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INTERNATIONAL STANDARD

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colour inside

Semiconductor devices – Micro-electromechanical devices – Part 41: RF MEMS circulators and isolators

Dispositifs à semiconducteurs – Dispositifs microélectromécaniques – Partie 41: Circulateurs et isolateurs à MEMS RF

IEC 62047-41:2021-06(en-fr)

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Dispositifs à semiconducteurs – Dispositifs microélectromécaniques – Partie 41: Circulateurs et isolateurs à MEMS RF

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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 41: RF MEMS circulators and isolators

FOREWORD

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

FDIS	Report on voting
47F/376/FDIS	47F/380/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62047 series, published under the general title *Semiconductor devices – Micro-electromechanical devices*, can be found on the IEC website.

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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 41: RF MEMS circulators and isolators

1 Scope

This part of IEC 62047 specifies the terminology, essential ratings and characteristics, and measuring methods of RF (Radio Frequency) MEMS (Micro-Electro-Mechanical Systems) circulators and isolators.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60747-1:2010, *Semiconductor devices – Part 1: General*

IEC 60749-10, *Semiconductor devices – Mechanical and climatic test methods – Part 10: Mechanical shock*

IEC 60749-12, *Semiconductor devices – Mechanical and climatic test methods – Part 12: Vibration, variable frequency*

IEC 60749-21, *Semiconductor devices – Mechanical and climatic test methods – Part 21: Solderability*

IEC 60749-22, *Semiconductor devices – Mechanical and climatic test methods – Part 22: Bond strength*

IEC 62047-1, *Semiconductor devices – Micro-electromechanical devices – Part 1: Terms and definitions*

IEC TS 61967-3, *Integrated circuits – Measurement of electromagnetic emissions – Part 3: Measurement of radiated emissions – Surface scan method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62047-1 and the following 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 General terms

3.1.1
circulator
three-port device in which the incident wave to any port is transmitted to the next port according to an order of sequence determined by the sense of a static magnetic biasing field

Note 1 to entry: By reversing the magnetic biasing field, the order of sequence is reversed.

Note 2 to entry: This property may be used to switch electromagnetic waves.

[SOURCE: IEC 60050-726:1982, 726-17-08, modified – The word “multiport” is replaced by “three-port”]

3.1.2
isolator
two-port device having much greater attenuation in one direction of propagation than in the opposite direction

[SOURCE: IEC 60050-726:1982, 726-17-19]

3.2 RF characteristics parameters

3.2.1
insertion loss
L_{ins}
resulting from the insertion of a network into a transmission system, the ratio of the power delivered to that part of the system following the network, before insertion of the network, to the power delivered to that same part after insertion of the network

Note 1 to entry: The insertion loss is generally expressed in decibels.

[SOURCE: IEC 60050-726:1982, 726-06-07]

3.2.2
isolation
L_{iso}
amplitude of the power attenuation, in the reverse direction of signal transmitted

3.2.3
return loss
L_{ret}
ratio of the incident power at the specified port to the reflected power at the same port

Note 1 to entry: Usually the return loss is expressed in decibels.

[SOURCE: IEC 60747-16-4:2004, 3.3 modified – “in the linear region”, “ΔP_{ref}(dBm) = ΔP_{inc}(dBm)” and “of the power transfer curve” are deleted.]

3.2.4
magnetic leakage
B_{leak}
maximum spatial field intensity of a RF MEMS circulator/isolator

4 Essential ratings and characteristics

4.1 Identification and types

General description of the function of the RF MEMS circulator/isolator and their applications should be stated. The statement should include the details of manufacturing technologies about the RF MEMS circulator/isolator with different operation, configuration, and actuation mechanism. The statement should also include packaged form including terminal numbering and package materials.

The RF MEMS circulator/isolator shall be clearly and durably marked in the order given below:

a) manufacture's name or trade mark;

b) device type and serial number;

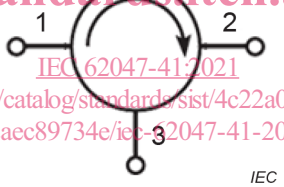
c) year and week (or month) of manufacture;

d) terminal identification (optional);

e) factory identification code (optional).

4.2 Application and specification description

Information on application of the RF MEMS circulator/isolator shall be given. Block diagrams of the RF MEMS circulator/isolator and the applied systems should be also given. All terminals should be identified in the block diagram and their functions shall also be stated. See Figure 1 and Figure 2.



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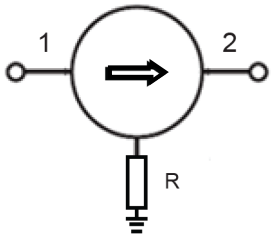
Key

1 terminal 1

2 terminal 2

3 terminal 3

Figure 1 – Terminals of RF MEMS circulators



IEC

Key

1 terminal 1

2 terminal 2

R terminated load

Figure 2 – RF MEMS isolator with terminated load

4.3 Limiting values and operating conditions

This statement should include limiting conditions and values. In particular, electrical limiting values (input power, handling power, power dissipation, etc.) and temperature conditions (operating, ambient, storage, and soldering) shall be given in the statement. These values are indicated within Table 1.

Table 1 – Limiting values and operating conditions

Parameters	Symbol	Unit	Min.	Max.
power handling capability	P_{max}	W		+
operating temperature	T_{op}	°C	+	+
soldering temperature	T_{sol}	°C		+
storage temperature	T_{stg}	°C	+	+

4.4 RF characteristics

RF characteristic parameters shall be stated with minimum (Min.), typical (Typ.), and maximum (Max.) values as shown in Table 2.

Table 2 – RF characteristics

Parameters	Symbol	Unit	Min.	Typ.	Max.
insertion loss	L_{ins}	dB		+	+
isolation	L_{iso}	dB	+	+	
return loss	L_{ret}	dB		+	+
center frequency	f_{center}	GHz		+	
VSWR(optional)	VSWR			+	
impedance (optional)	R	Ω		+	
magnetic leakage (optional)	B_{leak}	A/m			+

4.5 Reliability characteristics

Any specific mechanical characteristics and environmental ratings applicable shall be stated. The characteristics shall be stated with their symbol, unit, minimum (Min), typical (Typ.), and maximum (Max.) values as shown in Table 3.

Table 3 – Reliability characteristics

Parameters	Symbol	Unit	Min.	Typ.	Max.
Power handling capability	P_{max}	W			+
Life time	t_{life}	h	+		
Shock	A_{shock}	g	+		
Vibration	$A_{vibration}$	m/s^2	+		
Bond/Solder Shear Strength	P_w	MPa	+		

4.6 Additional information

Some additional information should be given such as handling precautions, physical information (e.g. outline dimensions, terminals, accessories, etc.), package information, printed circuit board interface and mounting information, and other information, etc.

5 Measuring methods

5.1 General

5.1.1 General precautions

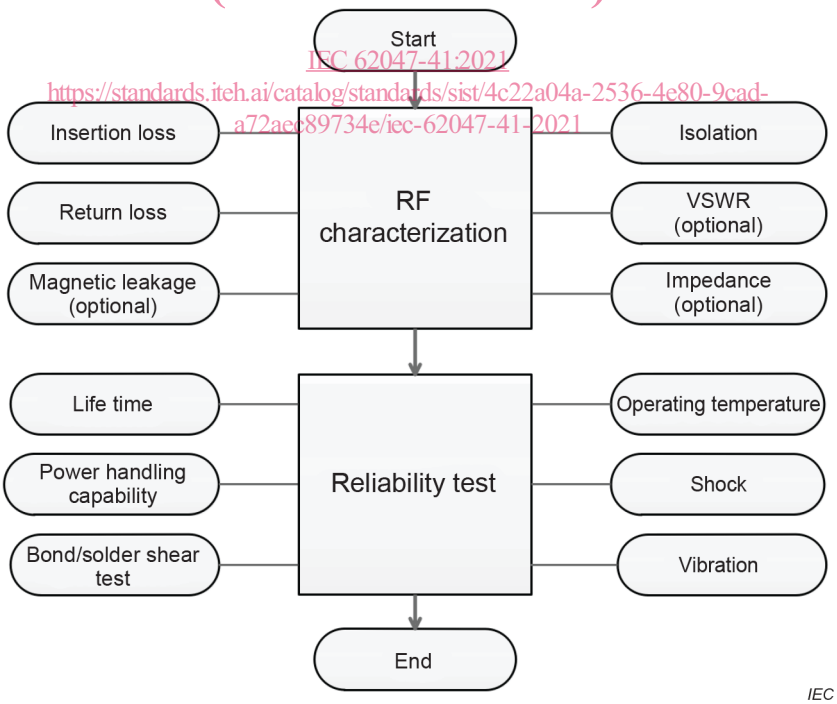
The measurement accuracy, protection of devices and measuring equipment and accuracy of measuring circuits listed in 6.3, 6.4 and 6.6 of IEC 60747-1:2010 shall be applied. Although the level of the signal can be specified in either power or voltage, in this document it is expressed in power unless otherwise specified.

5.1.2 Characteristic impedance

The characteristic impedance of the measurement system, as shown in all the circuits of this document, is 50 Ω. If it is not 50 Ω, it shall be specified.

5.1.3 Measurement procedure

Generally, the test procedures for RF characteristics and reliability of the RF MEMS circulator/isolator are performed as shown in Figure 3.



NOTE The RF MEMS circulator/isolator can be measured as shown in Figure 3. After mounting the circulator/isolator devices onto test fixture, RF characteristics are measured by using a network analyser or other equivalent test equipment. If the measurements are satisfactory, reliability tests (life time, shock, vibration, bond/solder shear test, etc.) are performed for commercially use.

Figure 3 – Measurement procedure of RF MEMS circulators/isolators

5.1.4 Handling precautions

The RF MEMS circulator/isolator devices in this document are chip types or packaged device types. Before measurement, the devices should be suitably packaged and mounted on a test fixture and measured by using a vector network analyser.

Since the impedance of the network analyser is usually 50 Ω, the termination condition between the RF MEMS circulator/isolator and the equipment should be considered carefully.

Before connecting the RF MEMS circulator/isolator to the test fixture, the network analyser, cable, and connectors should be calibrated. The full 2-port calibration technique is effective to compensate the system errors (i.e. presenting open-circuit impedance, short-circuit impedance, through standards at the ends of test cable connectors, 50 Ω load impedance, and storing the measured values for correction of the RF MEMS circulator/isolator measurement).

After calibration, connect the test cable with the circulator/isolator test fixture with 50 Ω connectors. The reading of S-parameter on the display of the network analyser is taken. A reflection coefficient S_{11} and a transmission coefficient S_{21} of 2-port S-parameters are translated into reflection attenuation and insertion attenuation, respectively.

If a different frequency range is required, the entire calibration sequence shall be repeated.

5.2 Insertion loss (L_{ins})

5.2.1 Purpose

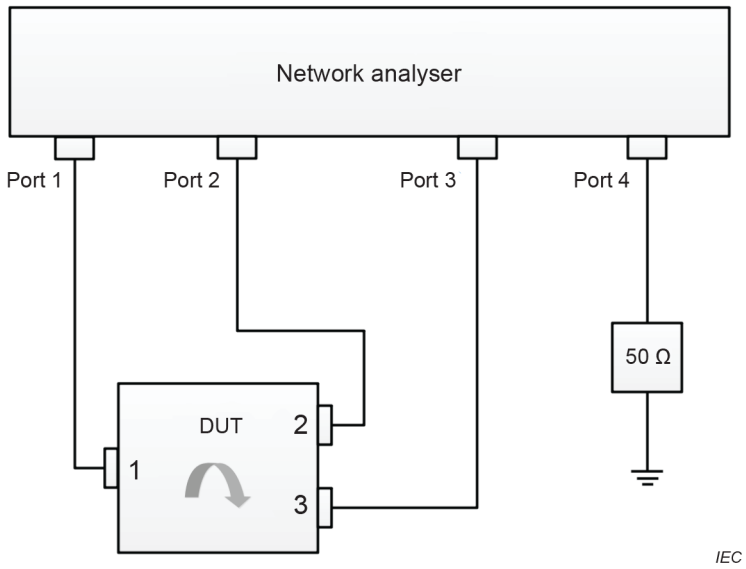
To measure the insertion loss under specified conditions.

5.2.2 Circuit diagram

Measuring methods should be selected properly according to the network analyser, which may provide two or more ports for testing.

a) Method A): with the 4-port network analyser:

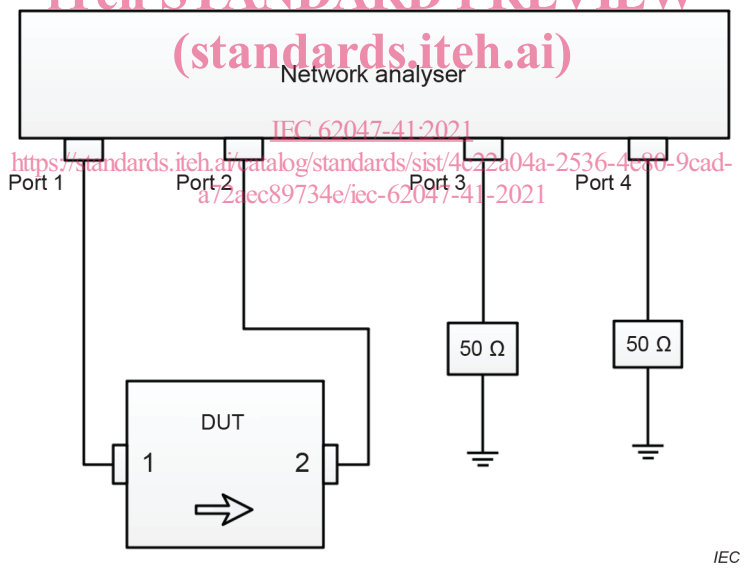
   1) The measuring circuit diagram for the insertion loss measurements of the circulator is shown in Figure 4. The circulator is a 3-port device, taking the 4-port network analyser. And the fourth port of the network analyser should be properly terminated during testing.



NOTE Other equivalent test equipment can be used instead of the network analyser.

Figure 4 – Measuring circuit diagram of the circulator with 4-port network analysers

2) The measuring diagram for the insertion loss measurements of the isolator is shown in Figure 5. The isolator is a 2-port device, just taking 2 ports of the network analyser.



NOTE Other equivalent test equipment can be used instead of the network analyser.

Figure 5 – Measuring circuit diagram of the isolator with 4-port network analysers

b) Method B): with the 2-port network analyser

1) The measuring circuit diagram for the insertion loss measurements of the circulator is shown in Figure 6. The cables should be connected differently, which is consistent with the transfer direction of devices. As the circulator is a 3-port device, the spared port of the circulator should be properly terminated during testing.