



SURFACE VEHICLE RECOMMENDED PRACTICE

J973™

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(R) Ignition System Measurements Procedure

RATIONALE

This document contains technology and test procedures that have superseded the technologies and test procedures outlined in the previous version of this document.

SAE J973 has been reaffirmed to comply with the SAE Five-Year Review policy.

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1. SCOPE

This SAE Recommended Practice specifies the design and/or evaluation with the specific equipment, conditions, and methods for distributorless battery ignition systems intended for use in various internal combustion engines including automotive, marine, motorcycle, and utility engine applications. The test procedures listed in this document are limited to measurements performed on a test bench only and do not include measurements made directly on engines or vehicles. This standard is not intended to supply information for battery ignition systems used in aircraft applications of any type.

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 J139 Ignition System Nomenclature and Terminology

SAE J2031 High-Tension Ignition Cable

SAE J2032 Ignition Cable Assemblies

3. IGNITION SYSTEM DEFINITION

Scope: Single-ended coil on plug (COP) and coil near plug (CNP) (refer to SAE J139). This document is not proposing methods to measure any of the advanced technologies mentioned in the SAE J139 document. Those advanced technologies may require advanced methodologies for collection of performance characteristics.

The ignition system as defined for the tests tabulated in this report shall consist of:

- a. A coil. This can be the conventional induction coil or an air or magnetic core transformer.
- b. High voltage, metal conductor ignition cables which are specified to eliminate the varying effects of the different kinds of cable with high impedance conductors. Resistance per foot, as well as inductance of spark plug cables built to suppress radiation, can be quite different from manufacturer to manufacturer.

NOTE: Some ignition systems may not function properly with metallic secondary cables due to EMI and may require low-resistance inductance cables.

- c. Any auxiliary switching means implicit with the system being tested such as a transistorized control unit. The standard switching device used in modern systems is the insulated gate bipolar transistor (IGBT).

The preceding devices shall be interconnected as the manufacturer recommends or similar to the conventional system (see Figure 15).

4. SYSTEM LOAD

For the purposes of this standard, the assumed loads for the ignition coil will be capacitance, resistance, and a Zener diode string as shown in Figure 1. For certain tests, as designated in Section 6, the capacitive and resistive loads will be directly connected to the coil high voltage tower with the coil not firing. A high voltage load of 20 pF or other as specified by OEM for COP ignition system (this can be a section of shielded ignition cable) to simulate the capacitance of the cables and spark plugs as normally encountered on a vehicle. At suitable times, a low voltage coefficient (0.0005%/V max), non-inductive 1.0 MW resistor, with a power rating of approximately 10 W, should be used to represent the fouling accumulated onto the spark plug. The resistor simulates spark plug fouling due to carbon or other fuel additives. This is a standard condition, but if the user deviates from this, then it is to be documented in the test procedure. Load may vary according to customer requirements.

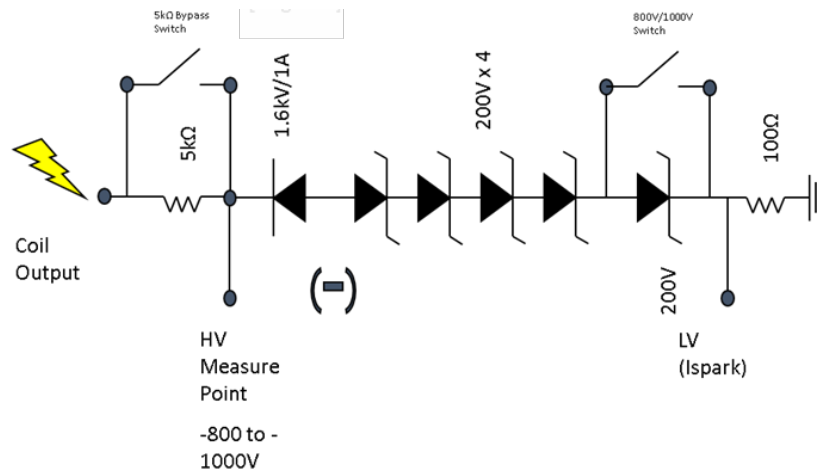


Figure 1 - Representation of Zener diode string

5. IGNITION PARAMETER MEASUREMENTS

5.1 Available Secondary (Spark) Voltage

The minimum voltage at the spark plug terminal with the terminal connected to a load referenced to ground under specified conditions. This condition is usually a capacitive load representative of the engine environment around the coil and spark plug. This measurement is fundamental to spark ignition systems. Comparing available secondary voltage to the voltage that must be exceeded to fire spark plugs (in a given engine) determines the adequacy of the ignition system (see Figure 2).

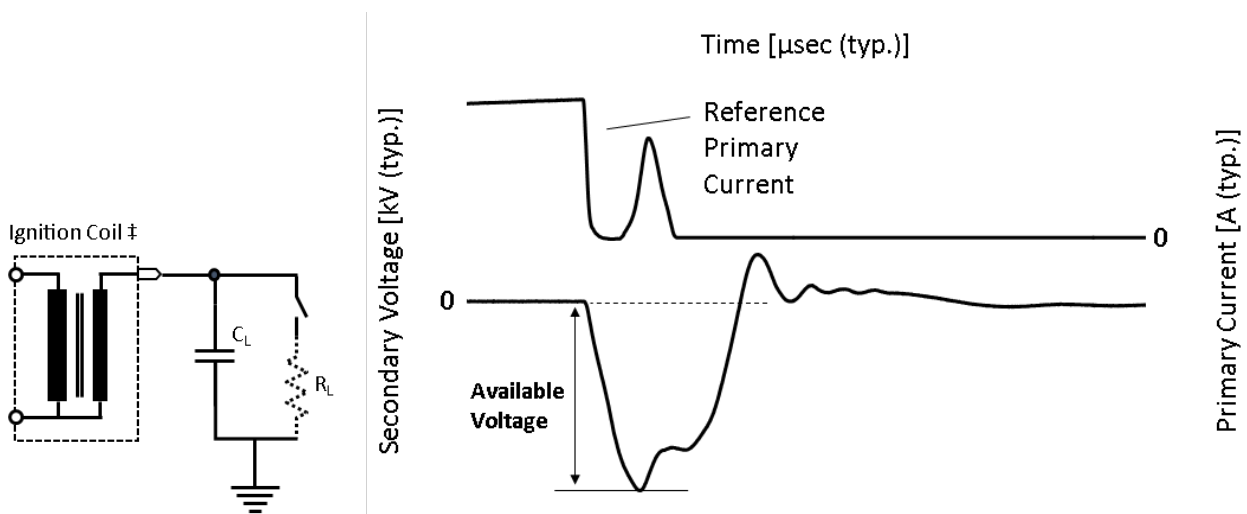


Figure 2 - Example of secondary voltage waveform

5.2 Open-Circuit Coil Secondary Voltage

The voltage measured at the coil output terminal without loading (see Figure 3). The coil is likely to be considered not installed or away from the installed capacitance due to the valve cover, the environment around the boot, and the spark plug. A specified capacitance may also be placed from the high voltage terminal to ground to represent the installed system. This presents maximum voltage to the ignition coil and possible stress to IGBT clamping. This is due to the stress put upon the insulation around the windings and the stress to the driving element (IGBT) experiencing the reflected voltage from this event upon its collector. Typically, this voltage is measured with a very low capacitance HV probe.

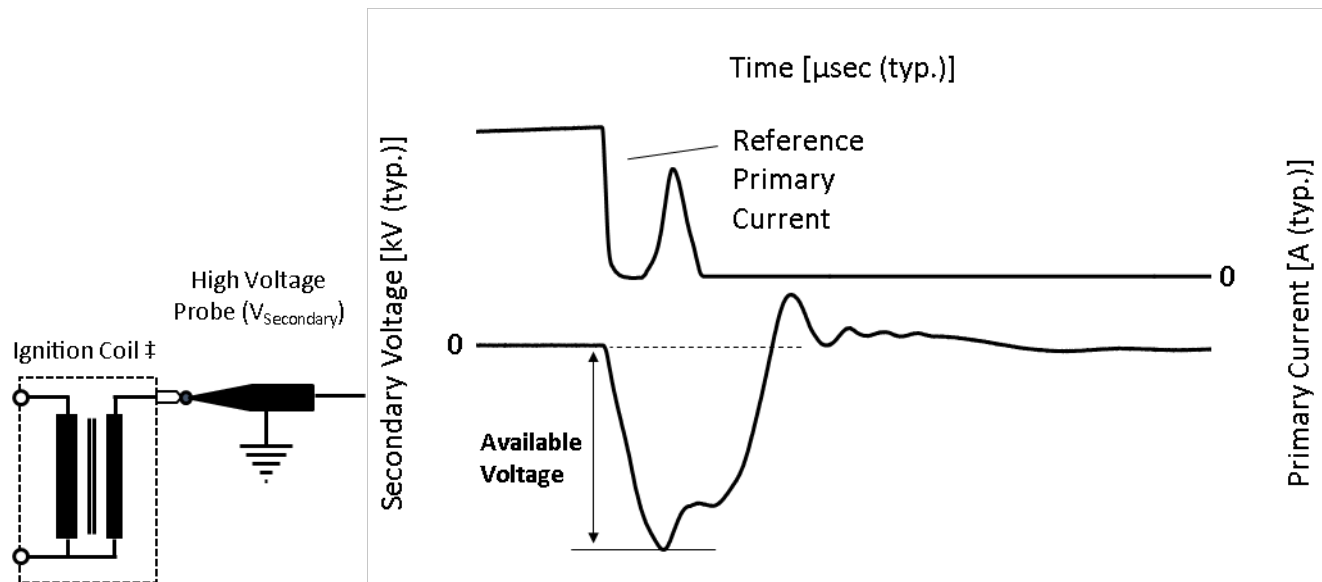


Figure 3 - Example of secondary voltage waveform

5.3 Loaded Secondary Voltage

The voltage measured at the spark plug terminal with a non-inductive ($1\text{ M}\Omega \pm 1\%$, 10 W $0.0005\%/V$ maximum voltage coefficient, dielectric strength that exceeds the system voltage) load resistor connected to the cable spark plug terminal. This may also have a specified capacitance in parallel with the resistor. This is representative of available voltage when there is a severe plug fouling condition represented by Figure 4. This may also be called minimum available voltage requirement.

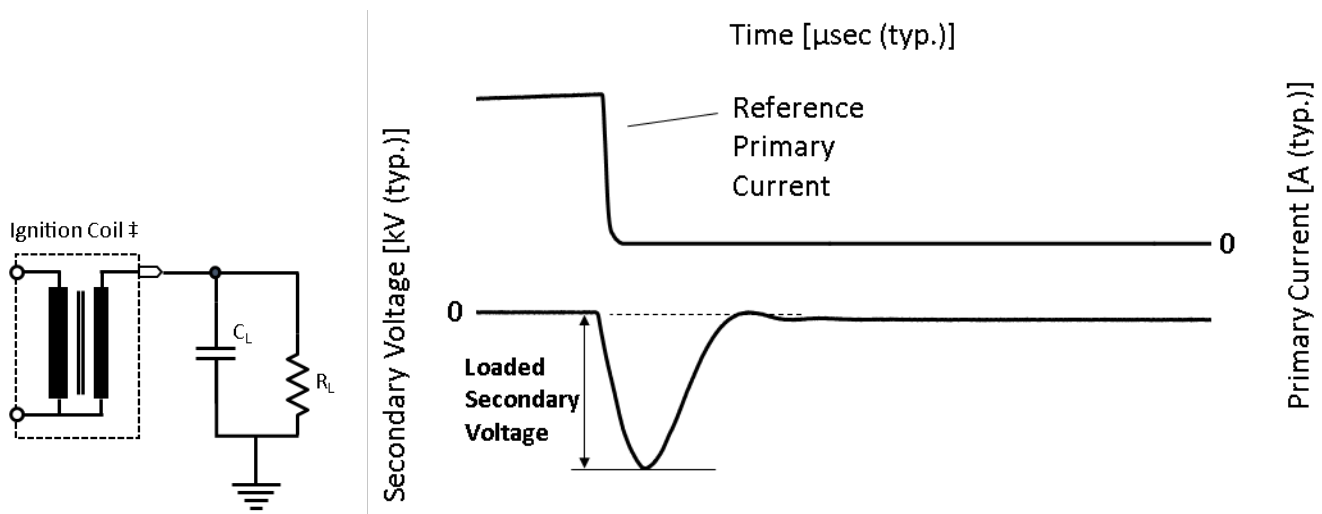


Figure 4 - Example secondary voltage waveform illustrating secondary voltage for a fouled spark plug with a low shunt resistance

5.4 Secondary Voltage at Primary Current Switch On (Feed Forward Voltage)

Voltage induced in secondary winding due to rate of change of primary current at switch on (transformer effect) as shown in Figure 5. This measurement occurs at the beginning of the current ramp of the primary coil. It is the voltage that appears on the secondary output as the current changes over time on the primary coil. This is most pronounced during the moment of turning on the ignitor. This turn on can produce a peak voltage that could produce a spark before it is expected. This is measured at a specified load and battery voltage condition.

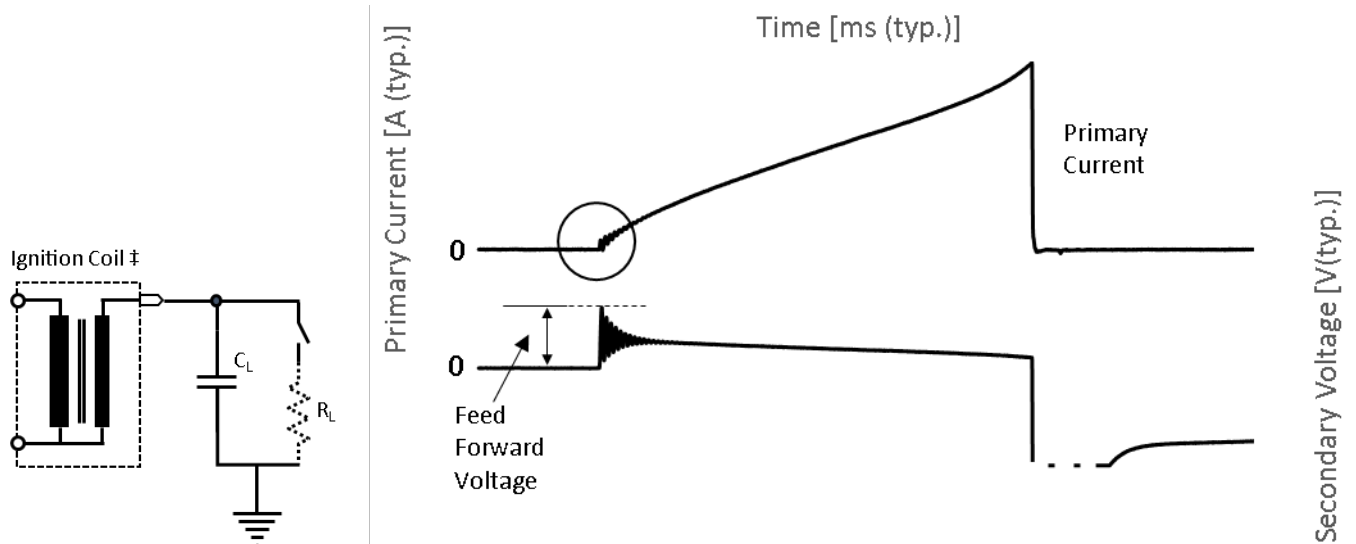


Figure 5 - Example close-up of secondary voltage waveform illustrating voltage induced during turn on of primary current of ignition coil

5.5 Spark Current (Zener Load)

The instantaneous current observed in the secondary circuit during discharge of the ignition coil passing through the spark gap electrodes during arcing (see Figure 6). This measurement describes the current flow through the electrode gap during the discharge. For an inductive ignition coil, this occurs at the beginning of discharge. The critical parameter is the peak inductive current value. However, the instantaneous values over the duration of the spark event are useful in determining spark energy. This can also refer to the secondary current across a load R_L .

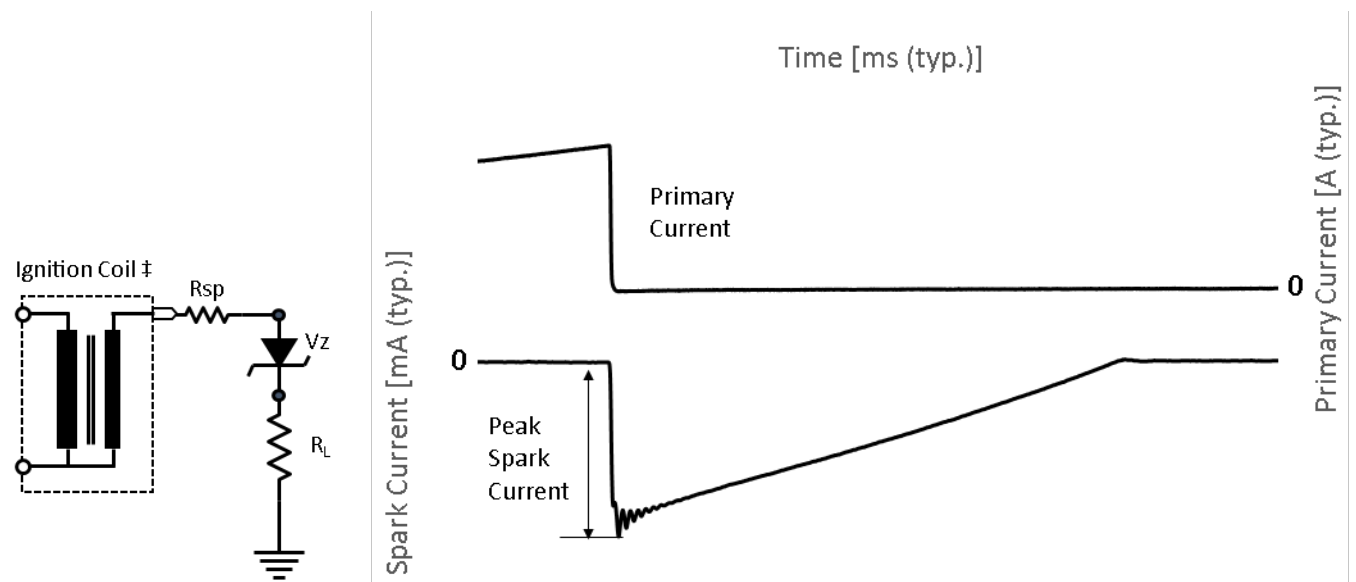


Figure 6 - Example secondary current waveform with a 1000 V Zener load showing peak inductive secondary current