

INTERNATIONAL STANDARD



**Coaxial communication cables –
Part 9: Sectional specification for flexible RF coaxial cables**

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**Coaxial communication cables –
Part 9: Sectional specification for flexible RF coaxial cables**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COAXIAL COMMUNICATION CABLES –

Part 9: Sectional specification for flexible RF coaxial cables

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 61196-9 has been prepared by subcommittee 46A: Coaxial cables, of IEC technical committee 46: Cables, wires, waveguides, RF connectors, RF and microwave passive components and accessories. It is an International Standard.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) Title: "RF flexible cables" is changed to "flexible RF coaxial cables",
- b) Clause 2: different standards are added,
- c) Subclauses 4.2 to 4.5: materials and construction details are added,

- d) Subclause 5.1: nominal characteristic impedance is added,
- e) Subclause 5.2: rated temperature range is added,
- f) Subclause 5.4: power rating is added,
- g) Subclause 5.4: bending radius is added,
- h) Clause 6: cable identification is revised,
- i) Clause 7: completely revised, different requirements or typical values are added,
- j) Annex A: Stress-crack resistance is added,
- k) Annex B: Vibrations is added.

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

Draft	Report on voting
46A1620/CDV	46A/1634/RVC

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/publications.

This document is to be read in conjunction with IEC 61196-1:2005.

A list of all parts in the IEC 61196 series, published under the general title *Coaxial communication cables*, 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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COAXIAL COMMUNICATION CABLES –

Part 9: Sectional specification for flexible RF coaxial cables

1 Scope

This part of IEC 61196 specifies the materials and cable construction for RF flexible coaxial communication cables with solid or with semi-air-spaced dielectric, IEC type designation, identification, marking and labelling, standard rating and characteristics, requirements of finished cables, quality assessment, delivery and storage, etc.

This document applies to RF flexible coaxial communication cables for use in mobile communication systems, microwave test equipment and other fields. It is read in conjunction with IEC 61196-1:2005.

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 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-20:2021, *Environmental testing – Part 2-20: Tests – Test Ta and Tb: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60754-1, *Test on gases evolved during combustion of materials from cables – Part 1: Determination of the halogen acid gas content*

IEC 60811-607, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 607: Physical tests – Test for the assessment of carbon black dispersion in polyethylene and polypropylene*

IEC 60966-1:2019, *Radio frequency and coaxial cable assemblies – Part 1: Generic specification – General requirements and test methods*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

IEC 61196-1:2005, *Coaxial communication cables – Part 1: Generic specification – General, definitions and requirements*

IEC 61196-1-1, *Coaxial communication cables – Part 1-1: Capability approval for coaxial cables*

IEC 61196-1-101, *Coaxial communication cables – Part 1-101: Electrical test methods – Test for conductor d.c. resistance of cable*

IEC 61196-1-102, *Coaxial communication cables – Part 1-102: Electrical test methods – Test for insulation resistance of cable dielectric*

IEC 61196-1-103, *Coaxial communication cables – Part 1-103: Electrical test methods – Test for capacitance of cable*

IEC 61196-1-105, *Coaxial communication cables – Part 1-105: Electrical test methods – Test for withstand voltage of cable dielectric*

IEC 61196-1-106, *Coaxial communication cables – Part 1-106: Electrical test methods – Test for withstand voltage of cable sheath*

IEC 61196-1-108, *Coaxial communication cables – Part 1-108: Electrical test methods – Test for characteristic impedance, phase and group delay, electrical length and propagation velocity*

IEC 61196-1-110, *Coaxial communication cables – Part 1-110: Electrical test methods – Test for continuity*

IEC 61196-1-111, *Coaxial communication cables – Part 1-111: Electrical test methods – Stability of phase test methods*

IEC 61196-1-112, *Coaxial communication cables – Part 1-112: Electrical test methods – Test for return loss (uniformity of impedance)*

IEC 61196-1-113, *Coaxial communication cables – Part 1-113: Electrical test methods – Test for attenuation constant*

IEC 61196-1-114, *Coaxial communication cables – Part 1-114: Electrical test methods – Test for inductance*

IEC 61196-1-116, *Coaxial communication cables – Part 1-116: Electrical test methods – Test for impedance with time domain reflectometry (TDR)*

IEC 61196-1-119, *Coaxial communication cables – Part 1-119: Electrical test methods – RF average power rating*

IEC 61196-1-126, *Coaxial communication cables – Part 1-126: Electrical test methods – Corona extinction voltage*

IEC 61196-1-201:2009, *Coaxial communication cables – Part 1-201: Environmental test methods – Test for cold bend performance of cable*

IEC 61196-1-203, *Coaxial communication cables – Part 1-203: Environmental test methods – Test for water penetration of cable*

IEC 61196-1-206, *Coaxial communication cables – Part 1-206: Environmental test methods – Climatic sequence*

IEC 61196-1-209, *Coaxial communication cables – Part 1-209: Environmental test methods – Thermal cycling*

IEC 61196-1-212, *Coaxial communication cables – Part 1-212: Environmental test methods – UV stability*

IEC 61196-1-215, *Coaxial communication cables – Part 1-215: Environmental test methods – High temperature cable ageing*

IEC 61196-1-301, *Coaxial communication cables – Part 1-301: Mechanical test methods – Test for ovality*

IEC 61196-1-302, *Coaxial communication cables – Part 1-302: Mechanical test methods – Test for eccentricity*

IEC 61196-1-313, *Coaxial communication cables – Part 1-313: Mechanical test methods – Adhesion of dielectric and sheath*

IEC 61196-1-314, *Coaxial communication cables – Part 1-314: Mechanical test methods – Test for bending*

IEC 61196-1-316, *Coaxial communication cables – Part 1-316: Mechanical test methods – Test of maximum pulling force of cable*

IEC 61196-1-317, *Coaxial communication cables – Part 1-317: Mechanical test methods – Test for crush resistance of cable*

IEC 61196-1-324, *Coaxial communication cables – Part 1-324: Mechanical test methods – Test for abrasion resistance of cable*

IEC 62037-4, *Passive RF and microwave devices, intermodulation level measurement – Part 4: Measurement of passive intermodulation in coaxial cables*

IEC 62153-4-3, *Metallic communication cable test methods – Part 4-3: Electromagnetic compatibility (EMC) – Surface transfer impedance – Triaxial method*

IEC 62153-4-4, *Metallic communication cable test methods – Part 4-4: Electromagnetic compatibility (EMC) – Test method for measuring of the screening attenuation as up to and above 3 GHz, triaxial method*

IEC 62230, *Electric cables, Spark-test method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61196-1 as well as the following apply.

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

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

3.1

flexible coaxial communication cable

coaxial cable which can repeat flexure in service

Note 1 to entry: The typical construction for this type of cable is a single inner conductor which can be solid or stranded covered by dielectric core material, which is surrounded by a braided outer conductor(s), with a protective sheath.

4 Materials and cable construction

4.1 Cable construction

The cable construction shall be in accordance with 4.2 to 4.5 and the requirements stated in the relevant detail specification.

4.2 Inner conductor

The inner conductor shall be a solid or strand copper wire or solid or strand copper clad steel wire according to IEC 61196-1:2005, 4.4.1 to 4.4.4 or any other appropriate material as stated in the relevant detail specification. The conductor can be coated or uncoated. If it is silver plated, the minimum thickness of the silver coating shall be 1 µm.

The nominal diameter shall be stated in the relevant detail specification.

Diameter tolerance for the completed inner conductor shall be as specified in the relevant detail specification.

The inner conductor shall be smooth and continuous.

4.3 Dielectric

The construction of the dielectric shall be one of the materials listed below or a combination of the following:

- a) solid dielectric (such as: solid polyolefin, solid polytetrafluoroethylene (PTFE), solid fluorinated ethylene propylene (FEP), solid perfluoroalkoxyalkane (PFA), etc.);
- b) semi-air-spaced dielectric (such as: foamed polyolefin, foamed FEP, foamed PFA, low density PTFE, etc.);
- c) any other appropriate materials and types as specified in the relevant detail specification.

The nominal diameter and thickness shall be stated in the relevant detail specification.

The tolerance of the dielectric diameter shall be stated in the relevant detail specification.

4.4 Outer conductor or screen

The construction of the outer conductor or screen should be a wrap or/and braid. It consists of one or more of the following layer(s):

- a) metal foil layer or metallized film layer (when applicable): metal foil layer or metallized film layer is optional, which can be copper foil, copper plastic composite tape or any other films as stated in the relevant detail specification. These layers can be applied longitudinally or helically over the dielectric of coaxial cable, with a sufficient overlap as specified in the relevant detail specification;
- b) braid: a braid of plain or coated wire or tape. Joints in the braiding wires or tapes shall be soldered, twisted, or woven in, and there shall be no joint in the complete braid. The braid shall be applied evenly. The braid angle and the filling factor or coverage factor shall be specified in the relevant detail specification.

The construction, material, maximum diameter of the outer conductor or screen shall be specified in the relevant detail specification.

4.5 Sheath

IEC 61196-1:2005, Subclause 4.7 applies with the following amendments and additions.

- a) the outer sheath of a cable shall be a thermoplastic material as specified in the relevant detail specification, including the material type;
- b) the minimum sheath thickness shall be specified in the relevant detail specification;
- c) the nominal diameter and tolerance of the sheath shall be specified in the relevant detail specification.

5 Standard rating and characteristics

5.1 Nominal characteristic impedance

The nominal characteristic impedance shall be 50 Ω or specified in the relevant detail specification.

5.2 Rated temperature range

Unless otherwise specified in the relevant detail specification, the ratings temperature of the materials used in a cable shall be as specified in Table 1.

Table 1 – Rated temperature

Materials used in cable	Storage °C	Installation °C	Operational °C
PE	–40 to +70	–20 to +60	–40 to +70
PVC	–40 to +75	–20 to +60	–40 to +70
TPE	–40 to +85	–20 ~ +60	–40 ~ +80
LSZH	–25 to +70	–20 to +60	–25 to +70
FEP	–55 to +200	–20 to +60	–55 to +200
PFA	–55 to +250	–20 to +60	–55 to +230
ETFE	–55 to +150	–20 to +60	–55 to +150
PTFE	–60 to +250	–20 to +60	–60 to +250
The rated temperature of the cable should comprehensively consider the high temperature and low temperature resistance of the inner conductor, dielectric, outer conductor and sheath of a cable.			

5.3 Operating frequency

The operating frequency range is specified in the relevant detail specification.

5.4 Power rating

When required, the power rating is specified in the relevant detail specification.

5.5 Bending radius

5.5.1 Static bending radius

The static bending radius R of the cable shall not be less than 5 times the cable diameter D , i.e. $R \geq 5 \times D$, or as specified in the relevant detail specification.

5.5.2 Dynamic bending radius

The dynamic bending radius R of the cable shall not be less than 10 times the cable diameter D , i.e. $R \geq 10 \times D$, or as specified in the relevant detail specification.

6 Identification, marking and labelling

6.1 Cable identification

6.1.1 Type name

Cables shall be identified by the following:

- a) a number giving the nominal characteristic impedance of the cable in ohms, for example, "50";
- b) a number that corresponds to the approximate diameter measured over the dielectric in mm.

6.1.2 Variants

The variant of cables should be identified by the following:

- a) Type name, see 6.1.1.
- b) Distinguishing number: It should consist of three characters (XYZ) which distinguish the different construction and material of the various cables.

The "X" specifies the material type of the inner conductor.

The "Y" specifies the material type and structure of the dielectric.

The "Z" specifies the material type of sheath.

Details are listed in Table 2.

Table 2 – Distinguishing number

"X"	Material of the inner conductor	"Y"	Material and structure of dielectric	"Z"	Material of sheath
1	Solid silver plated copper wire	No Entry	Solid PTFE	1	FEP
2	Solid silver plated copper clad steel wire	E	Expand PTFE	2	PFA
3	Strand silver plated copper wire	P	Profiled PTFE	3	ETFE
4	Strand silver plated copper clad steel wire	FP	Foamed PFA	4	PVC
5	Solid copper wire	SP	Solid PFA	5	LSZH
6	Strand copper wire	FF	Foamed FEP	6	TPE
7	Other material	SF	Solid FEP	7	Other material
		ST	Solid ETFE		
		SE	Solid PE		
		FE	Foamed PE		
		o	Other material		

6.2 Cable marking

The cable marking shall be applied to the sheath.

The marking shall comply with 6.2 or as specified in the relevant detail specification.

Cable marking shall be made up of the following elements:

- a) variants naming (see 6.1);
- b) the number of the IEC sectional specification.

For example: 50-1.5-1FP2 IEC 61196-9 means 50 Ω flexible cable with silver plated copper conductor, foamed PFA dielectric, PFA sheath, 1,5 mm approximate dielectric diameter according to IEC 61196-9.

6.3 Labelling

Unless otherwise stated by local or regional regulations, labelling shall be provided in accordance with IEC 61196-1:2005, 6.3 and the detail specification.

7 Requirements of finished cables

7.1 General

The cable shall be tested in accordance with the IEC 61196-1 series or this Clause 7. The requirements given below shall apply. Unless otherwise specified, all measurements shall be carried out under standard atmospheric conditions for testing in accordance with IEC 60068-1:2013, Clause 4.

7.2 Electrical requirements of finished cables

Electrical measurements shall be according to Table 3.

Table 3 – Electrical measurements

Subclause	Parameter	Test procedure	Requirements/Remarks
7.2.1	Continuity	IEC 61196-1-110	Inner conductor shall be continuous. Outer conductor shall be continuous.
7.2.2	Conductor direct current resistance (inner and outer)	IEC 61196-1-101	When applicable, value in accordance with the relevant detail specification
7.2.3	Insulation resistance	IEC 61196-1-102	$\geq 1\,000\text{ M}\Omega\cdot\text{km}$, unless otherwise specified in the detail specification.
7.2.4	Withstand voltage of dielectric	IEC 61196-1-105	The test voltage and duration – specified in the detail specification.
7.2.5	Withstand voltage of sheath ^a	IEC 61196-1-106	Unless otherwise specified in the relevant detail specification, the following test voltage shall be applied for one minute. 2 kV (RMS) for sheath thickness over 0,5 mm and up to and including 0,8 mm. 3 kV (RMS) for sheath thickness over 0,8 mm and up to and including 1,0 mm. 5 kV (RMS) for sheath thickness over 1,0 mm: 5 kV (RMS)
7.2.6	Spark test ^a	IEC 62230	The test voltage – specified in the relevant detail specification.
7.2.7	Capacitance	IEC 61196-1-103	Value in accordance with the relevant detail specification, typical values are for: 50 Ω and solid PTFE, PFA or FEP: 94 pF/m 50 Ω and expanded or profiled PTFE: 86 pF/m 50 Ω and foamed PFA or FEP: 80 pF/m 50 Ω and solid PE: 99 pF/m 50 Ω and foamed PE: 76 pF/m to 87 pF/m

Subclause	Parameter	Test procedure	Requirements/Remarks
7.2.8	Inductance	IEC 61196-1-114	When required, value in accordance with the relevant detail specification.
7.2.9	Characteristic impedance	IEC 61196-1-116	Tolerance specified in the detail specification.
7.2.10	Relative propagation velocity (velocity ratio)	IEC 61196-1-108	Value in accordance with the relevant detail specification, typical values are for: Solid PTFE, PFA or FEP: 70,8 % Expanded or profiled PTFE: 78 % Foamed PFA or FEP: 83 % Solid PE: 66 % 50 Ω and foamed PE: 77 % to 88 %
7.2.11	Return loss	IEC 61196-1-112	Specified in the relevant detail specification, normalized to 20 °C
7.2.12	Attenuation	IEC 61196-1-113	The cable shall comply at any frequency with the following formula. $a \times \sqrt{f} + b \times f + c + \frac{d}{\sqrt{f}}$ The term $d / \sqrt{f}$ should be added in case of copper clad conductor material to match the curve at low frequencies. The coefficients a, b, c and d shall be given in the relevant detail specification.
7.2.13	PIM	IEC 62037-4	Applicable to 50 Ω cables. When required, test frequencies (f_1 and f_2), input power, PIM values in accordance with the relevant detail specification. Typical cables with following connectors, when tested at frequency 700 MHz\800 MHz\900 MHz\ 1 800 MHz\ 2 100 MHz\2 600 MHz, input power:2×20 W, the PIM shall be as follows: ≤-150 dBc (with N type connectors); ≤-155 dBc (with 4.3/10 type connectors); ≤-155 dBc (with 7/16 type connectors).
7.2.14	RF power	IEC 61196-1-119	When required, value in accordance with the relevant detail specification
7.2.15	Phase stability vs temperature	IEC 61196-1-111	When applicable, test temperature, test frequency and value in accordance with the relevant detail specification
7.2.16	Phase stability vs bending	IEC 61196-1-111	When applicable, test frequency, diameter of mandrel and value in accordance with the relevant detail specification
7.2.17	Phase difference	IEC 60966-1: 2019, Subclause 8.7	When applicable, at least two samples are taken and fitted with suitable connectors for testing. The sample length, test frequency and phase difference shall be specified in the detailed specification.
7.2.18	Transfer impedance	IEC 62153-4-3	When applicable, value in accordance with the relevant detail specification. If not otherwise specified in the relevant detail specification, the transfer impedance shall be tested after completion of the cable bending test (IEC 61196-1-314) according to the detail specification.

Subclause	Parameter	Test procedure	Requirements/Remarks
7.2.19	Screening attenuation	IEC 62153-4-4	When applicable, value in accordance with the relevant detail specification. If not otherwise specified in the relevant detail specification, the screening attenuation shall be tested after completion of the cable bending test (IEC 61196-1-314) according to the detail specification. An alternative test method can be used when specified in the relevant detail specification.
7.2.20	Corona extinction voltage	IEC 61196-1-126	When required, value in accordance with the relevant detail specification.
^a Select one of them.			

7.3 Environmental requirements of the finished cable

Environmental requirements shall be according to Table 4.

Table 4 – Environmental requirements of the finished cable

Subclause	Parameter	Test procedure	Requirements/remarks
7.3.1	Cold bend performance	IEC 61196-1-201: 2009	Test method A or B as specified in the detail specification. Unless otherwise specified in the relevant detail specification, the test temperature value is: – 55 °C ± 2 °C (ETFE, FEP or PFA sheath), – 40 °C ± 2 °C (PVC or TPE sheath), – 25 °C ± 2 °C (LSZH sheath). The mandrel diameter is ten (10) times the nominal outside diameter of the cable sample under test. Requirement: No cracks, flaws or other damage in the cable surface.
7.3.2	Water penetration	IEC 61196-1-203	When applicable, specified in the relevant detail specification
7.3.3	Climatic sequence	IEC 61196-1-206	TA, TB and t1 as specified in the relevant detail specification. Number of cycles: 3 minimum Influenced mechanical and electrical characteristics shall be as specified in the relevant detail specification
7.3.4	Thermal ageing	IEC 61196-1-215	When required, one sample should be used for the test. The temperature value is: 260 °C ± 5 °C (PFA sheath), 230 °C ± 5 °C (FEP sheath), 180 °C ± 2 °C (ETFE sheath), 110 °C ± 2 °C (TPE sheath), 100 °C ± 2 °C (PVC or LSZH sheath). Duration: 168 h or as specified in the detail specification. Requirements after ageing and cooling down to standard atmospheric conditions. a) The displacement of the cable elements shall comply with that indicated in the relevant cable specification. b) No cracks, flaws or other damage in the cable surface.

Subclause	Parameter	Test procedure	Requirements/remarks
7.3.5	Stress-crack resistance (for FEP sheath)	Annex A	The diameter of mandrel shall be specified in the relevant detail specification. No cracks, flaws or other damage in the cable surface.
7.3.6	Thermal cycling	IEC 61196-1-209	Transmission characteristics shall remain within the specified limits.
7.3.7	UV stability	IEC 61196-1-212	When applicable, no cracks shall be seen under visual examination.

7.4 Mechanical requirements of the finished cables

Mechanical requirements shall be according to Table 5.

Table 5 – Mechanical requirements of the finished cable

Subclause	Parameter	Test procedure	Requirements/remarks
7.4.1	Visual examination	IEC 61196-1: 2005, Subclause 4.2	No observable defects
7.4.2	Dimensional examination	IEC 61196-1: 2005, Subclause 4.3	Value in accordance with the detail specification
7.4.3	Ovality of the dielectric	IEC 61196-1-301	When applicable, value in accordance with the detail specification
7.4.4	Ovality of the sheath	IEC 61196-1-301	When applicable, value in accordance with the detail specification
7.4.5	Eccentricity of dielectric	IEC 61196-1-302	When applicable, $\leq 10\%$, or value in accordance with the relevant detail specification
7.4.6	Eccentricity of the sheath	IEC 61196-1-302	When applicable, $\leq 10\%$, or value in accordance with the relevant detail specification
7.4.7	Carbon black content	IEC 60811-607	When applicable, specified in the relevant detail specification
7.4.8	Adhesion of dielectric	IEC 61196-1-313	When applicable, specified in the relevant detail specification
7.4.9	Bending	IEC 61196-1-314	Specified in the relevant detail specification. Transmission characteristics shall remain within the specified limits
7.4.10	Tensile strength of cable (longitudinal pull)	IEC 61196-1-316	When applicable, according to the relevant detail specification. Characteristic impedance shall remain within the specified limits.
7.4.11	Crush resistance of cable	IEC 61196-1-317	When required, the load as specified in the relevant detail specification shall be applied for 2 min. Characteristic impedance shall remain within the specified limits. It will recover in two minutes. No physical damage of the sheath.
7.4.12	Abrasion resistance	IEC 61196-1-324	When applicable, according to the relevant detail specification
7.4.13	Solderability	IEC 60068-2-20: 2021	Test Ta, method 1 When applicable, shall be in accordance with IEC 61196-1:2005, 4.4.5.
7.4.14	Vibration	Annex B	Swept frequency, vibration amplitude, duration in accordance with the relevant detail specification. Transmission characteristics shall remain within the specified limits.