

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series 5, 8, 15, 25/28 and 35 kV

Data Sheet

June 2012

Description	<p>3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series, contain one-piece, skirted, silicone rubber terminations, qualified as IEEE Standard 48 Class 1 for outdoor weather-exposed applications. The termination assemblies consist of a skirted insulator, high-dielectric constant (Hi-K) stress control tube, conformable Hi-K stress controlling compound and built-in environmental top sealing compound. The insulator is made of a dark gray silicone rubber with excellent tracking resistance and hydrophobic properties.</p> <p>The complete assembly is pre-stretched and loaded onto a removable core. The disposable core can be recycled. The kits are designed for terminating solid dielectric jacketed concentric neutral (JCN) and concentric neutral (CN) power cables rated 5 through 35 kV.</p>
Kit Contents	<p>Each kit contains sufficient quantities of the following materials to make one single-phase termination (compression lug is not included in kit).</p> <ul style="list-style-type: none">• 1 Hi-K, Tracking Resistant, Silicone Rubber Termination• 2 Strips Scotch® Mastic Sealing Strip 2230• 1 Instruction Sheet
Features	<ul style="list-style-type: none">• Conforms to IEEE Standard 48 Class 1 requirements for 5, 8, 15, 25/28 and 35 kV terminations• One-piece versatile design, allowing quick installation and accommodating a wide range of cable sizes• Cold Shrink delivery system allows easy installation: Simply place termination over prepared cable and unwind core to shrink into place (no force fit required)• Hi-K stress control: Specially formulated high-dielectric constant material minimizes surface stress by more uniformly distributing the electrical field over the entire surface of the insulator• Compact design provides for easier installation in restricted spaces• Silicone rubber insulators, EPDM stress control tubes, stress controlling compound and environmental sealing compound are compatible with common solid dielectric insulations, such as polyethylene (PE), cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR).

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Stress Control

The 3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series, controls the electric field stress distribution with special Hi-K materials, which are an integral part of the termination. The Hi-K materials, with a dielectric constant (K) of greater than 15, capacitively distribute the field that surrounds the termination.

The stress concentrations in a continuous length of shielded cable are typically 50 V/mil adjacent to the shield to about 70 V/mil at the conductor. The QT-III termination reduces the cable stresses at the termination to less than those in the continuous shielded portion of the cable.

Electrical flux is refracted to distribute the voltage stress in a controlled manner along the entire termination length extending beyond the cable shield cutoff. By controlling the electric field, the stress concentrations on the termination insulator surface are kept below 15 V/mil at rated voltage. This stress distribution permits high-power frequency performance and impulse performance with a compact termination design.

Figure 1 illustrates an actual computerized stress plot of the QT-III termination.

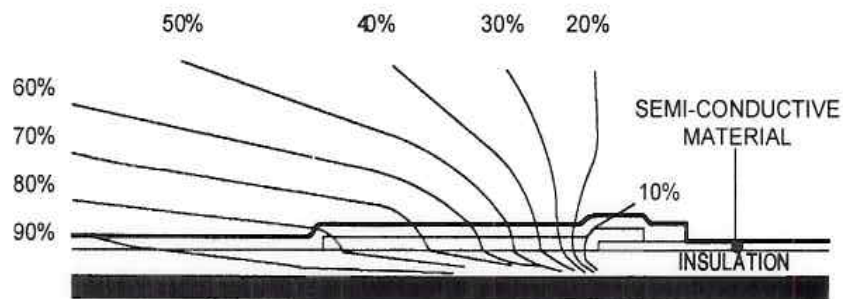


Figure 1

Applications

The 3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series are designed for:

- 5, 8, 15, 25/28 and 35 kV voltage classes
- Jacketed concentric neutral (JCN) and concentric neutral (CN) cables
- Solid dielectric insulations, such as polyethylene, XLPE and EPR
- Protected and weather-exposed contaminated locations
- Free-hanging or bracket-mounting arrangements
- These terminations can be field tested using normal cable testing procedures (Reference; ANSI/IEEE Standard 400 "Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems." Refer to most recent version.)

The amount of airborne contamination determines the operating environment. Operating environments are described as areas having varying degrees of airborne contaminant or pollution severity that may or may not affect the long-term performance of terminations. These operating environments are defined as light, medium, heavy and extremely heavy variations of pollution severity. The appropriate termination selection depends on the system voltage and operating environment. (See tables next page)

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Applications,
continued

Recommended Application Guide

Termination Kit	System Voltage	Operating Environment			
		Light	Medium	Heavy	Extremely Heavy
(2 Skirt) 7642-S-2	15 kV	√	√	√	
(4 Skirt) 7652-S-4 – 7656-S-4	15 kV	√	√	√	√
(8 Skirt) 7663-S-8 – 7666-S-8	15 kV	√	√	√	√
(4 Skirt) 7652-S-4 – 7656-S-4	25/28 kV	√	√	√	
(8 Skirt) 7663-S-8 – 7666-S-8	25/28 kV	√	√	√	√
(8 Skirt) 7663-S-8 – 7666-S-8	35 kV	√	√	√	*

Recommended operation environments are marked with a check (√).

*Consult 3M sales representative.

Pollution Severity Level Guide

Light	Heavy
<ul style="list-style-type: none"> • Areas without industry and with low-density housing • Areas subjected to frequent winds and/or rainfall with low-density industry and housing • Agricultural areas◇ • Mountainous areas <p>All of these regions should be situated at least 7 miles from the coast and should not be exposed to coastal winds.*</p>	<ul style="list-style-type: none"> • High-density industrial areas and some urban areas with high-density housing, especially those with infrequent rainfall • Areas subjected to moderate concentration of conductive dust, particularly industrial smoke-producing deposits • Areas generally close to the coast and exposed to coastal spray or to strong winds carrying sand and salt, and subjected to regular condensation
Medium	Extremely Heavy
<ul style="list-style-type: none"> • Non-polluting industrial areas subject to infrequent rainfall and with average-density housing • Areas subjected to frequent winds and/or rainfall with high-density industry and housing • Areas exposed to wind from the coast, but generally over two miles from the coast 	<ul style="list-style-type: none"> • Usually very limited areas having extremely heavy pollutants from industrial sites, especially those located near oceans and subjected to prevailing winds from the sea • Very small isolated areas where terminations are located immediately adjacent to a pollutant source, especially downwind (cement plants, paper mills, etc.)

◇Use of fertilizers by spraying, or the burning of crop residues, can lead to a higher pollution level due to dispersal by wind.

*Distances from coast depend on the topography of the coastal area and on the extreme wind conditions.

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series 5, 8, 15, 25/28 and 35 kV

Typical Properties

Not for specifications. Values are typical, not to be considered minimum or maximum. Properties measured at room temperature 73°F (23°C) unless otherwise stated.

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series terminations, can be used on cables with a rated maximum operating temperature of 221°F (105°C) and emergency overload rating of 284°F (140°C).

Terminations constructed from these kits meet the requirements of IEEE 48, “IEEE Standard Test Procedures and Requirements for High Voltage Alternating-Current Cable Terminations” and are designated Class 1 for outdoor weather-exposed locations. The current rating of these terminations meets or exceeds the current rating of the cables on which they are installed.

Termination Selection Table

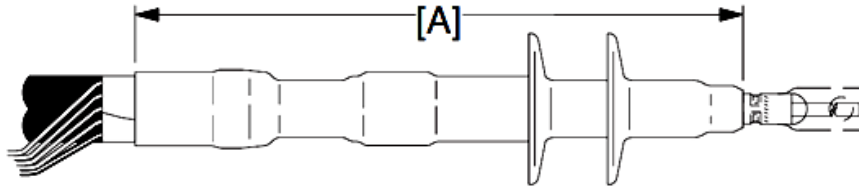
Kit Number	Cable Insulation O.D. Range in. (mm)	Conductor Range (AWG and kcmil)				
		5 kV 100% and 133%	8 kV 100% and 133%	15 kV 100% and 133%	25/28 kV 100% and 133%	35 kV 100% and 133%
7642-S-2	0.64 - 1.08 (16,3 - 27,4 mm)	4/0 – 400	3/0 – 300	2 - 4/0 (35 - 120 mm ²)	–	–
7652-S-4	0.64 - 1.08 (16,3 - 27,4 mm)	4/0 – 400	3/0 – 300	2 - 4/0 (35 - 120 mm ²)	2 - 1/0 (35 - 50 mm ²)	–
7653-S-4	0.72 – 1.29 (18,3 – 32,8 mm)	300 – 500	250 – 500	2/0 – 300 (70 -150 mm ²)	2 – 4/0 (35 – 120 mm ²)	–
7654-S-4	0.83 – 1.53 (21,1 – 38,9 mm)	500 – 750	350 – 700	4/0 – 500 (120 – 240 mm ²)	2/0 – 250 (70 – 125 mm ²)	–
7655-S-4	1.05 – 1.80 (26,7 – 45,7 mm)	700 – 1500	600 – 1250	500 – 1000 (240 – 500 mm ²)	250 – 800 (150 – 400 mm ²)	–
7656-S-4	1.53 – 2.32 (38,9 – 58,9 mm)	1750 – 2000	1500 – 2000	1250 – 2000 (625 – 1000 mm ²)	900 – 1750 (500 – 800 mm ²)	–
7663-S-8	0.72 – 1.29 (18,3 – 32,8 mm)	300 – 500	250 – 500	2/0 – 300 (70 – 150 mm ²)	2 – 4/0 (35 – 120 mm ²)	2 – 2/0 (35 – 70 mm ²)
7664-S-8	0.83 – 1.53 (21,1 – 38,9 mm)	500 – 750	350 – 700	4/0 – 500 (120 – 240 mm ²)	2/0 – 250 (70 – 125 mm ²)	2 – 4/0 (35 - 120 mm ²)
7665-S-8	1.05 – 1.80 (26,7 – 45,7 mm)	700 – 1500	600 – 1250	500 – 1000 (240 – 500 mm ²)	250 – 800 (150 - 400 mm ²)	3/0 – 600 (95 – 325 mm ²)
7666-S-8	1.53 – 2.32 (38,9 – 58,9 mm)	1750 – 2000	1500 – 2000	1250 – 2000 (625 – 1000 mm ²)	900 – 1750 (500 – 800 mm ²)	700 – 1500 (350 – 725 mm ²)

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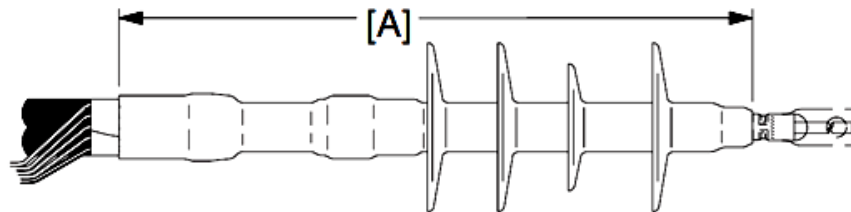
Typical Properties, *continued*

Not for specifications. Values are typical, not to be considered minimum or maximum. Properties measured at room temperature 73°F (23°C) unless otherwise stated.

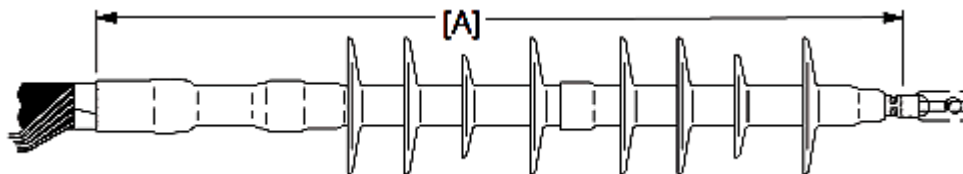
Typical Dimensions



Kit Number	Dimension [A] Max.	Wet Creepage Distance Max.	Arcing distance Max.
7642-S-2	9.8" (249 mm)	13.3" (338 mm)	9.8" (249 mm)



Kit Number	Dimension [A] Max.	Wet Creepage Distance Max.	Arcing distance Max.
7652-S-4	12.25" (311 mm)	18.50" (470 mm)	12.25" (311 mm)
7653-S-4	12.25" (311 mm)	18.50" (470 mm)	12.25" (311 mm)
7654-S-4	12.25" (311 mm)	18.50" (470 mm)	12.25" (311 mm)
7655-S-4	12.25" (311 mm)	18.50" (470 mm)	12.25" (311 mm)
7656-S-4	13.25" (337 mm)	19.50" (495 mm)	13.25" (337 mm)



Kit Number	Dimension [A] Max.	Wet Creepage Distance Max.	Arcing distance Max.
7663-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7664-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7665-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7666-S-8	21.50" (546 mm)	34.00" (864 mm)	21.50" (546 mm)

**3M™ Cold Shrink Silicone Rubber Termination Kits QT-III,
7640-S, 7650-S and 7660-S Series
5, 8, 15, 25/28 and 35 kV**

**Typical Properties,
continued**

Not for specifications. Values are typical, not to be considered minimum or maximum. Properties measured at room temperature 73°F (23°C) unless otherwise stated.

Hi-K Stress Control Tube

Physical Properties (Test Method)	Typical Value English units (metric)
Tensile Strength (ASTM D412)	1500 psi (10,34 N/mm ²)
Modulus Elongation @ 100% @ 300%	160 psi (1,10 N/mm ²) 500 psi (3,45 N/mm ²)

Electrical Properties (Test Method)	Typical Value
Dielectric Constant (K) (ASTM D150) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH	22
Dissipation Factor (ASTM D150) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH	0.10

Hi-K Stress Controlling Compound

Electrical Properties (Test Method)	Typical Value
Dielectric Constant (K) (ASTM D150) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH 100 mil (2,54 mm) thickness	25
Dissipation Factor (ASTM D150) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH 100 mil (2,54 mm) thickness	0.9

Environmental Sealing Compound

Electrical Properties (Test Method)	Typical Value English units (metric)
Dielectric Strength (ASTM D149) 75 mil (1,90 mm) thickness	300 V/mil (11,8 kV/mm)

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**Typical Properties,
continued**

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Silicone Rubber Insulator

Physical Properties (Test Method)	Typical Value English units (metric)
Color	Dark Gray
Tensile Strength (ASTM D412)	850 psi (5,86 N/mm ²)
Modulus Elongation @ 100% @ 300%	130 psi (0,90 N/mm ²) 400 psi (2,76 N/mm ²)
Hydrophobic Recovery (3M Test Method 406) > 90° Contact Angle	5.0 hrs.

Electrical Properties (Test Method)	Typical Value English units (metric)
Dielectric Constant (S.I.C.) (ASTM DI50) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH	3.6
Dissipation Factor (ASTM DI50) 60 Hz @ 1,000 V, 73°F (23°C), 50% RH	0.003
Dielectric Strength (ASTM D149) 75 mil (1,90 mm) thickness	500 V/mil (19,68 kV/mm)
Track Resistance (ASTM 2303) 3.5 kV	5.0 hrs.

**Product
Specifications**

The 3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series, cable terminations must have a voltage class rating equal to or greater than the cable being terminated. The rating shall be 5, 8, 15, 25/28 or 35 kV as an IEEE Standard 48 Class 1 termination. It must have a maximum continuous operating temperature rating of 221°F (105°C), with an emergency overload rating of 284°F (140°C). The termination stress control shall be capacitive and constructed of a Hi-K stress control compound and a Hi-K EPDM rubber tube. The installation shall not require using silicone grease.

The termination shall be of a skirted design, constructed of tracking resistant silicone rubber, dark gray in color. The termination must be of a pre-stretched cold shrink design, installed without the application of a heat source. The termination kit shall include all materials required (except lug and vinyl tape) and shall accommodate jacketed concentric neutral (JCN) and concentric neutral (CN) cables. The Class 1 termination kits shall be used with listed copper or aluminum compression lugs.

**Engineering/
Architectural
Specifications**

Terminating of all 5, 8, 15, 25/28 and 35 kV shielded power cables, indoors and in weather-protected equipment, shall be performed in accordance with instructions included in the 3M™ Termination Kits QT-III 7640-S, 7650-S and 7660-S Series. This shall include all outdoor weather-exposed areas for jacketed concentric neutral (JCN) and concentric neutral (CN) cables. The termination kits shall be used in conjunction with 3M™ Scotchlok™ Copper Compression Lugs, 30000 and 31000 Series, 3M™ Scotchlok™ Copper/Aluminum Compression Lugs, 40000 Series, or 3M™ Stem Connectors SC Series.

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series 5, 8, 15, 25/28 and 35 kV

Performance Tests

Typical Results, IEEE Standard 48 Short-Term Test Sequence

Insulation Class Test	15 kV (2 Skirt)		15 / 25 kV (4 skirt)		35 kV (8 Skirt)	
	Requirements	Results	Requirements	Results	Requirements	Results
Partial Discharge Extinction Voltage @ 3pC	13 kV	25 kV	13 / 21.5 kV	25 / 33 kV	30 kV	45 kV
Power Frequency Voltage 1 min. Dry Withstand	50 kV	85 kV*	50 / 65 kV	95 / 100 kV*	90 kV	125 kV*
Power Frequency Voltage 10 sec. Wet withstand	45 kV	65 kV*	45 / 60 kV	70 / 75 kV*	80 kV	100 kV*
Power Frequency Voltage 6 hour Dry Withstand	34 kV	75 kV*	35 / 60 kV	85 / 90 kV*	76 kV	115 kV*
Direct Voltage 15 min. Dry Withstand	75 kV	Passed	75 / 105 kV	Passed / Passed	140 kV	Passed
Lightning Impulse Voltage Withstand (BIL)	110 kV	135 kV*	110 / 150 kV	165 / 175 kV*	200 kV	240 kV*
Partial Discharge Extinction Voltage @ 3 pC	13 kV	25 kV	13 / 21.5 kV	25 / 33 kV	30 kV	45 kV

*All higher voltages, flashover occurs without breakdown.

Typical Results, IEEE Standard 48 Long-Term Test Sequence

Insulation Class Test	15 kV (2 Skirt)		15 / 25 kV (4 skirt)		35 kV (8 Skirt)	
	Requirements	Results	Requirements	Results	Requirements	Results
Partial Discharge Extinction Voltage @ 3pC	13 kV	25 kV	13 / 21.5 kV	25 / 33 kV	30 kV	45 kV
Cyclic Aging 30 days, 266°F (130 °C) conductor temperature Power frequency Voltage Withstand	26 kV	Passed	26 / 43 kV	Passed / Passed	60 kV	Passed
Partial Discharge Extinction Voltage @ 3 pC	13 kV	25 kV	13 / 21.5 kV	25 / 33 kV	30 kV	45 kV
Lightning Impulse Voltage Withstand (BIL)	110 kV	135 kV*	110 / 150 kV	165 / 175 kV*	200 kV	240 kV*

*All higher voltages, flashover occurs without breakdown.

Partial Discharge Corona Tests

The purpose of corona testing is to determine whether all properly installed terminations operate corona-free at a minimum of 150% of their operating voltage. For this test, the applied test voltage is gradually increased until high frequency discharges appear on the test set's oscilloscope display. The voltage at which these discharges reach a magnitude of 3 pico-coulombs is recorded as the corona starting voltage (CSV). The applied voltage is then lowered until the discharge level drops below 3 pC, and this is recorded as the corona extinction voltage (CEV).

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Performance Tests, *continued*

Power Frequency (AC) Withstand Tests

All 3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series, exceed the IEEE Standard 48 requirements for a Class 1 termination.

Lighting Impulse Tests

For these tests, a normal 1.2 X 50 micro-second voltage wave is applied to the termination's lug. The testing consists of both positive and negative polarity surges per IEEE Standard 48 BIL requirements. The 3M QT-III 7640-S, 7650-S and 7660-S Series terminations exceed these BIL requirements.

Sealing Tests

Termination top and bottom seals are tested by applying 7 psi (0,05 MPa) to the cable conductor strands with the termination submerged in water. Both seals withstand this internal air pressure for 6 hours without leaking.

Environmental Performance

When airborne contaminants are deposited on a termination surface, destructive leakage currents can be initiated when the surface becomes wet. Fog and drizzle are worse than rain. Rain tends to wash the pollutants off the termination, while fog will wet the pollutants, making the surface conductive to varying degrees, promoting leakage current formation. This is most typical of hydrophilic surfaces typified by porcelain. (Figure 2)

The surface of the 3M™ QT-III Silicone Insulator is hydrophobic, which makes it less likely to erode or track because the surface does not wet readily (Figure 3). This either prevents or minimizes leakage current formation. On occasion, severe environmental conditions can be sustained for long time periods and cause any polymeric surface to lose its hydrophobicity. However, the silicone insulator surface will re-establish its hydrophobic surface within 24 hours. This prevents the surface from becoming increasingly hydrophilic with time, which would result in premature failure or flashover. This unique ability of the 3M QT-III silicone is a major factor in providing a long service life.

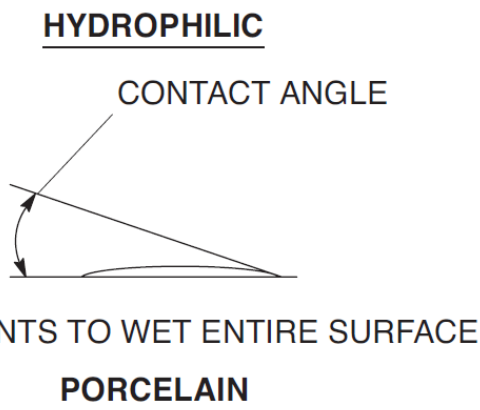


Figure 2

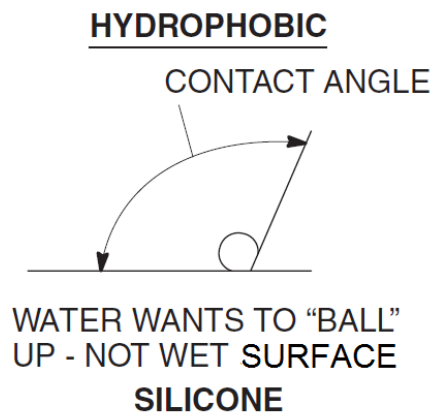


Figure 3

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series 5, 8, 15, 25/28 and 35 kV

Installation Techniques

⚠ Caution

Working around energized electrical systems may cause serious injury or death. Installation should be performed by personnel familiar with good safety practice in handling electrical equipment. De-energize and ground all electrical systems before installing product.

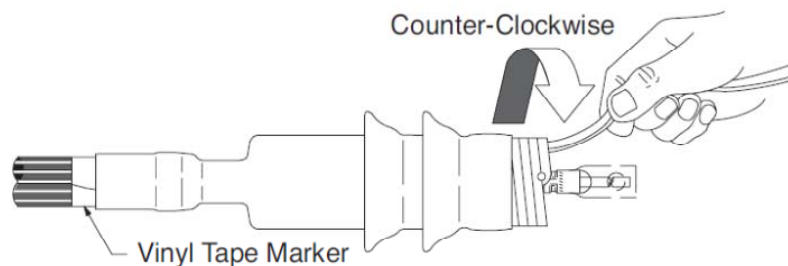
Detailed instructions are included in each kit to provide the installer with all information required to properly install the appropriately sized 3M™ 7640-S, 7650-S and 7660-S Series terminations. A brief summary of the installation steps for jacketed concentric neutral (JCN) cable is outlined as follows:

1. Prepare cable according to standard procedure.
2. Apply bottom mastic seal. (Figure 4)



Figure 4

3. Install lug using a listed crimping tool and die.
4. Install termination onto cable and unwind core, allowing termination to shrink into place. (Figure 5)




NOTE: The material being removed at this step is mixed polymers and can be recycled with  waste.

Figure 5

3M™ Cold Shrink Silicone Rubber Termination Kits QT-III, 7640-S, 7650-S and 7660-S Series 5, 8, 15, 25/28 and 35 kV

Maintenance

It is good practice to incorporate a general inspection/cleaning of 3M™ Cold Shrink Silicone Rubber Terminations QT-III during normal scheduled or maintenance inspections. Once the area has been de-energized, the terminations can be inspected, and if need be, cleaned. Some recommendations for surface cleaning 3M™ Cold Shrink Silicone Rubber Terminations QT-III are as follows;

- Use a can of compressed 'air' in order to blast off dust and miscellaneous airborne contaminants on the surface of the termination body. If needed, wipe the surface of the termination with a cable cleaning solvent, such as 3M™ Cable Cleaning Solvent (CC-2), and allow it to dry before re-energizing the installation.
- Mix a mild soap and water solution (deionized water is recommended, if available) in a hand sprayer, or spray bottle, and spray down the surface of the termination. Wipe dry, or allow to air dry, before re-energizing.
- If tan discoloration between skirts is observed on the surface of the termination, wipe with a cable cleaning solvent. The discoloration itself does not pose any detrimental effect to the installation, and may not disappear entirely, but it will lighten up to some degree. This discoloration is a typical result of the outgassing effect of EPR cable and does not interfere with the performance of the termination in any capacity.

Do not abrade the surface of the termination in any way. Do not use high pressure cleaning (this can tear, or split, the termination), high pressure water with corn cobs, sandpaper or other abrasive products. This will damage the termination surface and reduce tracking and arcing resistance.

Shelf Life & Storage

As provided in the expanded state, the 3M Cold Shrink Silicone Rubber Termination Kits QT-III 7640-S, 7650-S and 7660-S Series have a 3-year shelf life from the date of manufacture when stored in a humidity controlled storage (50°F/10°C to 80°F/27°C and <75% relative humidity).

Availability

Please contact your local distributor; available from 3M.com/electrical [Where to Buy] or call 1.800.245.3573.

**3M™ Cold Shrink Silicone Rubber Termination Kits QT-III,
7640-S, 7650-S and 7660-S Series
5, 8, 15, 25/28 and 35 kV**


**IMPORTANT
NOTICE**

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product, which are not contained in 3M's current publications, or any contrary statements contained on your purchase order, shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M

**Warranty; Limited
Remedy; Limited
Liability**

This product will be free from defects in material and manufacture at the time of purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any indirect, special, incidental or consequential loss or damage arising from this 3M product, regardless of the legal theory asserted.**

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Note: The core material being removed from the Termination is mixed polymers and can be recycled with Other  waste.

3M

Electrical Markets Division
6801 River Place Blvd.
Austin, TX 78726-9000
800.245.3573
FAX: 800.245.0329
www.3M.com/electrical

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