AMERICAN RAILWAY ENGINEERING AND
MAINTENANCE OF WAY ASSOCIATION

COMMUNICATIONS & SIGNALS MANUAL

Section 14 – Electrical Devices, Foundations, Hardware
- 14.1 - Recommended Wire Connectors, Terminals
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2007

SECTION 14 - ELECTRICAL DEVICES, FOUNDATIONS, HARDWARE

Part	C	Type & Subject	Pages	Status
14.1 Recommended Wire Connectors, Terminals				
14.1.1	37-2	Recommended Design Criteria and Functional/Operating Guidelines for Solderless Crimp-Type Wire Terminals for Use in Wiring Signal Apparatus	5	Reaffirmed 2006
14.1.2	37-2	Recommended Design Criteria and Functional/Operating Guidelines for Solderless Screw-Clamp or Screwless Cage-Clamp Terminal Blocks Used in Wiring Signal Apparatus with Copper Wire Only	13	Reaffirmed 2006
14.1.5	37-2	Recommended Design Criteria for Molded Terminal Blocks	3	Revised 2006
14.1.6	37-2	Recommended Design Criteria for Multiple Unit Binding Post Type Terminal Block	2	Reaffirmed 2006
14.1.8	37-2	Recommended Design Criteria for Molded Binding Post Type Terminal Block, Details & Assemblies	3	Reaffirmed 2007
14.1.9	37-2	Recommended Practices for Arrester Terminal Block Assemblies with Ground Straps	1	Reaffirmed 2006
14.1.10	37-2	Recommended Design Criteria for Binding Posts	4	Revised 2006

Note: C = Committee responsible for Manual Part.

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Part	C	Type & Subject	Pages	Status
14.1.11	37-2	Recommended Design Criteria for Binding Posts, Nuts & Washers, Details & Assemblies	2	Revised 2006
14.1.12	37-2	Recommended Design Criteria for Standard Binding Posts	2	Reaffirmed 2006
14.1.15	37-2	Recommended Design Criteria for Terminal Connectors, Details	4	Reaffirmed 2006
14.2 Recommended Electrical Devices				
14.2.1	37-2	Recommended Design Criteria and Functional/Operating Guidelines for Incandescent Electric Lamps	9	Revised 2005
14.2.10	37-2	Recommended Design Criteria for a Transformer, Dry-Type, Air-Cooled	9	Revised 2005
14.2.15	37-2	Recommended Design Criteria for Resistors	6	Revised 2006
14.2.20	37-2	Recommended Design Criteria for Air-Cooled Reactor for Line and Track Circuits	4	Revised 2004
14.2.25	37-2	Recommended Design Criteria for an Impulse Transformer for Coded Control System	3	Revised 2004
14.4 Recommended Foundations				
14.4.1A	36-2	Recommended Design Criteria for a Precast Concrete Foundation, Details	2	Reaffirmed 2005

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Part	C	Type & Subject	Pages	Status
14.4.2A	36-2	Recommended Design Criteria for Components of a Precast Concrete Foundation for 4-in. Mast Assembly	1	Reaffirmed 2005
14.4.2B	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 4-in. Mast Assembly	1	Extended 1998
14.4.3A	36-2	Recommended Design Criteria for Top and Spider Components of a Precast Concrete Foundation for 5-in. and 6-in. Mast Assembly	1	Reaffirmed 2005
14.4.3B	36-2	Recommended Design Criteria for Base and Bolt Components for a Precast Concrete Foundation for 5-in. and 6-in. Mast Assembly	1	Extended 1998
14.4.3C	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 5-in. and 6-in. Mast Assembly	1	Extended 1998
14.4.7A	36-2	Recommended Design Criteria for Top and Base Components of a Precast Concrete Foundation for Signal Bridge Assembly	1	Reaffirmed 1998
14.4.7B	36-2	Recommended Design Criteria for a Spider Component and Nut Assembly of a Precast Concrete Foundation for Signal Bridge Assembly	1	Reaffirmed 2005
14.4.7C	36-2	Recommended Design Criteria for a Low Profile Precast Concrete Foundation for Signal Bridge Assembly	2	Reaffirmed 2005

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Part	C	Type & Subject	Pages	Status
14.4.8A	36-2	Recommended Design Criteria for Top and Base Components of a Precast Concrete Foundation for 4 Bolt Single Mast Cantilever 12 ft. - 30 ft. Assembly	1	Reaffirmed 2005
14.4.8B	36-2	Recommended Design Criteria for a Spider Component of a Precast Concrete Foundation for 4 Bolt Single Mast Cantilever 12 ft. - 30 ft. Assembly	1	Reaffirmed 2005
14.4.8C	36-2	Recommended Design Criteria for Slab Components of a Precast Concrete Foundation for 4 Bolt Single Mast Cantilever 12 ft. - 30 ft. Assembly	1	Reaffirmed 2005
14.4.8D	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 4 Bolt Single Mast Cantilever 12 ft. - 30 ft. Assembly	1	Reaffirmed 2005
14.4.8E	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 4 Bolt Single Mast Cantilever 12 ft. - 30 ft. Assembly	1	Reaffirmed 2005
14.4.9A	36-2	Recommended Design Criteria for Top and Base Components of a Precast Concrete Foundation for 8 Bolt Single Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005

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Part	C	Type & Subject	Pages	Status
14.4.9B	36-2	Recommended Design Criteria for a Spider Component of a Precast Concrete Foundation for 8 Bolt Single Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.9C	36-2	Recommended Design Criteria for Slab Components of a Precast Concrete Foundation for 8 Bolt Single Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.9D	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 8 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.9E	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 8 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.10A	36-2	Recommended Design Criteria for Top and Base Components of a Precast Concrete Foundation for 6 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.10B	36-2	Recommended Design Criteria for Spider Components of a Precast Concrete Foundation for 6 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005

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Part	C	Type & Subject	Pages	Status
14.4.10C	36-2	Recommended Design Criteria for Slab Components of a Precast Concrete Foundation for 6 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.10D	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 6 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.10E	36-2	Recommended Design Criteria for a Precast Concrete Foundation for 6 Bolt Double Mast Cantilever 28 ft. - 40 ft. Assembly	1	Reaffirmed 2005
14.4.11	36-2	Recommended Design Criteria for a Precast Concrete Pier for Instrument Housings, Details & Assembly	2	Reaffirmed 2005
14.4.17	36-2	Recommended Design Criteria for Galvanized Steel Foundations, Assemblies, for Flashing-Light Signals	2	Revised 1998
14.4.19	36-2	Recommended Design Criteria for Galvanized Steel Foundations, Pyramid Type, Assemblies for Highway-Rail Grade Crossing Gate, Wayside Signals	2	Reaffirmed 2001
14.4.21	36-2	Recommended Design Criteria for Galvanized Steel Foundations, Assemblies for Instrument House, Option 1	2	Revised 1998

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Part	C	Type & Subject	Pages	Status
14.4.21A	36-2	Recommended Design Criteria for Galvanized Steel Foundations, Assemblies for Instrument House, Option 2.	2	Revised 1998
14.4.23	36-2	Recommended Design Criteria for Galvanized Steel Foundations, Assemblies for Instrument Case	2	Revised 1998
14.4.25	36-2	Recommended Design Criteria for Galvanized Steel Case Platform, Assemblies	2	Revised 1998
14.4.30	36-2	Recommended Design Criteria and Installation for Pour-in-Place Foundation	2	Reaffirmed 2005
14.4.31	36-2	Recommended Design Criteria and Installation for Pour-in-Place 60 in. Foundation for Single Base Plate Cantilevers with up to 40 ft. Aluminum Arm and 17 ft. Roadway Clearance	2	Reaffirmed 2005
14.4.32	36-2	Recommended Design Criteria and Installation for Pour-in-Place 84 in. Foundation for Single Base Plate Cantilevers with Special Applications	2	Reaffirmed 2005
14.4.33	36-2	Recommended Design Criteria and Installation for Pour-in-Place Foundation for Single Base Plate Cantilevers	2	Reaffirmed 2005
14.4.34	36-2	Recommended Design Criteria and Installation for Pour-in-Place Foundation for Bridge Base Plate	2	Reaffirmed 2005

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Part	C	Type & Subject	Pages	Status
14.4.35	36-2	Recommended Design Criteria and Installation for Pour-in-Place Foundation for Double Base Plate Cantilevers	2	Reaffirmed 2005
14.4.36	36-2	Recommended Design Criteria and Installation for Pour-in-Place Foundation for Quad Base Plate Cantilevers	2	Reaffirmed 2005
14.6 Recommended Hardware, Fittings and Other Devices				
14.6.1	37-2	Recommended Design Criteria for Signs Other Than for Highway-Rail Grade Crossings	3	Revised 2004
14.6.2A	36-3	Recommended Design Criteria for Letters, Rounded-Type, 5-1/2-in., Details	1	Reaffirmed 2002
14.6.2B	36-3	Recommended Design Criteria for Numerals, Rounded-Type 5-1/2-in., Details	1	Reaffirmed 2002
14.6.3	36-3	Recommended Design Criteria for Letters, Rounded-Type, 4-in., Details	1	Reaffirmed 2002
14.6.20	37-2	Recommended Design Criteria for Bolts, Nuts and Threads	2	Revised 2004
14.6.21	37-2	Recommended Design Criteria for Plain and Spring Lock Washers	1	Revised 2004
14.6.22	37-2	Recommended Design Criteria for Cotters (Size-Drilling-Location)	1	Reaffirmed 2006

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Part	C	Type & Subject	Pages	Status
14.6.27	37-2	Recommended Design Criteria for Wood-Locking Cast Iron Washers for 3/4-in. and 7/8-in. Bolts	2	Reaffirmed 2007
14.6.31	37-2	Recommended Design Criteria for Steel Pipe Conduit	1	Revised 2004
14.7 Recommended Instructions				
14.7.1	37-2	Recommended Instructions for Incandescent Electric Lamps	3	Revised 2005

Recommended Design Criteria and Functional/Operating Guidelines for Solderless Crimp-Type Wire Terminals for Use in Wiring Signal Apparatus

Reaffirmed 2006 (5 Pages)

A. Purpose

This Manual Part recommends design criteria and functional/operating guidelines for solderless crimp-type wire terminals used in wiring signal apparatus. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. General

1. This Manual Part applies to terminals of the insulated and non-insulated type for stranded copper wire sizes No. 22-4 AWG.

2. Conductor insulation should be supported and gripped by the terminal.

3. The terminal barrel should be serrated or have dimples for maximum contact area and tensile strength.

4. Terminals shall be capable of being applied to the conductor with a tool recommended by manufacturer, to provide mechanical security and electrical performance, as required.

5. Recommended crimping tool shall provide for a complete crimping cycle before releasing and returning to the original open position. Tool(s) shall be calibrated according to the manufacturer's specifications.

C. Metal Parts

1. The current carrying portions of the terminals shall be of copper or suitable copper alloy and be plated over the entire surface and conform to Military Specification MIL-T-7928G (General Specification for Terminals*)* with tin or other suitable plating material except cadmium or zinc.

2. Metallic coating shall be of quality and thickness to withstand tests specified without exposing the base metal. The terminals shall exhibit no fracturing or flaking as a result of the crimping/reshaping operation.

3. The terminal barrel shall have a brazed seam, tubular barrel, or be provided with a copper sleeve that covers, but shall not extend beyond, the wire barrel.

D. Insulation

1. Terminals of the insulated type shall have the outer surface of the wire barrel, and copper sleeve, if supplied, covered with insulation that extends over the wire barrel to a point not more than 3/16 in. from the assembly of binding post, nut and washer for terminals on No. 22 AWG to No. 10 AWG wire nor more than 7/16 in. on terminals for No. 8 AWG to No. 4 AWG wire.

2. Insulation shall extend a sufficient distance beyond the barrel and over the conductor insulation and be of a quality and thickness to meet the requirements of the prescribed tests.

3. Insulation and metal sleeve, if used, shall remain in its original position on the barrel before and after the crimping operation conforming to Mil. Spec. MIL-T-7928G.

4. Insulation shall be non-corrosive, resistant to abrasion and fungus and shall not support combustion.

5. Insulation shall be capable of being crimped at temperatures of -15°C (+5°F) to +49°C (+12°F) and remain so when exposed to a continuous temperature of +85°C (+185°F).

6. Each terminal should properly indicate conductor size range and manufacturer. The insulating sleeve should be of the following color for proper identification of conductor size range:

22/18 AWG – Red	2/10 AWG - Yellow
20/16 AWG – Green	8 AWG - Red
16/14 AWG – Blue	6 AWG - Blue
12/10 AWG (Heavy Duty) - Yellow/Black	4 AWG - Yellow

E. Performance Requirements

Terminals shall meet the following requirements when attached to the conduct or size for which they are designed and when crimped with tools recommended by manufacturer. Where terminal is designed to accommodate a range of wire sizes, the minimum and maximum wire size shall be tested.

1. General

   All tests shall be made at room temperature unless otherwise specified and the test area shall be free from drafts. During temperature and voltage tests, terminals shall be securely bolted back to back and suspended in

free air with a minimum clearance of 18 in. Insulation supports, where provided, shall be closed on the conductor insulation for all tests to follow.

2. Temperature Rise Test

Temperature rise measurements shall be made by means of thermocouples or other thermo-resistive devices. Temperature shall be measured at the barrel of each terminal and at a point embedded in the conductor strands at a minimum distance of 36 in. from the terminals and from the power source. Test currents as specified in Table 1411-1 shall be conducted through the conductor and attached terminals continuously until the temperature is stabilized (after three consecutive readings are within 1°C, taken at 3 min. intervals). The temperature of the terminal shall not exceed by +5°C (9+°F) more than that of the conductor to which it is connected.

3. Current Overload Test

Immediately following the temperature rise and with the temperature stabilized at the current listed in Table 1411-1, 125% of the test current for 2 hr. and 200% of the test current for 5 min. shall be applied in this order and temperature rise measurements made at the conclusion of each period. The temperature of the terminal shall not exceed that of the conductor to which it is connected by more than 10°C (+18°F).

4. Voltage Drop Test

This test shall be conducted initially using the "Initial" values listed in Table 1411-1 and then repeated after the Corrosion Test, Section E5 and the Vibration Test, Section E6, using the "After Test" values listed in Table 1411-1, as directed. Voltage drop shall be measured while the specified test current in Table 1411-1 is applied and after the temperature of the wire has stabilized. The test points shall be between the intersection of the tongue and barrel of the terminal and at a point on the conductor 1/16 in. back from the wire receiving end of the terminal. The voltage drop shall not exceed the value listed in Table 1411-1.

5. Corrosion

The salt spray (corrosion) test shall be in accordance with method 101, test condition A of MIL-STD-202. Terminal assemblies shall be mounted in the corrosion chamber in the horizontal position. Adjoining samples shall be separated by at least 1.4 in. and shall not come in contact with metallic or wooden objects so that the salt fog will have free access to the samples. At the completion of the exposure period, the samples shall be

washed with distilled water, air dried for a minimum of 1 hr. and have the corrosion on the terminal tongue removed with fine sandpaper. The terminals shall then pass the requirements of the Voltage Drop Test, Section E.4, and the Tensile Strength Test, Section E.7.

6. Vibration

Terminals shall be attached to a 12 in. length of wire, installed on a binding post conforming to Manual Part 14.1.11 (Recommended Design Criteria for Binding Posts, Nuts and Washers, Details & Assemblies), and mounted on a vibration table with the free end of the conductor secured to a stable support. The terminals shall be vibrated in accordance with method 201 of MIL-STD-202 for 18 hr. on each of two axes mutually perpendicular to each other and to the axis of the wire. The terminals shall then pass the requirements of the Voltage Drop Test, Section E.4, and the Tensile Strength Test, Section E.7.

7. Tensile Strength

This test shall be conducted initially on new samples and then repeated on samples subjected to the Corrosion Test and the Vibration Test. The mechanical connection of the conductor and terminal shall not break when subjected to the tensile load specified in Table 1411-1, applied at the rate of 1 in. per minute.

8. Dielectric Strength Test (for insulated terminals)

The terminal insulation shall be wrapped with a thin, conductive foil firmly pressed into and around the crimped surface of the barrel. The foil may extend back along the conductor insulation but shall be far enough away from the terminal tongue to prevent flashovers. The test voltage shall be applied between the tongue and the foil, conforming to method 301 of MIL-STD-202. The terminals shall conform to Manual Part 11.5.1 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment) Section D.7, Class A Roadbed, and no breakdown of the insulation shall be evident.

Table 1411-1

Conductor Size (AWG)	Test Current (amperes)	Maximum Voltage Drop (mV) Millivolt drop of equivalent length of wire plus value listed below		Minimum Tensile Strength
		Initial	After Test	(lb)
22	9	1	3	15
20	11	1	3	19
18	16	1	3	38
16	22	1	3	50
14	32	1	3	70
12	41	1	3	110
10	55	1	3	150
8	73	1	3	225
6	101	1	3	300
4	135	1	3	400

Recommended Design Criteria and Functional/Operating Guidelines for Solderless Screw-Clamp or Screwless Cage-Clamp Terminal Blocks Used in Wiring Signal Apparatus with Copper Wire Only

Reaffirmed 2006 (13 Pages)

A. Purpose

1. This Manual Part recommends design criteria and functional/operating guidelines for terminal blocks used in the wiring of signal apparatus which are installed in weather protected enclosures, having circuits rated at 600 volts or less and utilize solid and/or stranded copper wire sizes No. 24 AWG through No. 2 AWG. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. General

1. The terminal block assembly described by these recommendations provides an alternate method for terminating or connecting copper wires and cables.

2. Terminal blocks and installed accessories (i.e. jumpers, test sockets, etc.) used where electrical shock hazards exist, as defined in Manual Part 11.1.1 (Recommended Functional/Operating Guidelines for Electrical Safety), shall be "touchproof" or insulated in design.

3. The metallic clamping mechanism of the terminal block shall surround the wire on all sides to prevent wire strands from splaying outside the clamping area.

4. When mounting rail is used, the terminal block or terminal block assembly should be suitable for and be mounted on DIN 35 type rail.

5. When screw-type terminal blocks are used, the screws shall be tightened to the manufacturer's recommended torque value.

6. Each clamping mechanism of the terminal block shall be limited to the connection of one wire or conductor.

7. The terminal block should be properly sized to allow the wire insulation to fit freely into the terminal block housing and designed to prevent the wire insulation from exerting pressure on the adjacent terminal block.

C. Manufacturer Documentation

1. The manufacturer should provide all documentation necessary to allow the purchaser to identify and select the proper terminal block or terminal block assembly based on the purchaser's particular requirements, along with application notes and suggestions, installation techniques, proper set up and testing routines, maintenance procedures requirements, and repair and replacement instructions.

2. Manufacturer should provide material specifications and engineering type drawings of applicable terminal blocks and accessories.

3. Operational instructions should also be available and, in the case of screw-type terminal blocks, the instructions/decals should list the screw torque requirements in units of inch-pounds.

D. Mechanical Requirements

1. The terminal block should be of sufficient size and design to accommodate a standard straight-bladed screwdriver with a minimum blade width of 1/8 in.

2. The terminal block should be designed to accept solid and/or stranded copper conductors without requiring special wire preparation, such as crimps, ferrules or tinning, to assure the mechanical and electrical connection integrity without damage to conductors.

3. If it is necessary to remove a stranded wire frequently from the terminal block or connector, the use of a ferrule or cable-end-sleeve may be desirable. The design of the terminal block should not prevent or interfere with the use of this wire preparation. Due consideration should be given to the increase in conductor size when using a ferrule.

4. The current carrying portions of the terminal block shall be copper or copper alloy for good conductivity and hardness without the risk of stress cracking and also to keep the coefficient of expansion similar to that of the copper conductor.

5. The contact surface of current carrying parts shall be coated or plated to prevent corrosion. Coating/plating should be of tin, lead, nickel, or tin/lead alloy.

6. The wire clamping mechanism shall be inherently corrosion resistant or plated to resist corrosion.

7. All metallic and current carrying portions of the terminal block shall remain inside the insulating housing and not be able to become detached. All screws shall be captive and not be able to be removed.

8. A rotating member itself (the screw or screw pad) shall not apply mechanical pressure directly to the wire or conductor. Instead it should transmit the required pressure to a yoke or saddle piece, which shall be constructed in such a way as to maintain continuous pressure and compensate for cold flow or settling strands of the conductor. Pressure shall not be transmitted through the insulating material.

9. Terminal blocks shall maintain minimum leakage (air) and minimum creepage (over surface) distances between all metallic portions of the terminal block having electric potential and all other metallic parts and components insulated therefrom conforming to Table 1412-1.

Table 1412-1

Volts	Leakage	Creepage
0 - 300	1/4 (6.4)	3/8 (9.5)
301 - 600	3/8 (9.5)	1/2 (12.7)

Distance in inches (mm)

10. When mounting rail is used, terminal blocks should be able to be removed from the mounting rail independent from adjacent terminal block.

11. When the terminal block assembly is installed on the mounting rail, the terminal blocks, with the exception of grounding terminal blocks, should be permitted to slide laterally to the vacant portion of the mounting rail providing that a sufficient and diverted force is applied. Vibration or temperature changes shall not cause lateral movement.

12. Positive mechanical locking mechanisms (end stops) shall be used to prevent the terminal block assembly from sliding on the mounting rail, when mounting rail is used.

13. The physical strength of the insulating housing and conductor clamping mechanism should, when installed, exceed the force exerted by the tightening torque when connecting the largest wire size for which it was designed.

14. The wire entrance cavity of each terminal block should be smoothly tapered and closed on all sides to help prevent splayed wire strands.

E. Environmental Considerations and Requirements

Environmental considerations and requirements shall apply to all parts, components, mounting rail, if used, and hardware necessary for complete makeup of the terminal block assembly, and shall be designed for an environmental temperature operating range between -40°C (-40°F) and +85°C (+185°F).

1. All non-metallic materials shall resist deterioration caused by sunlight and ultraviolet light exposure.

2. All non-metallic materials shall be water, moisture and vapor resistant with respect to absorption properties.

3. All non-metallic materials shall be fungi growth resistant and not offer a source of oxygen or other biogenic elements to microorganisms.

4. The presence of anaerobic earth bacteria, mold fungus and/or enzymes shall not result in degradation of the materials.

5. All non-metallic materials shall resist deterioration due to oil and gasoline spillage, films and vapors. Other fuels, lubricants, grease and cleaners commonly used in railroad service shall not cause deterioration.

6. All non-metallic materials shall be self-extinguishing according to UL94 V-2 and have a minimum Oxygen Index rate of 28%.

F. Chemical Requirements

The chemical requirements shall apply to all parts, components, mounting rails and hardware necessary for a complete terminal block assembly.

1. All non-metallic materials shall be chemically inert with regard to the metallic components.

2. All metallic materials shall have good chemical resistance.

G. Performance Tests

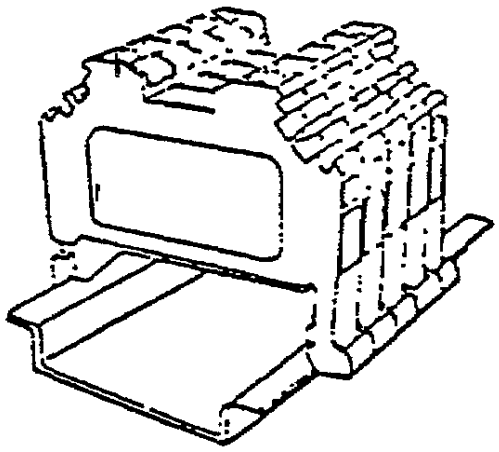
All terminal blocks shall meet the requirements of the following performance tests:

1. Mounting Retention, 2. Wire Pullout, 3. Moisture Resistance, 4. Insulation Resistance, 5. Voltage Drop, 6. Vibration, 7. Shock, 8. Temperature-rise, 9.

Overload Current, 10. Short Circuit, 11. High Temperature, 12. Temperature Cycling, and 13. Corrosion Resistance.

All individual tests shall be carried out on five unused samples, each mounted in horizontal position as shown in Figure 1412-1. For screw-type terminal blocks, screws shall be tightened according to manufacturer's recommended values using the appropriate torque-indicating tool.

Figure 1412-1



1. Mounting Retention Test

   A steel pin 6 in. (150 mm) long with a diameter corresponding to the maximum rated wire size of the terminal block is clamped in each clamping unit. At a distance of 4 in. (100 mm) from the center of the clamping unit, each test pin is individually and slowly rotated about the axis of the mounting rail or support by applying a force according to Table 1412-2. During this test, no terminal block may work free from its mounting rail.

Table 1412-2

Wire size, AWG (mm^2)	Test force, Pounds (N)
16 (1.3)	.68 (3)
14 (2.1)	.68 (3)
12 (3.3)	.68 (3)
10 (5.3)	3.38 (15)
8 (8.4)	3.38 (15)
6 (13.3)	3.38 (15)
4 (21.2)	6.75 (30)
2 (33.6)	6.75 (30)

2. Wire Pullout Test

After each connection is made, the conductor is to be subjected to a pullout force according to the values shown in Table 1412-3.

Table 1412-3

Wire size, AWG (mm^2)	Pullout force, Pounds (N)
20 (0.5)	6.75 (30)
18 (0.8)	6.75 (30)
16 (1.3)	9.0 (40)
14 (2.1)	11.5 (50)
12 (3.3)	13.5 (60)
10 (5.3)	18.0 (80)
8 (8.4)	20.5 (90)
6 (13.3)	21.0 (94)
4 (21.2)	30.0 (133)
2 (33.6)	42.0 (186)

The pull has to be applied steadily, for 1 min. in the direction of the axis of the conductor. Each of the five tests using stranded wire, are to be carried out in succession with the smallest (or minimum value of Table 1412-3, if smaller than No. 20 AWG) and largest size wire specified for the terminal block. New conductors are to be used for the first through the fourth test,

for the fifth test, the same conductor shall be used as for the fourth test, clamped at the same point. The maximum length of the test conductor shall be 39 in. (1 m).

The test is considered passed if the conductor does not come out of the terminal block during the test and does not break directly at the clamping point. After the test, the terminal block and the conductor shall show no deterioration impairing their further use.

3. Moisture Resistance Test

The humidity treatment is carried out in a humidity cabinet containing air with a relative humidity maintained between 91% and 95%. The temperature of the air, at all places where samples are located, is maintained with 1°C (1.8°F) of any convenient value between +20°C (+68°F) and +30°C (+86°F). The samples should be brought to the temperature of the cabinet prior to being placed in it.

The samples should remain in the cabinet for 48 hr. and upon removal should not show any damage. This test is also for the purpose of conditioning the terminal blocks for the insulation resistance test.

4. Insulation Resistance Test

The requirements of Manual Part 11.5.1 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment), Class C, shall be met.

5. Voltage Drop Tests

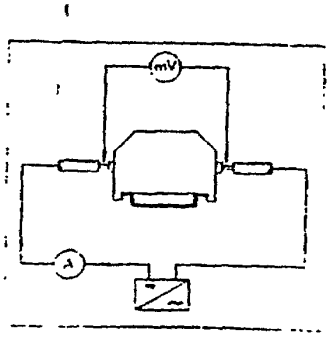
Voltage drop measurements are required for the vibration, short circuit test, high temperature, temperature cycling and corrosion test to follow.

For each test, a dc test current, 1/10 of the values listed in Table 1412-4, is to be applied to the terminal block. An initial voltage drop measurement shall be obtained prior to the start of each test and then as directed. The test arrangement and measuring points are shown in Figure 1412-2.

Table 1412-4

Wire size (AWG)	24	22	20	18	16	14	12	10	8	6	4	2
Rated current (A)	4	6	8	10	16	22	29	38	50	67	90	121

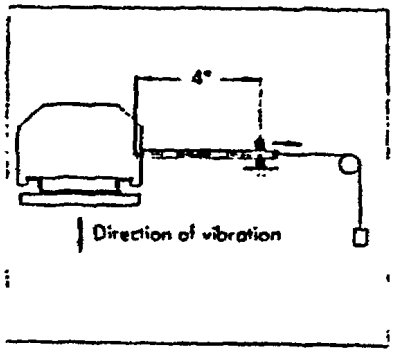
Figure 1412-2



6. Vibration Test

The vibration test is made using the largest and smallest wire sizes (both solid and stranded) the terminal block is designed to accommodate. The conductor, having been installed in the terminal block, is subjected to a steady pull of half the values as shown in Table 1412-3, with cables guided at a distance of 4 in. (100 mm) from the center of the clamping point as shown in Figure 1412-3.

Figure 1412-3



The rail mounted terminal blocks and the conductors are subjected to a vibration parallel to the direction of the axis of the conductor as follows:

a. For 2 hr. oscillations at a frequency of approximately 12 Hz at an amplitude of .04 in. (1 mm), and,

b. For 2 hr. oscillations at a frequency of approximately 50 Hz at an amplitude of .04 in. (1 mm).

Then the terminal blocks are rotated by 90 deg. around the axis of the conductor and subjected to the same tests.

The test is considered passed if the requirements of the Voltage Drop Test are met, no wires are pulled out of the terminal block and no conductors break at the clamping point.

7. Shock Test

Five terminal blocks are connected in series with a range of wire sizes, both solid and stranded. The terminal blocks are then connected to a testing device capable of detecting interruptions as small as 2 sec. The wires should be strain relieved as follows: No. 16 AWG through No. 10 AWG rated terminal blocks approximately 1.25 in. (32 mm), No. 8 AWG through No. 3/0 AWG rated terminal blocks - approximately 0.75 in. (20 mm).

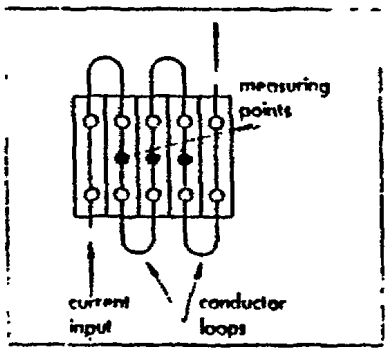
The terminal block assembly is then subjected to mechanical shock with a minimum acceleration of 20g in both the X and Y-axes.

The test is passed if no signal interruptions are observed and neither the terminal block nor the wires are damaged in any way.

8. Temperature Rise Test

Five terminal blocks are connected in series as shown in Figure 1412-4 by PVC-insulated wires of the maximum rated size. The minimum length of each of the six conductors shall be 39 in. (1m) for wire sizes up to No. 8 AWG and 79 in. (2m) for wire sizes larger than No. 8 AWG.

Figure 1412-4



The temperature is measured on the second, third and fourth terminal blocks. The tests are made at an ambient temperature, of +20°C (+68°F).

Initial temperature measurements are taken, than the appropriate test current is applied as in Table 1412-4. The terminal blocks are then subjected to the test until a constant temperature is obtained. The duration of the test should not exceed a period of 8 hr. Steady state temperature is deemed to be reached when the rate of rise does not exceed 1°C or 1.8°F per hour. The test is passed if the temperature rise on the measuring points does not exceed +45°C or +81°F.

The temperature rise test is repeated for the terminal block jumper system. The five terminal blocks are shared and the wire loops removed. Temperature measurements are taken on the second and third jumpers or on the jumper bar at a position between the second and third and between the third and fourth terminal blocks.

9. Overload Current Test

The overload current test is made with a test current being 1.6 times the maximum rated current, shown in Table 1412-4, with the maximum rated wire size connected to the terminal block, for a period of 1 hr.

The test is passed if no part of the terminal block shows any deterioration or damage to impair its further use.

10. Short-circuit Test

The terminal blocks with wires of maximum rated size connected, are to have the maximum rated current as shown in Table 1412-4, applied to them for a period of 15 min. and thereafter for 1 sec. with the ac current listed in Table 1412-5.

Table 1412-5

Wire size AWG (mm^2)	Test Current (amperes)
14 (2.1)	250
12 (3.3)	400
10 (5.3)	635
8 (8.4)	1000

This test is passed if there is no sign of damage on any part of the terminal block to impair its further use.

11. High Temperature Test

Five terminal blocks are mounted and wired with conductors of various sizes. The test is made in an air-circulating over at +110°C±5°C (+221°F to +239°F) for a duration of 168 hr.

The test is passed if the requirements of the Insulation Resistance Test and the Voltage Drop Test are met.

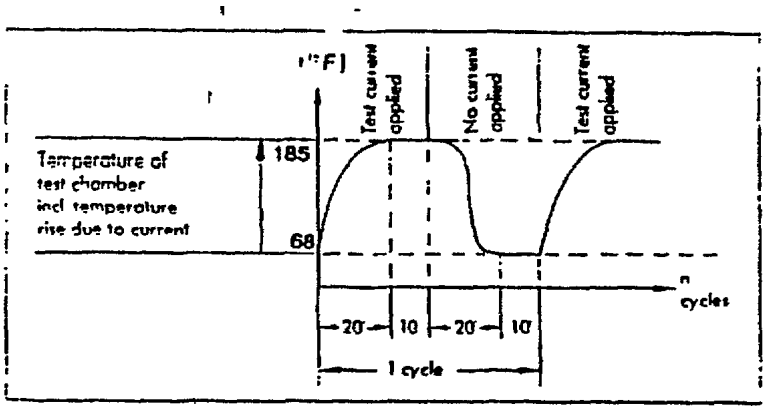
12. Temperature Cycling Test

The temperature cycling test is used to verify that the terminal block's wire clamping method is resistant to long term temperature and current on/off cycling.

The test is carried out on five terminal blocks of like size for each wire clamping method used. The maximum rated wire size is connected to the terminal blocks. The test current is the maximum rated current, as shown in Table 1412-4.

The samples are wired in series, connected to the current source and placed in the heating cabinet. For each terminal block the voltage drops are measured, initially, three times before and one time after 400 cycles, with each test cycle corresponding to Figure 1412-5.

Figure 1412-5



The test is passed if the requirements of the Voltage Drop Test are met.

13. Corrosion Test

The corrosion test simulates how the clamping method should perform after aging in normal use. It is performed in a suitable test chamber with a minimum volume of 300L and according to DIN EN ISO 06988.

H. Terminal Block Identification

Each terminal block assembly shall be properly identified by the manufacturer, and should include the following:

1. Manufacturer's name and identification mark.

2. Type reference or catalog number.

3. Wire size or range of sized designed for.

4. In the case of screw terminals, if an unusual application should require the screw to be tightened to a certain torque value, that value shall be shown, so indicated in inch-pounds.

I. Tagging, Marking and Nomenclature

A means should be provided on the insulating housing of the terminal block for identifying or marking the wire or conductor. The marker should attach firmly and securely to the terminal block, subject to all environmental and operating conditions and requirements. It should be possible to remove, replace or change the marker without damage to the terminal block.

J. Other Recommendations

The following items should also be considered:

1. Wire entry from the side or top for space savings.

2. Ease of wire installation and removal.

3. Multiple clamping units *on* the same current bar for multiple wire applications.

4. Ease of jumpering terminal blocks of the same or different sizes with one piece, push-in insulated jumpers.

5. Plug in voltage meter test sockets.

6. Availability of test and disconnect blocks.

7. Current meter test sockets.

8. Fuse and fusing capability.

9. Self-grounding terminal blocks that connect directly to the mounting rail.

10. Terminal block marking options.

Recommended Design Criteria for Molded Terminal Blocks
Revised 2006 (3 Pages)

A. Purpose

This Manual Part recommends design criteria for molded two-post and multiple unit terminal blocks. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. Other Considerations

The following should be considered:

1. Type of terminal block.

C. Design

1. The outlines of the terminal block base as shown on Manual Part 14.1.6 (Recommended Design Criteria for Multiple Unit Binding Post Type Terminal Block) and Manual Part 14.1.8 (Recommended Design Criteria for Molded Terminal Binding Post Type Block, Details & Assemblies) are for essential dimensions only, other dimensions and shape of base may be varied.

2. Multiple post terminal blocks of more than two posts should be so designed that they can be easily separated by cutting into sections of two or more terminals.

D. Binding Posts

1. Binding posts shall conform to Manual Part 14.1.12 (Recommended Design Criteria for Standard Binding Posts).

2. Binding posts shall conform to Manual 14.1.10 (Recommended Design Criteria for Binding Posts).

3. Binding posts shall conform to Manual Part 1.4.1, Section C.

E. Composition Material

Terminal block base should be of high quality molded phenolic or other suitable material which, after molding with binding post inserts, shall meet the physical requirements of Section F.

F. Physical Requirements

1. Impact

   a. Test should be made on single binding post section cut from the assembly. All nuts and washers should be removed and the section clamped securely between the jaws of an Izod type cantilever impact testing machine conforming to American Society for Testing & Materials (ASTM) Standard D256-05 (Test Method for Determining the Izod Pendulum Impact Resistance of Plastics) *so* the impact will be applied to the binding post perpendicular to the original longitudinal axis of the block. The vise jaws shall cover the entire height of the parallel sides of the molded base.

   b. The test piece shall withstand a force of 8.5 ft.-lb. applied to the binding post at a point 1 in. above the top to the molded base, without the molded insulation being damaged.

2. Torsion

   a. A terminal block base, complete with binding posts, prior to the assembly of nuts and washers, shall have one of the binding posts securely clamped in a vise with 5/16 in. of thread exposed between the vise and the adjacent face of the molded base.

   b. When a torsional force is applied to the molded base through an angle of 40°, the molded case shall hold the binding post securely against turning without damage to the molded base and the binding post shall not fracture or crack.

3. Water Absorption

   a. The molded terminal block base or any section thereof when tested for water absorption per ASTM Standard D570-98 (Standard Test Method for Water Absorption of Plastics) shall not show a water absorption gain of more than 0.75% by weight after 24 hr. immersion.

4. Resistance to Heat

   a. The completely assembled terminal block shall not be injuriously affected by atmospheric conditions or by changes in temperature between -40°F (-40°C) and +185°F (+85°C).

b. Material shall not melt, warp, or soften and shall be combustion resistant upon application of a temperature up to +185°F (+85°C). Material shall be self-extinguishing upon removal of the direct flame.

G. Dielectric Requirements

1. Shall conform to Manual Part 1.4.1, Sections E.1 and E.3.

2. Shall conform to Manual Part 11.5.1 (Recommended Environmental Requirements for Electrical and Electronic Railroad Signal System Equipment), Class A Roadbed.

Recommended Design Criteria for Multiple Unit Binding Post Type Terminal Block
Reaffirmed 2006 (2 Pages)

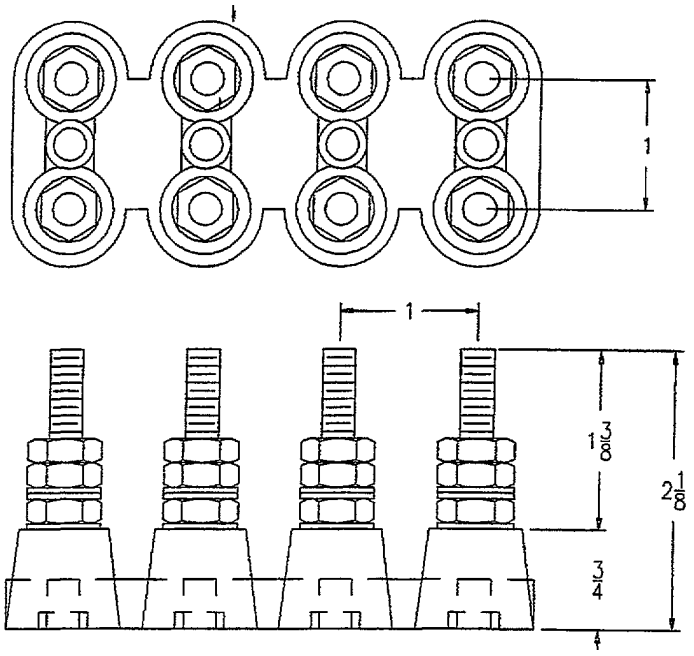


Figure 1416-1: Double Row Terminal Block Assembly

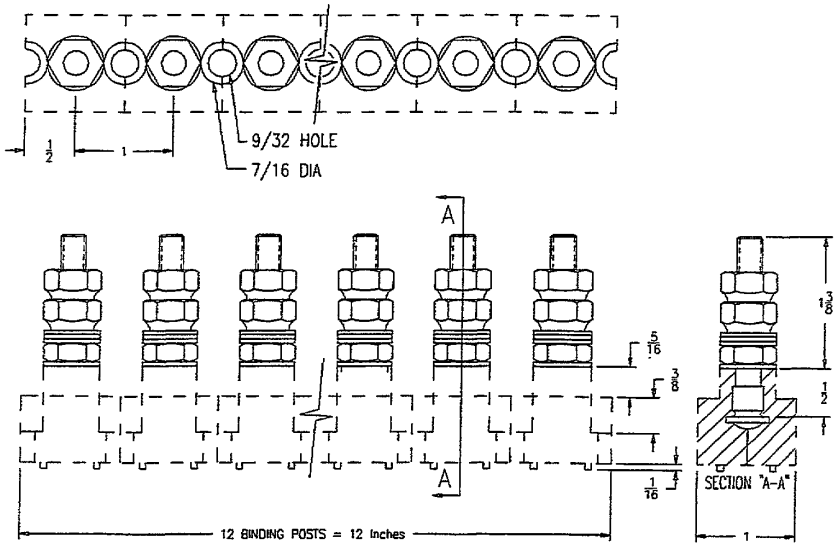


Figure 1416-2: Single Row Terminal Block Assembly

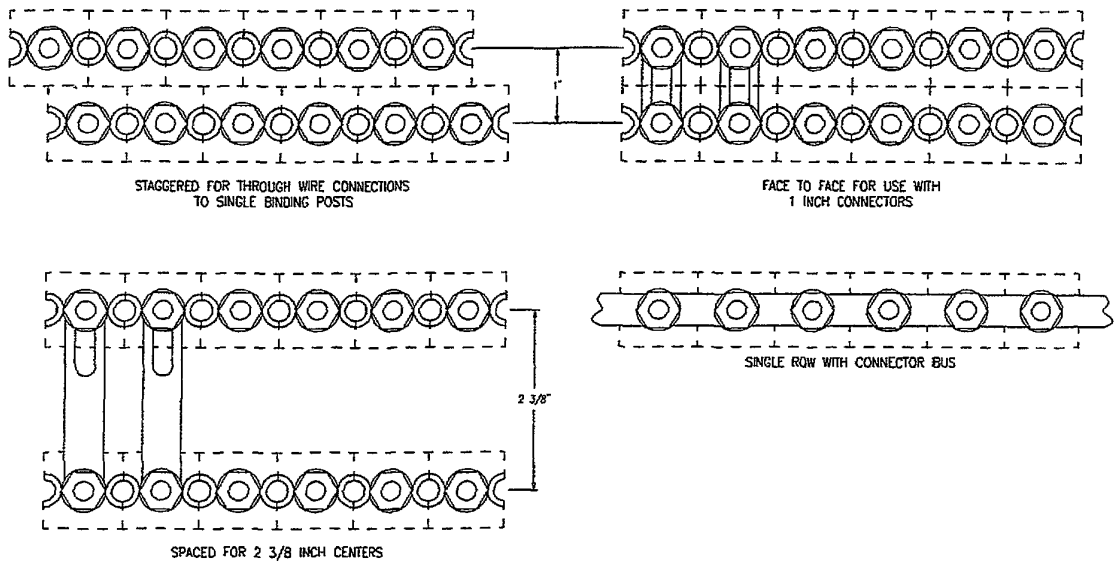


Figure 1416-3: Typical Configurations for Single Row Terminal Block Assemblies

Notes:

1. Material shall conform to Manual Part 14.1.5 (Recommended Design Criteria for Molded Terminal Blocks).

2. The washer and clamp nut in Manual Part 14.1.11 should be furnished assembled. Other washers, nuts and connector should be furnished unassembled unless otherwise indicated.

3. All dimensions are given in inches.

4. Hardware and binding post shall conform to the specific hardware Manual Parts listed below:

Hardware	Manual Parts
Washer	14.1.11-8
Clamp Nut	14.1.11-7
Binding Nut	14.1.11-6
Terminal Post	14.1.12-1 or 14.1.12-2
Connector (Straps)	14.1.15

Recommended Design Criteria for Molded Binding Post Type Terminal Block, Details & Assemblies

Reaffirmed 2007 (3 Pages)

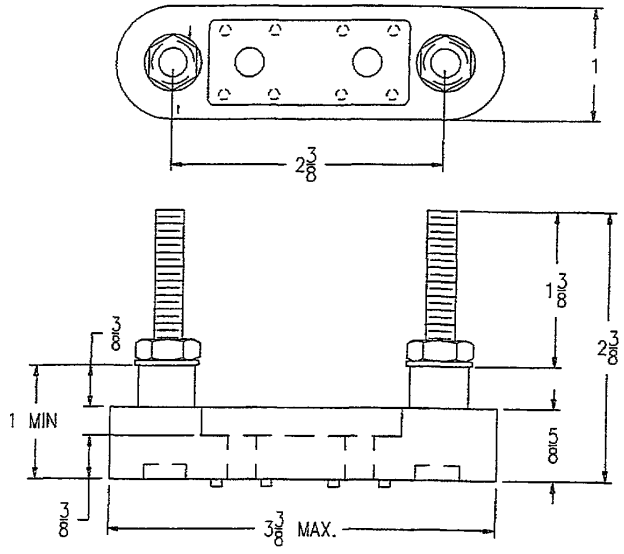


Figure 1418-1

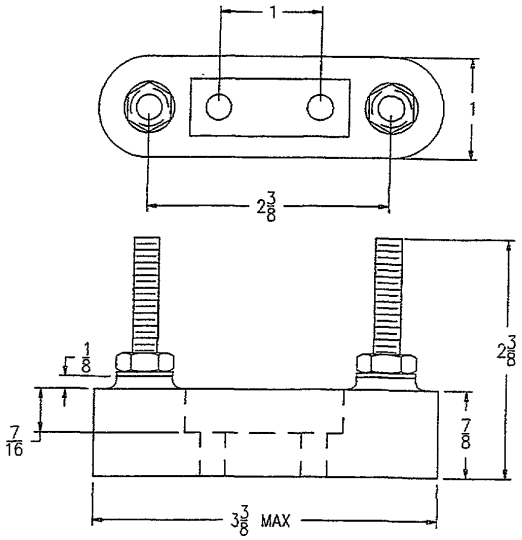


Figure 1418-2

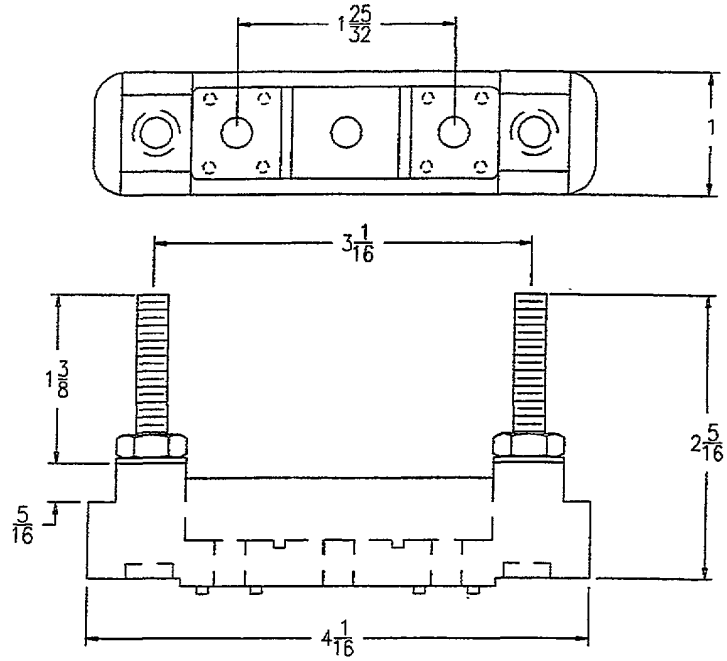


Figure 1418-3

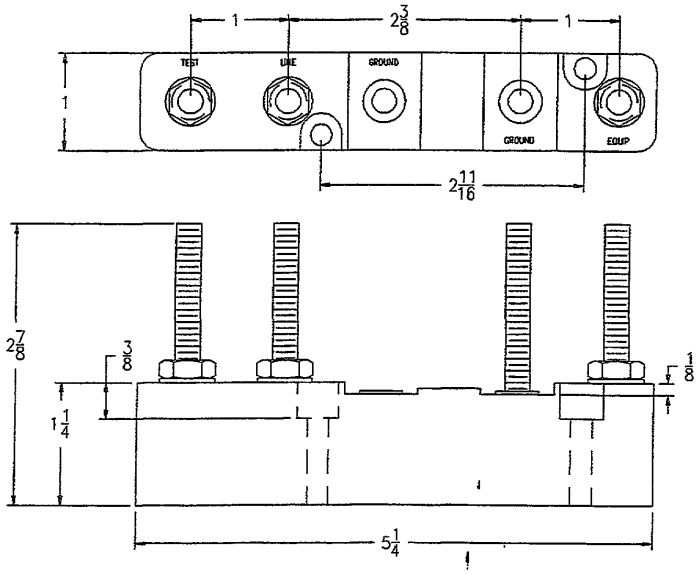


Figure 1418-4 (Equipment Post and Line Post internally connected together)

Notes:

1. Terminal block shall conform to Manual Part 14.1.5 (Recommended Design Criteria for Molded Terminal Blocks).

2. Mounting holes should be countersunk as indicated.

3. All dimensions given are in inches.

4. The washer and clamp nut in Manual Part 14.1.11 should be furnished assembled. Other washers, nuts and connector should be furnished unassembled unless otherwise indicated.

5. Hardware and binding post shall conform to the specific hardware Manual Parts listed below:

Hardware	Manual Parts
Washer	14.1.11-8
Clamp Nut	14.1.11-7
Binding Nut	14.1.11-6
Terminal Post	14.1.12-1 or 14.1.12-2
Connector (Straps)	14.1.15

Recommended Practice for Arrester Terminal Block Assemblies with Ground Straps

Reaffirmed 2006 (1 Page)

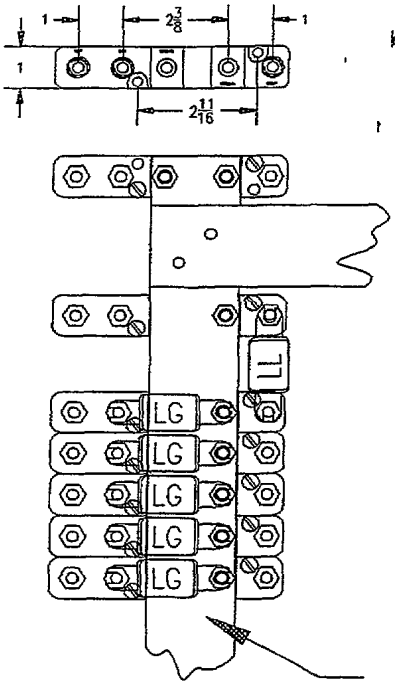


Figure 1419-1
Four Terminal Post Assembly
(MP14.1.8)
Arresters Shown for Reference

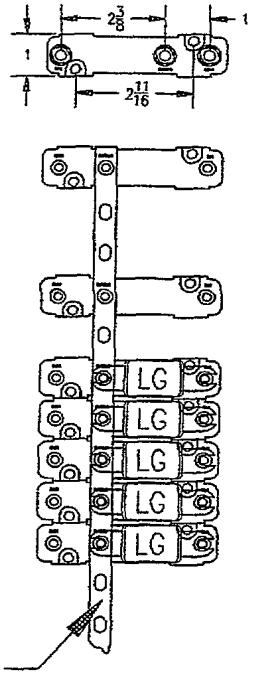


Figure 1419-2
Three Terminal Post Assembly
(MP14.1.7)
Arresters Shown for Reference

Notes:

1. The washer and clamp nut in Manual Part 14.1.11 should be furnished assembled. Other washers, nuts and connector should be furnished un-assembled unless otherwise indicated.

2. All dimensions are given in inches.

3. Hardware and binding post shall conform to the specific hardware Manual Parts listed below:

Hardware	Manual Parts
Washer	14.1.11-8
Clamp Nut	14.1.11-7
Binding Nut	14.1.11-6
Terminal Post	14.1.12-1 or 14.1.12-2

Recommended Design Criteria for Binding Posts
Revised 2006 (4 Pages)

A. Purpose

This Manual Part recommends design criteria for binding posts of a corrosion-resistant type having tensile and torsional strength, ductility and conductivity suitable for use in signal apparatus. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. Design

1. Binding posts should be of design befitting their usage: Manual Part 14.1.12 (Recommended Design Criteria for Standard Binding Posts) for molding into phenolic or other approved insulating material; Manual Part 14.1.11 (Recommended Design Criteria for Binding Posts Nuts and Washers, Details & Assemblies) design for mounting on properly designed insulating plates or blocks of phenolic, or other equivalent insulating material.

2. Binding posts should be of one of the following classes of material:

   Class A - Nickel-copper alloy.

   Class B - Copper-silicon alloy.

   Class C - Hardware bronze.

   Class D - Free cutting brass.

   Class E - Austenitic stainless steel.

3. Binding posts should be manufactured by either the cold upset-rolled thread or machine-cut method.

   a. Cold upset-rolled thread binding posts shall be of material per the following specifications:

Table 14110-1

Class	*Metals & Alloys*
A1	ASTM Standard B164-03(Standard Specification for Nickel-Copper Alloy Rod, Bar and Wire), Alloy UNS NO-4400, Cold Worked
B1	ASTM Standard B98/B98M-03(Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes)Alloy UNS C-65100 HO6

b. Machine-cut binding posts shall be of material per the following specifications:

Table 14110-1 (Continued)

Class	*Metals & Alloys*
A2	ASTM Standard B164-03(Standard Specification for Nickel-Copper Alloy Rod, Bar and Wire), Alloy UNS NO-4405, Cold Worked
B2	ASTM Standard B98/B98M-03(Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes)Temper UNS C-65500 HO4
C2	ASTM Standard B140/B140M-01 (Standard Specification for Copper-Zinc-Lead (Red Brass or Hardware Bronze) Rod, Bar, and Shapes) UNS c-31400, HO2 Temper
D2	ASTM Standard B16/B16M-00 (Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines) Alloy UNS C-3600, HO4 Temper
E2	ASTM Standard A276-04 (Standard Specification for Stainless Steel Bars and Shapes) Alloy UNS S-30400, Condition A, Cold finished

4. Binding Posts Class B1, B2, C2 and D2 shall be finished to conform to Manual Part 15.3.1, (Recommended Developmental Criteria for Metallic Coatings of Metals), Section B.

5. Binding posts Class Al, A2, and E2 are not required to be finished with a metallic coating.

C. Physical Requirements

1. Tensile strength:

   a. A specimen binding post, when tested in tension, shall not break at load less than the values specified in Table 14110-2. Values are based on tensile strengths in referenced ATSM standard and Tensile Stress Areas as given in ANSI/ASME Standard B1.1.

   b. The tensile test shall be made by mounting the binding post in the fixtures of a tensile testing machine with at least three full threads secured in a nut having tight fitting threads and supported under the head by a neat fitting attachment. A steadily increasing load shall

be applied between the nut and the underside of the head until fracture of the specimen occurs. The free-running crosshead speed of the testing machine shall not exceed 1/8 in. per minute.

Table 14110-2

Cold Upset- Rolled Thread Binding Posts Ultimate Load in Lb.				
Class	Size 10 – 32	Size 14 - 24	Size 5/16 in – 18	ULT, KSI
A1	917	1282	2384	80
B1	1037	1443	2682	90
Machine-Cut Binding Posts Ultimate Load in Lb				
A2	815	1140	2119	80
B2	958	1339	2490	94
C2	530	741	1378	52
D2	815	1140	2119	80
E2	1528	2137	3974	150

NOTE: The ultimate load is calculated by multiplying the area (square inches) at the minor diameter of the thread times the allowable ultimate stress (KSI x 1000) for the material, and dividing the result by the thread stress concentration factor, 1.6 for rolled threads, 1.8 for cut threads

2. Ductility

When a specimen binding post conforming to Manual Part 14.1.11 is placed in a neat fitting hole drilled in a steel block at an angle of 30 deg. to the face of the block, and the head subjected to pounding with a hammer until the underside of the head conforms to the face of the block, the head shall not break off or show cracking.

3. Torsional Properties

When a specimen binding post is securely clamped in a vise with the head and 5/16 in. length of threaded portion extending beyond the jaws of the vise, and the head then turned axially through an angle prescribed in Table 14110-3, the head shall not break off and the post should not fracture or crack.

Table 14110-3

Class	Material	Angle (Degree)
A1	Cold upset head rolled thread, nickel-copper alloy	100
B2	Copper-silicon alloy, cold upset head rolled thread	40
A2	Machine-Cut, nickel-copper alloy	100
B2	Machine-Cut, copper-silicon alloy	40
C2	Machine-Cut, hardware bronze	100
D2	Machine-Cut, free machining brass alloy	100
E2	Machine Cut, stainless steel alloy 100	100

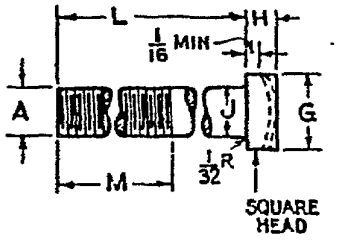
4. Stress Corrosion Test

   a. A specimen binding post, after having all plated coatings removed shall withstand an immersion for 15 min. in an aqueous solution of mercurous nitrate without cracking.

   b. Preparation of the solution and procedure to be followed in making this test shall conform to ASTM Standard B154-01 (Standard Test Method for Mercurous Nitrate Test for Copper and Copper Alloys).

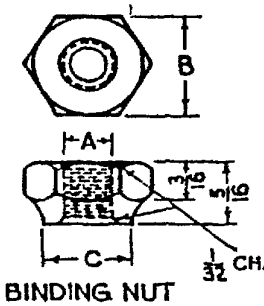
Recommended Design Criteria for Binding Posts, Nuts & Washers, Details & Assemblies

Revised 2006 (2 Pages)

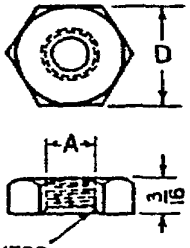


BINDING POST

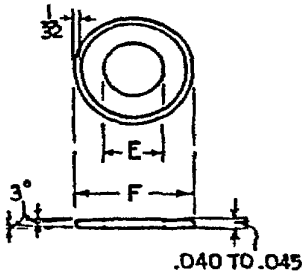
DOTTED LINES AND 1/16 DIMENSION ARE FOR COLD UPSET HEAD SEE NOTE 1



BINDING NUT
BRASS

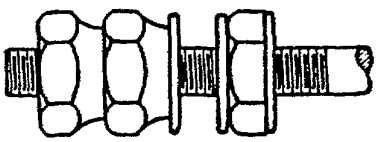


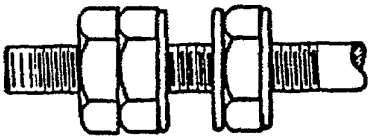
CLAMP NUT
BRASS



WASHER
COPPER

A	Binding Nut	B	C	Clamp Nut	D	Washer	E	F	Binding Post (Note 1)	J		G	H
										Max	Min		
10-32 UNF-2				14.1.11-2	7/16	14.1.11-3	13/64	1/2	14.1.11-4	.190	.164	3/8	1/8
14-24 UNS-2	14.1.11-6	1/2	7/16	14.1.11-7	1/2	14.1.11-8	17/64	9/16	14.1.11-9	.242	.210	3/8	5/32
5/16-18 UNC-2	14.1.11-11	1/2	15/32	14.1.11-12	1/2	14.1.11-13	21/64	5/8	14.1.11-14	.3125	.270	1/2	3/16





ASSEMBLIES

14.1.11-10 for 14-24

2 Binding Nuts	14.1.11-6
1 Clamp Nut	14.1.11-7
3 Washers	14.1.11-8
1 Binding Post	14.1.11-9

14.1.11-15 for 5/16-18

2 Binding Nuts	14.1.11-11
1 Clamp Nut	14.1.11-12
3 Washers	14.1.11-13
1 Binding Post	14.1.11-14

14.1.11-20 for 14-24

3 Clamp Nuts	14.1.11-73
3 Washers	14.1.11-83
1 Binding Post	14.1.11-91

14.1.11-16 for 5/16-18

3 Clamp Nuts	14.1.11-12
3 Washers	14.1.11-13
1 Binding Post	14.1.11-14

14.1.11-5 for 10-32

Clamp Nuts	14.1.11-2
Washers	14.1.11-3
Binding Post	14.1.11-4

Notes:

1. Order shall indicate length L, type and class of metal alloy, length M shall be manufacturer's standard unless otherwise indicated.

2. Washers should be tumbled bright and smooth.

3. 14-24 Binding post shall be used unless specified otherwise, alternate head designs 14.1.12-2 or 14.1.12-3 may be used where binding post is to be molded into phenolic or other equivalent insulating material. Details of head may be varied to suit manufacturing requirements.

4. All dimensions are given in inches.

5. Type, finish and class of metal alloy material for binding posts shall conform to Manual Part 14.1.10 (Recommended Design Criteria for Binding Posts). Brass nuts and copper washers shall conform to Manual Part 15.1.5 (Recommended Developmental Criteria for Various Types of Non-Ferrous Metals and Alloys). Threads shall conform to Manual Part 14.6.20 (Recommended Design Criteria for Bolts, Nuts and Threads).

6. Finish: Binding post, nuts and washers shall be nickel plated per ASTM Standard B456-03 (Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium) service condition SC1. Parts made from nickel-copper alloy do not need to be plated.

Recommended Design Criteria for Standard Binding Posts

Reaffirmed 2006 (2 Pages)

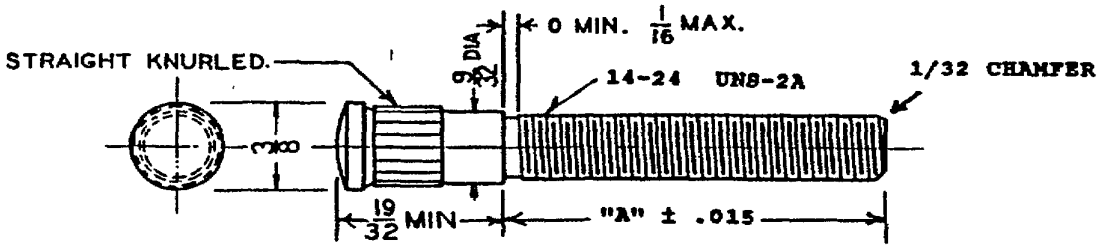


FIGURE 14.1.12-1

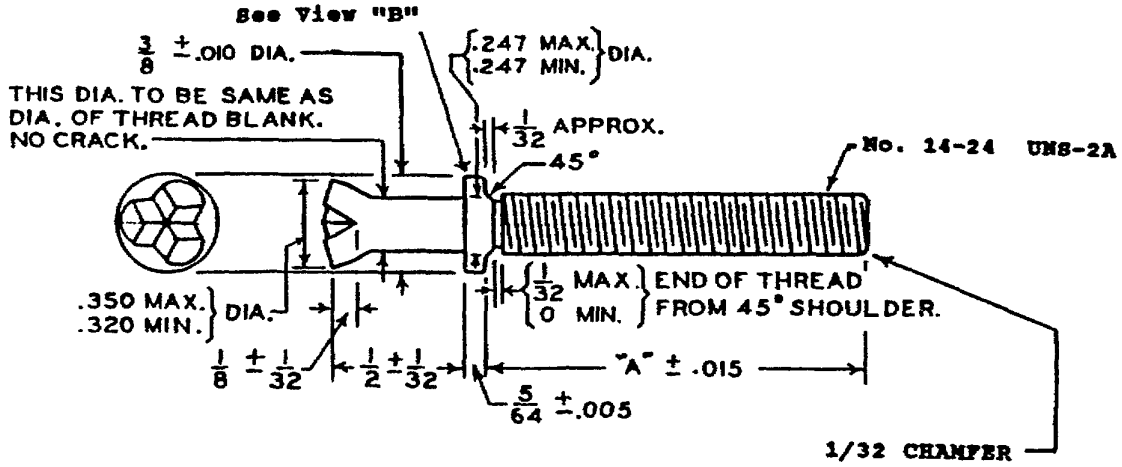
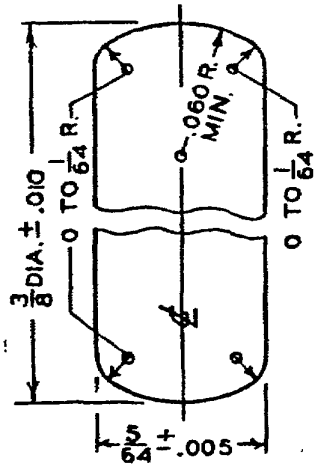


FIGURE 14.2.12-2



ENLARGE VIEW 'B'

Notes:

1. Finished post to be capable of withstanding a minimum breaking load per Manual Part 14.1.10 (Recommended Design Criteria for Binding Posts).

2. Dimension "A", 1-3/8 unless otherwise specified.

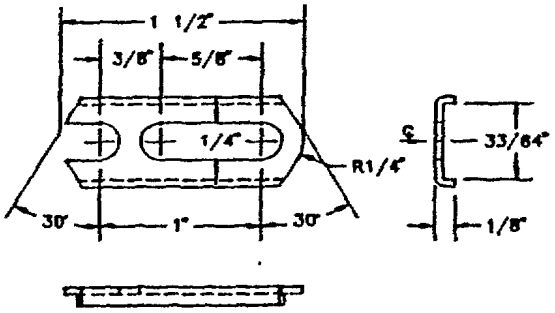
3. All dimensions are given in inches.

4. Binding posts shall conform to Manual Part 14.1.10.

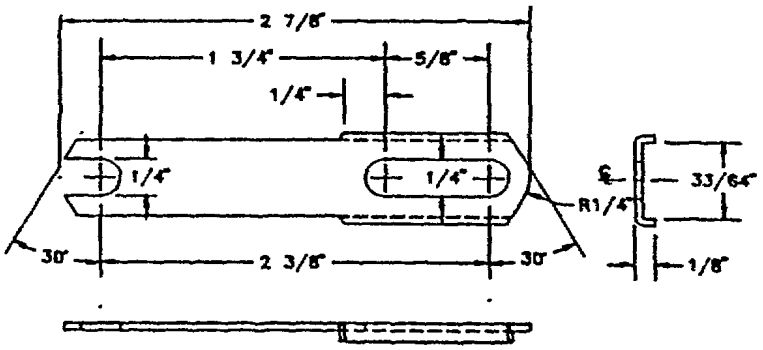
5. Threads shall be 14-24 UNS-2A conforming to Manual Part 14.6.20 (Recommended Design Criteria for Bolts, Nuts and Threads).

6. Details of head may be varied to suit manufacturing requirements.

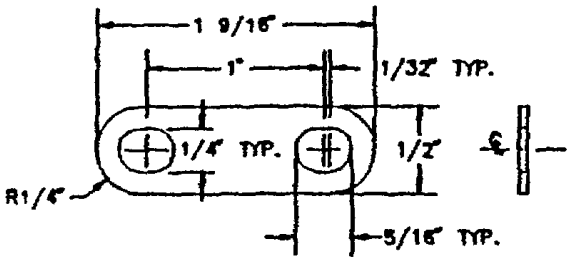
Recommended Design Criteria for Terminal Connectors, Details
Reaffirmed 2006 (4 Pages)



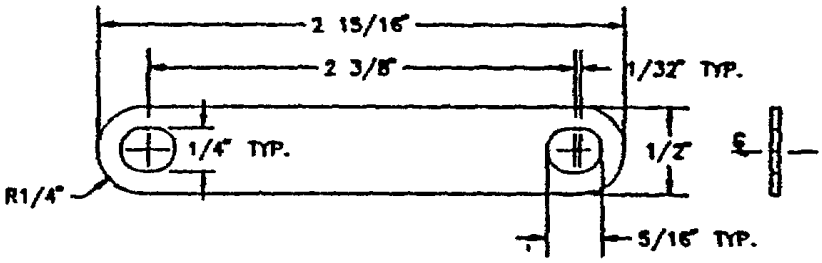
14.1.15-1 CONNECTOR
COPPER UNSC11000, H02 TEMPER
18 GA (0.0403)



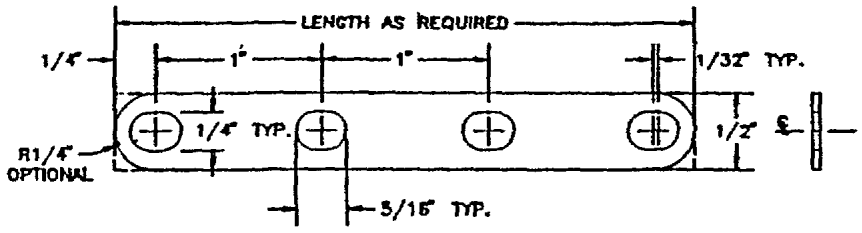
14.1.15-2 CONNECTOR
COPPER UNSC11000, H02 TEMPER
18 GA (0.0403)



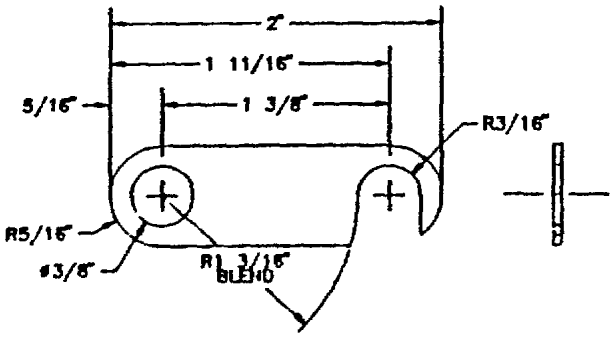
14.1.15-3 CONNECTOR
COPPER UNSC11000, H02 TEMPER
18 GA (0.0403)



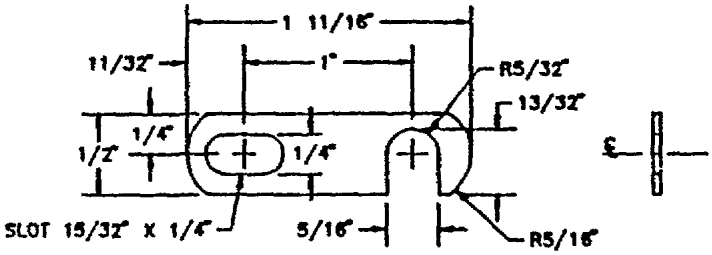
14.1.15-4 CONNECTOR
COPPER UNSC11000, H02 TEMPER
18 GA (0.0403)



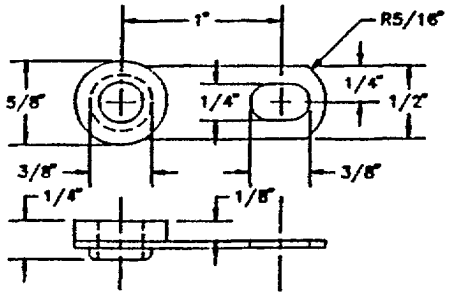
14.1.15-5 CONNECTOR BUS, BLANK
14.1.15-6 CONNECTOR BUS, HOLES AS SHOWN
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)



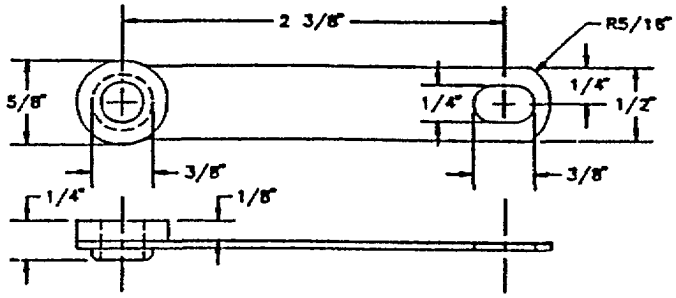
14.1.15-7 SWITCH BOX
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)



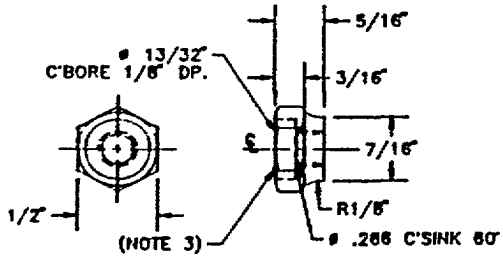
14.1.15-8 CONNECTOR
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)



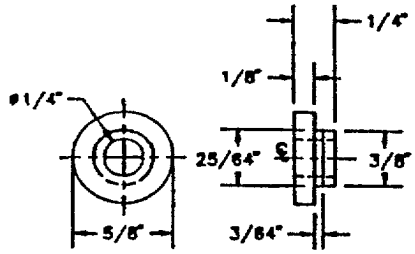
14.1.15–9 INSULATED TEST LINK ASS'Y
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)
SEE FIG. 14.1.15–12, 13 FOR DETAILS



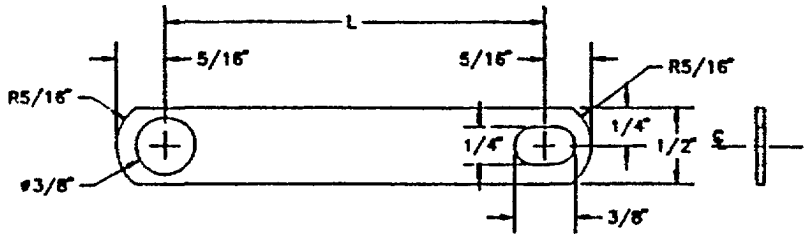
14.1.15–10 INSULATED TEST LINK ASS'Y
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)
SEE FIG. 14.1.15–12, 14 FOR DETAILS



14.1.15–11 GOLDNUT
BRASS ROD UNSC36000, H02 TEMPER
GOLD PLATE – 1–3 MICRO INCHES
USED WITH 14.1.15–9, 10



14.1.15–12 INSULATED WASHER
FRP NEMA PUB. NO. LI1–1989
PLATING NOT REQUIRED



14.1.15–13 CU BAR (L=1")
14.1.15–14 CU BAR (L=2 3/8")
COPPER UNSC11000, H02 TEMPER
16 GA (0.0403)

Notes:

1. Connector and connector buses shall conform to Manual Part 15.1.5 (Recommended Developmental Criteria for Various Types of Non-Ferrous Metals and Alloys) and nickel plated to conform to Manual Part 15.3.1 (Recommended Developmental Criteria for Metallic Coating of Metals), except as noted.

2. All dimensions are given in inches.

3. This side to be free of burrs.

Recommended Design Criteria and Functional/Operating Guidelines for Incandescent Electric Lamps

Revised 2005 (9 Pages)

A. Purpose

This Manual Part recommends design criteria and functional/operating guidelines for incandescent electric lamps generally required for wayside signals and highway-rail grade crossing warning devices used in railroad signal service. See Manual Part 1.4.1 (Identical Items "Boilerplate" for all Manual Parts), Section A.

B. General

1. Large lamps, designated as lamps, are regularly fitted with other than miniature bases. These lamps are used in railroad signal applications and shall be referred to as lamps hereafter in this Manual Part.

2. Lamps should conform to Appendix A.

3. Electrical units referred to in this Manual Part are the current International Units.

4. Units of luminous intensity shall be the International Candle as maintained by the National Institute of Standards & Technology, Gaithersburg, MD 20899.

5. The basis of photometric measure for all lamps may be either the total flux expressed in lumens, or the equivalent mean spherical candlepower, which is the average candlepower of the lamp in all directions in space and equals the total luminous flux of the lamp divided by 12.57.

6. The rating of lamps is expressed by volts together with either amperes, watts, candlepower or lumens.

7. The life of the lamp is the rated average laboratory life in hours. In two filament lamps the burnout of either filament is considered as the end of life. The average life or equivalent truncated average life is obtained by the summation of the lives of individual lamps divided by the number of lamps. Those lamps still operating at the termination of the test are treated as having lives of 125% of rated life.

C. Bulb and Stem

Bulb shall be uniform in size and shape, clear, clean and free from flaws and blemishes detrimental to service.