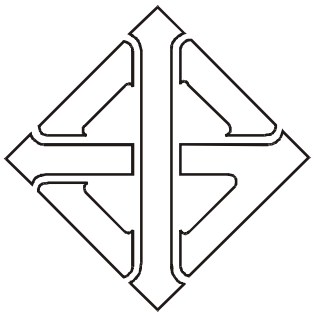

มาตรฐานผลิตภัณฑ์อุตสาหกรรม

THAI INDUSTRIAL STANDARD

มอก. 1537 – 2552

IEC 61204 (2001 – 05)

อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง – ลักษณะสมบัติเชิงสมรรถนะ และคุณลักษณะที่ต้องการด้านความปลอดภัย

LOW–VOLTAGE POWER SUPPLY DEVICES, D.C. OUTPUT–PERFORMANCE CHARACTERISTICS

สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม

กระทรวงอุตสาหกรรม

ICS 31.040.10

ISBN 978-616-231-070-6

มาตรฐานผลิตภัณฑ์อุตสาหกรรม

อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง – ลักษณะสมบัติเชิงสมรรถนะ และคุณลักษณะที่ต้องการด้านความปลอดภัย

มอก. 1537 – 2552

สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม
กระทรวงอุตสาหกรรม ถนนพระรามที่ 6 กรุงเทพฯ 10400
โทรศัพท์ 02 202 3300

ประกาศในราชกิจจานุเบกษา ฉบับประกาศและงานทั่วไป เล่ม 127 ตอนพิเศษ 86ง
วันที่ 15 กรกฎาคม พุทธศักราช 2553

มาตรฐานผลิตภัณฑ์อุตสาหกรรมอุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง - ลักษณะสมบัติเชิงสมรรถนะ ได้ประกาศใช้ครั้งแรกโดยรับ IEC 1204(1993-02) Low-voltage power supply devices, d.c. output- Performance characteristics and safety requirements มาใช้ในระดับเหมือนกันทุกประการ (Identical) โดยใช้ IEC ฉบับภาษาอังกฤษเป็นหลัก โดยประกาศในราชกิจจานุเบกษา ฉบับประกาศทั่วไป เล่มที่116 ตอนพิเศษที่ 88ง วันที่ 1 พฤศจิกายน พุทธศักราช 2542

เนื่องจาก IEC ได้แก้ไขปรับปรุงมาตรฐาน IEC 1204(1993-02) เป็น IEC 61204 (2001-05) จึงได้ยกเลิกมาตรฐานเดิมและกำหนดมาตรฐานใหม่โดยรับ IEC 61204 (2001-05) Low-voltage power supply devices, DC output - performance characteristics มาใช้ในระดับเหมือนกันทุกประการโดยใช้มาตรฐาน IEC ฉบับภาษาอังกฤษเป็นหลัก

คณะกรรมการมาตรฐานผลิตภัณฑ์อุตสาหกรรมได้พิจารณามาตรฐานนี้แล้ว เห็นสมควรเสนอรัฐมนตรีประกาศตามมาตรา 15 แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. 2511

ประกาศกระทรวงอุตสาหกรรม

ฉบับที่ 4199 (พ.ศ. 2553)

ออกตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม

พ.ศ. 2511

เรื่อง ยกเลิกและกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม

อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง -

ลักษณะสมบัติเชิงสมรรถนะและคุณลักษณะที่ต้องการด้านความปลอดภัย

โดยที่เป็นการสมควรปรับปรุงมาตรฐานผลิตภัณฑ์อุตสาหกรรม อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง - ลักษณะสมบัติเชิงสมรรถนะและคุณลักษณะที่ต้องการด้านความปลอดภัย มาตรฐานเลขที่ มอก.1537-2541

อาศัยอำนาจตามความในมาตรา 15 แห่งพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ. 2511 รัฐมนตรีว่าการกระทรวงอุตสาหกรรมออกประกาศยกเลิกประกาศกระทรวงอุตสาหกรรม ฉบับที่ 2477 (พ.ศ.2542) ออกตามความในพระราชบัญญัติมาตรฐานผลิตภัณฑ์อุตสาหกรรม พ.ศ.2511 เรื่อง กำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง - ลักษณะสมบัติเชิงสมรรถนะและคุณลักษณะที่ต้องการด้านความปลอดภัย ลงวันที่ 17 มิถุนายน พ.ศ.2542 และออกประกาศกำหนดมาตรฐานผลิตภัณฑ์อุตสาหกรรม อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง - ลักษณะสมบัติเชิงสมรรถนะและคุณลักษณะที่ต้องการด้านความปลอดภัย มาตรฐานเลขที่ มอก.1537-2552 ขึ้นใหม่ ดังมีรายละเอียดต่อท้ายประกาศนี้

ทั้งนี้ให้มีผลตั้งแต่วันถัดจากวันที่ประกาศในราชกิจจานุเบกษา เป็นต้นไป

ประกาศ ณ วันที่ 2 มีนาคม พ.ศ. 2553

ชาญชัย ชัยรุ่งเรือง

รัฐมนตรีว่าการกระทรวงอุตสาหกรรม

มาตรฐานผลิตภัณฑ์อุตสาหกรรม
อุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ ด้านออกเป็นไฟฟ้ากระแสตรง – ลักษณะสมบัติเชิงสมรรถนะ และคุณลักษณะที่ต้องการด้านความปลอดภัย

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้กำหนดขึ้นโดยรับ IEC 61204 (2001−05) Low−voltage power supply devices, DC output − performance characteristics มาใช้ในทุกระดับเหมือนกันทุกประการ (identical) โดยใช้ IEC ภาษาอังกฤษเป็นหลัก

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้เกี่ยวข้องกับวิธีการกำหนดคุณลักษณะที่ต้องการ สำหรับอุปกรณ์จ่ายกำลังไฟฟ้าแรงดันต่ำ (รวมถึงแบบการสวิตช์) ที่ให้ไฟฟ้ากระแสตรงด้านออกไม่เกิน 200 V d.c. ที่ระดับกำลังไฟฟ้าไม่เกิน 30 กิโลวัตต์ ทำงานจากแหล่งจ่ายกำลังไฟฟ้ากระแสสลับหรือกระแสตรง ที่มีแรงดันไฟฟ้าไม่เกิน 600 โวลต์ เป็นอุปกรณ์สำหรับใช้ในบริภัณฑ์ประเภท I หรือใช้เป็นงานเอกเทศเมื่อมีการป้องกันทางไฟฟ้าและทางกลอย่างเพียงพอ

วัตถุประสงค์ของมาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้ มีเจตนาเพื่อครอบคลุมแหล่งจ่ายตัวขับที่เป็นไฟฟ้ากระแสสลับหรือกระแสตรงทุกประเภทที่สามารถให้ค่ากำลังไฟฟ้าขาออกกี่ค่าก็ได้ โดยเฉพาะที่ผลิตพิเศษเพื่อการนำไปใช้โดยไม่ทราบวัตุประสงค์

ในกรณีที่แหล่งจ่ายกำลังไฟฟ้าที่ถูกพัฒนาขึ้นเป็นส่วนประกอบของบริภัณฑ์มาตรฐานผลิตภัณฑ์เฉพาะการนำมาตรฐานของ IEC 61204 มาประยุกต์ใช้อาจสามารถนำมาเป็นทางเลือก โดยเฉพาะอย่างยิ่งถ้ามาตรฐานผลิตภัณฑ์อุตสาหกรรมนั้นไม่ครอบคลุมลักษณะสมบัติเชิงสมรรถนะอย่างเพียงพอ

มาตรฐานผลิตภัณฑ์อุตสาหกรรมนี้อนุญาตให้ระบุรายละเอียดของอุปกรณ์นี้ ให้ตรงตามความต้องการของการใช้งานได้ โดยกำหนดค่าพารามิเตอร์ตามระดับสมรรถนะที่ต้องการ กำหนดนิยามที่จำเป็นซึ่งเกี่ยวข้องกับบริภัณฑ์ชนิดนี้และกำหนดการเลือกระดับสมรรถนะ ระดับสมรรถนะเหล่านี้จะถูกแบ่งชั้นคุณสมบัติ เพื่อผู้ผลิตและผู้ใช้สามารถที่จะเลือกและระบุพิสัยของแหล่งจ่ายกำลังไฟฟ้าให้เหมาะสมกับการใช้งาน

รายละเอียดให้เป็นไปตาม IEC 61204 (2001)

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE POWER SUPPLY DEVICES, DC OUTPUT – PERFORMANCE CHARACTERISTICS

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

This International Standard IEC 61204 has been prepared by subcommittee 22E: Stabilized power supplies, of IEC technical committee 22: Power electronics.

This consolidated version of IEC 61204 consists of the first edition (1993) [documents 22E(CO)24 and 22E(CO)26 and its amendment 1 (2001) [documents 22E/77/FDIS and 22E/80/RVD].

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience.

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

Annexes A to D form an integral part of this standard.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until 2003. At this date, the publication will be

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

INTRODUCTION

This International Standard, based on the British Standard BS6688: 1986, has been reworked and extended to take into account existing and forthcoming IEC standards. With regard to safety, there was close collaboration with IEC technical committee 74, working group 6: Safety requirements for power supplies.

LOW-VOLTAGE POWER SUPPLY DEVICES, DC OUTPUT – PERFORMANCE CHARACTERISTICS

1 General

1.1 Scope and object

This international Standard describes a method for specifying requirements for low-voltage power supply devices (including switching types) providing d.c. output(s) up to 200 V d.c. at a power level of up to 30 kW, operating from a.c. or d.c. source voltages of up to 600 V. The devices are for use within class I equipment or for free-standing operation when used with adequate electrical and mechanical protection.

This standard is intended to be used for all types of a.c. or d.c. driver power supplies with any number of outputs, specially produced for an unknown final application.

In the case where power supplies are developed as a component of equipment covered by specific product standards, these standards apply; the additional application of IEC 61204 may be useful as an option, especially if the performance characteristics are not sufficiently covered by the product standard.

It permits to specify a power unit to meet a particular application by the specification of parameters at required performance levels, to establish the essential definitions related to this type of equipment, and to establish a selection of levels of performance. These levels are carefully graded to enable manufacturers and users to select and specify a range of power supply devices suitable for their application.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently International Standards.

IEC 60038:1983, *IEC standard voltages*

IEC 60068: *Environmental testing*

IEC 60068-2-1:1990, *Environmental testing – Part 2: Tests – Tests A: Cold*

IEC 60068-2-2:1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 60068-2-6:1982, *Environmental testing – Part 2: Tests – Test Fc and guidance: Vibration (sinusoidal)*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and Guidance: Shock*

IEC 60068-2-29:1987, *Environmental testing – Part 2: Tests – Test Eb and Guidance: Bump*

IEC 60478: *Stabilized power supplies, d.c. output*

IEC 60478-1:1974, *Stabilized power supplies, d.c. output – Part 1: Terms and definitions*

IEC 60478-2:1986, *Stabilized power supplies, d.c. output – Part 2: Rating and performance*

IEC 60478-3:1989, *Stabilized power supplies, d.c. output – Part 3: Reference levels and measurement of conducted electromagnetic interference (EMI)*

IEC 60478-4:1976, *Stabilized power supplies, d.c. output – Part 4: Tests other than radio-frequency interference*

IEC 60478-5:1993, *Stabilized power supplies, d.c. output – Part 5: Measurement of the magnetic component of the reactive near field*

IEC 60651:1979, *Sound level meters*

IEC 60664-1:1992, *Insulation co-ordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60721: *Classification of environmental conditions*

IEC 60721-3-1:1987, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities. Storage*

IEC 60721-3-2:1985, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities. Transport*

IEC 60801: *Electromagnetic compatibility for industrial-process measurement and control equipment*

IEC 60801-4:1988, *Electromagnetic compatibility for industrial-process measurement and control equipment – Part 4: Electrical fast transient/burst requirements*

IEC 60950:1991, *Safety of information technology equipment, including electrical business equipment*

MIL-HDBK-217E:1974, *Reliability prediction of electronic equipment*

1.3 Definitions

For the purpose of this International Standard the definitions given in IEC 60950 and IEC 60478-1 apply, except where redefined in this standard.

2 Presentation of performance characteristics

The performance characteristics are detailed in 3.1 to 8.1 and are in accordance with the performance criteria listed in table III of IEC 60478-2.

The performance figure defines the maximum change (not typical) in the measured quantity which may be either positive or negative unless specified otherwise. Note that this implies that a 1 % change may mean a maximum difference of 2 % between quantities measured on a number of units.

The performance parameters are measured at 25 °C unless otherwise stated.

Tests relating to performance characteristics shall be as stated in table III of IEC 60478-2. Where a specific instruction appears to conflict with that indicated in table I or III, this standard shall take precedence.

The performance characteristics presentation of table I illustrates a typical application. The indication of the present IEC publication subclause numbering is mandatory. The absence of a performance figure indicates that no requirements exist. Indicating the performance letter coding within brackets is optional.

3 Performance

3.1 Rated outputs and total output power

The output voltages and performance levels of the unit shall be stated for each parameter. For a multiple output power supply, performance levels shall be indicated for each output.

The manufacturer/(user) shall confirm/(specify) that the variations in output voltage of the unit comply with the stated limits given in 3.2 to 3.18, as appropriate, under the least favourable combination of source voltage, load and temperature at the stated output level of the unit.

The manufacturer/(user) shall confirm/(specify) the minimum load value for the controlling output in a multiple output power supply that is required to maintain any other parameter within the specification. The nature of each output and its polarity, if fixed, shall also be stated or specified.

If the loads are defined by the customer, then the rated value of these loads shall be used in performance measurements. In all other cases, the output to be measured shall be at maximum, other outputs at 50 % of their rated output load, and voltage input of the power supply shall be at rated value.

The manufacturer/(user) shall confirm/(specify) the total output power at one of the preferred high ambient operating temperatures of 3.2.

Table 1 – Performance characteristics presentation

IEC 61204 Clause/subclause					
3.1	Rated outputs	Main output: 5 V 150 A Aux. 1: 12 V 15 A Aux. 2: 24 V 8 A			
	Total output power	1 000 W at 50 °C			
3.2	Ambient operating temperature range	Low: 0 °C (D) High: 50 °C (D) (70 °C with de-rating of 2,5 %/°C above 50 °C) Forced air cooled, internal fan			
3.3	Ambient storage temperature	–40 °C to +85 °C (A)			
3.4	Source voltage and frequency	Low: 88 V to 132 V (D) High: 176 V to 264 V (D) Frequency range: 48 Hz to 63 Hz			
3.5	Source current True R.M.S. Peak repetitive Peak inrush Harmonic distortion Power factor Efficiency	 20 A at 88 V input; 10 A at 176 V 50 A at 88 V input; 25 A at 176 V 30 A 0,65 0,65 0,70			
3.6	Source regulation	**Main output** 0,1 %	(A)	**Auxiliary output** 0,1 %	(A)
3.7	Load regulation Load change	0,2 % 0 to 100 %	(A) (A)	0,2 % 0 to 100 %	(A) (A)
3.8	Intrinsic error	N/A		N/A	
3.9	Adjustability of voltage output Span Resolution	 80 to 120 % 1 %		 80 to 120 % 1 %	
3.10	Periodic and random deviation a) Source frequency b) Switching frequency c) Total (30 MHz)	 0,1 % 0,5 % 1 %	 (A) (A) (B)	 0,1 % 0,5 % 1 %	 (A) (A) (B)
3.11	Cross regulation Load change	0,2 % 0 to 100 %	(A) (A)	0,2 % 0 to 100 %	(A) (A)
3.12	Temperature coefficient	0,02 %/°C	(B)	0,02 %/°C	(B)
3.13	Hold-up time	20 ms	(A)	N/A	
3.14	Start-up time	1 s	(C)	1 s	(C)
3.15	Turn-on (turn-off) overshoot	None	(A)	None	(A)
3.16	Transient response to load current changes Voltage deviation Recovery time Load change	 5 % 1 ms 50 % to 100 %	 (B) (A) (D)	 – – –	

Table 1 – Performance characteristics presentation *(continued)*

IEC 61204 Clause/subclause		
3.17	Output overvoltage protection Electronic inhibit	110 % to 130 % (E) (B)
3.18	output overcurrent protection	Constant current (A)
3.19	Mean-time between failures	65 000 Hrs. MIL-HDBK-217E, 25 °C, Gb
4	Requirements for safety	Protection class: I Overvoltage category: II Pollution degree: 2
5.2	Conducted EMI	IEC 60478-3, curve A
5.4	Input transient withstand voltage	2 kV (D)
6.1	Remote programming	Resistance (A) and voltage programming (B)
6.2	Remoting sensing	500 mV (A)
6.3	Mechanical characteristic	203 mm × 127 mm × 300 m
6.4	Series operation	250 V
6.5	Parallel operation	Equal current sharing (A)

3.2 Ambient operating temperature range

The operating temperature range of the unit shall be stated and specified in one of the following preferred ranges. The manufacturer shall confirm that the power supply is capable of continuous operation without derating at the maximum temperature stated, at maximum rated power output, and under the least favourable conditions in the convection cooled (free-air) environment up to 2 000 m. Derating of output current and power at elevated temperatures shall be clearly stated. If the power supply is intended for forced air or conduction cooling, the operating conditions shall be clearly specified and the devices tested under these cooling conditions.

The ambient temperature is defined as the final steady state temperature with the power supply dissipating maximum power, measured 50 mm below the power supply for convection cooling or at the air intake for forced-air cooling.

Low	A	–40 °C	High	A +85 °C
	B	–25 °C		B +70 °C
	C	–10 °C		C +55 °C
	D	0 °C		D +50 °C
	E	+5 °C		E +40 °C

3.3 Ambient storage and transit temperature range

The manufacturer shall confirm that the unit complies with a storage and transit temperature range of:

A –40 °C to +85 °C

B –25 °C to +70 °C

If pre-conditioning is required before use, due to the danger of condensation, the manufacturer shall state clearly what action needs to be taken.

The relative humidity for storage and transit shall be coded according to IEC 60721-3-1 and IEC 60721-3-2, respectively.

3.4 Source voltage and frequency

The range of source values acceptable by the power supply shall be stated and specified as one or more of the preferred values given below.

The manufacturer and/or user shall state whether automatic voltage selection is necessary.

The definitions of IEC 60038 apply.

Preferred source voltage ranges

Single-phase alternating current (a.c.)

Wide range	A	85 V to 264 V
Low range	B	85 V to 132 V
	C	88 V to 132 V
	D	93 V to 132 V
	E	90 V to 110 V
High range	B	170 V to 264 V
	C	176 V to 264 V
	D	187 V to 264 V
	E	195 V to 264 V
	F	207 V to 253 V
Frequency range	A	48 Hz to 440 Hz
	B	48 Hz to 63 Hz
	C	45 Hz to 55 Hz
	D	55 Hz to 65 Hz
	E	49 Hz to 51 Hz
	F	59 Hz to 61 Hz

These values are ranges which include the tolerance. If manual range change is required, this shall be clearly stated.

Three-phase alternating current (a.c.)

The values stated in IEC 60038 are preferred for three-phase a.c. networks.

Direct current (d.c.)

The values stated in IEC 60038 are preferred for direct current (d.c.).

Other values and ranges are acceptable but should be clearly stated and agreed between the customer and supplier. Alternatively, the nominal input voltage and tolerance may be stated.

3.5 Source current

The following quantities shall be stated both under nominal and under least favourable conditions:

a) r.m.s. source current [1)];

b) peak repetitive source current (a.c. sources only);

c) peak inrush current [2)];

d) the harmonic distortion factor (THD) of the source current waveform;

e) power factor (input W/input VA) [1)] (a.c. sources only);

f) efficiency.

If the least favourable condition is at other than maximum load, the actual load shall be stated.

Compliance with the stated performance shall be checked by inspection and in accordance with section twelve of IEC 60478-4.

3.6 Source effect (source regulation)

The regulation for the specified range of source voltage and frequency, with each output loaded to 50 % of maximum load at its specified output voltage, shall be stated and specified as one of the following preferred values:

A 0,1 %

B 0,2 %

C 0,5 %

D 1 %

E Unregulated

Compliance with the stated performance shall be checked by inspection and in accordance with section two of IEC 60478-4.

[1)] Care should be taken that measuring instruments give true r.m.s. reading in the presence of non-sinusoidal waveforms.

[2)] In measuring the peak inrush current, the charging current into EMI suppression capacitors is disregarded in the first millisecond after switch-on.

3.7 Load effect (load regulation)

The load regulation at the specified load range and least favourable source voltage for each output shall be stated and specified from the following preferred values:

Load regulation	*Load change*
A 0,2 %	A 0 to 100 %
B 0,5 %	B 10 to 100 %
C 1 %	C 25 to 100 %
D 5 %	D 50 to 100 %
E 10 %	

If the regulation curve is non-linear it is recommended that a graph, showing the relationship between the measured quantities, shall be given.

The test shall be performed at two different load settings as follows:

case 1 – all outputs at 100 % of full load, unless this exceeds the total power rating when case 1a should be used;

case 1a – all outputs other than the one where the load is changed, at 50 % of full load, or at an equal percentage load to achieve full power;

case 2 – all outputs, other than the one where the load is changed, at minimum load.

Compliance with the stated performance shall be checked by inspection and in accordance with section one of IEC 60478-4.

3.8 Output voltage tolerance (intrinsic error) – fixed outputs

The output voltage tolerance at nominal source voltage and at half the rated load for each output shall be stated in such a way as to comply with one of the following preferred values:

A 0,5 %
B 1 %
C 2 %
D 5 %
E 10 %

Compliance with the stated performance shall be checked by inspection, using the test circuit measurement of figure 6 of IEC 60478-4.

3.9 Adjustability of output voltage

The span and resolution of each adjustable output shall be stated under nominal source and half-rated load conditions.

If adjusting one output will affect another, this shall be stated.

3.10 Periodic and random deviation

Ripple and noise performance for each output shall be stated and specified as one of the following preferred values:

A 0,5 % peak-to-peak
B 1 % peak-to-peak
C 2 % peak-to-peak
D 5 % peak-to-peak
E 10 % peak-to-peak

Periodic and random variations shall be given for the following three bands:

a) low-frequency noise:
source frequency and its harmonics only (a.c. sources only);

b) switching noise:
switching frequency and its harmonics only;

c) total, including spikes (the bandwidth of the measuring equipment shall be stated).

Compliance with the stated performance shall be checked in accordance with the methods set out in annex A. It should be noted, that this method and definition is different to that used in IEC 60478-4.

If special weighting is applicable in some applications, such as telecommunications, the measuring methods and detailed results shall be stated in addition to the above.

3.11 Interaction effects (cross regulation)

The effect on the voltage of each output resulting from a change in the loading of other outputs in a multiple output power supply, for the specified load ranges shall be stated and specified to comply with one of the following preferred values:

Cross regulation	*Load change*
A 0,2 %	A 0 % to 100 %
B 2 %	B 10 % to 100 %
C 5 %	C 25 % to 100 %
D 10 %	D 50 % to 100 %
E 20 %	

The interaction effect shall take account of the following two conditions:

case 1 – all outputs at 100 % of full load, unless this exceeds the total power rating when case 1a should be used;

case 1a – all outputs other than the one where the load is changed, at 50 % of full load, or at an equal percentage load to achieve full power;

case 2 – all outputs, other than the one where the load is changed, at minimum load.

Compliance with the stated performance shall be checked by inspection and in accordance with section one of IEC 60478-4.

3.12 Temperature coefficient

The temperature coefficient shall be stated and specified as one of the following preferred values:

A 0,01 %/°C

B 0,02 %/°C

C 0,05 %/°C

In applications where this is a controlling parameter it is recommended that a graph be added, showing change in output voltage against temperature.

Compliance with the stated performance shall be checked by inspection and in accordance with section six of IEC 60478-4.

3.13 Hold-up time (turn-off decay time)

Starting from nominal output voltage and power, the source voltage at minimum +10 %, the hold-up time of the output voltage, within the specified range, shall be indicated. For d.c. input, the actual hold-up time shall be stated. For a.c. input, hold-up time shall be stated as one of the following periods:

A more than 20 ms from the next zero crossing; following the source voltage outage;

B 20 ms from the next zero crossing;

C 10 ms from the next zero crossing;

D less than 10 ms.

Compliance with the stated performance shall be checked by inspection under the stated conditions, using the test circuit measurement of figure 6 of IEC 60478-4.

3.14 Start-up time (turn-on delay time)

The time taken, after switch-on of the source, for the output voltage to enter the specification band shall be stated and specified as one of the following preferred values:

A 0,1 s

B 0,2 s

C 0,5 s

D 1,0 s

E 2,0 s

F 5,0 s

Compliance with the stated performance shall be checked by inspection and in accordance with section seven of IEC 60478-4.

3.15 Turn-on (turn-off) overshoot

The peak value of output overshoot at switch-on and switch-off shall be stated at nominal input, nominal power.

A None

B 1 %

C 5 %

The manufacturer shall clearly state if, at any time, the output changes polarity.

The manufacturer shall confirm that no overvoltage condition exists at any load and any source voltage between zero and the maximum specified.

If the sequence in which outputs come up or go down is controlled, the timing sequence and loads shall be stated.

3.16 Transient response to load current changes

The transient response at the output terminals of the power supply for each output shall be stated and should be specified as one of the preferred values given in table 2. Figures 1 and 2 illustrate the maximum output voltage deviation V_m, specified as a percentage arising from a load change I_x, specified as a percentage of rated valued I_m.

When the output voltage returns within the load regulation band as specified in 3.7 (V_r zone C of figures 1 and 2), the time T_R is defined as the total transient recovery time of the power supply. The characteristics in zone C can be under-damped, critically damped or oscillatory.

Compliance with the stated performance shall be checked by inspection and in accordance with section seven of IEC 60478-4.

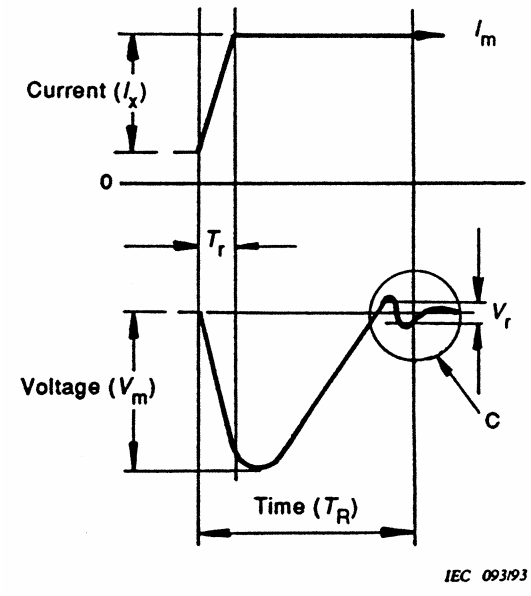


Figure 1 – Resistive load applied at the output terminals

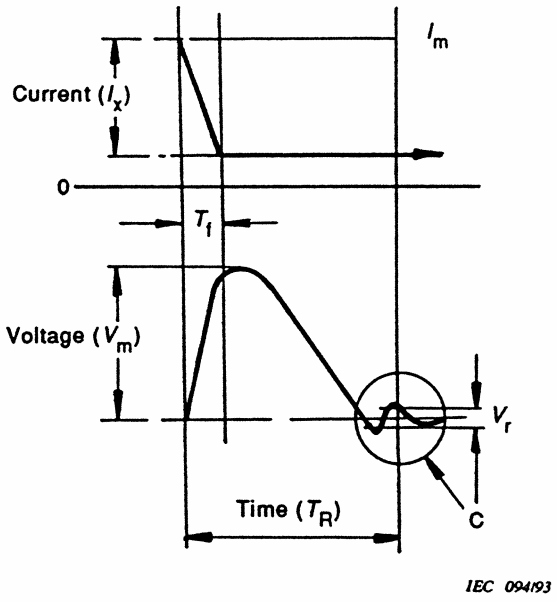


Figure 2 – Resistive load removed at the output terminals

Table 2 – Preferred transient response

Voltage deviation, V_m	Recovery time, T_R	Load change, I_x
A 2 %	A 1 ms	A 100 % to 0 % 0 % to 100 %
B 5 %	B 5 ms	B 100 % to 10 % 10 % to 100 %
C 10 %	C 20 ms	C 100 % to 25 % 25 % to 100 %
D 20 %	D 50 ms	D 100 % to 50 % 50 % to 100 %

NOTE The method of measurement should take account of transmission line effects, reactive loads, d*I*/d*t*, etc.

The rise time and fall time of load current changes T_r and T_f should be less than one-tenth of the specified recovery time T_R.

3.17 Output overvoltage protection

If overvoltage protection against internally generated faults of the power supply is provided, it shall be specified for each output and at one of the following preferred values. The manufacturer shall confirm that the output voltage never exceeds the stated maximum levels at any time and for any load.

A 110 % to 120 %
B 115 % to 125 %
C 110 % to 130 %
D 150 % max.
E None

The manufacturer/(user) shall state/(specify) whether the overvoltage protection circuit is:

A crowbar protection circuit across output;
B electronic inhibit;
C inhibit and "re-try" system.

For definitions see annex B.

The maximum continuous external supply current that can be absorbed by the power supply shall be stated.

Compliance with the stated performance shall be checked by inspection and in accordance with section sixteen of IEC 60478-4.

3.18 Output overcurrent protection

The manufacturer shall confirm whether the overcurrent protection is:

A constant current;
B foldback current;
C current trip;
D short-circuit proof only (not protected against continuous overloads).
E inhibit and retry mode

For cases A, B and C, the maximum current and the short-circuit current shall be stated. It is recommended that this be shown in the form of a graph as given in annex C. It should be noted that these definitions differ from those used in IEC 60478-1.

Compliance with this requirement shall be checked in accordance with section one of IEC 60478-4.

3.19 Mean time between failures (MTBF)

The MTBF shall be predicted at nominal input, nominal output power and at 25 °C ambient temperature, using the component count method and internationally accepted failure rate figures (such as those contained in MIL-HDBK-217E, ground benign conditions).

Information sources and reference conditions shall be stated.

In addition, the MTBF may be established by statistical inference following a life expectancy test under the prescribed conditions. In such a case all results as well as the confidence level shall be stated.

4 Requirements for protective devices

4.1 Thermal protection

The manufacturer/(user) shall confirm/(specify) that protection, if fitted, shall protect the unit from excessive ambient temperatures and the effect of blocked fans. If the system re-sets manually or automatically after cooling off this shall be stated/(specified).

4.2 Input overcurrent protection

The manufacturer/(user) shall confirm/(specify) that the unit is protected by fuses, or interrupting devices such as circuit breakers, thermal switches, or, if this has been impracticable, by a design providing input current limitation.

The manufacturer shall provide information on the type and rating of the required external fuse or circuit breaker.

The manufacturer/(user) shall also confirm/(specify) that any circuit shortage caused by a blown fuse or tripping of a circuit breaker will not cancel the protective action of protective earth connections.

5 Acoustic noise requirements

The manufacturer shall clearly state the frequency and the sound level of a unit operating in the audible band.

The sound level generated by any fans used and the airflow generated by them, shall also be stated.

Compliance with the stated performance shall be checked in accordance with section seventeen of IEC 60478-4, using equipment described in IEC 60651.

6 Additional requirements

6.1 Remote programming (remote control)

The availability of remote programming shall be stated for each output and shall be specified as one of the following preferred methods:

A Resistance programming (Ω/V)

B Voltage programming (V/V)

C Digital programming.

In case C, the type of interface and communication protocol shall be clearly stated.

Compliance with the stated performance shall be checked by inspection and measurement.

6.2 Remote sensing

The availability of remote sensing shall be stated for each output and shall be specified in terms of maximum total voltage drop per d.c. output line as one of the following preferred values:

A 500 mV

B 250 mV.

The unit's behaviour with (a) open-circuit sense connections, and (b) reversed sensing connections shall be stated.

Compliance with the stated performance shall be checked by inspection and measurement.

6.3 Mechanical characteristics

The dimensions and tolerances of the unit as well as its weight and the required method of installation and connection shall be stated.

Compliance with the stated requirements shall be checked by inspection and measurement.

6.4 Series operation

The maximum continuous voltage between output and case shall be stated by the manufacturer. Any special conditions for series operation, if allowed, shall be stated by the manufacturer.

6.5 Parallel operation

Operational characteristics shall be one of the following:

A equal current sharing maintained even when redundant parallel units fail;

B equal current sharing as long as all units are working;

C "master-slave" operation;

D no independently forced current sharing.

More detailed explanations are available in annex D.

The connection diagram shall be shown and instructions shall be given if any adjustments are required. Should it be necessary to derate the total load or reset current limits, this shall be stated.

6.6 Monitoring and control signals

The timing and voltage levels of the monitoring and control signals shall be stated. All such signals shall be in a state corresponding to normal working conditions, after turn-on and turn-off of the power supply, being free from any malfunctioning.

7 Test requirements

7.1 General

In addition to confirming that "the power supply withstands the tests specified in clauses 3 to 6", the manufacturer shall confirm that the unit, if subjected to the tests in 7.2, under the specified operating conditions, after these tests still complies with 3.4 to 3.10 and with clause 4.

7.2 Environmental tests

The manufacturer (user) shall confirm (specify) the IEC 60068 test to be performed with its exact type reference (for example, Ad, Ea, Fc, etc.) and level of severity. The manufacturer shall also confirm that the unit withstands the specified tests.

7.2.1 Cold

The unit, in operation, shall be tested according to IEC 60068-2-1.

7.2.2 Dry heat

The unit, in operation, shall be tested according to IEC 60068-2-2.

7.2.3 Damp heat

The unit, in operation, shall be tested according to IEC 60068-2-3.

7.2.4 Shock

The unit, not in operation, shall be tested according to IEC 60068-2-27.

7.2.5 Bump

The unit, not in operation, shall be tested according to IEC 60068-2-29.

7.2.6 Vibration

The unit, not in operation, shall be tested according to IEC 60068-2-6.

8 Miscellaneous requirements

8.1 Markings and instructions

The manufacturer shall provide all the necessary technical data, installation and operating instructions for the unit, and shall confirm that the marking of the unit complies with 1.7 of IEC 60950.

Compliance shall be checked by inspection.

Annex A
(normative)

Periodic and random deviation test methods

A.1 General

For the low-frequency measurement in 3.10 a) the normal, single-ended method is adequate. Any switching noise or high-frequency noise measured using this method shall be disregarded.

For measuring the switching and high-frequency content, one of the following methods shall be used.

A.2 Apparatus

a) *Differential test method*

The test leads in the differential test method shall be as shown in figure A.1.

The power supply under test should be connected via the differential leads to an oscilloscope having sufficient bandwidth and an adequate common mode rejection ratio (CMRR) as indicated in figure A.2. The oscilloscope should be earthed via the ground plane.

This measurement method gives rise to a 2:1 attenuation of the power supply device terminal noise voltage. The components used attenuate low frequencies, such as 50 Hz.

NOTE 1 The length of the test lead outside the coaxial cable is critical and should be kept as short as possible (10 mm long, solid tinned copper wire is preferred).

NOTE 2 The BNC T-connectors and 50 Ω terminators are not mandatory. Other types of 50 Ω connectors can be accepted.

NOTE 3 The coaxial cable screens are unconnected at the power supply device end of the cables, since any connection would result in earth current flowing through the screens and give an erroneous measurement.

b) *Current probe test method*

The test layout is shown in figure A.3.

This method has the advantage that there is galvanic isolation at the measuring point and therefore freedom from earth-loop effects.

The current/voltage transfer factor shall be taken into account. This depends on the value of *R*, the current probe transfer gain, and the voltage sensitivity of the oscilloscope. The test circuit shall have minimum inductance to minimize magnetic pick-up. Both the resistor and the capacitor shall be of "non-inductive" construction and the voltage rating of the capacitor shall be adequate for the power supply device output voltage. The correct polarity shall be observed. It is to be noted that using the values indicated, low-frequency noise (3.10 a) will be attenuated. If the power rating of the resistor is adequate the capacitor is not required.

A.3 Procedure

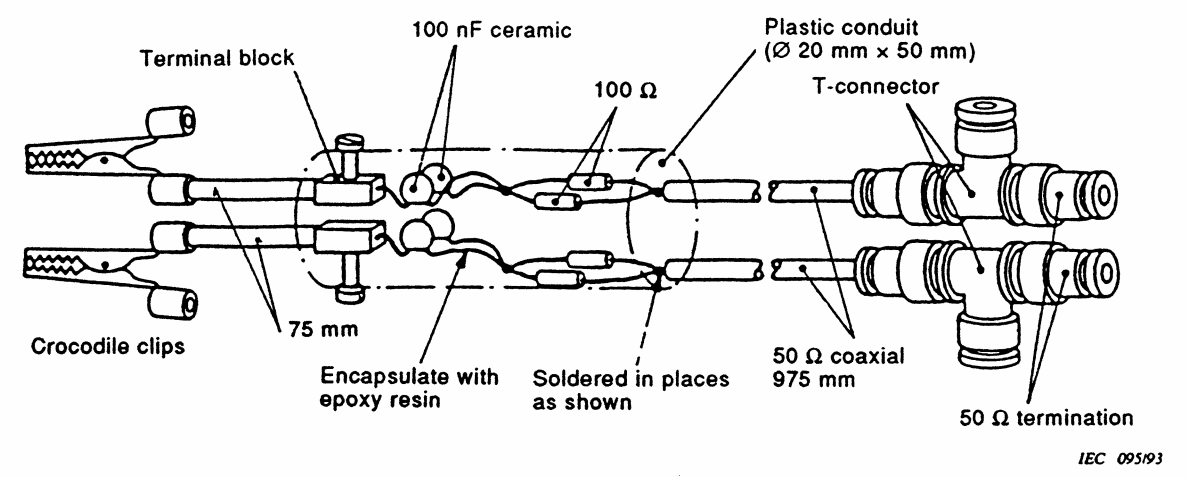
a) *Differential test method*

The procedure shall be as follows.

Balance the gain of Y1 and Y2 if necessary by connecting both probes to the same power supply terminal (power supply device turned on) and adjusting gain for the minimum display amplitude. Set the oscilloscope channel selector to Y1-Y2. Measure the differential noise voltage between the positive and negative terminals of the power supply.

b) *Current probe test method*

Special care shall be taken in calculating the power supply ripple voltage. Due allowance shall be made for the value of *R*, and the current probe transfer gain, as well as the voltage sensitivity of the oscilloscope. For example, if the oscilloscope indicates a peak-to-peak voltage of 5 mV using the circuit values of figure A.3 and a current probe transfer gain of 2 mA/mV, the actual ripple at the power supply device terminals is 5 mV × 2 mA/mV × 5 Ω = 50 mV.



NOTE Adapter and connector type are not mandatory.

Figure A.1 – Differential test probe

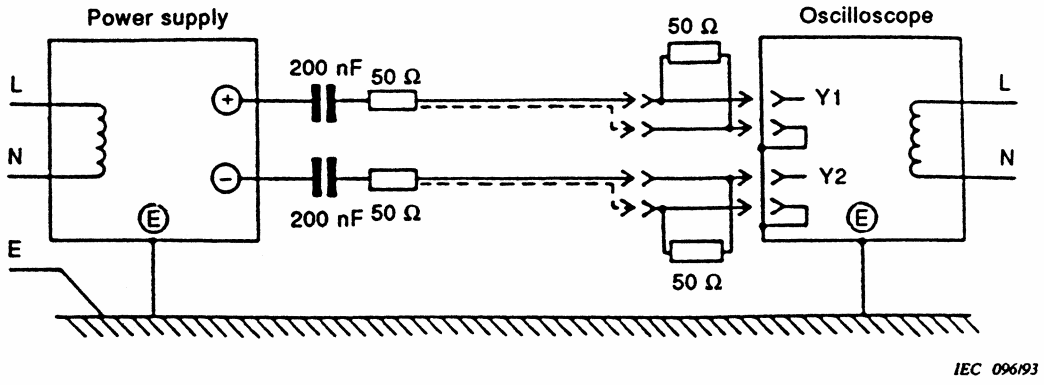
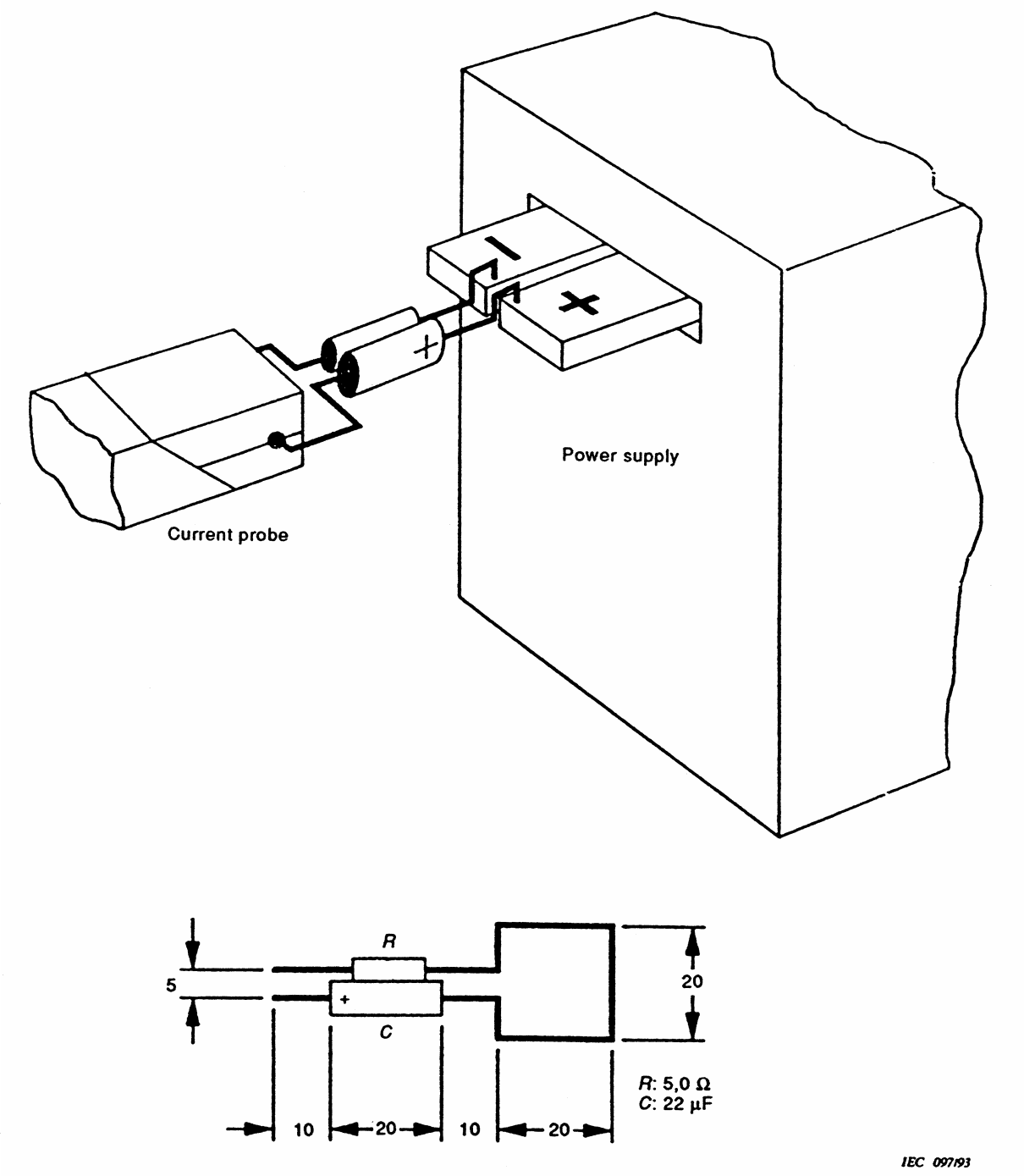


Figure A.2 – Differential test arrangement



Dimensions in millimetres

Figure A.3 – Current probe test arrangement

Annex B
(normative)

Output overvoltage protection

The following systems are recognized:

a) Crowbar protection circuit across output as defined in IEC 60478-1.

b) Electronic inhibit

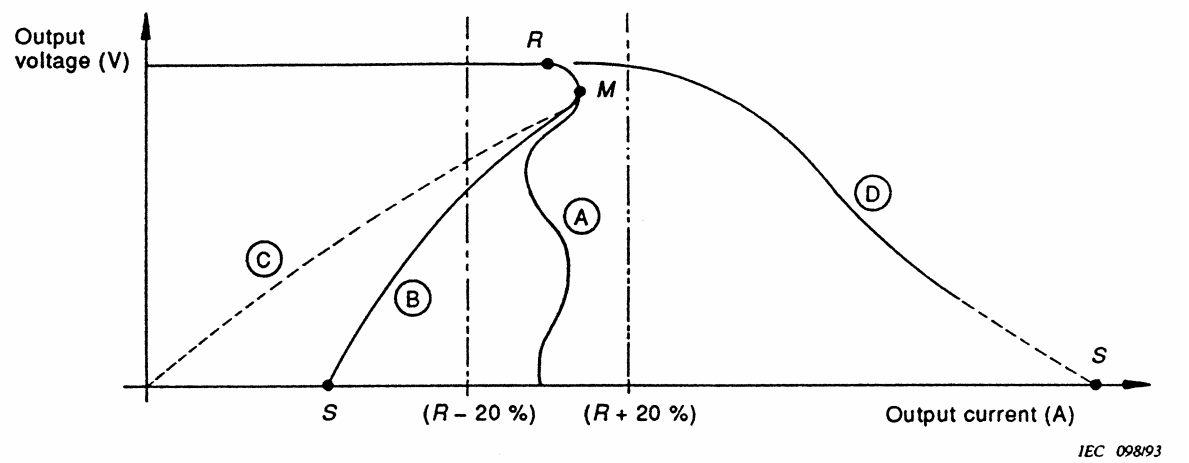
A system where on the occurrence of an overvoltage condition, the power supply is inhibited from supplying power. However, the output capacitor is not discharged and any external source of current will not be shorted out.

c) Inhibit and "re-try" system

This operates as per the electronic inhibit system b). However, while system b) is self-latching and will not reset until input is interrupted, on system c) the circuit resets after some time (normally about 10 s) and will try to establish the output again. If the overvoltage condition is still present, it will inhibit and then try again. The time taken between resets shall be stated.

Annex C
(normative)

Overcurrent protection characteristics



R = Rated current

M = Maximum limited current

S = Short-circuit current

Ⓐ = Constant current characteristics (current within 20 % of *R*)

Ⓑ = Foldback current characteristics

Ⓒ = Current trip characteristics

Ⓓ = Short-circuit proof characteristics

Figure C.1 – Overcurrent protection characteristics

Annex D
(normative)

Parallel operation

a) Equal current sharing maintained even when redundant parallel units fail

   In this system any number of units operating in parallel share the total load and should some units fail or become disconnected, or switched off, the remaining units will redistribute the load automatically (subject to maximum current ratings) so that they still share current equally.

b) "Equal" current sharing as long as all units are working

   If some units fail, become disconnected or switched off, the current is no longer shared equally.

c) "Master-slave" operation

   One unit acts as the "master" and the others are forced to deliver the same current as the master unit. If the master unit fails, the system fails.

d) No independently forced sharing

   There is no forced sharing, although sharing can be achieved by critical adjustment of output voltage, lead resistance, etc. It is normally advisable to set the current limit to the same value as the rated current and derate the total load.