



SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Misfire Generator Functional Requirements

RATIONALE

This SAE Recommended Practice provides performance requirements and guidelines for misfire generators for spark and compression ignition misfire generators.

FOREWORD

Historically, SAE has provided recommended practices where necessary to provide guidance to the automotive industry. Currently, misfire generators are required for misfire demonstration purposes to regulatory groups, and often used for development and calibration. Given the increase of world-wide marketing of motor vehicles and harmonization efforts, it is of interest to all vehicle manufacturers and control system suppliers to have an up-to-date recommended practice for a misfire generator that is applicable to most types of combustion control systems.

INTRODUCTION

This set of requirements identifies the means in which certain misfire functions shall operate. It is intended to provide the operating guidelines for certain required and developmental functions, standardize a minimum user interface, and establish the minimum hardware performance criteria. An ideal misfire generator for demonstration purposes is an external device capable of inhibiting combustion by only being connected to the vehicle through the vehicles electrical harness. If a user of this set of requirements were to intend to create a software based misfire generator, all aspects of misfire patterns, synchronization, and control signal timing shall be adhered to in order to ensure a compliant misfire pattern. Additional clarification as to how any software based misfire generator interacts with a vehicles control system may need to be provided to any regulatory executive officer for approval. It will not set nor force constraints upon the misfire generator's internal configuration or components other than the minimum hardware performance criteria. This will allow potential manufacturers to design a misfire generator without hardware technology constraints.

Unless otherwise identified within a given individual requirement within this SAE J2901 document, all references to misfire and engine operation shall pertain to all spark ignition or fuel injector control signals for a targeted combustion event in engines which support either single or multi-strike mode. Unless a requirement is stated to be an optional content or feature, the requirement shall be considered to describe required content or feature to be included in the misfire generator design.

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1. SCOPE

The intent of the specification is to present a functional set of requirements which define the user and hardware interfaces while providing sufficient capability to meet the misfire patterns for compliance demonstration and engineering development. Throughout this requirement, any reference to “ignition or injector control signal” is used interchangeably to infer that the effected spark ignition engine's ignition control signal or the compression ignition engine's injector control signal is interrupted, timing phased, or directly passed by the misfire generator.

For spark ignition engines, the misfire generator behaves as a spark-defeat device which induces misfires by inhibiting normal ignition coil discharge. It does so by monitoring the vehicle's ignition timing signals and suspends ignition coil saturation for selected cylinder firing events. The misfire generator will thereby induce engine misfire in spark ignited gasoline internal combustion engines; including rotary engines.

For compression ignition engines, the misfire generator behaves as a fuel injection-defeat device which induces misfire by inhibiting the normal fuel injection pulses. It does so by monitoring the injection pulses signal and suspending the injection pulses for selected cylinder firing events. The misfire generator will thereby induce engine misfire in compression ignition engines.

This requirement assumes that the user has a fundamental understanding of misfire diagnostics as well as ignition controls. This requirement is not intended to be an introductory misfire guideline or interpretation of regulatory requirements.

1.1 Purpose

This document is intended to define the standards for misfire generators which will be used in vehicles that are required to detect and report misfire to regulatory groups.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1930 Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms

3. TERMS AND DEFINITIONS

For the purposes of this document, the terms and definitions given in SAE J1930 and the following apply:

- **ACCELERATOR PEDAL** - A foot operated device which, directly or indirectly, controls the flow of fuel and/or air to the engine, controlling engine speed.
- **BANK** - Specific group of cylinders sharing a common control sensor, bank 1 always containing cylinder number 1, bank 2 the opposite bank.
- **BATTERY** - An electrical storage device designed to produce a DC voltage by means of an electrochemical reaction.
- **CAMSHAFT** - A shaft on which phased cams are mounted. The camshaft is used to regulate the opening and closing of the intake and exhaust valves.
- **CATALYST** - A substance that can increase or decrease the rate of a chemical reaction between substances without being consumed in the process. In automotive usage, the term catalyst is used to designate a device containing such substances for the purpose of lowering levels of harmful emissions in the exhaust gas that passes through it.

- **COIL (IGNITION)** - An electrical transformer device consisting of windings of conductors around an iron core, designed to increase the voltage, and for use in a spark ignition system.
- **CONTROL** - (1) A means or a device to direct and regulate a process or guide the operation of a machine, apparatus, or system. (2) An architectural system element which contains the algorithm for translating input mechanism abstractions into output mechanism abstractions and implements the desired customer and system behaviors for a given function or feature (SAE J1213-1).
- **CYLINDER DEACTIVATION** - An engine control strategy whereby some of the cylinders will be unfired, hence deactivated, under certain operating conditions in order to increase fuel economy. Although methodology may be different between manufactures, deactivated cylinders have some combination of being unfueled, unsparked, and valve actuation disabled.
- **DEVICE** - A piece of equipment or a mechanism designed for a specific purpose or function.
- **ELECTRICAL** - A type of device or system using actuators, motors, generators, solenoids, switches, relays, etc. and generally involving higher current flow than electronic systems or devices.
- **ELECTRONIC** - (1) A type of device or system using diodes, transistors, integrated circuits, microprocessors, etc. and generally involving lower current flow than electrical systems or devices. (2) The storage, retrieval, and display of information through media such as magnetic tape, laser disc, electronic read only memory (ROM), and random-access memory (RAM).
- **ENGINE** - A machine designed to convert thermal energy into mechanical energy to produce force or motion.
- **ENGINE CYCLE** - The duration in which it takes for an engine to complete the sequence of steps associated with its particular design. A four-stroke engine's engine cycle will be completed once all four phases have completed; intake, compression, power, and exhaust.
- **ENGINE CYCLE MODE** - Describes a mode of operation in which the misfire generator will use engine cycles as the means to determine the interval between independent control signal interrupts; ignition coil for spark ignition engines, or fuel injector for compression ignition engines.
- **GROUND** - An electrical conductor used as a common return for an electric circuit(s) and with a relative zero potential.
- **IGNITION** - System used to provide a high voltage spark for internal combustion engines.
- **IGNITION CONTROL MODULE** - A component in which the Ignition Driver and Coil are combined.
- **IGNITION DRIVER** - An electronic switch that controls the coil's primary winding current.
- **INJECTOR DRIVER** - An electronic switch that controls the injector current or voltage.
- **INTEGRATED DRIVER** - A common name for an Ignition Control Module.
- **MISFIRE** - A lack of combustion in the cylinder due to absence of spark, poor fuel metering, poor compression, or any other cause. This does not include lack of combustion events in non-active cylinders due to default fuel shut-off or cylinder deactivation strategies. This definition correlates to the CARB definition for "Engine Misfire". The misfire described in this document is the result of defeating all ignition or injector control signals intended for a combustion event.
- **MISFIRE GENERATOR - CONTROL UNIT** - A component of the misfire generator assembly designed to interrupt ignition or injector control signals. This unit may also contain user inputs and outputs and displays.
- **MISFIRE GENERATOR** - The misfire generator assembly, whose purpose is to artificially induce a lack of combustion in one or more cylinders of an internal combustion engine. The misfire generator can consist of, but is not limited to the misfire control unit, remote unit, and remote unit interface harness.

- **MULTI-STRIKE** – A spark ignition system designed to provide more than one ignition control signal for a given combustion event. A multi-strike capable system can be calibrated to provide one or multiple ignition control signals per combustion event.
- **REMOTE UNIT INTERFACE HARNESS** - A component of the misfire generator assembly that is intended to connect the misfire generator control unit and misfire remote unit to the vehicle wiring harness.
- **REMOTE UNIT** - A component of the misfire generator assembly intended to manage high current control signals. This unit may also contain user inputs and outputs and displays.
- **SMART COIL** - A generic term often used to describe an ignition control module which has an integrated coil driver.
- **SWITCH** - A device for making, breaking, or changing the connections in an electrical circuit.
- **VOLTAGE (HIGH)** - A voltage level greater than 60 VDC (e.g., 300 V systems)
- **VOLTAGE (LOW)** - A voltage level less than or equal to 30 VDC (e.g., 14 V systems)
- **WASTE SPARK** - Ignition system in which a single coil is used to fire opposing pair of cylinders twice per engine cycle. These companion cylinders are a pair of cylinders that are at top dead center (TDC) at the same time. The origin of the phrase refers to the fact that for every cylinder's combustion event ignited by a spark, its companion cylinder experiences a spark (of no consequence) at the same moment, which is near the end of the exhaust stroke.

4. SYMBOLS AND ABBREVIATED TERMS

- **CARB** - California Air Resources Board
- **ECM** - Engine Control Module
- **EDIS** - Electronic Distributorless System
- **FTP** - Federal Test Procedure
- **MF** - Misfire
- **PCM** - Powertrain Control Module

5. TECHNICAL REQUIREMENTS

5.1 General Requirements

The requirements specified in this document are necessary to ensure proper operation of both the external test equipment (misfire generator) and the vehicle during diagnostic testing and demonstration. Any reference to a misfire generator within this document refers to all associated sub-components. Any requirement specific to a sub-component will reference the sub-component individually. The misfire generator, when not intentionally interrupting any ignition or injector control signals, shall not affect normal operation of the controls system or diagnostics.

The misfire generator shall not cause any hardware or software remedial actions within the ignition system as a result of the misfire generator's connectivity or operation. For example: When cylinder's control signal is interrupted, a P0201 or P0351 DTC shall not set, and the ignition or injector control module will not be placed in a default state. Additional DTCs, which are associated with physical behavior of the system, can set. For example: Inducing high rates of misfire that are equal to or greater than a catalyst damaging level of misfire can cause a P0420 as well as a P0300 to set.

5.2 Ignition System Requirements

The subsequent descriptions provide a high-level description of how the misfire generator will interact with electronic ignition systems. The misfire generator is not intended to function with mechanical (systems that include distributors) or capacitive discharge ignition systems.

5.2.1 Ignition Systems

5.2.1.1 Spark Ignition Engines

There are many types of spark ignition configurations. The differences in the systems are primarily due to the separation of the coil in which energy is stored, the ignition driver that manages the ability of the coil to charge, and the spark plug in which the energy is discharged. The misfire generator shall be capable of interfacing with the following types of electronic ignition systems:

- Single-plug per coil - electronic ignition systems - Consisting of an electronic control unit, such as a PCM or ECM, ignition driver, ignition coil, and spark plug. These essential components can be configured in many configurations, yet their primary functionality will always be supported.
- Multi-plug per coil - opposing paired cylinders or "Waste Spark" - Configured such that a pair of opposing cylinder's, which are 360 degrees apart within the firing order, spark plugs are driven by a common coil. The pair of spark plugs fire twice per engine cycle.
- Multi-plug per coil - single cylinder - This ignition configuration is often referred to as "dual plug". This ignition system is essentially the same as the waste spark design with the exception that a single coil provides energy to two spark plugs which are connected to the same cylinder versus an opposing pair of cylinders.
- Exceptions (not within scope of this document): Mechanical distributor system, Capacitive discharge

The key functional variation that must be comprehended by the user, is determining if the misfire generator will be used with an ignition driver which is or is not integrated with the ignition coil. Integrated coil configurations are often referred to as smart coils. Any misfire generator built to these requirements shall be capable of supporting both integrated (smart coil) and non-integrated ignition coil (non-smart coil) configurations.

5.2.1.1.1 Coils with Integrated Drivers

Integrated drivers are an efficient means in which spark energy can be managed while having high-current control provided external to the PCM or ECM. This allows the PCM or ECM to be the source of the control signal timing, and the ignition assembly, or ignition driver, sources the high energy for the spark plug. The ignition control signal is 0-5V in which ignition occurs at the falling edge (rising edge initiates onset of coil charging)

For example: Given an ignition system with a falling edge 0-5 V control signal, the misfire generator induces engine misfire by interrupting the ignition control signal sent from the PCM or ECM to the ignition control module. The control signal is a low current digital signal. When the PCM or ECM sets the control signal to the high state (typically +5 V) the ignition driver enables primary current charge the coil, then when the PCM or ECM sets the ignition control signal to the low state the ignition driver allows the coil to discharge. The stored high voltage is delivered to the spark plug. The misfire generator induces misfire by keeping the ignition control signal to the ignition coil in the low state (about 0 V). The misfire generator is intended to be placed in between the PCM or ECM and ignition coil.

Coil Assembly with Integrated Driver

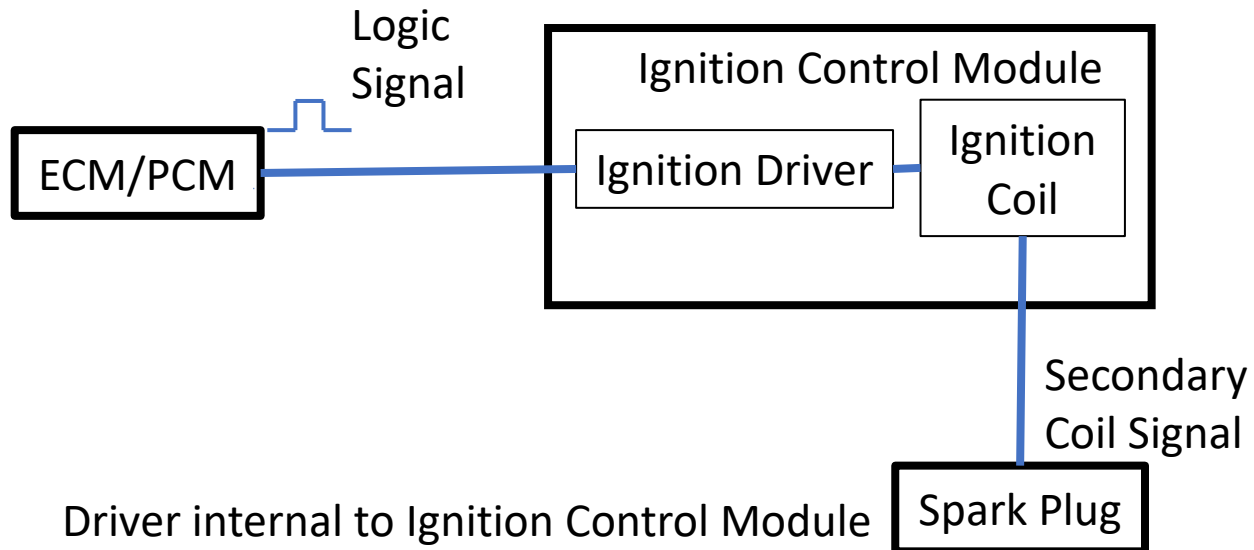


Figure 1 - Integrated driver - single spark plug per coil

5.2.1.1.2 Coils without Integrated Drivers

Non-Integrated drivers manage spark energy by means of an ignition driver internal to the PCM or ECM. This allows the PCM or ECM to be the source for controlling the primary coil energy, and the external ignition coil provides the high secondary energy for the spark plug.

The misfire generator shall induce engine misfire by diverting the primary coil energy to an alternate load. The misfire generator induces misfire by preventing sufficient current flow in the coil's primary winding to generate high voltage in the secondary winding. The misfire generator is intended to be placed in between the PCM or ECM and ignition coil.

Coil Assembly without Integrated Driver

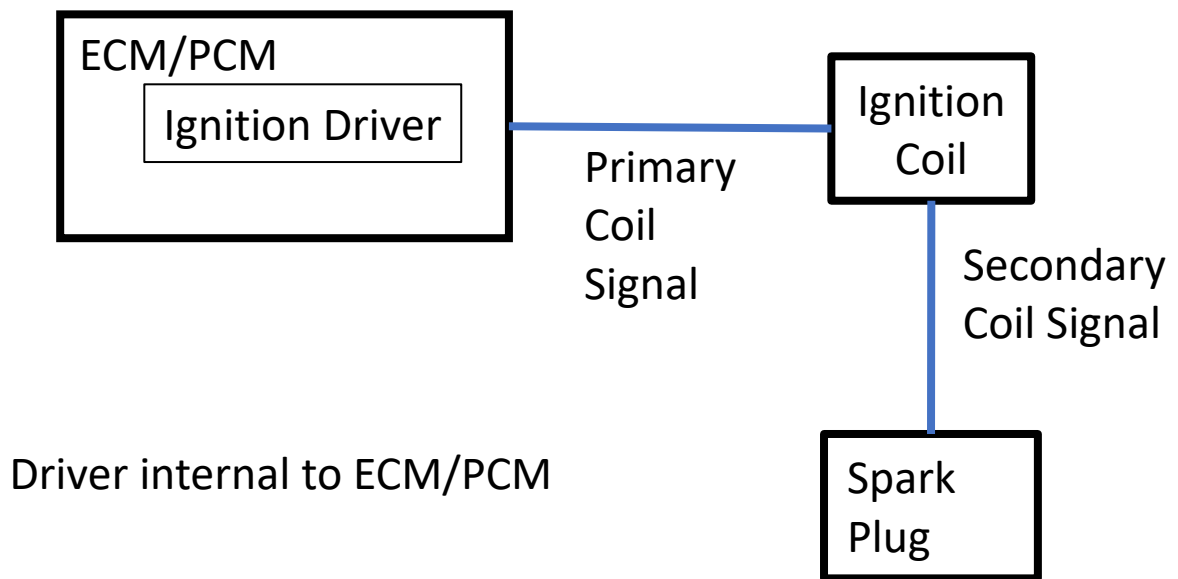


Figure 2 - Non-integrated driver - single spark plug

Waste Spark without Integrated Driver

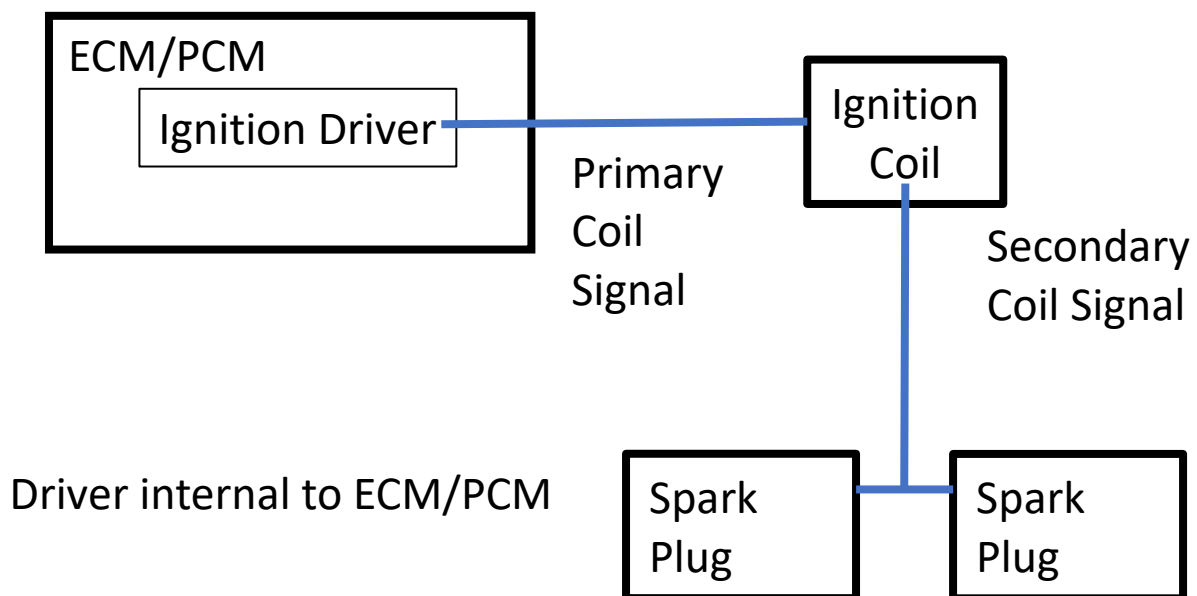


Figure 3 - Multi plug per coil or waste spark ignition

5.2.2 Compression Ignition Engines

There are many types of fuel delivery configurations. The differences in the systems are primarily due to the mechanism in which fuel flow through the injector is managed. Control signal configurations vary throughout the automotive industry, so PWM, analog, and digital signals are used. The misfire generator shall be capable of interfacing with the following types of fuel injection systems:

- Solenoid Injectors – Design of injector commonly seen on gas engines. ECM or injector driver module energizes the injector in which, typically, an electromagnet induces pintle movement to regulate injector fuel flow.
- Piezoelectric Injectors –Electrical potential causes the piezoelectric material inside the injector to expand. In conjunction with various internal mechanical arrangements, accurate and fast fuel management is possible with this injector type.
- HEUI Injectors – Hydraulically Actuated, Electronically Controlled, Unit Injection (HEUI) is a design whereby oil pressure is applied to a large internal diaphragm in order to create very high fuel pressures desired by direct injection engines. An electronically controlled valve regulates fuel flow.
- Exceptions (not within scope of this document): Mechanical Injectors

Compression engines typically incorporate multiple fuel pulses per engine cycle. The number, duration, and timing of pulses can change throughout the drive cycle. The misfire generator shall induce engine misfire by interrupting all injector control signals for a given engine cycle. The misfire generator is intended to be placed in between the Injector Driver Module, PCM or ECM and fuel injector.

5.3 Misfire Timing and Patterns

The misfire patterns listed below provide at a minimum the means whereby the misfire generator shall induce misfire for any regulatory demonstration. The additional development functions are for use during powertrain development; not regulatory demonstrations. The development functions are not mandatory for a misfire generator. If they are used, then their functionality shall match the behavior described in this document. A manufacturer may decide to require development functions to be present within their sourced misfire generator.

5.3.1 Timing

Two types of signal timing methods shall be supported; engine cycle and event. Both indicate how the misfire generator will count between induced misfires. The timing interval begins incrementing upon the first occurrence of the timing method to occur following the completion of the previous induced misfire. For multi-strike spark, or multi-pulse fuel, capable systems, a set of control signals will be intended for each cylinder. The entire set of control signals for an individual cylinder shall be treated in the same manner as a single control signal from a non-multi-strike/pulse capable controls system.

- 5.3.1.1 Engine Cycle timing is indexed upon the completion of each engine cycle. The misfire generator shall detect when the engine control system provides an ignition or injector control signal for each cylinder. Once all applied cylinders have had an ignition or injector control signal, then the misfire generator shall increment the engine cycle counter by one.

- 5.3.1.2 Event timing is indexed upon the receipt of each ignition control signal. The misfire generator shall detect when the engine control system provides an ignition control signal for each cylinder. Once an ignition control signal has been detected, then the misfire generator shall increment the event counter by one.

For example: Given a V8 engine in which the user desires to have cylinder 3 misfire once every 4 engine cycles. The following would occur:

When **engine cycle** timing is used, the interval selector is set to 4 engine cycles. Following the initial randomly selected misfire, all subsequent misfires will occur every 4th engine cycle. Once the setting is entered, the misfire generator will determine if the PCM or ECM has sent a control signal for cylinder 3 during the current engine cycle. If cylinder 3 has not yet received a control signal, then the misfire generator will induce a misfire on cylinder 3 during the current engine cycle and begin incrementing the interval counter at the end of the current engine cycle. If cylinder 3 has already received a control signal during the current engine cycle, then the misfire generator will allow the current engine cycle to be concluded and then induce a misfire in cylinder 3 during the next engine cycle. The interval counter will increment at the end of the engine cycle in which the misfire is induced. The interval counter is reset to zero once the 4th engine cycle is concluded.

When **event** timing is used, the interval selector is set to 32 control signals. Following the initial misfire, the misfire generator will allow 31-cylinder firings to occur before the next misfiring cylinder's control signal is defeated, thus preventing the 32nd event from occurring. Once the setting is entered, the misfire generator will wait until the PCM or ECM sends cylinder 31 control signals. The misfire generator will defeat the 32nd control signal, inducing a misfire, and then increment the interval counter upon every cylinder firing that occurs following the induced misfire. The interval counter is reset to zero once the 32nd event is defeated.

5.3.2 Required Misfire Patterns

Any of the cylinder combinations listed below shall be selectable by the user. The misfire generator shall be able to apply either the engine cycle or event timing method to any of the required misfire patterns.

5.3.2.1 Emissions Pattern

The emissions pattern is used to distribute misfires across all of the selected cylinders. The cylinder which is to be misfired will be dependent upon the interval and timing settings.

An **engine cycle** timed emissions pattern is characterized by equally spaced, complete engine cycle intervals, whose misfire is induced across randomly selected cylinders once the engine cycle interval has been reached. The misfired cylinder will be randomly chosen from all of the selected cylinders. While determining or demonstrating the vehicle's emissions level capabilities, all cylinders must be selected. This pattern is often referred to as "CERT or CARB misfire pattern". If the user has the number of selected cylinders to be less than the total number of cylinders, then the test/demonstration will be non-compliant. All control signals, for multi-strike/pulse systems, intended for the misfiring cylinder during the targeted engine cycle interval will be defeated.

An **event** timed emissions pattern is characterized by misfires that will occur at equally spaced combustion events based upon the selected cylinders. This pattern is not a demonstration compliant pattern, and should only be used for development purposes.

- 5.3.2.1.1 With engine cycle timing, the initial misfire will be randomly chosen to occur no earlier than the engine cycle in which the misfire generator has synchronized and no later than the interval setting following the engine cycle in which synchronization occurred.
- 5.3.2.1.2 With event timing, the initial misfire will occur at the interval setting following the engine cycle in which synchronization occurred. The interval shall begin being counted from the first applied cylinder of the engine cycle which misfires will begin occurring. If a small increment is selected multiple misfires can occur during an engine cycle.

For example: Given a V8 engine without cylinder deactivation enabled in which all 8 cylinders are applied with an interval setting of 10:

When **engine cycle** timing is used, a misfire will occur every 10th engine cycle following the first randomly selected engine cycle. Assuming that the randomly chosen number between 1 and 10 is chosen to be 4, then the initial misfire will occur after the misfire generator has been synchronized. If two engine cycles are necessary for synchronization, then the initial misfire will occur during the 6th engine cycle. Upon reaching the 6th engine cycle, the misfire generator will randomly select any of the cylinders.

When **event** timing is used, a misfire will occur every 10th combustion event following the first event of the first engine cycle after synchronization occurred. Upon reaching the 10th control signal, the misfire generator will induce a misfire. Beginning from cylinder A, the initial misfire will occur in cylinder C of the next engine cycle.

5.3.2.2 Cylinder Misfire Patterns

The following cylinder misfire combinations shall be capable of being produced with either event or engine cycle timing and all interval settings.

5.3.2.2.1 Single cylinder - Any individual cylinder shall be able to be isolated from all of the available cylinders.

5.3.2.2.2 Opposing pair - Any cylinders which are symmetrical to each other within the crankshaft rotation and/or firing order.

5.3.3 Optional Developmental Ignition Functionality

Any of the cylinder combinations listed below shall be selectable by the user. The misfire generator shall be able to apply either the engine cycle or event timing method and all interval settings to any of the developmental misfire patterns.

5.3.3.1 Cylinder Misfire

5.3.3.1.1 Sequential - Any two cylinders that are sequential within the firing order regardless of their physical location within the given engine design.

5.3.3.1.2 Individual banks - Any cylinders that are located upon a common engine bank.

5.3.3.1.3 Arbitrary combinations of cylinders - Any cylinders that are located in the engine. This number of cylinders shall allow any combination of cylinders, regardless of firing order or physical configuration, equal to no more than one less than the max number of cylinders.

5.3.3.2 Multi-Strike Individual Pulse Interruption

The ability to interrupt less than all of the control signals intended for a given cylinder may create a partial burn. A complete misfire may not result. Multi-strike/pulse misfire functionality shall be compatible with the CERT and cylinder misfire patterns with the added ability to target either all or some of the control signals for targeted cylinders. Allowing only one of the control signals, which are intended for a given cylinder, to be defeated. Multi-strike/pulse functionality should include a means whereby the user can select an individual control signal.

5.4 User Interface Requirements

The misfire generator shall support no less than the following user inputs. Any additional inputs/features/controls that are included within an individual design shall not replace or alter the functionality of the inputs described within this section.

5.4.1 Inputs

Unless otherwise stipulated, the user inputs can be external, or included within a menu structure. Some inputs, such as the misfire switch will be required to be externally mounted on the misfire generator.

5.4.1.1 Misfire Switch

This input is associated with the misfire generator's ability to interrupt spark, or not. The misfires will occur based upon additional user input settings.

- 5.4.1.1.1 This input shall be placed externally on the misfire generator control unit.
- 5.4.1.1.2 Shall be a toggle or rocker switch. Function cannot be managed with a menu selection.
- 5.4.1.1.3 The input is to be labeled in a manner in which 'MISFIRE' and 'NO MISFIRE' operational states are to be clearly differentiated. Each position shall be independently, and distinctively, labeled.
- 5.4.1.1.4 The labels shall be different from the applied cylinders labels (see 5.4.1.5).
- 5.4.1.1.5 When the switch is placed in the 'MISFIRE' position, the misfire generator begins to induce misfires according to the user settings.
- 5.4.1.1.6 When the switch is placed in the 'NO MISFIRE' position, the misfire generator will pass all control signals from the PCM or ECM to the ignition coil, fuel injector, or driver module such that no misfire is induced. The vehicle must operate in a manner consistent with that of the vehicle not having a misfire generator connected.
- 5.4.1.1.7 Status monitoring (see 5.7.1.4).

5.4.1.2 Misfire Interval

The misfire interval selection sets the increment that is used to calculate the occurrence rate of misfire. The number indicates the number of events **until** the next misfire, not the number of events between misfires. Events refer to either ignition control signal events or engine cycles depending upon the timing method selected by the user.

- 5.4.1.2.1 This input may be provided to the user either through externally mounted mechanism, or menu screen.
- 5.4.1.2.2 To be labeled 'INTERVAL'.
- 5.4.1.2.3 When the input is an externally mounted mechanism, the input should be a thumb wheel switch or equivalent that supports independent increment and decrement functionality.
- 5.4.1.2.4 The interval shall be an integer value.
- 5.4.1.2.5 Each individual increment in the interval setting increases the number of engine cycles or ignition or injector control signals between misfires by 1.
- 5.4.1.2.6 Each individual decrement in the interval setting decreases the number of engine cycles or ignition or injector control signals between misfires by 1.
- 5.4.1.2.7 When the timing method selection is 'ENGINE CYCLE', the number indicates the number of engine cycles from one misfire to the next misfire.
- 5.4.1.2.8 When the timing method selection is 'EVENT', the number indicates the number of ignition or injector control signals from one misfire to the next misfire.
- 5.4.1.2.9 Status monitoring (see 5.7.1.4).

5.4.1.3 Timing Method

Timing method input sets the misfire timing method in which the misfire generator interval determination will be based.

- 5.4.1.3.1 This input may be provided to the user either through externally mounted mechanism, or menu screen.
- 5.4.1.3.2 The following labels shall be used:
 - 5.4.1.3.2.1 'ENGINE CYCLE'
 - 5.4.1.3.2.2 'EVENT'

- 5.4.1.3.3 When the input is an externally mounted mechanism, the switch should be a toggle or rocker switch.
- 5.4.1.3.4 When the switch is placed in the 'ENGINE CYCLE' position, the misfire generator begins to induce misfires according to the engine cycle timing setting (see 5.3.1.1).
- 5.4.1.3.5 When the switch is placed in the 'EVENT' position, the misfire generator begins to induce misfires according to the event timing setting (see 0).
- 5.4.1.3.6 Status monitoring (see 5.7.1.4).
- 5.4.1.4 Max Number of Cylinders

The max number of cylinders input sets the number of cylinders that are included in the engine in which the misfire generator will be connected.

- 5.4.1.4.1 This input may be provided to the user either through externally mounted mechanism, or menu screen.
- 5.4.1.4.2 When externally mounted, the input should be a thumb wheel switch or equivalent that supports independent increment and decrement functionality.
- 5.4.1.4.3 The interval shall be an integer value.
- 5.4.1.4.4 Each individual increment in the max number of cylinders input increases the number of engine cylinders by 1.
- 5.4.1.4.5 Each individual decrement in the max number of cylinders input decreases the number of engine cylinders by 1.
- 5.4.1.4.6 Status monitoring (see 5.7.1.4).
- 5.4.1.5 Applied Cylinders

This input is associated with the misfire generator's ability to interrupt spark on an individual cylinder once the Misfire Switch has been placed in its 'MISFIRE' position. The misfires will occur based upon additional user input settings.

- 5.4.1.5.1 This input may be provided to the user either through externally mounted mechanism, or menu screen.
- 5.4.1.5.2 When the input is an externally mounted mechanism, the switch should be a toggle or rocker switch.
- 5.4.1.5.3 The input is to be labeled in a manner in which 'MISFIRE' and 'NO MISFIRE' operational states are clearly differentiated. Each position shall be independently, and distinctively, labeled.
- 5.4.1.5.4 The labels shall be different from the misfire switch labels (see 5.4.1.1).
- 5.4.1.5.5 Each cylinder shall have its own associated applied cylinder input. When a particular cylinder is set to the 'MISFIRE' position, the misfire generator will include the cylinder associated with each independent applied cylinder input in the desired misfire pattern. For example: Since the misfire generator supports 12 cylinders, the engine cylinders A through L will each have their own independent applied cylinder input.
- 5.4.1.5.6 When a particular cylinder is set to the 'NO MISFIRE' position, the misfire generator will pass all ignition or injector control signals from the PCM or ECM to the ignition coil, fuel injector, or driver module such that no misfire is induced for that particular cylinder. The vehicle must operate in a manner consistent with that of the vehicle not having a misfire generator connected to that particular cylinder.
- 5.4.1.5.7 When less than the max number of cylinders is selected, the misfire generator will determine engine cycle boundaries based upon the total of all cylinders. However, the misfire interval will only use those cylinders that have been selected (applied switch for each particular cylinder that has been set to MISFIRE) when counting events until the next induced misfire. Counting will begin with the first applied cylinder that has been set to the 'MISFIRE' position that occurs in the first engine cycle.