IEC 62969-2

Edition 1.0 2018-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Semiconductor devices – Semiconductor interface for automotive vehicles – Part 2: Efficiency evaluation methods of wireless power transmission using resonance for automotive vehicles sensors

Dispositifs à semiconducteurs – Interface à semiconducteurs pour les véhicules automobiles – Partie 2: Méthodes d’évaluation du rendement de la transmission d’énergie sans fil par résonance pour les capteurs de véhicules automobiles

IEC 62969-2:2018-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 31.080.99

ISBN 978-2-8322-5442-4

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International Standard IEC 62969-2 has been prepared by IEC technical committee 47: Semiconductor devices.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
47/2450/FDIS	47/2460/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62969 series, published under the general title *Semiconductor devices – Semiconductor interface for automotive vehicles*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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- amended.

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SEMICONDUCTOR DEVICES – SEMICONDUCTOR INTERFACE FOR AUTOMOTIVE VEHICLES –

Part 2: Efficiency evaluation methods of wireless power transmission using resonance for automotive vehicles sensors

1 Scope

This part of IEC 62969 specifies procedures and definitions for measuring the efficiency of the wireless power transmission system for the automotive vehicles sensors. This document deals with the power range below 500 mW.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
wireless power transfer
technology of power transmission/receiving without power line

3.2
resonance frequency
f
special frequency which is determined by inductance and capacitance of the coil

3.3
resonant wireless power transfer
energy transfer maximizing method using the concord of resonance frequency between the two coils which make magnetic inductive coupling

3.4
power driving coil
coil which receives RF power directly

Note 1 to entry: The power driving coil is part of the basic elements of the resonant wireless power transmission system.

3.5
transmitting resonator coil
coil which transfers power using magnetic resonance

Note 1 to entry: The transmitting resonator coil is part of the basic elements of the resonant wireless power transmission system.

3.6
receiving resonator coil
coil which is receiving wireless power

Note 1 to entry: The receiving resonator coil is part of the basic elements of the resonant wireless power transmission system.

3.7
load coil
coil which supplies power to the devices

Note 1 to entry: The load coil is part of the basic elements of the resonant wireless power transmission system.

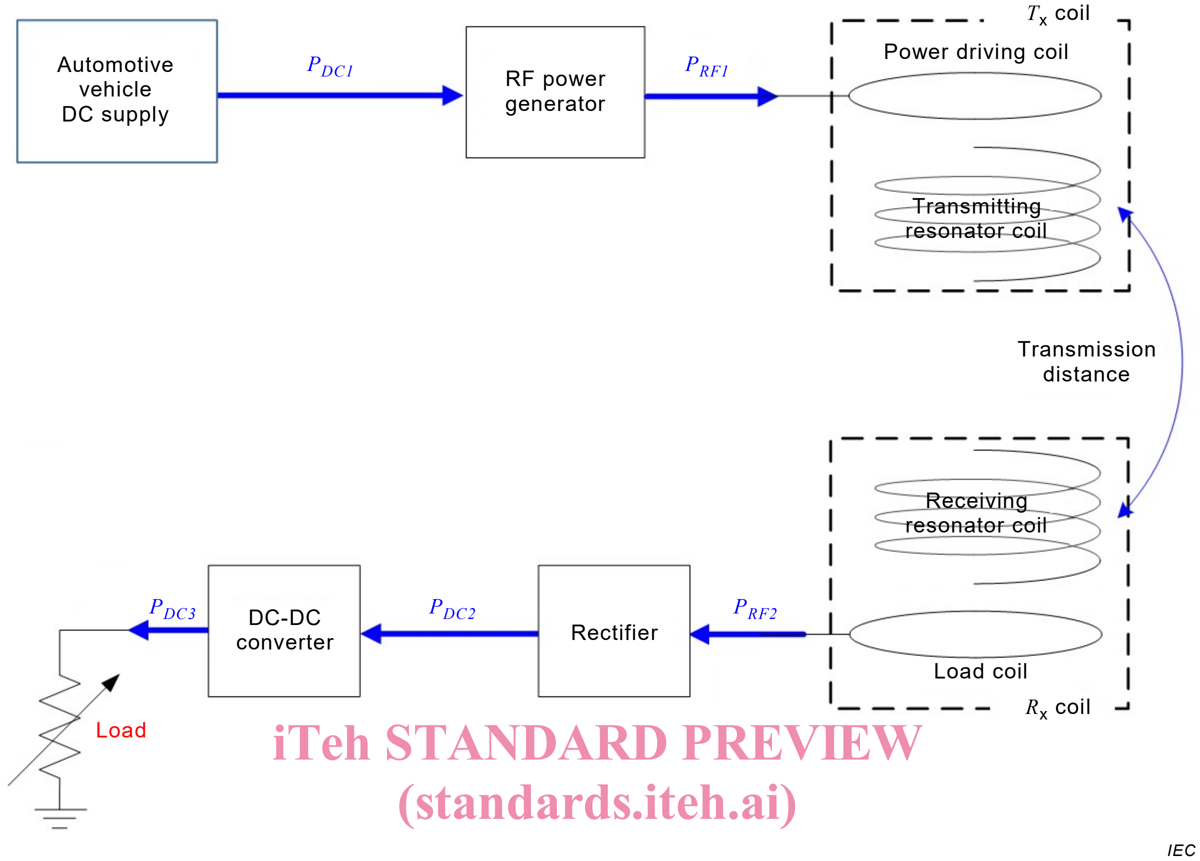
3.8
resonator coil
coil, the inductance and capacitance of which have been determined according to its geometry

4 Testing methods

4.1 General

The concept of resonant wireless power transfer system is shown in Figure 1 and efficiency is a function of the loading conditions (*e.g.* light load, medium load, and full load) as well as the degree of coupling between the transmission and receiver coils (e.g. weak coupling or perfect coupling). The system comprises six main functional units which are an automotive vehicle DC supply unit, a RF power generator unit, a T_x coil unit, an R_x coil unit, a rectifier unit and a DC-DC converter unit. The T_x coil unit includes a power driving coil and a transmitting resonator coil. The R_x coil unit includes a receiving resonator coil and a load coil.

The automotive vehicle DC supply means that the supplied electric power which is provided by vehicle, which voltage can be +12V or +24V. The RF power generator unit is the circuit which can convert DC power to RF power. At this time, the frequency of RF power can be hundreds of kHz to tens of MHz. The T_x coil unit and the R_x coil unit are actually delivering power wirelessly. The rectifier unit is the electric circuit which can convert RF power to DC power. The DC-DC converter unit converts the level of DC voltage. The rectified voltage is different from the voltage for driving a load. Therefore, the DC-DC converter is required. Finally a load can be connected to the output of DC-DC converter. The value of characteristic impedance (Z_0) should be specified when designing a high frequency circuit and measuring the high frequency characteristics. Usually the value of Z_0 is 50 Ω.



Key

P_{DC1} DC power from automotive vehicle DC supply

P_{RF1} RF power from RF power generator

P_{RF2} RF power from R_x coil

P_{DC2} DC power from rectifier

P_{DC3} DC power from DC-DC converter

Figure 1 – Schematic diagram of wireless power transmission system

4.2 RF power generation efficiency

The RF power generation efficiency is defined as the conversion efficiency when the power is converted from DC power to RF power which is shown in Figure 2. The efficiency is represented by the ratio of RF output power to the used power for DC input. The efficiency can be affected by the efficiency of inverter circuit when the used frequency is lower than 1 MHz and the efficiency of power amplifier when the used frequency is higher than 1 MHz. The efficiency can be calculated by measuring the power calculated from the voltage and current of P_{DC1} and by measuring the RF power of P_{RF1} using RF power sensor. During the efficiency measurement, the RF output power is adjusted to sufficient. The RF power generation efficiency shall be given as shown by Formula (1) below:

$$\eta_{RF} = \frac{P_{RF1}}{P_{DC1}} \quad (1)$$

where

η_{RF} is RF power generation efficiency;

P_{RF1} is RF power from RF power generator;

P_{DC1} is DC power from automotive vehicle DC supply.

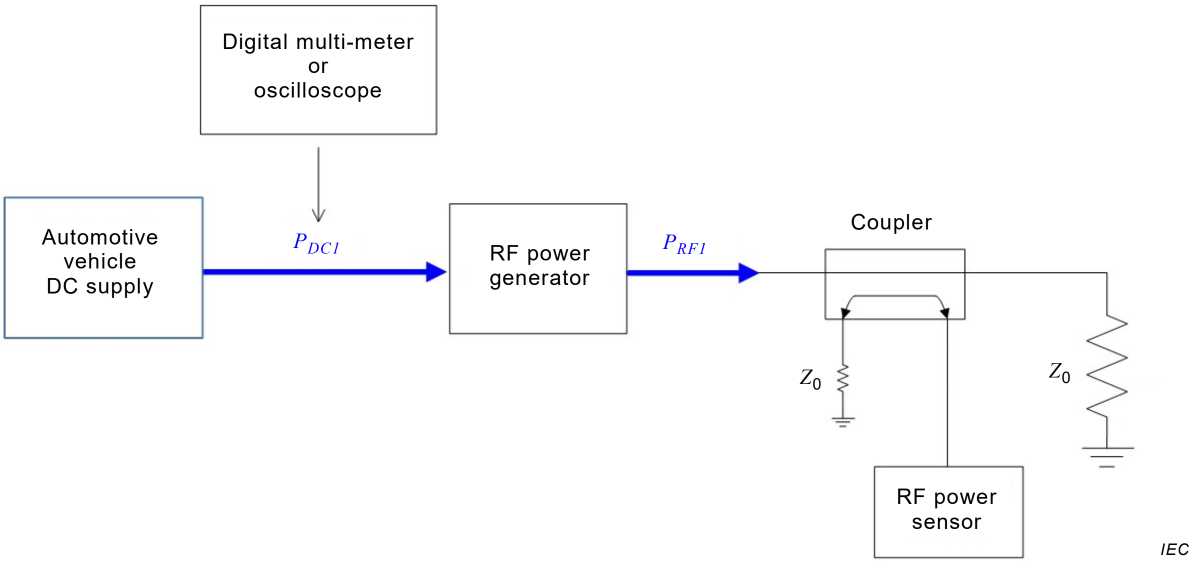


Figure 2 – Measurement schematics for RF power generation efficiency

4.3 RF coupling efficiency

The RF coupling efficiency is defined as the transmission efficiency when the signal is transferred wirelessly which is shown in Figure 3. The efficiency is represented by the ratio of RF output power to the RF input power. The efficiency can be affected by the coupling of between transfer and receiver part, the resistance loss between transfer and receiver part, radiation. The RF coupling efficiency is major efficiency of the wireless power transmission system.

The RF coupling efficiency can be measured by s-parameter using Vector Network Analyser (VNA). The RF coupling efficiency shall be given as shown by Formula (2) below:

$$\eta_{Coupling} = |S_{21}|^2 = \frac{P_{RF2}}{P_{RF1}} \quad (2)$$

where

η_{Coupling}	is RF coupling efficiency;
P_{RF1}	is RF power from RF power generator;
P_{RF2}	is RF power from R_x coil.

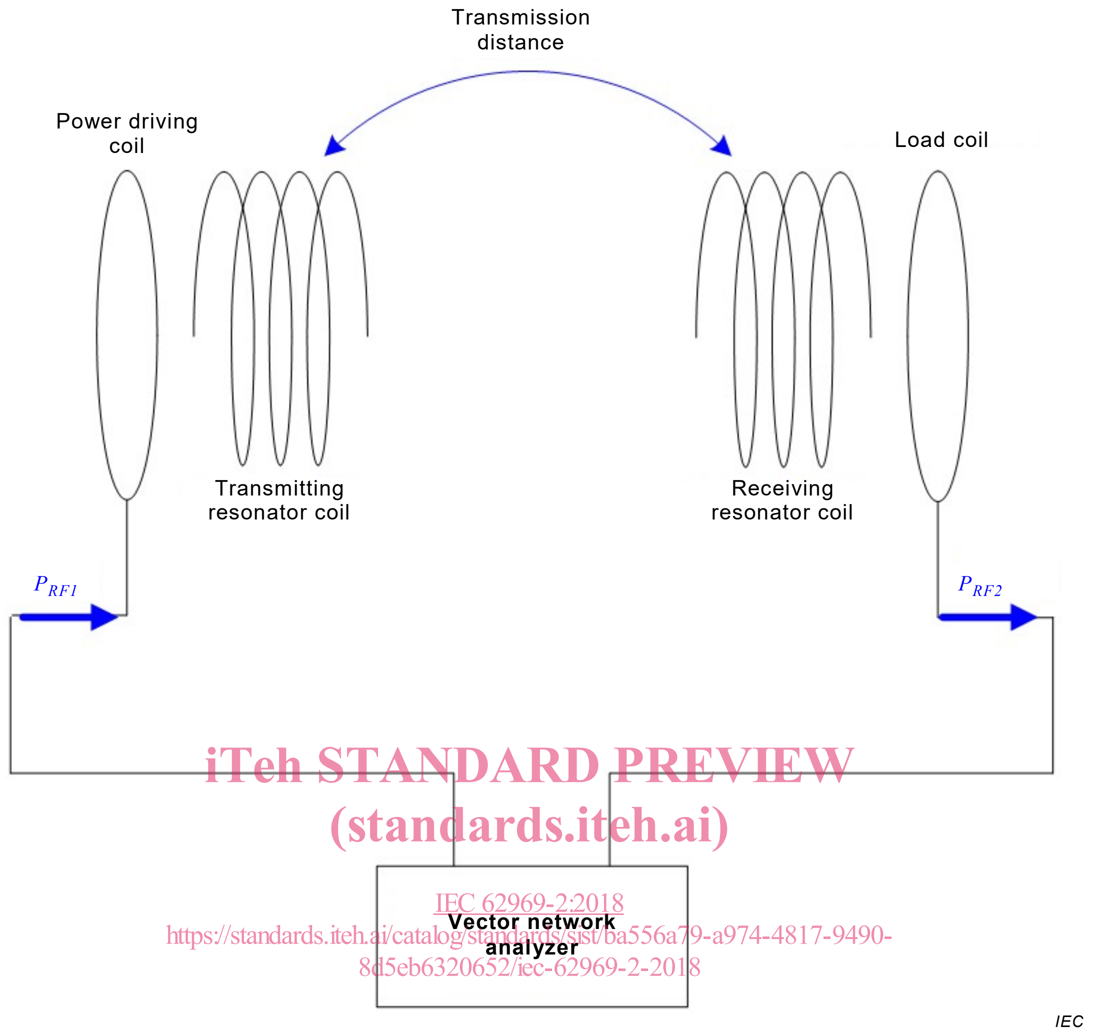


Figure 3 – Measurement schematics for RF coupling efficiency

4.4 RF rectifying efficiency

The RF rectifying efficiency is defined as the efficiency when the power is transferred from P_{RF2} to P_{DC2} which is shown in Figure 4. The RF rectifying efficiency is represented by the power ratio of DC output power by rectifying circuit to received RF input power. The RF rectifying efficiency can be affected by the diodes efficiency. The RF rectifying efficiency shall be given as shown by Formula (3) below:

$$\eta_{Rect} = \frac{P_{DC2}}{P_{RF2}} \quad (3)$$

where

η_{Rect} is RF rectifying efficiency;

P_{DC2} is DC power from rectifier;

P_{RF2} is RF power from R_x coil.