UL 1659

ISBN 0-7629-0221-3

Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords

Underwriters Laboratories Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062-2096

UL Standard for Safety
for
Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords, UL 1659

Second Edition, Dated September 30, 1997

Revisions: This Standard contains revisions through and including August 19, 1998. UL is in the process of converting its Standards for Safety to the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on the page. Significant benefits that will result from UL's use of SGML are increased productivity, reduced turnaround times, and data and information consistency, reusability, shareability, and portability. The changes noted in these revised pages are needed to modify the format and layout of this Standard to allow it to be converted to SGML. These editorial changes are now in effect.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The revisions dated August 19, 1998 include a reprinted title page (page 1) for this Standard.

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Page	Date
tr1, tr2	August 19, 1998
1	September 30, 1997 (Reprinted August 19, 1998)
2 – 11	September 30, 1997
12, 12A, 12B	August 19, 1998
13 – 16	September 30, 1997
17, 18	August 19, 1998
19, 20	September 30, 1997
21, 22, 22A, 22B	August 19, 1998
23 – 28	September 30, 1997

SEPTEMBER 30, 1997
(Title Page Reprinted: August 19, 1998)

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UL 1659

Standard for

Attachment Plug Blades for Use in Cord Sets and Power-Supply Cords

First Edition – September, 1993

Second Edition

September 30, 1997

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

Revisions of this standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

ISBN 0-7629-0221-3

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product employing materials or having forms of construction differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be judged to comply with the Standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 General

1.1.1 These requirements cover the blades of attachment plugs and current taps intended to be connected to the conductors of flexible cords using crimped connections, for use on cord sets and power-supply cords complying with the Standard for Cord Sets and Power-Supply Cords, UL 817, within the limits set forth in 1.2.1 for type of blades and 1.3.1 for size of conductors.

1.1.2 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

1.2 Type of blades

1.2.1 These requirements apply to blades, solid and folded, of attachment plugs and current taps rated 15 or 20 A, for general purpose use. These requirements do not apply to the grounding blade (pin) of grounding type attachment plugs or current taps.

1.3 Conductor sizes

1.3.1 These requirements apply to blades intended to be attached to Nos. 18 AWG (0.82 mm^2) – 10 AWG (5.3 mm^2) conductors.

2 Glossary

2.1 For the purpose of this Standard the following definitions apply.

2.2 BLADE – The part of an attachment plug or current tap intended to be inserted into the contacts of an outlet device of matching configuration and the integral extension of this part, located within the attachment plug or current tap, to which the conductor of a flexible cord is connected.

2.3 CONTACT SURFACE AREA – The area on each side of a blade that is intended to make electrical contact with the contacts of an outlet device.

2.4 CRIMPED CONNECTION – An electro-mechanical connection made between a blade and a conductor by compressing the portion of the blade, termed "the integral extension" in 2.2, against the conductor.

3 Units of Measurement

3.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

4 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 The construction of a blade shall be such that all strands of the intended conductor will be contained within the crimp terminal.

6 Materials

6.1 A blade shall be plated or unplated 70/30 cartridge brass (Alloy #260 of the Copper Development Association).

6.2 Copper alloy parts of other than 70/30 cartridge brass (Alloy #260 of the Copper Development Association) shall be resistant to corrosion cracking, as determined by the 10 Day Moist Ammonia Air Test, Section 17.

7 Dimensions

7.1 General

7.1.1 Blade dimensions shall be in accordance with Figure 7.1 or 7.2, as applicable.

7.2 Contact surface area

7.2.1 A contact surface area shall be located on each side of a folded blade. The location and minimum size of the areas shall be as specified in Figure 7.3 except as modified in 7.2.2. A solid blade which complies with the thickness requirement in 7.3.1 is considered to have the required surface area. See 7.2.4.

7.2.2 A contact surface area of a non-polarized folded blade shall extend into the tapered portion at the tip of the blade profiles as shown in Figure 7.4. See Compression Force Test, Section 16.

7.2.3 A contact surface area of a folded blade shall be flat and continuous except for

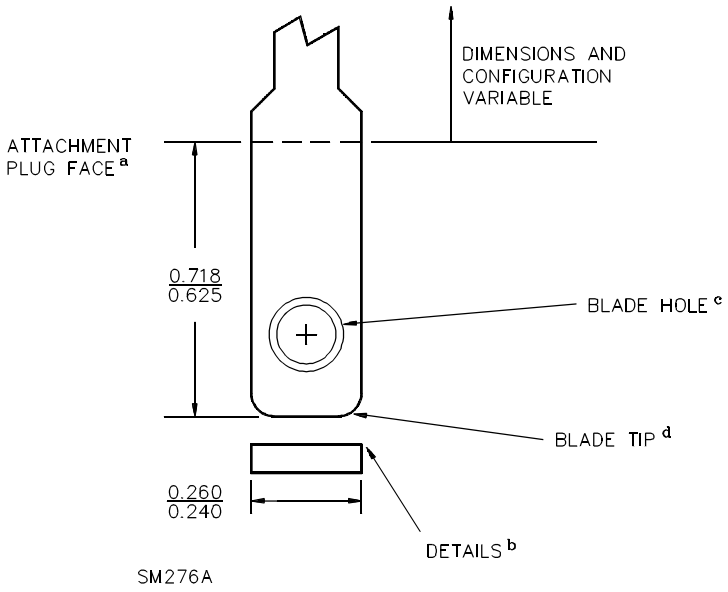
a) The hole shown in Figure 7.5, if provided,

b) A close fitting seam (without gaps) that is formed by folding a blade and butting two edges together in the contact surface area, rather than along the edge of the blade, or

c) A die-stamped manufacturer's identification marking that is no deeper than needed for legibility.

7.2.4 A blade surface area, with or without the optional blade hole, and with or without the hole chamfer, that is totally flat (without embossing or other raised sections) is considered to have the required contact surface area for that side of the blade.

Figure 7.1
Non-polarized blade



NOTES –

a) The location of the attachment plug face is shown above solely to provide a frame of reference.

b) See Figure 7.3 for details.

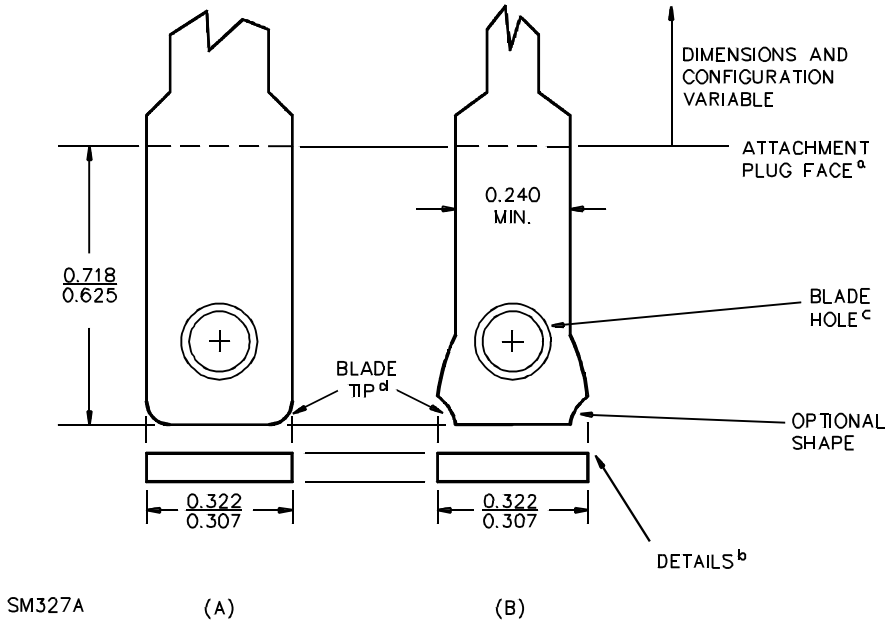
c) If used, locate as shown in Figure 7.5.

d) See Figure 7.4 for typical blade tip and stem dimensions.

All dimensions in inches

inch	mm	inch	mm
0.240	6.10	0.625	15.9
0.260	6.60	0.718	18.2

Figure 7.2
Polarized blade



NOTES –

a) The location of the attachment plug face is shown above solely to provide a frame of reference.

b) See Figure 7.3 for details.

c) If used, locate as shown in Figure 7.5.

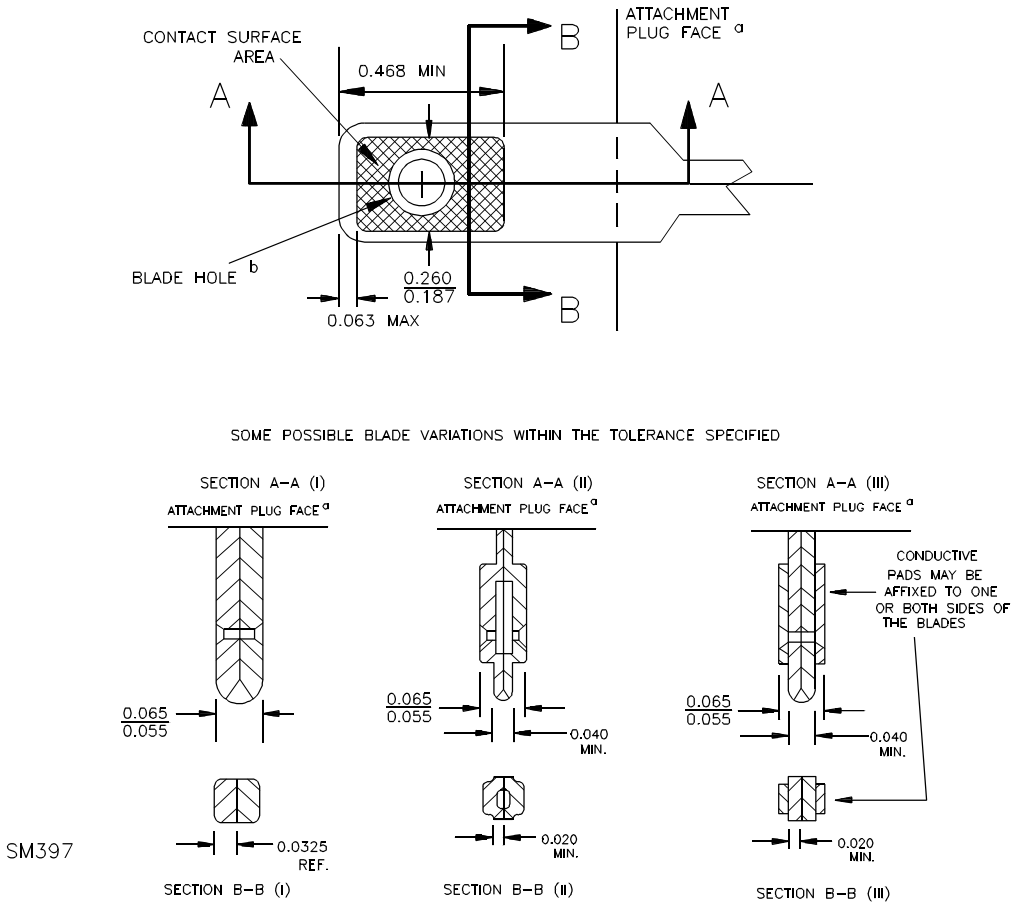
d) See Figure 7.4 for typical blade tip and stem dimensions.

All dimensions in inches

inch	mm	inch	mm
0.240	6.10	0.625	15.9
0.307	7.80	0.718	18.2
0.322	8.18		

Figure 7.3
Minimum blade contact area

(Blade profile not specified)



NOTES –

a) The location of the attachment plug face is shown above solely to provide a frame of reference.

b) If used, locate as shown in Figure 7.5.

All dimensions in inches

inch	mm	inch	mm	inch	mm
0.020	0.51	0.055	1.39	0.187	4.75
0.0325	0.83	0.063	1.60	0.260	6.60
0.040	1.02	0.065	1.65	0.468	11.88

7.3 Blade thickness

7.3.1 The blade thickness shall be 0.055 – 0.065 inch (1.40 – 1.65 mm) at all points in the minimum contact surface area defined in 7.2.1 and shall be 0.040 – 0.065 inch (1.02 – 1.65 mm) in all other areas intended to be exposed.

7.3.2 A folded blade shall be formed from sheet material 0.0275 – 0.032 inch (0.70 – 0.82 mm) thick except as noted in 7.3.3.

7.3.3 A blade folded along its length or folded at the tip with both free ends intended to be located within the body of the attachment plug may be formed from sheet material at least 0.020 inch (0.51 mm) thick.

7.3.4 The thickness in the minimum contact surface area of a blade described in 7.3.3 shall not be readily compressible to less than 0.055 inch (1.40 mm) as determined by the Compression Force Test, Section 16. A blade constructed with continuous contact of the 2 blade sides around the outer periphery of the minimum contact surface area is not readily compressible for the purpose of this requirement.

7.4 Blade profile

7.4.1 A polarized or non-polarized blade shall have a profile similar to one of those shown in Figure 7.4 and shall have the dimensions specified for that profile.

7.4.2 The leading edge of a blade folded at the tip or otherwise formed to be a straight line shall be at least 0.125 inch (3.2 mm) long and formed without burrs. See Figure 7.4.

7.4.3 The stem of a blade shall be at least 0.240 inch (6.10 mm) wide and the sides of the blade profile shall be straight and parallel without notches or other discontinuities except at the end (tip) which may be shaped as shown in Figure 7.4. A non-polarized blade shall not be wider than 0.260 inch (6.60 mm) at its widest exposed dimension. A polarized blade shall not be wider than 0.322 inch (8.17 mm) at its widest exposed dimension.

7.5 Polarizing features

7.5.1 In order to reduce the likelihood of inserting a polarized blade into a non-polarized slot of an outlet device, a polarized blade shall have the width specified in Figure 7.4.

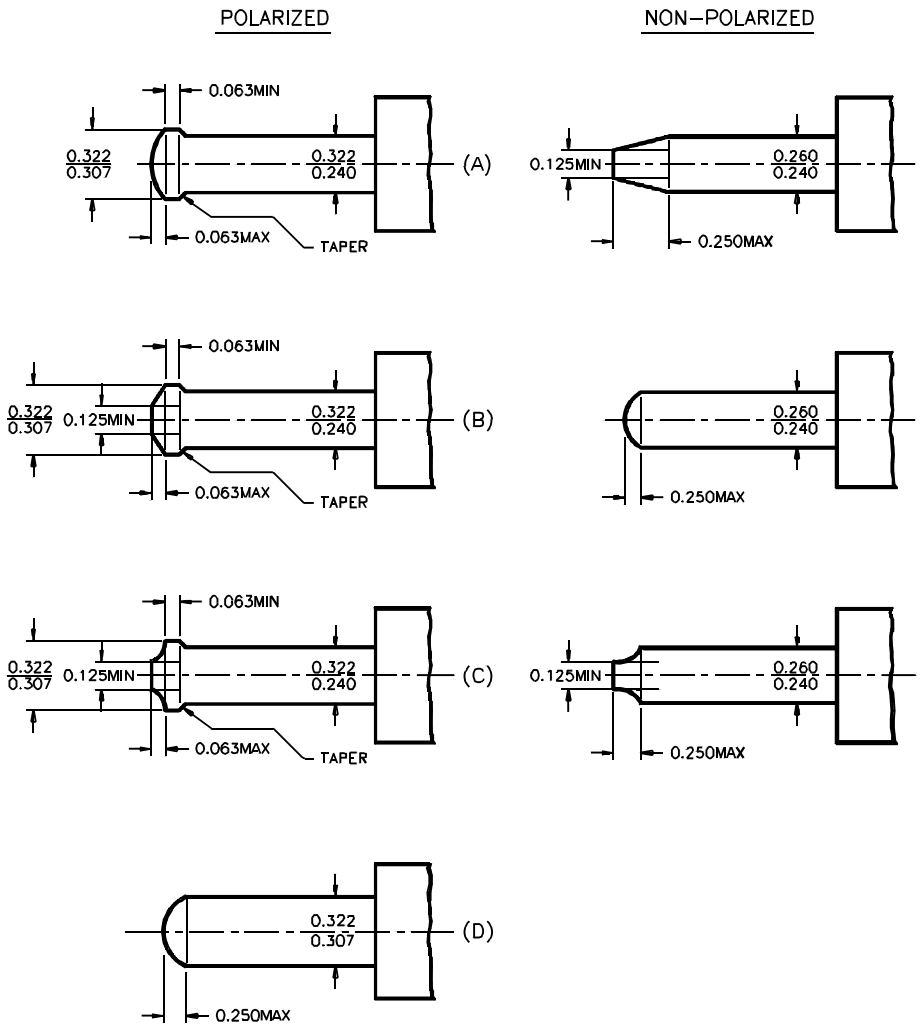
7.5.2 A polarized blade shall not have sharp corners or edges that could cut into the material at the ends of a non-polarized slot in an outlet device in an attempt to insert the blade. Determination of sharp corners shall be done in accordance with the requirements for tests for sharpness of edges on equipment, UL 1439.

7.5.3 The minimum thickness of the polarizing portion of a polarized blade outside the designated blade contact area shall be 0.040 inch (1.02 mm).

7.5.4 A polarized blade profile having a tip width greater than the stem width (similar to those shown in Figure 7.4, items A, B, and C) shall have a taper from the tip width to the stem width that will reduce the likelihood of snagging the back surface of the blade on material that may surround a polarized slot in an outlet device.

Figure 7.4
Specific blade tip and stem dimensions

(Profiles shown are typical)



SM330A

All dimensions in inches

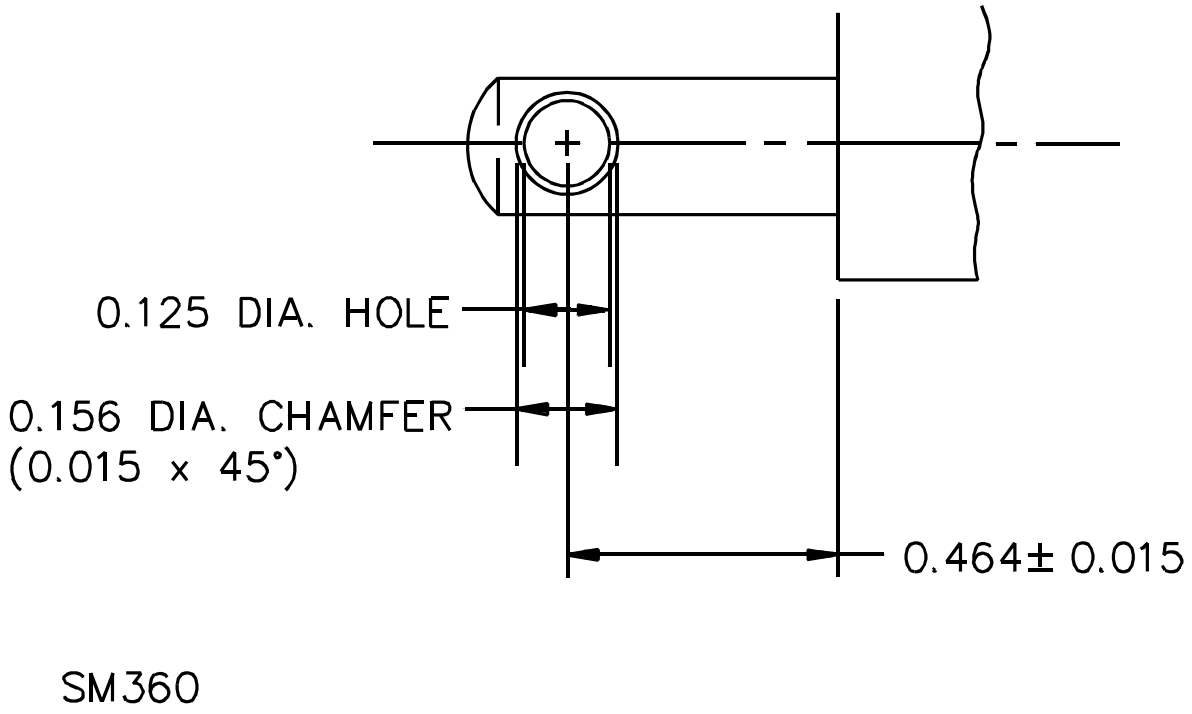
inch	mm	inch	mm	inch	mm	inch	mm
0.063	1.60	0.240	6.10	0.260	6.60	0.322	8.18
0.125	3.20	0.250	6.35	0.307	7.80		

7.6 Optional blade hole and chamfer

7.6.1 A blade may have a hole with or without a chamfer as shown in Figure 7.5. The edges of the hole and chamfer shall not have burrs or other projections that extend beyond the plane of the blade contact surface area.

Figure 7.5
Flat blade hole location

Figure 7.5 revised August 19, 1998



NOTE – If hole is used, locate as shown. If hole has chamfer, form as shown.

All dimensions in inches

inch	mm	inch	mm
0.015	0.380	0.156	3.960
0.125	3.175	0.464	11.79

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PERFORMANCE

8 General

8.1 A blade shall perform acceptably when separate sets of assemblies are subjected to the test sequences specified in Table 8.1.

Table 8.1
Test sequence

Test sequence 1	Test sequence 2	Test sequence 3
Secureness Static Heating Heat-Cycling	Pull-Out	Compression Force

9 Representative Assemblies

9.1 Separate sets of assemblies are to be used for each of the test sequences specified in Table 8.1.

9.2 The basic set for test sequences 1 and 2 is to consist of four blade/conductor assemblies for each combination of blade and test conductor or conductors to be tested. The basic set for test sequence 3 is to consist of four blades not assembled to any conductors.

9.3 Tests conducted on a non-polarized blade are considered to represent testing on a polarized blade that differs only in the width or profile of the blade; however, tests conducted on a polarized blade are not considered to represent testing on a non-polarized blade.

9.4 Stranded flexible cord conductors described in 9.5 and 9.6 are to be used for testing. The number and size of the individual conductor strands, tinning or coating of the conductor, conductor insulation type, or other construction limitations on the type of flexible cord are to be as specified by the manufacturer.

9.5 Untinned conductors are to be used in preparing the test assemblies unless the blades are intended for use solely on tinned conductors. Tests on untinned conductors are considered to represent tests on tinned conductors.

9.6 For test sequence 1, blades are to be tested when assembled to the conductors used in the flexible cords described in Table 9.1.

Table 9.1
Assembly requirements for test sequence 1

Assembly set number	Conductors used in flexible cord type[b]	Cord conductor insulation[a,c]	Test conductor strandings for nos. 18 – 10 AWG flexible cord[a,d]				
			18 AWG	16 AWG	14 AWG	12 AWG	10 AWG
1	S	Class 40 sulfur-cured rubber or Class 41 sulfur-cured neoprene	34 AWG	34 AWG	30 AWG	30 AWG	30 AWG
2	S	Class 40 sulfur-cured rubber or Class 41 sulfur-cured neoprene	30 AWG	30 AWG	26 AWG	26 AWG	26 AWG
3	SPT-3	Class 43 polyvinyl chloride (PVC)	36 AWG	34 AWG	34 AWG	30 AWG	30 AWG
4	SPT-3	Class 43 polyvinyl chloride (PVC)	30 AWG	30 AWG	30 AWG	26 AWG	26 AWG

[a] Test conductors with the insulation and stranding specified are available from Underwriters Laboratories Inc.

[b] Test conductors may be obtained from other flexible cord types if they employ the required insulation compound and, for sets 1 and 2, the same thickness of conductor insulation as that used in Type S. See 10.3.

[c] A blade need not be tested on Class 40 sulfur-cured rubber or Class 41 sulfur-cured neoprene conductor insulation if the manufacturer opts to restrict its use to flexible cords employing only Class 43 polyvinyl chloride (PVC) or other thermoplastic conductor insulation. See 9.4.

[d] The values indicated represent the cord conductor strandings that are commercially available in these flexible cord sizes. The manufacturer may opt to specify the cord conductor stranding range in lieu of the values stated here. See 9.4.

9.7 For test sequence 2, blades are to be tested when assembled to the conductors used in flexible cords, described in Table 9.2.

Table 9.2
Assembly requirements for test sequence 2

Assembly set number	Test conductor strandings for nos. 18 – 10 AWG flexible cord[a]	
	18 AWG	16 – 10 AWG
1	36 AWG	36 AWG
2	30 AWG	26 AWG

[a] The manufacturer may specify the maximum and minimum cord conductor stranding in lieu of the values stated here. See 9.4.

10 Preparation of Assemblies

10.1 To determine if a blade complies with the performance requirements, representative blades are to be assembled to flexible cord conductors of the type specified in 9.4 – 9.7 in the manner specified by the manufacturer. For the Heat-Cycling Test, a control-conductor assembly is also to be prepared as described in 10.2, 11.5, and 11.6.

10.2 All test and control cord conductors are to be previously unused and shall comply with the requirements in 9.4 – 9.7.

10.3 The insulated conductors are to be separated from the complete flexible cord prior to assembly on the blade. Jackets, braids, wraps and fillers are to be completely removed and discarded. Braidless parallel cords are to be split completely into individual conductors. Care should be taken in separating the conductors to avoid damage to the conductor insulation.

10.4 If a blade is not provided with the optional blade hole as shown in Figure 7.5, a hole of the size and location shown is to be drilled in the blades for test sequence 1 (prior to attachment of the test lead or thermocouple).

10.5 Cord conductors are to be stripped immediately prior to assembly to the blade for a distance that is proper for insertion into the crimp terminal and are to be assembled to the blade in the manner specified by the manufacturer, except that any insulation grips provided on the crimp terminal are to be left open. The conductor is not to be brushed or abraded unless such preparation is specified by the manufacturer. Any thread markers incorporated within the conductor stranding are to be left intact unless the blade manufacturer specifies a means for their removal.

10.6 The connection between the cord conductor and the blade is to be made before the start of the first test on any set. Additional adjustment is not to be done during the testing program.

10.7 If a blade is intended to be assembled to a cord conductor by means of a specific tool, this tool is to be used to assemble the blade to the cord conductor in the intended manner.

10.8 If a blade is intended to be assembled to a cord conductor by means of more than one type of specific tool, the blade shall perform acceptably in the tests when any of the specific tools is employed in the assembly operation. This requirement may necessitate conducting additional series of tests for a blade assembled by means of each type of specific tool.

11 Temperature Measurements

11.1 Temperatures are to be measured by thermocouples consisting of wires not larger than No. 24 AWG (0.21 mm^2) and not smaller than No. 30 AWG (0.05 mm^2).

11.2 When thermocouples are used in determining temperatures in electrical equipment, it is common practice to employ thermocouples consisting of No. 30 AWG (0.05 mm^2) iron and constantan wire and a suitable temperature indicating instrument; and such equipment is to be used whenever referee temperature measurements by thermocouples are necessary.

11.3 The thermocouples and related instruments are to be accurate and calibrated in accordance with good laboratory practice. The thermocouple wire is to conform with the requirements for special thermocouples as listed in the table of limits of error of thermocouples in the Standard for Temperature Measurement Thermocouples, ANSI MC96.1-1982.

11.4 A control conductor is to be used in the determination of the stability factor in the Heat-Cycling Test as described in 14.3. The length of the control conductor is to be 48 inches (1.22 m). The control conductor is to be located in the test assembly as described in 13.3 and Figure 13.1 after it has been prepared in the manner described in 10.5 and 10.6.

11.5 A thermocouple on a control conductor is to be located at the midpoint of the conductor length and under the conductor insulation. The following technique is to be employed:

a) A small flap is to be cut into the conductor insulation and rolled back to expose the conductor.

b) The thermocouple bead is to be positioned on the conductor surface in the valley between conductor strands and secured as described in 11.6.

c) The flap of insulation is to be repositioned and secured by heat-shrinkable tubing extending not more than 1/2 inch (12.7 mm) on each side of the flap, or by an equivalent means of holding the test conductor insulation in place.

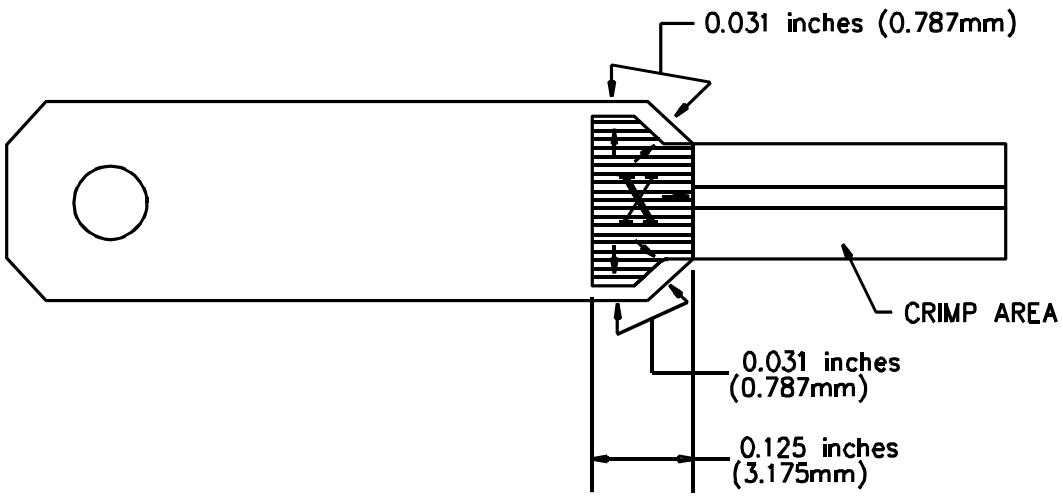
11.6 A thermocouple on a control conductor is to be secured by soldering, by use of a thermally conductive adhesive suitable for temperatures of at least 150EC (270EF), or by other equivalent means that will permit the replacement of the conductor insulation over the thermocouple location.

11.7 A thermocouple on a blade is to be positioned as shown in Figure 11.1. A thermocouple is to be installed so as to obtain thermal and mechanical bonding with the surface of a blade and without causing an appreciable change in the temperature of the blade and without penetration of the surface of the blade; for example, by the use of small quantities of a thermally conductive adhesive suitable for temperatures of at least 150EC (270EF) or by spot welding. Soldering or drilling and peening is not acceptable.

Exception: If the blade construction and assembly are such that the thermocouple cannot be located as shown in Figure 11.1, the thermocouple may be located on the opposite side of the blade stem near the crimp area.

Figure 11.1
Thermocouple location

Figure 11.1 revised August 19, 1998



SM361C THERMOCOUPLE LOCATED WITHIN ZONE X ON CRIMP SIDE OF BLADE

11.8 Thermocouples intended to measure the ambient temperature for a blade set under test are to be installed on 2 inch (5.08 cm) square by 1/4 inch (6.4 mm) thick sections of unplated copper bus. Bus sections are to be located 2 feet in front, 2 feet in back and 2 feet on each side of the test assembly. A bus section is not to be mounted behind the test assembly. All measurements are to be made to the centerline of the nearest blade or conductor. If all thermocouples employed are the same length, they may be connected in parallel to provide an average ambient temperature reading; otherwise, the individual ambient temperature readings are to be used to calculate the average ambient temperature.

11.9 An alternate method of locating the ambient temperature thermocouple is to place one bus at the center of a loop formed by the sets.

12 Secureness Test

12.1 The joint between a blade and the wire of an assembly shall be intact after being subjected to the test described in 12.2 for 30 minutes. There shall not be any breakage of the conductor or any strand of the conductor, shearing of parts, or other damage to the blade.

12.2 A blade is to be terminated to a length of insulated flexible cord conductor that is at least 3 inches (7.62 cm) longer than the height specified in Table 12.1 and is to be rigidly secured so that the axis of the crimp connection is in a vertical position. The free end of the wire is to be passed through a bushing of the size specified in Table 12.1. The bushing is to be attached to an arm driven by a motor at a rate of approximately 9 rpm and in such a manner that the center of the bushing describes a circle in a horizontal plane as shown in Figure 12.1. The circle is to have a diameter of 3 inches (7.62 cm) and its center is to be vertically below the center of the cord conductor opening in the crimped connection of the blade. The distance between the upper side of the bushing and the cord conductor opening of the crimped connection is to be ±1/2 inch (±12.7 mm) of the distance specified in the column titled Height in Table 12.1. The bushing is to be lubricated so there is no binding, twisting, or rotation of the insulated cord conductor. A weight as specified in Table 12.1 is to be suspended from the free end of the cord conductor.

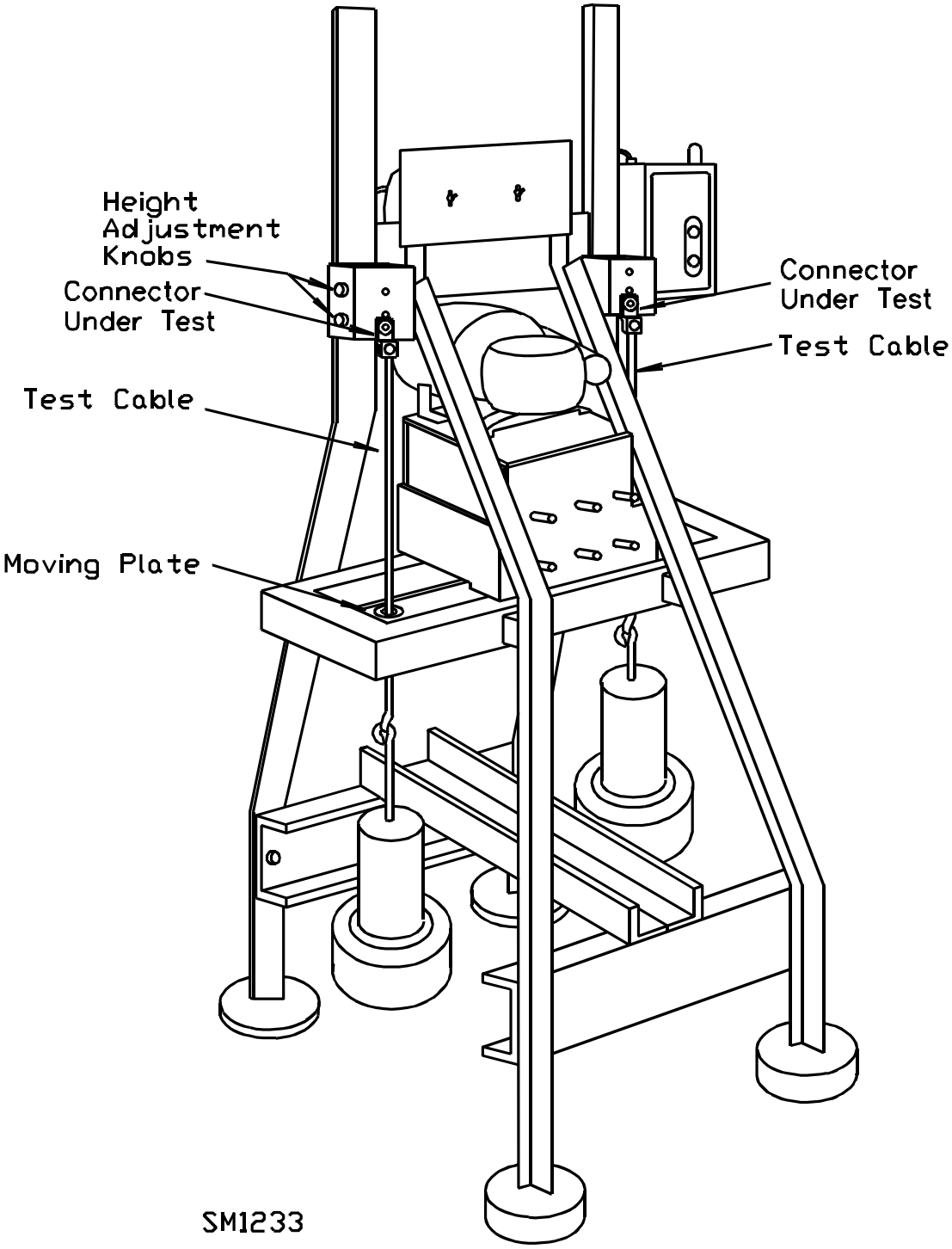
12.3 Breakage of the conductor or any strand of the conductor is to be determined by examination of the complete blade assembly after the test described in 12.2 has been completed. If the conductor or a strand of the conductor becomes visibly unattached, breakage is considered to have occurred.

Table 12.1
Secureness test values

Size of conductors		Diameter of bushing hole[a]		Height		Weight	
AWG	(mm^2)	inches	(mm)	inches	(mm)	pounds	(kg)
18 – 16	(0.82 – 1.3)	1/4	(6.4)	10-1/4	(260)	2	(0.9)
14	(2.1)	3/8	(9.5)	11	(279)	3	(1.4)
12 – 10	(3.3 – 5.3)	3/8	(9.5)	11	(279)	5	(2.3)

[a] If a hole with the diameter given is not adequate to accommodate the wire without binding, a bushing having a hole of a slightly larger diameter may be used.

Figure 12.1
Secureness test machine



13 Static Heating Test

13.1 The sets previously subjected to the Secureness Test described in Section 12 shall continuously carry the test current indicated in Table 13.1 until stable temperatures are reached without exceeding a 30EC (54EF) temperature rise above ambient temperature.

Table 13.1
Static heading test currents for conductors

Wire size		Static heating test current, amperes
AWG	(mm^2)	
18	(0.82)	10
16	(1.3)	13
14	(2.1)	18
12	(3.3)	25
10	(5.3)	30

13.2 After completing the Secureness Test, the test conductor on each device is to be trimmed to 12 inches (30.5 cm) in length.

13.3 The test assembly and securing hardware are to be as described in 13.4 – 13.7.

13.4 The sets are to be assembled into the test fixture shown in Figures 13.1 and 13.2. If a blade is not provided with the optional blade hole as shown in Figure 7.5, a hole of the size and location shown is to be drilled in the blade and deburred (prior to attachment of the test lead or thermocouple). Individual blade/conductor assemblies are to be separated by at least 7 inches (17.8 cm) when measured center-to-center. The No. 4-40 brass screws used to secure the blades in the test fixture are to be tightened with a torque of 7 in-lbf (0.8 N•m).

13.5 The test fixture and assemblies are to be mounted a minimum of 24 inches (61 cm) from the building floor, ceiling, and walls.

Exception: The spacing need not be maintained if a solid thermal insulating backboard separates the test devices from the building floor, ceiling, or walls. Devices are to be spaced at least 4 inches (10.2 cm) from the thermal insulating backboard.

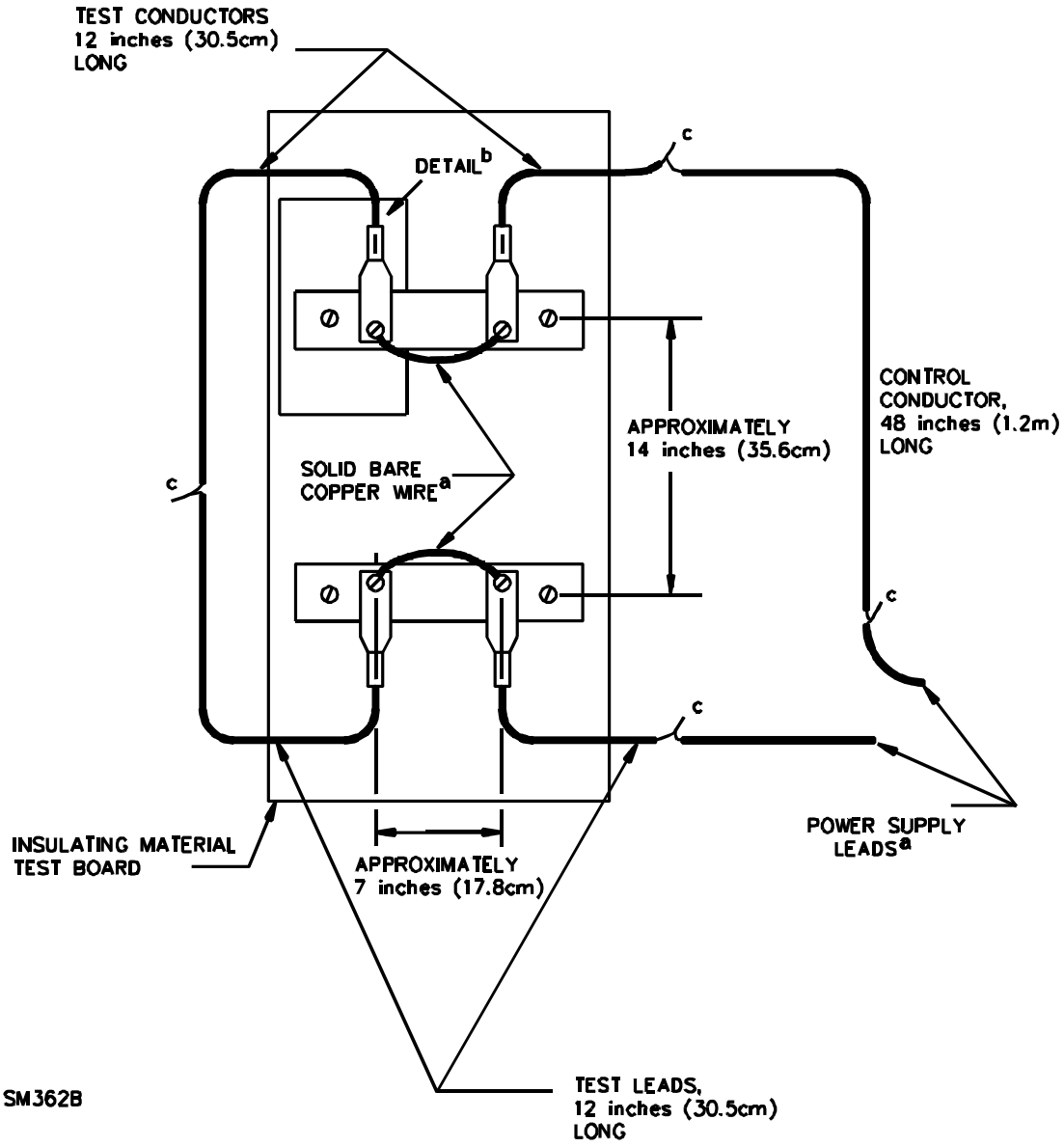
13.6 Test assemblies are to be located in a substantially vibration- and draft-free location where the average ambient air temperature can be maintained in the range of 25 ±5EC (77 ±9EF). The air flow in the testing location is not to exceed 25 feet per minute (7.62 meters per minute).

13.7 Test sets and the control conductor are to be connected in series and to a current source that is maintained at or above the required value by regulation or frequent adjustment. The test current is to flow through the blades at any potential that will result in the required current. Temperature measurements are to be taken in the manner described in Temperature Measurements, Section 11.

13.8 A test device is considered to have attained a stable temperature during the Static Heating Test when three readings, taken at not less than 5-minute intervals, show no further rise above the ambient temperature.

Figure 13.1
Test assembly

Figure 13.1 revised August 19, 1998



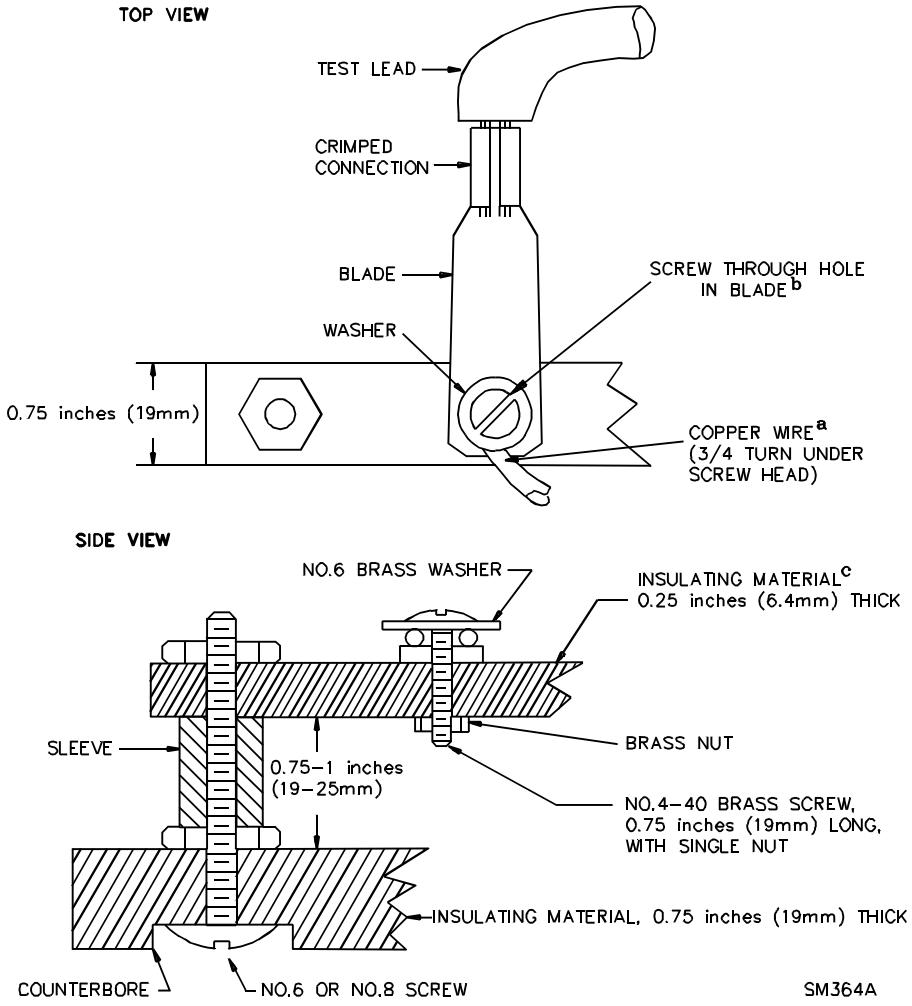
NOTES –

a) Two wire sizes larger than test conductor.

b) See Figure 13.2 for detail.

c) All conductors are connected by twisting and soldering.

Figure 13.2
Test assembly – detail



NOTES –

a) Two wire sizes larger than test conductor.

b) If hole not provided in blade, drill hole as described in 13.4.

c) 150EC minimum rated phenolic or equivalent.

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14 Heat-Cycling Test

14.1 After completing the Static Heating Test described in Section 13, the sets shall complete 500 cycles of 45 minutes current-on and 15 minutes current-off operations while carrying the test current indicated in Table 14.1. Temperatures are to be measured and recorded during the first cycle and for at least 1 cycle of each working day. The Heat-Cycling Test shall be completed without any blade exceeding a 125EC (225EF) temperature rise above the ambient temperature for any recorded cycle. The stability factor "S" described in 14.3 is to be determined for each of the 11 blade temperature measurements (taken at approximately 25, 50, 75, 100, 125, 175, 225, 275, 350, 425, and 500 cycles) and shall not exceed ±10.

Table 14.1
Heat-cycling test currents for conductors

Wire size		Heat-cycling test
AWG	(mm^2)	current, amperes
18	(0.82)	20
16	(1.3)	25
14	(2.1)	32
12	(3.3)	37
10	(5.3)	45

14.2 Temperatures are to be measured no sooner than the last 5 minutes of the normal current-on time. If the size of test set of the speed of the data acquisition system is such that not all measurements can be completed within 5 minutes, the current-on time is to be extended as necessary to complete such measurements. This current-on time is to be followed by the required fifteen minute off period to complete the cycle.

14.3 The temperature deviation "d" for the 11 individual temperature measurements is to be determined by subtracting the associated control-conductor temperature from the blade temperature. The value of "d" is a positive number when the blade temperature is more than that of the control conductor and a negative number when the blade temperature is less than that of the control conductor. The average of the 11 temperature deviations is then to be determined. The stability factor "S" for each of the 11 temperature measurements mentioned in 14.1 is to be determined by subtracting algebraically the average temperature deviation "d" from the value of the temperature deviation for that temperature measurement.

Example:

Temperature EC

Cycle number	Blade	Control conductor	d	S
25	55.3	60.6	!5.3	+0.9
50	57.0	63.6	!6.6	!0.4
75	57.7	65.6	!7.9	!1.7
100	56.5	64.3	!7.8	!1.6
125	57.8	64.4	!6.6	!0.4
175	57.0	64.8	!7.8	!1.6
225	57.8	64.8	!7.0	!0.8
275	57.4	65.7	!8.3	!2.1
350	57.0	62.0	!5.0	+1.2
425	64.9	67.6	!2.7	+3.5
500	61.2	64.6	!3.4	+2.8
			Sum: !68.4	
			Average: !6.2	

15 Pull-Out Test

15.1 When subjected to a force of 20 lb (89 N) a blade shall not separate from the cord conductor to which it has been assembled. There shall not be any breakage of the conductor or any strand of the conductor, shearing of parts, or other damage to the blade.

15.2 A blade is to be connected as intended to a length of wire not less than 12 inches (30.5 cm) and is to be rigidly secured so that the axis of the crimp connection is in a vertical position. With reference to 15.1, the force may be directly and gradually applied by means of a test weight, or a tensile testing machine adjusted so that the head travels at a speed of 1 inch (25.4 mm) per minute until the test force has been reached. The full test force is to be held for one minute.

15.3 Breakage of the conductor or any strand of the conductor is to be determined by examination of the complete blade assembly after the test described in 15.2 has been completed. If the conductor or a strand of a conductor becomes visibly unattached, breakage is considered to have occurred.

16 Compression Force Test

16.1 A folded-over blade made from sheet metal stock less than 0.0275 inch (0.70 mm) thick shall not be deformed so that the overall blade thickness in the contact area is less than 0.055 inch (1.40 mm) thick when subjected to a compression force of 5 lbf (23 N) applied normal to the center of the contact area by a 1/8 inch (3.2 mm) diameter steel rod having a flat face.

Exception: The compression force need not be applied if metal-to-metal contact is provided along the entire outer periphery of the blade contact surface area. Small openings in the blade tip area as shown in Figure 7.4 are not precluded by this requirement.

16.2 With reference to 16.1, the blade is to be supported on a flat plate and the force is to be directly and gradually applied by means of a test machine adjusted so that the head travels at a speed of not more than 1 inch (25.4 mm) per minute until 5 lbf (23 N) has been reached. The full test force is then to be maintained for one minute.

16.3 Upon completing the application of the force as described in 16.2, the blade is to be examined with a ball or pin micrometer or other suitable measuring instrument to determine compliance with 16.1.

17 10 Day Moist Ammonia Air Test

17.1 After being tested as described in 17.2 – 17.4, a copper alloy part of other than 70/30 cartridge brass (see 6.2) shall not show any evidence of cracking when examined using 25X magnification.

17.2 Each representative part is to be subjected to the physical stresses normally imposed on or within a part as a result of assembly with other components. Such stresses are to be applied to the representative part prior to, and be effective during, the test.

17.3 Three representative parts are to be degreased and then continuously exposed in a set position for ten days to a moist ammonia-air mixture maintained in a glass chamber approximately 12 by 12 by 12 inches (305 by 305 by 305 mm) having a glass cover.

17.4 Approximately 600 mL of aqueous ammonia having a specific gravity of 0.94 is to be maintained at the bottom of the glass chamber below the representative parts. The representative parts are to be positioned 1-1/2 inches (38 mm) above the aqueous ammonia solution and supported by an inert tray. The moist ammonia-air mixture in the chamber is to be maintained at atmospheric pressure with the temperature constant at 34 ±2EC (93 ±3.6EF).

MARKING

18 General

18.1 A blade shall be marked with the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified.

Exception: The manufacturer's identification may be in a traceable code if identified by the brand or trademark owned by a private labeler.

18.2 An instruction sheet provided with the blades or the smallest container, reel, or packaging carton containing blades shall be legibly and permanently marked with:

a) The manufacturer's name, trade name, or trademark;

b) A distinctive catalog or model number or the equivalent;

c) The conductor size or sizes (AWG) for which the blade is intended;

d) The conductor strand gauge or gauges for which the blade is intended;

e) A statement limiting the use of the blade to tinned conductors only, if the blade has only been found to be acceptable with tinned conductors;

f) The types of flexible cords for which the blade is intended. See 18.3.

g) A statement referring to the manufacturer's assembly instructions. See Instructions for Assembly, Section 19.

18.3 The packaging mentioned in 18.2 for blades intended for use solely for a specific cord type or cord insulation, such as on Type SE, SEO, SJE, SJEO, SPE1, SPE2, SPE3, SPT1, SPT2, SPT3, SVE or SVEO flexible cords shall be marked with the statement "For use only on Type _____ flexible cords" or equivalent.

18.4 If a manufacturer produces blades at more than one factory, each product or smallest packaging carton shall have a distinctive marking, which may be in code, by which it may be identified as the product of a particular factory.

19 Instructions for Assembly

19.1 Installation instructions shall be provided by the blade manufacturer on or in the smallest shipping container or on a separate information sheet and shall include:

a) Attaching Tool – The recommended tool or equivalent means that results in the assembly complying with (d). The tool or tool part shall be identified by one of the following:

1) Catalog or type designation.

2) Color coding.

3) Die index number.

4) Other equivalent means.

b) Preliminary Preparation of Conductor Required – Instructions for preparation of the conductors, such as removing thread markers or twisting strands of the conductors together before assembly.

c) Wire Strip Length – The strip length marking.

d) Dimension of Finished Crimp Connection – The dimensions of a finished crimp connection, including tolerances.

e) Tool Tolerances – Critical tool or die dimensions, including tolerances, that may affect the quality of the crimp connection.

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