
**Electrically propelled road vehicles —
Test specification for electric
propulsion components —**

**Part 1:
General test conditions and
definitions**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 37, *Electrically propelled vehicles*.

A list of all parts in the ISO 21782 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Until now, there was no international standardized test procedure for the motor system including motors, inverters DC/DC converters and their combinations for electric propulsion systems of electrically propelled road vehicles available. There are some International Standards for industrial use which consider the steady/constant running of motors and inverters but don't consider the dynamic operation (acceleration/deceleration).

The ISO 21782 series was prepared aiming at the reproducibility of test results which will enable to compare and evaluate fairly the performance and reliability of electric propulsion system components such as the motor system (the motor, inverter, DC/DC converter and their combinations).

The overview of the ISO 21782 series is in [Tables 1](#) to [4](#) shown below.

Table 1 — Contents of Part 1: general test conditions and definitions

Item of Part 1	Description
Introduction	Background and purpose of the ISO 21782 series
Terms and definitions	Terms to use in the ISO 21782 series
Abbreviated terms	Abbreviated terms to use in the ISO 21782 series
General test conditions	Definition of general condition; — Operating point — Current, voltage and power — DC input voltage — Temperature and humidity — Measurement accuracy

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Table 2 — Contents of Part 2: performance testing of the motor system

Item of Part 2	Description	Motor	Inverter	Chopper	Motor system
Measurement of total loss and total efficiency	This test measures total loss and total efficiency between the input power of inverter and the output power of the motor.				5.1
Temperature rise test	This test investigates the temperature rise characteristics of each part of the motor system within the specified range.				5.2
Torque characteristic test	This test measures the torque characteristics specified in the specifications of the motor system.				5.3
Torque ripple test	This test measures the torque ripple of the motor.				5.4

Table 3 — Contents of Part 3: performance testing of the motor and the inverter

Item of Part 3	Description	Motor	Inverter	Chopper	Motor system
Measurement of loss and efficiency	This test measures loss and efficiency between the input power and the output power.	5.1.1	5.2.1	5.3.1	
	This test measures conversion rate between the input power and the output power.		5.2.1	5.3.1	

Table 3 (continued)

Item of Part 3	Description	Motor	Inverter	Chopper	Motor system
Temperature rise test	This test investigates the temperature rise characteristics of each part of the component within the specified range.	5.1.2	5.2.2	5.3.2	
Torque characteristic test	This test measures the torque characteristics specified in the specifications of the motor.	5.1.3			
Cogging torque test	This test measures the cogging torque of the permanent magnetic motor.	5.1.4			

Table 4 — Contents of Part 6: operating load testing of the motor and the inverter

Item of Part 6	Description	Motor	Inverter	Chopper	Motor system
Operation endurance tests of motor	Cyclic test of high acceleration/deceleration endurance	4.1.1			
	Cyclic test of torque pattern endurance including maximum torque	4.1.2			
	Over speed test	4.1.3			
Operation endurance tests of inverter	Cyclic test of output current pattern endurance including maximum current		4.2.1		
Breakdown strength verification test	Contents of this test are mainly spin test, data acquisition of mechanical strength of the motor.	4.3.1			

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Electrically propelled road vehicles — Test specification for electric propulsion components —

Part 1: General test conditions and definitions

1 Scope

This document specifies the test procedures for performance and operating load for voltage class B electric propulsion components (motor, inverter, DC/DC converter) and their combinations (motor system) of electrically propelled road vehicles.

This document specifies the terms and definitions used in the ISO 21782 series and general test conditions.

2 Normative references

There are no normative references in this document.

3 Terms and definitions (standards.iteh.ai)

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:

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

3.1 chopper

DC electronic *power converter* (3.18) without an intermediate AC link giving a variable output voltage by varying the periods of conduction and non-conduction in an adjustable ratio

[SOURCE: IEC 60050-811:2017, 811-19-11, modified — The phrase "electronic power DC convertor" was modified to DC electronic power converter.]

3.2 conversion rate

ratio of output base wave power or output DC power to input DC power

3.3 DC link inductor

component boosted by the *chopper* (3.1) circuit, a magnetic energy storage and released in response to actuation of the switching element

3.4 efficiency

ratio of output power to input power

**3.5
induction motor**

IM
AC electric motor in which the electric rotor current needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding

EXAMPLE Asynchronous motor.

**3.6
inverter**

electric energy converter that changes direct electric current to single-phase or polyphase alternating currents

[SOURCE: IEC 60050-151:2001, 151-13-46]

**3.7
maximum current for duration of t_0**

$I_{t=t_0}$
maximum current defined for the time frame t_0 which can be constantly achieved for t_0 seconds starting from the steady state condition of room temperature (RT) and the nominal cooling conditions until the inverter (3.6), chopper (3.1) reaches the defined maximum temperature limit

**3.8
maximum operating speed**
upper limit revolution speed for the torque-motor speed characteristics

**3.9
maximum power for duration of t_0** (standards.iteh.ai)

$P_{t=t_0}$
maximum power defined for the time frame t_0 which can be constantly achieved for t_0 seconds starting from the steady state condition of RT and the nominal cooling conditions until the motor, inverter (3.6) and chopper (3.1) reaches the defined maximum temperature limit

**3.10
maximum speed**

n_m
highest defined speed which can maintain maximum power

Note 1 to entry: Maximum speed can be limited by control software or supplier's definitions.

**3.11
motor system**

electric propulsion system for electrically propelled road vehicle comprising a combination of components such as motor, inverter (3.6) and if necessary, DC/DC converter

**3.12
maximum torque for duration of t_0**

$M_{t=t_0}$
highest torque defined for the time frame t_0 which can be constantly achieved for t_0 seconds until the power limitation at higher speed starting from the steady state condition of RT and the nominal cooling conditions until the motor reaches the defined maximum temperature limit

**3.13
maximum voltage for unlimited operating capability**

highest value of OS1

Note 1 to entry: See ISO/PAS 19295 about OS1.

3.14
minimum voltage for unlimited operating capability
 lowest value of OS1

Note 1 to entry: See ISO/PAS 19295 about OS1.

3.15
no-load induced electromotive force

E_0
 voltage generated in the armature when the motor is rotated at the *rated speed* (3.21) as a power generator while the terminal of the synchronous motor is opened

3.16
operating load test
 test method that take into account the deterioration due to the operation of the device itself

3.17
output frequency
 frequency of the *inverter* (3.6) output current

3.18
power converter
 device that converts electric energy from DC to AC or from AC to DC

EXAMPLE AC frequency conversion, DC power conversion, etc.

3.19
permanent magnet motor
 PM

motor using permanent magnets for the field magnetic poles

3.20
rated frequency

f_r
output frequency (3.17) at the operating point corresponding to the *rated speed* (3.21) of the combined motor

3.21
rated speed

n_r
 intersection of the *maximum torque for duration of t_0* (3.12) and iso-power line

3.22
rated voltage

u_r
 central value of OS1

Note 1 to entry: See ISO/PAS 19295 about OS1.

4 Abbreviated terms

AC	alternating current
ACL	3-phase inductance equivalent to the leakage inductance of motor
DC	direct current
DUT	device under test
EMF	electromotive force

PWM pulse width modulation

RL ACL with series resistance equivalent to phase resistance of motor

RT room temperature

5 General test conditions

5.1 Operating points

Operating points as used in test are defined in [Figure 1](#), [Table 5](#) and [6](#).

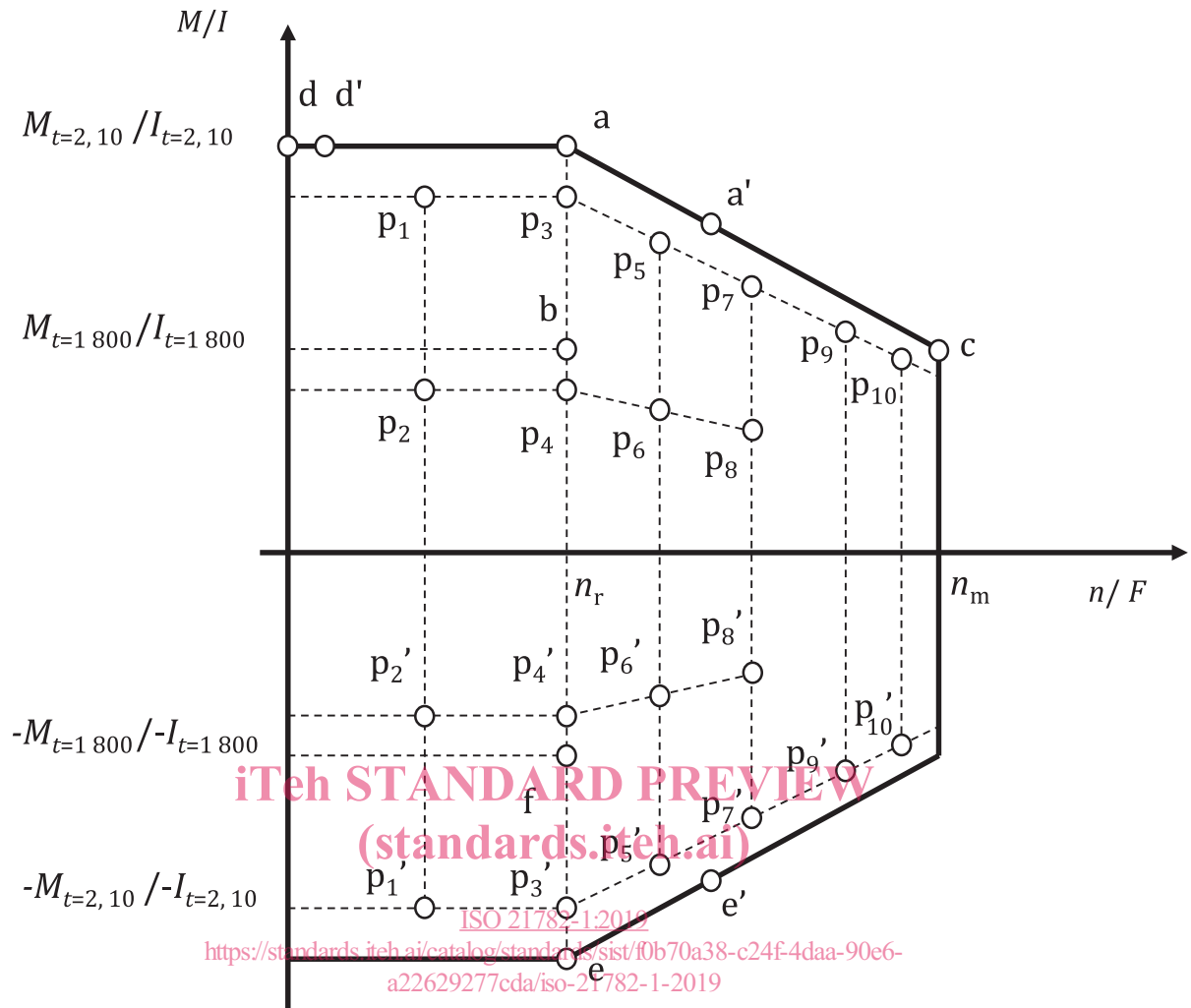
t_0 shall be 2 s, 10 s or 1 800 s.

As an operation for t_0 , also 30 s or 60 s may be chosen instead of 2 s and 10 s.

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Key

- n motor speed (in min^{-1})
- F frequency (in Hz)
- M torque (in Nm)
- I current (in A)
- $M_{t=2,10} / I_{t=2,10}$ maximum motoring torque/current duration for $t_0=2, 10$ (in Nm)/(in A)
- $M_{t=1800} / I_{t=1800}$ maximum motoring torque/current duration for $t_0=1800$ (in Nm)/(in A)
- $-M_{t=2,10} / -I_{t=2,10}$ maximum regenerating torque/current duration for $t_0=2, 10$ (in Nm)/(in A)
- $-M_{t=1800} / -I_{t=1800}$ maximum regenerating torque/current duration for $t_0=1800$ (in Nm)/(in A)
- n_m maximum speed/frequency (in min^{-1})/(in Hz)
- n_r rated speed/frequency (in min^{-1})/(in Hz)
- a, a', b, c, d, d', e, p₁-p₁₀ operating points as defined in Table 5
- e', f, p₁'-p₁₀' optional operating points as defined in Table 6

Figure 1 — Operating points

Table 5 — Definition of operating points

Operating point	Motor speed (in min^{-1}) /frequency (in Hz)	Torque (in Nm) /current (in A)	Output power (in W)
a	rated speed/frequency	$M_{t=2,10} / I_{t=2,10}$	$P_{t=2,10}$