeed protection | TurnOnMIL SoftRevLimit | Test Failed Since Key Cycle Test Failed |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|---|---|
| 574 | 190/31 | APP1LockOverspeedFault Engine speed is higher than expected when APP has been overridden to 0% after startup when APP has not been below 3%. | TurnOnMIL EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 611 | 91/4 | APP1RangeLow APP1 Voltage Range Low Fault This fault indicates APP1 signal line has shorted to XDRG or ground, or APP1 signal line has opened. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 612 | 29/4 | APP2RangeLow APP2 Voltage Range Low Fault This fault indicates APP2 signal line has shorted to XDRG or ground, or APP2 signal line has opened. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 621 | 91/3 | APP1RangeHigh APP1 Voltage Range High Faults This fault indicates APP1 signal line has shorted to XDRP or power line. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 622 | 29/3 | APP2RangeHigh APP2 Voltage Range High Faults This fault indicates APP2 signal line has shorted to XDRP or power line. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 631 | 91/1 | APP1AdaptLoMin APP1 Low Adapt Min Faults The purpose of this diagnostic is to make sure the APP1 voltage is above a rational low threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 632 | 29/1 | APP2AdaptLoMin APP2 Low Adapt Min Faults The purpose of this diagnostic is to make sure the APP2 voltage is above a rational low threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 641 | 91/16 | APP1AdaptHiMax APP1 High Adapt Max Faults The purpose of this diagnostic is to make sure the APP1 voltage is below a rational high threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|---|---|
| 642 | 29/16 | APP2AdaptHiMax APP1 High Adapt Max Faults The purpose of this diagnostic is to make sure the APP2 voltage is below a rational high threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 651 | 91/18 | APP1AdaptHiMin APP1 High Adapt Min Faults The purpose of this diagnostic is to make sure the APP1 voltage is above a rational low threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 652 | 29/18 | APP2AdaptHiMin APP2 High Adapt Min Faults The purpose of this diagnostic is to make sure the APP2 voltage is above a rational low threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 661 | 91/0 | APP1AdaptLoMax APP1 Low Adapt Max Faults The purpose of this diagnostic is to make sure the APP1 voltage is below a rational high threshold. This fault can be caused by APP1 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 662 | 29/0 | APP2AdaptLoMax APP2 Low Adapt Max Faults The purpose of this diagnostic is to make sure the APP2 voltage is below a rational high threshold. This fault can be caused by APP2 sensor drifting or Pedal mechanism failure. | TurnOnMIL | Test Failed Since Key Cycle |
| 691 | 91/7 | APP_Sensors_Conflict APP Sensor Conflict Faults The purpose of this diagnostic is to detect a potential situation where the APP1 and APP2 position disagree the Pedal position. The fault can be caused by a failed position sensor or fouling on the traces in the Pedal. | TurnOnMIL IdleMode Level4PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|---|--|
| 711 | 6658/5 | LSDFault_Dither1 Dither Valve Faults The purpose of this diagnostic is to detect a wiring/circuit fault of dither valve. The fault can be caused by a failed dither valve or wiring harness open/short. | TurnOnMIL DisableGasO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 712 | 6659/5 | LSDFault_Dither2 Dither Valve Faults The purpose of this diagnostic is to detect a wiring/circuit fault of dither valve. The fault can be caused by a failed dither valve or wiring harness open/short. | TurnOnMIL DisableGasO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 713 | 257/5 | LSDFault_CSValve Cold start valve open/short | TurnOnMIL | Test Failed Since Key Cycle |
| 714 | 2648/5 | LSDFault_CheckEngine Check Engine Lamp Driver Line Short or Open Fault This monitor is to detect Check Engine Lamp open or short Fault. | TurnOnMIL | Test Failed Since Key Cycle |
| 715 | 677/5 | LSDFault_CrankDisable Starter Control Driver Line Short or Open Fault This monitor is to detect Starter Control open or short Fault. | TurnOnMIL | Test Failed Since Key Cycle |
| 716 | 6719/5 | LSDFault_FuelPump Fuel Pump Line Short or Open Fault This monitor is to detect fuel pump open or short Fault. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 717 | 632/4 | LSDFault_LockOff Lock-Off Driver Line Short or Open Fault The fuel lock off device(s) has an open or short condition. | TurnOnMIL DelayedEngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 718 | 1213/4 | LSDFault_MIL MIL Driver Line Short or Open Fault This monitor is to detect MIL open or short Fault. | TurnOnMIL | Test Failed Since Key Cycle |
| 719 | 854/5 | PreO2HeaterFault Pre O2 Heater open/short | TurnOnMIL DisableLiquidO2Ctrl DisableGasO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 720 | 855/5 | PostO2HeaterFault Post O2 Heater open/short | TurnOnMIL DisableLiqPostO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|---|--|--|
| 721 | 1695/18 | GasFuelAdaptRangeLow In LPG mode, system had to adapt rich more than expected | TurnOnMIL Level1PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 731 | 1695/16 | GasFuelAdaptRangeHi In LPG mode, system had to adapt lean more than expected | TurnOnMIL Level1PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 741 | 1118/2 | GasO2NotActive Pre-catalyst O2 sensor inactive on LPG, open O2 sensor signal or heater leads, defective O2 sensor | TurnOnMIL DisableGasO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 742 | 3227/8 | GasPostO2Inactive Post-catalyst O2 sensor inactive on LPG, open O2 sensor signal or heater leads, defective O2 sensor. | TurnOnMIL DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 743 | 724/8 | GaseousPostO2Switching Gas Post O2 sensor switched too much | TurnOnMIL DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 751 | 1118/17 | GasO2FailedLean Pre-catalyst O2 sensor indicates extended lean operation on LPG | TurnOnMIL DisableGasO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 752 | 3227/17 | GasPostO2FailedLean Pre-catalyst O2 sensor indicates extended lean operation on LPG | TurnOnMIL DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 771 | 1118/15 | GasO2FailedRich Pre-catalyst O2 sensor indicates extended rich operation on LPG | TurnOnMIL DisableGasO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 772 | 3227/15 | GasPostO2FailedRich Pre-catalyst O2 sensor indicates extended rich operation on LPG | TurnOnMIL DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 821 | 1695/16 | LiqFuelAdaptRangeHi In Gasoline mode, system had to adapt lean more than expected | TurnOnMIL Level1PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 831 | 1695/18 | LiqFuelAdaptRangeLow In Gasoline mode, system had to adapt rich more than expected | TurnOnMIL Level1PowerLimit | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 841 | 1118/2 | LiqO2NotActive Pre-catalyst O2 sensor inactive on gasoline, open O2 sensor signal or heater leads, defective O2 sensor | TurnOnMIL DisableLiquidO2Ctrl DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 842 | 3227/8 | LiqPostO2Inactive Post-catalyst O2 sensor inactive on gasoline, open O2 sensor signal or heater leads, defective O2 sensor. | TurnOnMIL DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 843 | 724/10 | LiquidPostO2Switching Liq Post O2 sensor switched too much | TurnOnMIL DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|---------|--|---|---|
| 851 | 1118/17 | LiqO2FailedLean Pre-catalyst O2 sensor indicates extended lean operation on gasoline | TurnOnMIL DisableLiquidO2Ctrl DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 852 | 3227/17 | LiqPostO2FailedLean Pre-catalyst O2 sensor indicates extended lean operation on gasoline | TurnOnMIL DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 871 | 1118/15 | LiqO2FailedRich Pre-catalyst O2 sensor indicates extended rich operation on gasoline | TurnOnMIL DisableLiquidO2Ctrl DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 872 | 3227/15 | LiqPostO2FailedRich Pre-catalyst O2 sensor indicates extended rich operation on gasoline | TurnOnMIL DisableLiqPostO2Ctrl | Test Failed Since Key Cycle Test Failed |
| 911 | 724/4 | O2RangeLow Pre-catalyst O2 sensor voltage out of range low, sensor signal shorted to ground | TurnOnMIL DisableLiquidO2Ctrl DisableGasO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 912 | 3227/4 | O2_PostCatRangeLow Post-catalyst O2 sensor voltage out of range low, sensor signal shorted to ground | TurnOnMIL DisableLiqPostO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 921 | 724/3 | O2RangeHigh Pre-catalyst O2 sensor voltage out of range high, sensor signal shorted to power | TurnOnMIL DisableLiquidO2Ctrl DisableGasO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 922 | 3227/3 | O2_PostCatRangeHigh Post-catalyst O2 sensor voltage out of range low, sensor signal shorted to ground | TurnOnMIL DisableLiqPostO2Ctrl DisableGasPostO2Ctrl | Test Failed Since Key Cycle Test Failed Test Failed |
| 931 | 3468/4 | FuelTempRangeLow Fuel Temperature Sensor voltage too low Normally set if the fuel temperature sensor wire has shorted to ground or the sensor has failed. | TurnOnMIL | Test Failed Since Key Cycle |
| 932 | 3468/3 | FuelTempRangeHigh Fuel Temperature Sensor voltage too high Normally set if the fuel temperature sensor wire has been disconnected or the circuit has opened to the ECU. | TurnOnMIL | Test Failed Since Key Cycle |
| 933 | 177/3 | TransOilTemp | TurnOnMIL RPMLimit | Test Failed Since Key Cycle Test Failed |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|----------|---|-----------------------------|--|
| 991 | 914/15 | ServiceFault1 Indicates that the interval for routine service has expired. | (None) | (None) |
| 992 | 914/16 | ServiceFault2 Indicates that the interval for routine service has expired. | (None) | (None) |
| 993 | 914/0 | ServiceFault3 Indicates that the interval for routine service has expired. | (None) | (None) |
| 994 | 1350/15 | ServiceFault4 Indicates that the interval for routine service has expired. | TurnOnMIL | Test Failed Since Key Cycle |
| 995 | 1350/16 | ServiceFault5 Indicates that the interval for routine service has expired. | TurnOnMIL | Test Failed Since Key Cycle |
| 941 | 518/19 | TSC1RxTimeoutFault TSC1 CAN message Source address 1 is not being received | TurnOnMIL IdleMode | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 951 | 513/16 | ControlLossFault Estimated engine torque is higher than expected at low pedal position. | TurnOnMIL EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 961 | 629/9 | CPU_HighLoad CPU usage is higher than calibrated maximum threshold. | TurnOnMIL | Test Failed Since Key Cycle |
| 962 | 629/11 | SRAMFault RAM Fault caused the module to reset. | TurnOnMIL EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 963 | 629/31 | FLASHFault Flash Memory Fault caused the module to reset. | TurnOnMIL EngineShutdown | Test Failed Since Key Cycle Test Failed Since Key Cycle |
| 964 | 516096/1 | ApplIntTask_MinStackFault Application Interrupt Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 965 | 516097/1 | BGNDTask_MinStackFault Background Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 966 | 516098/1 | FGNDAngleTask_MinStackFault Foreground Angle Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 967 | 516099/1 | FGNDTask_MinStackFault Foreground Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|-----------|--|--------------|-----------------------------|
| 968 | 516100/0 | HeapUsage_High Heap usage is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 969 | 516101/1 | InterruptTask_MinStackFault Interrupt Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 971 | 516102/1 | KernelTask_MinStackFault Kernel Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 972 | 516103/1 | MainAppTask_MinStackFault Main Application Interrupt Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 973 | 516104/1 | SHUTDOWNTask_MinStackFault Shutdown Task Stack last value calculated for min bytes Free is lower than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 974 | 516105/0 | IdleLoopTime_Fault last observed idle loop time is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 975 | 629/14 | InvalidCalibration_Fault Most recent calibration save attempt failed. Applied only to development modules. | TurnOnMIL | Test Failed Since Key Cycle |
| 976 | 516106/14 | UnexpectedReset_Fault Unexpected Reset cause observed on last CPU Reset | TurnOnMIL | Test Failed Since Key Cycle |
| 977 | 516107/14 | Vector_AccessFault Vector/Matrix indexing access error detected | TurnOnMIL | Test Failed Since Key Cycle |
| 978 | 516108/0 | FGND_5ms_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 979 | 516109/0 | FGND_10ms_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 981 | 516110/0 | FGND_20ms_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 982 | 516111/0 | BGND_50ms_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |

Table A-1. MI-21 Fault Specifications (cont'd.)

| DFC | SPN/FMI | Fault Name and Description | Fault Action | Fault Condition |
|-----|----------|---|--------------|-----------------------------|
| 983 | 516112/0 | BGND_500ms_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |
| 984 | 516113/0 | BGND_1s_SlipDetect_Fault the maximum observed Elapsed Time of this periodic trigger is higher than allowed threshold | TurnOnMIL | Test Failed Since Key Cycle |

References

EN ISO 1175:2020, *Safety of Industrial Trucks — Electrical/Electronic Requirements (ISO 1175:2020)*

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13849-2:2015, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation (ISO 13849-2:2015)*

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

Revision History

New Manual—

Declarations

DECLARATION OF INCORPORATION Of Partly Completed Machinery 2006/42/EC

File name: 00660-EU-02-01
 Manufacturer's Name: WOODWARD INC.
 Manufacturer's Address: 1041 Woodward Way
 Fort Collins, CO 80524 USA

Model Names: MI21 Systems

This product complies, where applicable, with the following requirements of EN 1175:2020, Chapter 4: 4.3.10.1, 4.3.10.2, 4.5.2, 4.5.5, 4.5.6.1, 4.5.6.2, 4.5.6.3, 4.5.10

Applicable Standards: EN 1175:2020: *Safety of industrial trucks - Electrical/electronic requirements*
 EN 12895:2015+A1:2019: *Industrial trucks — Electromagnetic compatibility*

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
 Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Inc. of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER

Signature: 
 Full Name: Annette Lynch
 Position: Engineering Manager
 Place: Woodward Inc., Fort Collins, CO, USA
 Date: 05-January-2023

**DECLARATION OF INCORPORATION
Of Partly Completed Machinery
S.I. 2008 No. 1597**

File name: 00660-EU-UKCA-02-01
Manufacturer's Name: WOODWARD INC.
Manufacturer's Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Names: MI21 Systems

This product complies, where applicable, with the following requirements of EN 1175:2020, Chapter 4: 4.3.10.1, 4.3.10.2, 4.5.2, 4.5.5, 4.5.6.1, 4.5.6.2, 4.5.6.3, 4.5.10

Applicable Standards: EN 1175:2020: *Safety of industrial trucks - Electrical/electronic requirements*
EN 12895:2015+A1:2019: *Industrial trucks — Electromagnetic compatibility*

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

The person authorized to compile the technical documentation:

Name: Andy Marshall, General Manager at Woodward Prestwick
Address: 5 Shawfarm Road, Prestwick, Ayrshire, Scotland, United Kingdom KA9 2TR

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Inc. of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Regulation S.I. 2008 No. 1597 as partly completed machinery:

MANUFACTURER



Signature

Annette Lynch

Full Name

Engineering Manager

Position

Woodward Inc., Fort Collins, CO, USA

Place

05-January-2023

Date

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication **35218**.



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