



UL 363

STANDARD FOR SAFETY

Knife Switches

[ULNORM.COM](https://www.ulnorm.com) : Click to view the full PDF of UL 363 2020

ULNORM.COM : Click to view the full PDF of UL 363 2020

UL Standard for Safety for Knife Switches, UL 363

Eleventh Edition, Dated August 12, 2011

SUMMARY OF TOPICS

This revision of ANSI/UL 363 dated June 10, 2020 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated January 10, 2020.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical photocopying, recording, or otherwise without prior permission of UL.

UL provides this Standard "as is" without warranty of any kind, either expressed or implied, including but not limited to, the implied warranties of merchantability or fitness for any purpose.

In no event will UL be liable for any special, incidental, consequential, indirect or similar damages, including loss of profits, lost savings, loss of data, or any other damages arising out of the use of or the inability to use this Standard, even if UL or an authorized UL representative has been advised of the possibility of such damage. In no event shall UL's liability for any damage ever exceed the price paid for this Standard, regardless of the form of the claim.

Users of the electronic versions of UL's Standards for Safety agree to defend, indemnify, and hold UL harmless from and against any loss, expense, liability, damage, claim, or judgment (including reasonable attorney's fees) resulting from any error or deviation introduced while purchaser is storing an electronic Standard on the purchaser's computer system.

No Text on This Page

[ULNORM.COM](https://ulnorm.com) : Click to view the full PDF of UL 363 2020

AUGUST 12, 2011
(Title Page Reprinted: June 10, 2020)



ANSI/UL 363-2011 (R2020)

1

UL 363

Knife Switches

First Edition – November, 1917
Second Edition – May, 1939
Third Edition – February, 1955
Fourth Edition – February, 1966
Fifth Edition – March, 1971
Sixth Edition – September, 1976
Seventh Edition – November, 1980
Eighth Edition – February, 1987
Ninth Edition – December, 1994
Tenth Edition – January, 2000

Eleventh Edition

August 12, 2011

This ANSI/UL Standard for Safety consists of the Eleventh Edition including revisions through June 10, 2020.

The most recent designation of ANSI/UL 363 as a Reaffirmed American National Standard (ANS) occurred on May 20, 2020. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

COPYRIGHT © 2020 UNDERWRITERS LABORATORIES INC.

No Text on This Page

ULNORM.COM : Click to view the full PDF of UL 363 2020

CONTENTS

INTRODUCTION

1	Scope	5
2	Components	5
3	Units of Measurement	5
4	Undated References	5

CONSTRUCTION

5	General	5
6	Bases – Insulating Material	5
7	Current-Carrying Parts	6
8	Hinges and Blades	8
9	Wiring Terminals	9
10	Fuses and Fuseholders	10
11	Spacings.....	10

PERFORMANCE

12	General	12
13	Temperature Test	12
14	Overload Test.....	12
15	Dielectric Voltage-Withstand Test	14

PERFORMANCE – 10KA MAXIMUM AVAILABLE FAULT CURRENT CIRCUITS

16	General	14
17	Short-Circuit Withstand Test.....	14
18	Low-Level Dielectric Voltage-Withstand Test	15
19	Closing Test.....	15
20	Low-Level Dielectric Voltage-Withstand Test (Repeated).....	16
21	Test Calibration	16

PERFORMANCE – HIGHER THAN 10 KA AVAILABLE FAULT CURRENT CIRCUITS

22	General	16
23	Close-Open Test	16
24	Dielectric Voltage-Withstand Test	17
25	Short-Circuit Withstand Test.....	18
26	Low-Level Dielectric Voltage-Withstand Test	20
27	Closing Test.....	20
28	Low-Level Dielectric Voltage-Withstand Test (Repeated).....	21
29	Galvanometers	21
30	Circuit Measurement Verification	22
31	Calibration of Test Circuit	22
	31.1 General.....	22
	31.2 Current	24
	31.3 Voltage	25
	31.4 Power factor.....	25
	31.5 Recovery voltage.....	27

RATINGS

32 Voltage27
33 Current27
34 Withstand28

MARKINGS

35 Content28

ULNORM.COM : Click to view the full PDF of UL 363 2020

INTRODUCTION

1 Scope

1.1 These requirements cover open knife switches for use in accordance with the National Electrical Code, ANSI/NFPA-70.

1.2 These requirements cover switches with or without fuseholders; switches having individual bases intended for either front or rear wiring connection; and switch parts without bases intended for mounting on switchboards and panelboards. Switches may be single- or multi-pole and with or without quick-break or auxiliary contacts, except where such contacts are specifically required.

2 Components

2.1 Except as indicated in [2.2](#), a component of a product covered by this standard shall comply with requirements for that component.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or
- b) Is superseded by a requirement in this standard.

2.3 A component shall be used in accordance with its rating established for the intended conditions of use.

2.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

CONSTRUCTION

5 General

5.1 A knife switch (including all parts) shall have the mechanical integrity to resist the abuses likely to be encountered during intended service.

6 Bases – Insulating Material

6.1 A base for mounting uninsulated live parts shall be of an insulating material that is mechanically strong, moisture-resistant, and as resistant to combustion as the materials mentioned in [6.2](#). The material shall be capable of withstanding the most severe conditions likely to be met in service.

6.2 Porcelain, slate, marble, phenolic composition, and cold-molded composition are acceptable for supporting an uninsulated live part.

6.3 A base of slate, marble, or porcelain shall not be less than 1/2 inch (12.7 mm) thick.

6.4 A material other than those mentioned in [6.2](#) may be used for supporting an uninsulated live part provided it demonstrates equivalent properties.

6.5 Unimpregnated fiber, rubber, and so-called hot-molded shellac and tar composition are not acceptable for supporting an uninsulated live part.

6.6 Insulating material, including barriers between live parts of opposite polarity, and material that may be in the arc path formed by the opening of the switch, shall be acceptable for the particular application. See [11.6](#) and [11.7](#).

6.7 A base shall have not less than two holes for mounting screws. A base with an area of more than 25 in² (161 cm²) shall have three or more holes for mounting screws. In any case, a mounting-screw hole shall be so located or counter-sunk that there is a spacing of not less than 1/2 inch (12.7 mm) over the surface of the insulating material between the head of the screw or washer and the nearest uninsulated live part. A mounting-screw hole located between uninsulated live parts of opposite polarity shall be countersunk unless barriers, or the equivalent, keep the screw head from being in the path of a possible arc between such live parts.

6.8 Live screw heads or nuts on the underside of a base shall be countersunk not less than 1/8 inch (3.2 mm) in the clear, and then covered with a waterproof, insulating, sealing compound which does not soften at a temperature 15°C (27°F) higher than the temperature observed at the point where it is used, but not lower than 65°C (149°F) in any case.

Exception: Parts that are staked, upset, or otherwise prevented from loosening may be insulated from the mounting surface by material other than sealing compound or by the provision of a spacing through air from the mounting surface of not less than 1/2 inch (12.7 mm).

7 Current-Carrying Parts

7.1 Except for plated No. 10 (4.8 mm diameter) and larger wire-binding screws, nuts, and stud terminals, iron or steel (plain or plated) shall not be used for parts that are depended upon to carry current. Plated iron or steel screws, nuts, and stud terminals, if not depended upon to carry current, may be used with soldering lugs and pressure-wire connectors.

7.2 Copper and brass are not acceptable for the plating of steel wire-binding screws, nuts, and stud terminals, but a plating of cadmium or zinc is acceptable.

7.3 Bolts, washers, and nuts at the hinges of knife switches are considered to be parts that are not depended upon to carry current.

7.4 Silver, copper, or a copper-base alloy is acceptable for current-carrying parts. Such parts may be of other metal provided an investigation demonstrates that the metal is acceptable for the particular application. Switch blades and jaws shall be of copper, but terminal parts and mounting pieces of a switch rated at 60 A or less may be of brass.

7.5 If brass is used instead of copper for any current-carrying parts, consideration is to be given to the fact that the resistance of brass is from two to four times that of copper.

7.6 All current-carrying parts shall have ample metal to provide mechanical strength and comply with the temperature requirement in [13.1](#).

7.7 A knife switch complies with the requirement in [7.6](#) if current-carrying parts are so proportioned that the current density is not greater than 1000 A/in² (155 A/cm²) of cross section for commercially pure copper, and if the current density at clamped or bolted contacts is not greater than 200 A/in² (31.0 A/cm²). The current density for contact surfaces of blades and jaws is not to be greater than 75 A/in² (11.6 A/cm²).

7.8 A knife switch having current densities at surface contacts greater than indicated in [7.7](#) may have other means (such as positive pressure at contact surfaces) to reduce heating, if such means demonstrates equivalent performance.

7.9 A break jaw, a hinge jaw, a fuse contact, or a metal part carrying or holding such a part, shall be securely and rigidly fastened to the supporting base or mounting surface and shall be prevented from turning or shifting in position by means other than friction between surfaces. This may be accomplished by one of the following:

- a) Two screws or rivets;
- b) Square shoulders or mortises;
- c) A dowel pin, lug, or offset;
- d) A connecting strap or clip fitted into an adjacent part; or
- e) By some other equivalent method.

7.10 If parts are held together by screws, a threaded part shall have not less than two full, clean-cut threads, not finer than American National Standard threads, where the screw passes entirely through the piece. If the screw does not pass entirely through the threaded part, it shall engage full, clean-cut threads for a distance of not less than the diameter of the screw.

7.11 If a break jaw, hinge jaw, or fuse contact is held in a slot or hole milled in a mounting piece, the parts shall fit together closely and shall comply with [Table 7.1](#), and [Figure 7.1](#) and [Figure 7.2](#).

Table 7.1
Securing of jaws and contacts

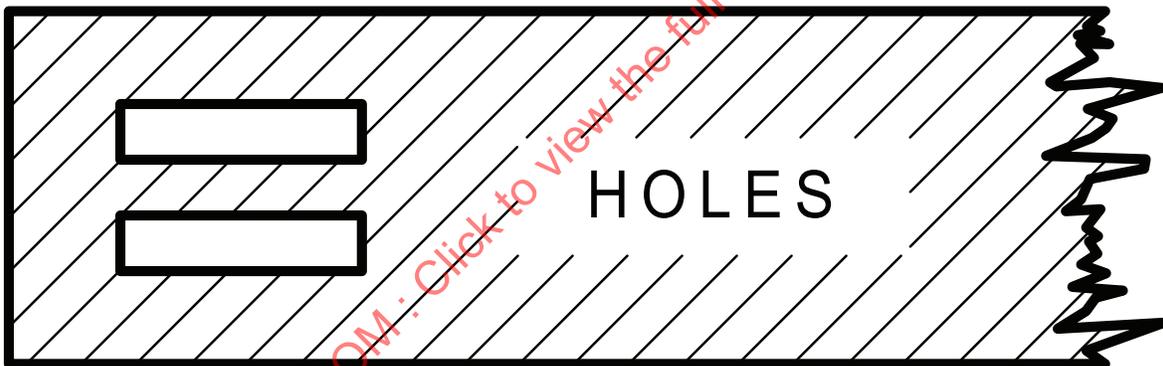
Construction		Rating in amperes	Means of securing
Slotted, See Figure 7.1		100 or less	Pinning required, soldering not acceptable
		over 100	Pinning and soldering required
Milled Opening, see Figure 7.2 .	Jaw or contact securely swaged on the underside of the mounting piece.	100 or less	Pinning soldering, or both acceptable but neither is required
		over 100	Soldering required, additional pinning acceptable but not required
	Jaw or contact not securely swaged on the underside.	Any	Pinning and soldering required

Figure 7.1
Construction slots



su1004

Figure 7.2
Construction holes



su1003

8 Hinges and Blades

8.1 The dimensions of blades, break jaws, and hinge jaws shall be as indicated in [Table 8.1](#).

8.2 An auxiliary contact of the quick-break type shall be provided on each blade of a switch rated at 600 V and more than 100 A. Such an auxiliary contact shall, when practicable, be used on all direct-current switches rated at more than 250 V.

8.3 For convenience in installation, the blades of a 30 or 60 A switch may be constructed for reversing the ends at which the blades are hinged.

8.4 A double-throw switch to be mounted so that the throw is vertical shall be provided with a locking device to maintain the blade or blades in the open position when so set.

8.5 A single-throw switch to be mounted in the inverted position shall be provided with a locking device so that the blades will remain in the open position when so set.

Table 8.1
Dimensions of blades and jaws

Switch rating in volts	Minimum acceptable dimensions in inches (mm)							
	Blades			Jaws				
	Width		Thickness	Width		Thickness		
125 dc or ac	1/2	(12.7)	5/64	(2.0)	1/2	(12.7)	3/64	(1.2)
250 dc or ac	1/2	(12.7)	5/64	(2.0)	1/2	(12.7)	3/64	(1.2)
500 ac	5/8	(15.9)	1/8	(3.2)	5/8	(15.9)	1/16	(1.6)
600 dc or ac	5/8	(15.9)	1/8	(3.2)	5/8	(15.9)	1/16	(1.6)

8.6 If a hinge is used to carry current, it shall be provided with spring washers held in place by locknuts or pins, or the equivalent, so arranged that a firm and secure connection is maintained at any position of the switch blade. Two spring washers per hinge shall be used if the current rating involved is 100 A or more.

8.7 Common forms of acceptable hinge construction are as follows:

- a) Two nuts on a hinge pin – one a clamping nut and the other a locknut;
- b) One nut on a hinge pin acting as a locknut, with the pin threaded through the adjacent hinge jaw;
- c) A single nut split radially; or
- d) One nut with the hinge pin riveted over the outside face.

8.8 Rivets shall not be used as hinge pins for a switch rated at more than 100 A.

8.9 Rivets may be used as hinge pins for a switch rated at 100 A or less. If tubular rivets are employed, the metal of the rivet shall not be less than 0.025 inch (0.64 mm) thick.

8.10 The crossbar of a multi-pole switch shall be secured to each blade to prevent turning or twisting.

8.11 A crossbar less than 3 inches (76.2 mm) in length shall be made of insulating material. If a crossbar 3 inches or more in length is made of metal to provide greater mechanical strength, the metal shall be insulated from the blades and separated from the break jaws to the extent that arcing does not occur from the break jaws to the crossbar when the switch is opened under overload conditions. See Overload Test, Section [14](#).

8.12 Vulcanized fiber, impregnated hard wood, and phenolic or cold-molded composition are acceptable as materials for crossbars.

9 Wiring Terminals

9.1 A knife switch shall be provided with a means for the connection of the smallest size wire having an ampacity equal to the rating of the device. Acceptable means of connection are as follows:

- a) Terminal pads for the mounting of wire connectors or connection of bus bars;
- b) A wiring terminal provided with a soldering lug firmly bolted or held by a screw or provided with a pressure-wire connector; and
- c) A wire-binding screw employed at a wiring terminal intended for the connection of a 10 AWG (5.3 mm²) or smaller wire if an upturned lug or the equivalent is provided to hold the wire in position.

Exception: Knife switches without a base intended for mounting on panelboard, switchboard, or the like, need not comply with this requirement.

9.2 If a wire-binding screw is employed at a wiring terminal, the binding screw shall not be smaller than No. 10 (4.8 mm diameter), with no more than 32 threads per inch, except that a No. 8 (4.2 mm diameter) machine screw having no more than 32 threads per inch may be used at a terminal intended only for the connection of a 14 AWG (2.1 mm²) conductor.

9.3 A terminal plate for a wiring lug shall have sufficient area, and the stud shall be so located, that a clamped surface is provided between the plate and the lug such that the current density does not exceed 200 A/in² (31.0 A/cm²).

9.4 A double-throw switch having three or more poles shall not have front-connected terminals for the hinge contacts of the inner pole or poles unless the required spacings between uninsulated live metal parts of opposite polarity are provided either by increased spacings between poles, or by the use of barriers as described in [11.6](#) and [11.7](#).

10 Fuses and Fuseholders

10.1 If a knife switch has provision for fuses, the base on which fuseholders are mounted shall comply with the requirements in [6.1](#) – [6.8](#). A switch having the combination voltage rating 250 dc – 500 ac shall not be provided with fuseholders, except as noted in [11.5](#).

10.2 The construction of a fuseholder shall be such that it cannot be used with a fuse having either a current rating greater than, or a voltage rating less than, that of the fuse size for which it is intended.

10.3 Fuseholders and fuse terminals shall be of either the cartridge-enclosed or plug-fuse type and shall comply with the requirements in the Standard for Fuseholders, Part 1: General Requirements, UL 4248-1, Standard for Fuseholders, Part 5: Class G, UL 4248-5, Standard for Fuseholders, Part 6: Class H, UL 4248-6, Standard for Fuseholders, Part 8: Class J, UL 4248-8, Standard for Fuseholders, Part 9: Class K, UL 4248-9, Standard for Fuseholders, Part 12: Class R, UL 4248-12, and Standard for Fuseholders, Part 15: Class T, UL 4248-15, except as modified by this standard.

11 Spacings

11.1 Break distances and spacings between uninsulated live parts shall be as indicated in [Table 11.1](#), except that a 10-percent tolerance is applicable to the distance through air between such parts of opposite polarity within the zone of the switch mechanism.

11.2 The break distance is to be measured over the surface of the base between the break jaw(s) and the corresponding hinge jaw(s), and between the break jaw(s) and the corresponding blade(s) while the blade(s) are in the open position.

11.3 In measuring the distance over the surface of a crossbar between live parts of opposite polarity, no deduction is to be made for washers, nuts, or other metal parts used to secure the handle to the crossbar.

11.4 A 3-pole switch that has 125 V spacings between blades and is intended for use on a 125 – 250 V system, shall have the spacings required in group II of [Table 11.1](#) and shall be rated at 125 V.

11.5 A 3-pole switch that has 250 V spacings between blades and is intended for use on a 250 – 500 V system shall have the spacings required in group III of [Table 11.1](#), except that a 30-A switch shall have the spacings required in group IV and shall be rated at 250 V. Fuseholders, if provided, shall be of the 600 V class.

11.6 If a barrier is employed in a knife switch to provide the spacings between uninsulated live parts of opposite polarity, the required through-air and over-surface spacings shall be provided as measured in the shortest path over or around the barrier.

11.7 A barrier shall be made of nonabsorptive insulating material and, if located within the influence of the arc path formed by the opening of the switch, be as resistant to combustion as the materials mentioned in 6.2. If a barrier is not integral with the base or other surface with which it is used, the construction shall provide a tight joint between the barrier and the base or other surface.

**Table 11.1
Spacings between uninsulated live parts**

Group	Electrical ratings		Minimum acceptable spacings in inches (mm)			
			Within zone of switch mechanism		Outside zone of switch mechanism	
			Through air and over surface		Opposite polarity	
			Volts	Amperes	Opposite polarity	Break distance
I	125 ^a (dc or ac)	30	1 (25.4)	3/4 (19.1)	1/2 (12.7)	3/4 (19.1)
		60	1-1/4 (31.8)	1 (25.4)		
	125 (dc or ac)	30	1-1/4 (31.8)	1 (25.4)		
		60	1-1/2 (38.1)	1-1/4 (31.8)		
		100	1-1/2 (38.1)	1-1/4 (31.8)		
II	125 (dc or ac)	200 – 300 ^b	2-1/4 (57.2)	2 (50.8)	1/2 (12.7)	3/4 (19.1)
		400 – 600	2-3/4 (69.8)	2-1/2 (63.5)		
		800 – 6000	3 (76.2)	2-3/4 (69.8)		
	250 (dc or ac)	30	1-3/4 (44.5)	1-1/2 (38.1)		
		60	2-1/4 (57.2)	2 (50.8)		
		100	2-1/4 (57.2)	2 (50.8)		
		200 – 300 ^b	2-1/2 (63.5)	2-1/4 (57.2)		
III	250 (dc or ac)	400 – 600	2-3/4 (69.8)	2-1/2 (63.5)	3/4 (19.1)	1-1/4 (31.8)
		800 – 6000	3 (76.2)	2-3/4 (69.8)		
		30	2-1/4 (57.2)	2 (50.8)		
	250 dc– 500 ac ^c or 500 ac	60	2-1/4 (57.2)	2 (50.8)		
		100	2-1/4 (57.2)	2 (50.8)		
IV	250 dc– 500 ac ^c or 500 ac	200 – 300 ^b	2-1/2 (63.5)	2-1/4 (57.2)	1 (25.4)	2 (50.8)
		400 – 600	2-3/4 (69.8)	2-1/2 (63.5)		
		800 – 6000	3 (76.2)	2-3/4 (69.8)		
		30	2-1/4 (57.2)	2 (50.8)		
V	600 (dc or ac)	30	4 (101.6)	3-1/2 (88.9)	1 (25.4)	2 (50.8)
		60	4 (101.6)	3-1/2 (88.9)		

Table 11.1 Continued on Next Page

Table 11.1 Continued

Group	Electrical ratings		Minimum acceptable spacings in inches (mm)			
			Within zone of switch mechanism		Outside zone of switch mechanism	
			Through air and over surface		Opposite polarity	
			Volts	Amperes	Opposite polarity	Break distance
		100 – 6000	4-1/2 (114.3)	4 (101.6)		
^a For switchboards and panelboards only. ^b The 300 A rating for use only on switchboards. ^c A d-c, 250 V fused switch rated at 100 A or more differs only from an a-c, 500 V fused switch of the same current rating in the spacing of the fuse clips. Accordingly, such a switch, if shipped unmounted, may have the combination voltage rating 250 dc – 500 ac.						

PERFORMANCE

12 General

12.1 Compliance of a knife switch with the requirements for temperature, overload, and dielectric voltage-withstand in Sections 13 – 15, shall be determined by subjecting a representative switch of each rating to the tests mentioned in the order given.

13 Temperature Test

13.1 A knife switch shall be capable of carrying its rated current continuously without any part showing a temperature rise of more than 30°C (54°F). Except for a device marked for direct current only, alternating current shall be employed for the Temperature Test.

13.2 If a test is necessary to determine whether a switch complies with the requirement in 13.1 (see also 7.7), the device is to be mounted as in actual service, with connections made using the smallest size of wire having an ampacity equal to the current rating of the switch. The ampacity of an a-c switch rated at 1200 A or more (see 33.2) is to be determined by a heating test. A fused knife switch is to be tested with the fuse or fuses omitted. The test may be made at any convenient voltage. Temperature readings are to be obtained by means of thermocouples. A temperature is considered to be constant when three successive readings, taken at 15-minute intervals, indicate no change.

13.3 The requirement in 13.2 is based on the fact that a knife switch rated at 1200 A or more generally has less ampacity when used on alternating current (due to skin effect) than when used on direct current.

13.4 The Temperature Test described in 13.1 may be conducted at any ambient temperature within the range of 10 – 40°C (50 – 104°F).

14 Overload Test

14.1 A knife switch shall remain capable of performing its intended function when operated manually for 50 cycles, making and breaking 150 percent of its rated current. The switch shall be operable at the conclusion of the test and not exhibit any wear, loosening of parts, or other effects that could reduce the ability of the switch to perform as intended. During this operation:

- a) The rate of testing shall be the number of cycles per minute indicated in Table 14.1;

- b) The test potential shall not be less than the rated voltage of the switch and shall be not more than 110 percent of that voltage; and
- c) The power factor for an alternating-current switch shall be 0.75 – 0.80.

Table 14.1
Rate of operation

Switch rating in amperes	Cycles per minute
30	6
60	6
100	6
200	5
400	4
600	3
800	2
1200	1
Over 1200	1

14.2 A double-throw switch shall be subjected to four overload tests as follows:

- a) With the line connected to the hinge jaws and the load connected to one set of contact jaws;
- b) With the line connected to the hinge jaws and the load connected to the other set of contact jaws;
- c) With the line connected to one set of contact jaws and the load connected to the hinge jaws; and
- d) With the line connected to the other set of contact jaws and the load connected to the hinge jaws.

14.3 A switch having a current rating of more than 1200 A at 250 V or less shall be subjected to the Overload Test required for a switch rated at 1200 A. A switch having a current rating of more than 600 A at more than 250 V shall be subjected to the Overload Test required for a switch rated at 600 A. See [33.2](#).

14.4 To determine whether a knife switch complies with the requirements in [14.1](#) – [14.3](#), the test or tests are to be made under the conditions described in [14.5](#) – [14.7](#).

14.5 A switch shall be mounted as in actual service, with the line terminals connected to a supply circuit as described in [14.6](#) and [14.7](#), and the load terminals connected to the necessary resistance or resistive-inductive load.

14.6 A knife switch intended for use on direct-current circuits, or not specifically marked for alternating current only, shall be tested with direct current, with a noninductive resistance load.

14.7 A knife switch intended only for alternating-current circuits shall be tested with alternating current and with an inductive load. The test shall be made on a circuit having a frequency of 60 Hz, except that a lower frequency may be employed if agreeable to those concerned. Resistance and reactance components of the load shall not be connected in parallel, except that an air-core reactor in any phase may be shunted by resistance, the loss in which is approximately 1 percent of the total power dissipation in that phase.

15 Dielectric Voltage-Withstand Test

15.1 A knife switch (with fuses in place, if fuseholders are provided) shall be capable of withstanding for 1 minute without breakdown the application of a 60 Hz essentially sinusoidal potential of 1000 V plus twice the maximum rated voltage:

- a) Between terminals of opposite polarity with the switch closed; and
- b) Between line and load terminals with the switch open.

15.2 To determine whether a switch complies with the requirement in [15.1](#), the test is to be made using a 500 VA or larger capacity transformer, where output voltage is essentially sinusoidal and can be varied. The applied potential is to be increased gradually from zero until the required test value is reached, and is to be held at that voltage for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as is consistent with the value being correctly indicated by the voltmeter.

PERFORMANCE – 10kA MAXIMUM AVAILABLE FAULT CURRENT CIRCUITS

16 General

16.1 To determine if a switch complies with the requirements of short-circuit withstand, low-level dielectric voltage-withstand, and closing, as given in Sections [17](#) – [20](#), a representative switch of each rating shall be subjected to the tests. A switch marked with two or more short-circuit withstand ratings shall be tested at each rating unless a test at one rating is representative of the performance at the other ratings. See [34.1](#).

Exception: A switch marked for use with or having integral provision for overcurrent protective devices having a continuous current rating not greater than the switch rating is acceptable for a 10,000 A short-circuit withstand rating without short-circuit testing.

16.2 A switch is to be tested in the open, not in an enclosure.

17 Short-Circuit Withstand Test

17.1 An unfused knife switch, having a 5000, 7500, or 10,000 A short-circuit withstand rating and marked for use with overcurrent protective devices having a continuous current rating greater than that of the switch, shall be subjected to the tests outlined in [17.2](#) – [17.7](#). The 5000 and 7500 A levels are applicable only to combinations of the switch and a circuit breaker. A previously untested representative switch may be used.

17.2 A circuit of 5000, 7500, or 10,000 A rms available symmetrical current, see [17.1](#), shall be closed on the switch. For a switch marked for use with external fuses or a specified circuit breaker, the switch shall withstand the designated current until the overcurrent protective device(s), see [17.4](#), opens. For a switch not marked as requiring a specific circuit breaker, the test current shall be maintained for 3 cycles. After the circuit is opened:

- a) There shall be no breakage to the extent that the integrity of the mounting of live parts is impaired;
- b) The switch shall be capable of being opened manually with the handle; and
- c) The switch blade itself shall not separate from the jaw.

17.3 For the test mentioned in [17.2](#):

- a) The open-circuit voltage of the power-supply circuit is not to be less than the maximum rated voltage of the switch;
- b) The available rms symmetrical short-circuit current in amperes is not to be less than 5000, 7500 or 10,000 A, as appropriate;
- c) The circuit is to be as indicated in [Figure 25.1](#). External overcurrent protective devices are to be connected where the "CL" fuses are indicated. See [17.4](#); and
- d) The power factor of the circuit is to be 0.45 – 0.50, lagging.

17.4 The overcurrent protective devices indicated in [17.2](#) are to be externally connected Class H fuses of the maximum rating for the case size of the rating specified or circuit breakers of the type and rating indicated by the marking.

17.5 The tests specified in [17.2](#) may be performed without overcurrent protective devices if it can be shown that the test-circuit current was maintained for a period of time at least equal to the opening time of the specified overcurrent protective devices at the level of current involved.

17.6 For the performance of the test, the line and load terminals of the switch are to be connected to the corresponding test-circuit terminals by short copper-wire leads, maximum of 4 ft (1.22 m) per terminal, each of which has an ampacity not less than the current rating of the switch.

Exception: Cable length as provided for in [17.7](#) need not comply with this requirement.

17.7 If the physical arrangement of the test facilities requires leads longer than specified in [17.6](#), the additional length of leads shall be included in the circuit calibration.

18 Low-Level Dielectric Voltage-Withstand Test

18.1 Unless the same representative switch is to be subjected to the Closing Test, a switch that has been subjected to the Short-Circuit Withstand Test shall be capable of withstanding for 1 minute without breakdown the application of a 48 – 62 Hz essentially sinusoidal potential:

- a) Between line and load terminals with the switch open;
- b) Between terminals of opposite polarity with the switch closed; and
- c) Between live parts and dead metal.

18.2 The test potential shall be twice the voltage rating of the switch but not less than 900 V.

18.3 To determine if a switch complies with the requirements in [18.1](#), the test is to be made using a 500 VA or larger transformer, the output voltage of which can be varied. Starting at zero, the applied potential is to be increased until the required test value is reached and held at that value for 1 minute. The increase in the applied potential is to be at a uniform rate and as rapid as consistent with its value being correctly indicated by a voltmeter.

Exception: The transformer may be less than 500 VA, if the output voltage is measured directly.

19 Closing Test

19.1 A representative switch shall be closed on a current magnitude equal to the short-circuit withstand rating. After the fault has cleared, the switch shall comply with the requirements specified in [17.2](#) (a), (b), and (c).

19.2 The switch for this test is to be that used for the Short-Circuit Withstand Test, or a previously untested switch may be employed. The conditions of the Closing Test are to be the same as for the Short-Circuit Withstand Test, [17.3](#) – [17.7](#). Complete physical closure of the switch contacts need not be established.

Exception No. 1: Switches rated more than 1200 A at 240 V or less, and switches rated more than 600 A at more than 250 V, need not comply with this requirement.

Exception No. 2: Any other switches marked: "For isolating use only", need not comply with this requirement.

20 Low-Level Dielectric Voltage-Withstand Test (Repeated)

20.1 The Dielectric Voltage-Withstand Test described in [18.1](#) – [18.3](#) shall be conducted following the Closing Test.

Exception No. 1: Switches rated more than 1200 A at 240 V or less, and switches rated more than 600 A at more than 250 V, need not comply with this requirement.

Exception No. 2: Any other switches marked: "For isolating use only", need not comply with this requirement.

21 Test Calibration

21.1 Test circuits intended to deliver a maximum 10,000 A rms symmetrical current shall be calibrated as described in the Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures, UL 489.

PERFORMANCE – HIGHER THAN 10 kA AVAILABLE FAULT CURRENT CIRCUITS

22 General

22.1 These requirements specify the additional performance requirements with which switches shall comply if they are to be acceptable for use on circuits having available fault currents greater than 10 kA as evidenced by marking. See [34.1](#).

23 Close-Open Test

23.1 A switch shall be capable of being operated to make and break 600 percent of its rated current for the number of operations indicated in [Table 23.1](#).

Exception No. 1: Switches rated more than 1200 A at 240 V or less, and switches rated more than 600 A at more than 250 V, need not comply with this requirement.

Exception No. 2: Any other switches marked: "For isolating use only", need not comply with this requirement.

Table 23.1
Close-open test operation

Type of switch	Number of operations
Polyphase	3
Single Phase	5

23.2 For the test mentioned in [23.1](#), a previously untested switch is to be used. The line terminals of the switch are to be connected to the power supply circuit and the load terminals of the switch are to be connected to an inductive load. The power factor of the load is to be 0.45 – 0.50, except a lower power factor may be used if agreeable to those concerned. A shunting resistance as described in [23.3](#) may be employed. The test potential is to be as described in [23.4](#). The rate of operation is not specified but the switch is to be closed and opened as quickly as practical in service. The blades and jaws may be serviced before each operation.

23.3 Resistance and reactance components of the load shall not be connected in parallel, except that an air-core reactor in any phase may be shunted by resistance, the loss of which is approximately 1 percent of the total power consumption in that phase. The shunting resistance used with an air-core reactor may be calculated from the formula

$$R_{SH} = 100 \left(\frac{1}{PF} - PF \right) \frac{E}{I}$$

in which:

PF is the power factor;

E is the closed-circuit phase voltage; and

I is the phase current.

23.4 The circuit on which the test is conducted shall have a normal frequency recovery voltage (see [31.5.1](#) – [31.5.3](#)) equal to the rated voltage of the device, except that the recovery voltage need not be determined if the closed-circuit voltage is not less than 90 percent of the rated voltage of the device. The open-circuit voltage shall be not more than 110 percent of the rated voltage, except that a higher open-circuit voltage may be used if agreeable to those concerned.

23.5 Upon completion of the test, the test switch is not to be serviced in any manner before conducting the Dielectric Voltage-Withstand Test described in [24.1](#). After completion of the Dielectric Voltage-Withstand Test, the switch may be serviced prior to the Short-Circuit Withstand Test.

23.6 Servicing is considered to be filing, lubricating, deburring, and the like. There is to be no disassembly of the device to accomplish the servicing. Servicing is not to include replacement of any part.

23.7 At the conclusion of the test, the switch shall be in operating condition. Burning or pitting of the contacts is considered to be acceptable, but line-to-line breakdown is considered to be unacceptable.

24 Dielectric Voltage-Withstand Test

24.1 The Dielectric Voltage-Withstand Test described in [18.1](#) – [18.3](#) shall be conducted following the Close-Open Test, except that the test potential shall be 1000 V plus twice the voltage that is to be applied between the parts in question when the switch is connected in accordance with its maximum voltage rating.

25 Short-Circuit Withstand Test

25.1 After completion of the test described in [24.1](#), a circuit capable of providing the maximum short-circuit withstand current for which the switch is rated shall be closed on that switch. The switch shall withstand the designated current until the overcurrent protective devices, see [25.3](#), open, and after the circuit is opened:

- a) There shall be no breakage to the extent that the integrity of the mounting of live parts is impaired;
- b) Neither end of a bar or tube as described in [25.5](#) shall be completely ejected from the fuse clips and no line end of a bar or tube shall bridge from a fuse clip to dead metal, and the switch blade itself shall not separate from the jaw; and
- c) The switch shall be capable of being opened manually with the operating handle.

25.2 For the test mentioned in [25.1](#):

- a) The open-circuit voltage of the power-supply circuit is not to be less than the maximum rated voltage of the switch;
- b) The available short-circuit current in rms symmetrical amperes is not to be less than the marked short-circuit withstand current rating of the switch;
- c) The circuit is to be as indicated in [Figure 25.1](#), and is to include the necessary measuring equipment and the fuse-mounting means. A circuit breaker is to be used if specified for use with an unfused switch; and
- d) The power factor of the circuit is to be 0.25 – 0.30 lagging for a circuit of 10,001 – 20,000 A, and 0.15 – 0.20 lagging for circuits over 20,000 A.

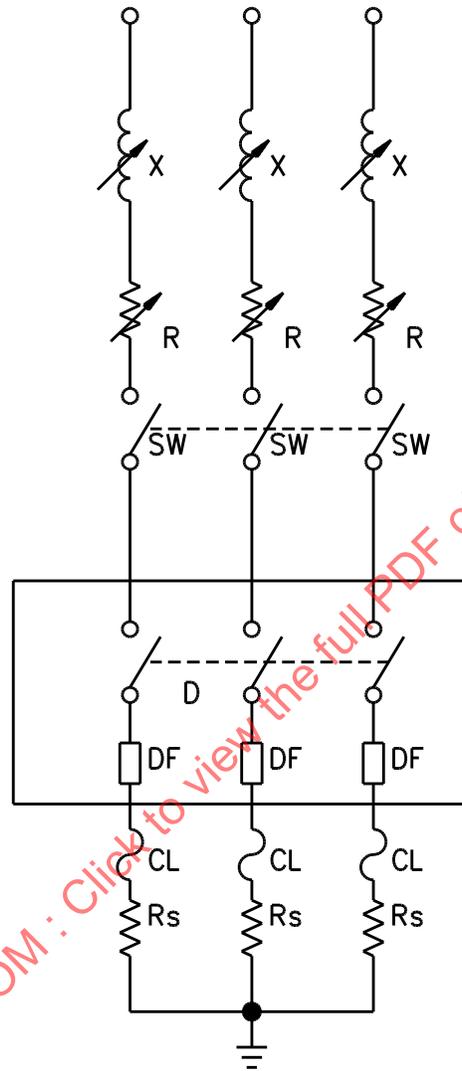
25.3 The overcurrent protective devices specified in [25.1](#) shall be one of the following:

- a) For fused switches, fuses as described in [25.7](#); or
- b) For unfused switches, externally connected fuses as described in [25.7](#) or circuit breakers as marked on the switch.

25.4 The tests specified in [25.1](#) may be performed without overcurrent protection devices if it can be shown that the test-circuit current was maintained for a period of time at least equal to the opening time of the specified overcurrent protective devices at the level of current involved.

Figure 25.1

Circuit for withstand and closing tests supply-rated voltage, 3-phase – 60 Hertz



S0849-2

X – Variable tap air-core reactor

R – Variable resistor

SW – Closing switch – may be located as shown or ahead of limiting impedance

D – Device under test

R_S – Coaxial shunts for metering current

CL – Current-Limiting fuses or circuit breaker used during test

DF – Dummy fuse

Common connection of outer shells of coaxial shunts may be grounded if no other grounds on the circuit.

25.5 For the performance of the test, the line and load terminals of the switch are to be connected to the corresponding test-circuit terminals by short copper-wire leads, not longer than 4 ft (1.22 m) per terminal, each of which has an ampacity not less than the current rating of the switch. For a switch with an integral fuseholder, a copper bus or tube, having a cross section not smaller than the blade (or ferrule) of the fuse that the fuseholder is intended to accommodate, is to be installed in each fuseholder in the switch. Each of these bars or tubes may be individually reinforced to enable it to withstand the short-circuit forces. If the fuse is intended to be secured in place by bolts, the test is to be conducted with the bolts in place if the bar or tube would not normally otherwise remain in position. Otherwise, the test is to be performed with the bolts omitted.

Exception: Cable length as provided for in [25.6](#) need not comply with this requirement.

25.6 If the physical arrangement of the test facilities requires leads longer than specified in [25.5](#), the additional length of leads shall be included in the circuit calibration.

25.7 Fuses used shall have characteristics representing the peak let-through current (I_p) and clearing I^2t values associated with the maximum rated fuses the device either accepts or is to be externally protected by. For an unfused switch it is assumed that protection will be provided by the maximum fuse in the case size of the indicated fuse. The fuses are to be installed on the load side of the device as shown in [Figure 25.1](#) with any device fuse clips bridged by dummy fuses. Each of these fuses is to be of such characteristics that, when tested on a single-phase circuit, it will permit a peak let-through current and clearing I^2t of not less than the corresponding values specified in the requirements for the class and current and voltage ratings of the fuse intended for use in the switch being tested. Special test fuses having the required characteristics may be used. Special test fuses of the same physical dimensions as a fuse the switch is intended to accommodate may be used in place of the dummy fuses in the switch. To obtain the required values of these characteristics, it may be necessary to employ a fuse having a current rating larger than that of the fuse which the switch accommodates and of a different class.

25.8 The fuse referred to in [25.7](#) may be any Class G, J, L, T, or R fuse without regard to its peak let-through current and clearing I^2t , if the test current is below the point (threshold value of the fuse) at which the fuse is considered to be current limiting.

25.9 Fuses used for tests are to be selected from a lot from which two devices have been selected if the fuses are of Class G, J, R (K5), or T and one device if the fuse is Class L and which have been calibrated to determine that their I^2t and I_p characteristics comply with the prescribed values called for in [25.7](#).

25.10 The current available and other circuit characteristics are to be determined as indicated in Sections [29](#) – [31](#).

25.11 With the device in the full closed position, the test circuit is to be closed on the device. For devices tested on a single-phase circuit, controlled closing shall be employed so that maximum current flow (I_p) is obtained. The closing angle shall be essentially at zero of the voltage wave (maximum offset) or later, to produce the start of arcing within 30 electrical degrees prior to system peak voltage.

26 Low-Level Dielectric Voltage-Withstand Test

26.1 Unless the same switch is to be subjected to the Closing Test, a switch that has been subjected to the Short-Circuit Withstand Test shall comply with the requirements in [18.1](#) – [18.3](#).

27 Closing Test

27.1 A switch shall be closed on a circuit capable of providing the maximum short-circuit withstand current for which the switch is rated. After the circuit has cleared, the switch shall comply with the requirements specified in [25.1](#) (a), (b), and (c).

Exception No. 1: Switches rated more than 1200 A at 250 V or less, and switches rated more than 600 A at more than 250 V, need not comply with this requirement.

Exception No. 2: Any other switches marked: "For isolating use only", need not comply with this requirement.

27.2 The representative switch for this test is to be that used for the Short-Circuit Withstand Test, or a previously untested switch may be employed. The conditions of the Closing Test are to be the same as for the Short-Circuit Withstand Test described in [25.2](#) – [25.10](#). Complete physical closure of the switch contacts need not be established.

28 Low-Level Dielectric Voltage-Withstand Test (Repeated)

28.1 The Dielectric Voltage-Withstand Test described in [18.1](#) – [18.3](#) shall be conducted following the Closing Test.

29 Galvanometers

29.1 The galvanometers in a magnetic oscillograph employed for recording voltage and current during circuit calibration and switch testing shall have a flat, ± 5 percent, frequency response from 50 – 1200 Hz.

29.2 Using an audio-oscillator, having output impedance and output voltage capable of driving a magnetic-oscillograph galvanometer and capable of delivering at least 100 mA rms with a wave form that remains sinusoidal over a frequency range of 50 – 1200 Hz, gradually increase the frequency of the signal applied to the galvanometer and determine that the peak-to-peak amplitude of the galvanometer deflection does not increase or decrease by more than 5 percent from the deflection at 60 Hz throughout this frequency range when corrected output voltage is supplied to the galvanometer, and the sensitivity is adjusted to produce a deflection not less than 1 inch (25 mm).

29.3 Galvanometers shall be calibrated as described in [29.4](#) – [29.8](#).

29.4 When a shunt is used to determine the circuit characteristics, a direct-current calibrating voltage should be used. The voltage applied to the oscillograph galvanometer circuit is to result in a deflection of the galvanometer approximately equivalent to that which is expected when the same galvanometer circuit is connected to the shunt and the nominal short-circuit current is flowing. The voltage is to be applied so as to cause the galvanometer to deflect in both directions. Additional calibration is to be made using approximately 50 percent and 150 percent of the voltage used to obtain the deflection indicated above. The sensitivity of the galvanometer circuit in volts per inch (or millimeter) is to be determined from the deflection measured in each case, and the results of the six trials averaged. The peak amperes per inch (or millimeter) is obtained by dividing the sensitivity by the resistance of the shunt. This multiplying factor is used for the determination of the rms current as described in [31.2.1](#).

29.5 A 60 Hz sine-wave potential may be used for calibrating the galvanometer circuit, using the same general method described in [29.4](#). The resulting factor must be multiplied by 1.414.

29.6 When a current transformer is used to determine the circuit characteristics, an alternating current is used to calibrate the galvanometer circuit. The value of current applied to the galvanometer circuit is to result in a deflection of the galvanometer approximately equivalent to that which is expected when the same galvanometer is connected to the secondary of the current transformer and nominal short-circuit current is flowing in the primary. Additional calibrations are to be made at approximately 50 percent and 150 percent of the current used to obtain the deflection indicated above. The sensitivity of the galvanometer circuit in rms amperes per inch (or millimeter) is to be averaged. The average sensitivity is multiplied by the current-transformer ratio and by 1.414 to obtain peak amperes per inch. This constant is used for the determination of the rms current as described in [31.2.1](#).

29.7 All the galvanometer elements employed are to align properly in the oscillograph, or the displacement difference are to be noted and used as needed.

29.8 The sensitivity of the galvanometers and the recording speed is to be sufficient to provide a record from which values of voltage current, and power factor can be measured accurately. The recording speed is to not be less than 60 inches (1.53 m) per second and higher speeds are recommended.

30 Circuit Measurement Verification

30.1 A noninductive coaxial shunt that has been found acceptable for use as a reference coaxial shunt shall be used to verify the manufacturer's instrumentation. This may be accomplished by connecting the shunt in series with the instrumentation of each phase of the manufacturer's test circuit. A single-phase circuit of the same voltage and current as that required for the switch test is to be used.

30.2 The circuit is to be closed as nearly as possible at the angle that will produce a current wave with maximum offset. The short-circuit current and voltage are to be recorded. The primary voltage is to be recorded if primary closing is used. The current and power factor measured by the reference shunt should be within 5 percent of that measured using the manufacturer's instrumentation.

30.3 If three reference shunts are available, one can be inserted in each of the phase legs and a 3-phase circuit established at the same voltage and current as the test circuit. Controlled closing is not required for polyphase circuits. The same instrumentation accuracy is applicable as stated in [30.2](#).

30.4 With the secondary open-circuited, the transformer is to be energized and the voltage at the test terminal observed to see if rectification is taking place. If rectification is occurring, the circuit is not acceptable for test purposes because the voltage and current will not be sinusoidal. Six random closings are to be made to demonstrate that residual flux in the transformer core will not cause rectification. If testing is done by closing the secondary circuit, this check can be omitted providing testing is not commenced before the transformer has been energized for approximately 2 seconds, or longer if an investigation of the test equipment shows that a longer time is necessary.

30.5 When the verification of the accuracy of the manufacturer's instrumentation is completed, the reference shunts are to be removed from the circuit – they are not to be used during the final calibration of the test circuit or during the test of the devices.

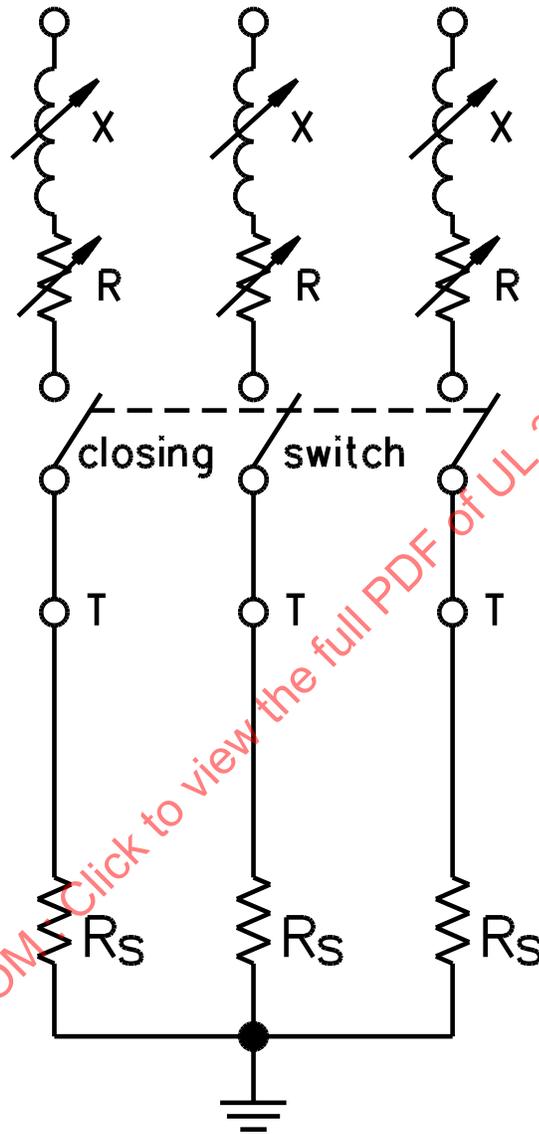
31 Calibration of Test Circuit

31.1 General

31.1.1 The test circuit shall be calibrated as described in [31.2.1](#) – [31.5.3](#). Assuming that shunts are used for current measurement the calibration tests are normally to be conducted with the test terminals connected as indicated in [Figure 31.1](#).

Figure 31.1

Test circuit verification supply-rated voltage, 3-phase – 60 Hertz



ULNORM.COM Click to view the full PDF of UL 363 2020

SB0850

X – Variable-tap air-core reactor

R – Variable resistor

T – Test terminals

Rs – Manufacturer's shunts for metering current. Coaxial shunts may have shell grounded if no other grounds on circuit

Common connection of outer shells of coaxial shunts may be grounded if no other grounds on the circuit.