

3M™ Cold Shrink QS4 Integrated Splice Kits 35 kV

QS4-35TS-1/0-350 and QS4-35TS-350-1000

For Tape Shield, Wire Shield, UniShield® and Longitudinally Corrugated (LC) Cables

Data Sheet

July 2014

⚠ CAUTION

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

Product Description

The 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 are 35 kV-class inline splices for joining tape shield, wire shield, UniShield® and longitudinally corrugated (LC) power cables. They are a cold shrink design sized to fit Type MV-90 or Type MV-105 cables with copper or aluminum conductor sizes ranging from 1/0 AWG to 1000 kcmil (60 to 500 mm²). The cold shrink splice body is a one-piece molded design made of specially formulated silicone rubbers, while the jacketing is made of EPDM rubber for physical protection. Each splice manufactured is factory tested to provide reliability.

The splices can be used with standard copper (Cu) or aluminum (Al/Cu) inline compression (crimp type) connectors or specified shearbolt connectors, and can be used for size transitions within the listed kit size range. They are designed to exceed minimum industry test standards, and have a BIL rating of 250 kV (equal to a 46 voltage class). The Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 meet or exceed the 35 kV Voltage Class rating requirements of ANSI/IEEE Std. 404.

Kit Contents for QS4-35TS-1/0-350 and QS4-35TS- 350-1000

- 1 3M™ Cold Shrink Silicone Rubber Integrated Splice Body
- 1 3M™ Cold Shrink Adapter Tube (2 adapters in the QS4-35TS-1/0-350 Kit)
- 2 3M™ Red Compound P55/R Tubes
- 6 Scotch® Mastic Sealing Strips 2230
- 2 Scotch® Rubber Mastic Tape 2228 Rolls
- 5 Constant Force Springs
- 1 U-Shaped Ground Braid
- 1 3M™ Cable Cleaning Pad CC-3
- 1 Cable Preparation Template (2 templates in the QS4-35TS-350-1000 Kit)
- 1 Wire Brush
- 2 3M™ EMI Copper Foil Shielding Tape 1181 Strips
- 1 Instruction Booklet

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Splice Features

- **Cold Shrink Design** — for quick and easy installation; excellent for cable size transitions
- **Complete Kit** — includes the required products to make one splice
- **Silicone Rubber Construction** — for good high and low temperature performance
- **Production Tested** — partial discharge and A.C. withstand tests to provide reliability
- **Computer Aided Design** — for compact size and optimal distribution of electrical field
- **Special Electrode Design** — minimizes electrical stress at critical cable/splice interface
- **Smooth Edge Neutral Extension Sock** — virtually no frayed edges
- **Separate Ground** — standard joint includes braid for easy connection to ground

Applications

- For splicing 35 kV shielded power cables:
- For inline splicing
 - For feeder and distribution circuits
 - For tape shielded cables
 - For wire shielded cables
 - For UniShield® cables
 - For longitudinally corrugated (LC) shielded cables
 - For copper or aluminum conductors
 - For use with standard inline crimp connectors
 - For use with specified 3M™ Shearbolt Connectors QCI Series
 - For size transition splicing
 - For direct burial installations
 - For submerged locations

Physical and Electrical Properties

The 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 can be used on cables with a rated operating temperature up to 105°C, and an emergency overload rating of 140°C. A splice constructed from this kit is rated for 35 kV and meets or exceeds the requirements of IEEE Std. 404. The current rating of the splice meets or exceeds the current rating for the cables on which it is installed. BIL rating is 250 kV, which exceeds the normal 200 kV BIL rating for a 35 kV voltage class.

Splice Selection Table

Kit Number	Cable Insulation O.D. Range Inches (mm)	Conductor Size Range AWG or kcmil (mm ²)
QS4-35TS-1/0-350	1.07 - 1.70 (27,2 - 43,2)	1/0 - 350 (60 - 185)
QS4-35TS-350-1000	1.24 - 2.07 (31,5 - 52,6)	350 - 1000 (185 - 500)

Table 1

Connector Dimensional Requirements Table

Kit Number	Minimum O.D. Inches (mm)	Maximum O.D. Inches (mm)	Maximum Length Inches (mm)			Connector O.D. Range Requiring adapters Inches (mm)
			Aluminum (Al/Cu) Compression	Copper (Cu) Compression	3M™ Shearbolt Connector QCI Series	
QS4-35TS-1/0-350	0.51 (13,0)	1.70 (43,2)	6.00 (152)	6.50 (165)	5.12 (130)	0.51 - 1.07 (13,0 - 27,2)
QS4-35TS-350-1000	0.87 (22,1)	2.07 (52,6)	7.50 (191)	8.25 (210)	7.83 (199)	0.87 - 1.60 (22,1 - 40,6)

Table 2

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Typical dimensions (Installed Splice)

Kit Number	Typical Length (L) Inches (mm)	Typical Diameter (D) Inches (mm)
QS4-35TS-1/0-350	38 (965)	3.60 (91)
QS4-35TS-350-1000	40 (1016)	3.90 (99)

Typical Physical and Electrical Properties

Silicone Rubber (Splice Body – Insulation)

Physical Properties

Test Method	Typical Value*
Hardness – Shore A (ASTM D 2240)	50
Elongation (%) (ASTM D 412)	610
Tensile Strength (psi) (ASTM D 412)	1090 (7,5 N/mm ²)
Modulus @ 100% (psi) (ASTM D 412)	340 (2,3 N/mm ²)
Permanent Set % (100%, 100°C, 22 hrs) (3M TM 86)	5
Thermal Conductivity (W/m K) (ASTM D 518)	0.24

Electrical Properties

Dielectric Strength (V/mil) (ASTM D 149)	370 (14,6 kV/mm)
Dielectric Strength, Wet (V/mil) (ASTM D 149)	340 (13,4 kV/mm)
Dielectric Constant (ASTM D 150)	3.3
Dielectric Loss (ASTM D 150)	0.005
Volume Resistivity (Ohm-cm) (3M TM 80)	6x10 ¹⁴

Silicone Rubber (Splice Body – Inner Electrode)

Physical Properties

Test Method	Typical Value*
Hardness – Shore A (ASTM D 2240)	43
Elongation (%) (ASTM D 412)	510
Tensile Strength (psi) (ASTM D 412)	880 (6,1 N/mm ²)
Modulus @ 100% (psi) (ASTM D 412)	200 (1,4 N/mm ²)
Permanent Set % (100%, 100°C, 22 hrs) (3M TM 86)	4

Electrical Properties

Volume Resistivity (Ohm-cm) (3M TM 80)	50
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3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Silicone Rubber (Splice Body – Semi-Con Shell)

Physical Properties

Test Method	Typical Value*
Hardness – Shore A (ASTM D 2240)	43
Elongation (%) (ASTM D 412)	520
Tensile Strength (psi) (ASTM D 412)	890 (6,1 N/mm ²)
Modulus @ 100% (psi) (ASTM D 412)	230 (1,6 N/mm ²)
Permanent Set % (100%, 100°C, 22 hrs) (3M TM 86)	5

Electrical Properties

Volume Resistivity (Ohm-cm) (3M TM 80)	150
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*All values are averages, based on several determinations and are not intended for specification purpose.

Ethylene Propylene Rubber (Jacketing Tubes)

Physical Properties

Test Method	Typical Value*
Color	Black
Hardness – Shore A (ASTM D 2240)	48
Elongation (%) (ASTM D 412)	635
Tensile Strength (psi) (ASTM D 412)	1680 (11,6 MPa)
Modulus @ 100% (psi) (ASTM D 412)	170 (1,17 MPa)
Fungus Resistance, 28 days (ASTM G 21)	No Growth
Permanent Set % (250%, Strain) (5 min. recovery, @ 40°F, 4.4°C)	8.8 14.6

Electrical Properties

Dielectric Strength, Orig. (V/mil) (ASTM D 149)	490 (19,1 kV/mm)
Dielectric Strength, Wet (V/mil) (ASTM D 149)	465 (18,1 kV/mm)
Dielectric Constant, Orig. (ASTM D 150)	5.0
Dielectric Constant, Wet (ASTM D 150)	5.6

*All values are averages, based on several determinations and are not intended for specification purpose.

Shielding System (Shield Sock & Ground Braid)

Electrical Properties of Shield Sock

Description	Circular mil Area of Folded Sock	Circular mil Area of 2/0 AWG
Tinned Copper Strands	156,340	133,100

Electrical Properties of Ground Braid

Description	Circular mil Area of Braid (both tails)	Circular mil Area of 4 AWG
Tinned Copper Strands	43,200	41,740

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Product (Open Specification)

The tape shield, wire shield, UniShield® and longitudinally corrugated (LC) power cable splice shall meet the requirements of ANSI/IEEE Std. 404 for a 35 kV rating, and must be rated by the manufacturer for use on 35 kV class cable systems. It must be rated for continuous operation at 105°C, with an emergency overload temperature rating of 140°C. The splice shall be capable of splicing cables with copper or aluminum conductors sized from 1/0 AWG to 350 kcmil (60 to 185 mm²) and 350 to 1000 kcmil (185 to 500 mm²) or accommodate a conductor size transition within those size ranges. The splice shall be of a cold shrink design which does not require any additional heat source for installation. The cold shrink splice body must be of a molded design made of silicone rubber. The splice jacketing shall be made of EPDM rubber. The color of the splice body and outer jacket shall be black.

Engineering/ Architectural (Closed Specification)

Splicing of all 35 kV rated cables, tape shield, wire shield, UniShield® and longitudinally corrugated (LC) power cables, sized from 1/0 AWG to 1000 kcmil (60 to 500 mm²) copper or aluminum, shall be performed in accordance with the instructions provided with the 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000.

Performance Test IEEE Std. 404 35 kV Voltage Rating

Design Test and Sequence	Test Requirement
Minimum partial discharge (corona) level	30 kV-rms @ < 3pC
Alternating-current 1 minute withstand	71 kV-rms
Direct-current 15 minute withstand	125 kV-dc
Impulse withstand (BIL) at 25°C (77°F)*	±200 kV-crest (250 kV)*
Impulse withstand (BIL) at 140°C (284°F)*	±200 kV-crest (250 kV)*
Minimum partial discharge (corona) level	30 kV-rms @ < 3 pC
Cyclic aging (in air and water)	61 kV-rms
Minimum partial discharge (corona) level	30 kV-rms @ < 3 pC
High voltage time: 5 hr. alternating-current withstand	71 kV-rms
5 min. alternating-current withstand	91 kV-rms
Short-time current (ICEA P-32-382 and ANSI/IEEE C37.09)	250°C conductor temp with no damage
Alternating-current 1 minute withstand	71 kV-rms
Shielding	IEEE Std. 592
Connector thermal and mechanical	ANSI C119.4

Production Test	Test Requirement
Production splices tested	100%
Minimum partial discharge (corona) level	30 kV-rms @ < 3 pC
Alternating-current 1 minute withstand	69 kV-rms

*Notes: (1) BIL rating for QS4-35TS-1/0-350 and QS4-35TS-350-1000 is upgraded to ± 250 kV-crest.
(2) Impulse test wave is 1.2 x 50 µsec. (ANSI/IEEE Std. 4).

Additional Performance Tests

Test	Results
Smooth Shield Sock Load Cycling	500 cycles, 3 hrs on, 3 hrs off with 250A of current
Smooth Shield Sock Connection Short Circuit Test	10 cycles @ 40 kA – No Damage

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Operating Temperature

Reference: AEIC CS5 and AEIC CS6:
Normal Operation: 105°C
Emergency Operation: 140°C

Installation Techniques for QS4-35TS-1/0-350 and QS4-35TS-350-1000 Kits

Detailed instructions for installing the 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 are included with each kit. A Cable Preparation Template is provided:

1. Prepare cable according to standard procedure.
2. Slide integrated cold shrink splice body onto prepared cables.
3. Install connector. Dimensional requirements table provided.
4. Apply a tape marker on one cable.
5. Apply 3M™ Red Compound P55/R on cable insulation and fill in edge of cable semi-con. DO NOT use silicone grease.
6. Install splice over connector area, aligning end with tape marker, and removing core by pulling and unwinding counterclockwise.
7. Connect shield sock to cable metallic shielding using constant force springs.
8. If circuit grounding is required at this location, connect ground braid to cable metallic shielding using a constant force spring, and apply mastic sealing strips to seal ground strap at end of cable jacket.
9. Apply rubber mastic tape around the end of both cable jackets.
10. Install cold shrink jacketing tube over splice.
11. Connect ground braid to ground if splice is to be grounded.
12. If located in direct sunlight, overwrap splice with vinyl tape.

Maintenance

Components of the 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 are stable under normal storage conditions. Normal stock rotation procedures are recommended. As provided, in the expanded state, the QS4 integrated splice kits have an on-shelf storage life of three years from the date of manufacture. The installed splices can be field tested using standard field cable testing procedures (reference ANSI/IEEE Std. 400).

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Connectors for QS4 Splices

The QS4 Cold Shrink Splice kits are designed to be used with 3M™ Scotchlok™ Connectors 10000, 11000, and 20000 Series, 3M™ Connectors CI-Series, or other UL listed inline compression connectors that fit within the dimension limits listed in the 3M™ Connector Dimensional Requirements Table 2. In addition, the following transition connectors may be used:

Kit Number	Conductor Sizes (AWG or kcmil)	3M™ Compression Connectors	3M™ Shearbolt Connectors QCI Series
QS4-35TS-1/0-350	1/0 to 2/0	2000T 1/0-2/0 CU/AL	QCI-1/0-350
	1/0 to 3/0	CI-T4	
	1/0 to 4/0		
	2/0 to 3/0		
	2/0 to 4/0	2000T 2/0-4/0 CU/AL	
	3/0 to 4/0	CI-T7	
	2/0 to 250		
	3/0 to 250		
	4/0 to 250		
	3/0 to 350	2000T 3/0-350 CU/AL	
	4/0 to 350	2000T 4/0-350 CU/AL	
	250 to 350	2000T 250-350 CU/AL	
300 to 350	2000T 300-350 CU/AL		
QS4-35TS-350-1000	350 to 500	2000T 350-500 CU/AL	QCI-350-750
	350 to 600		
	500 to 600		
	350 to 750		
	500 to 750		
	500 to 1000		QCI-500-1000
	750 to 1000		

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Connectors for QS4 Splices

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Kit Number	Conductor Sizes (AWG or kcmil)	Homac Connectors	Burndy Connectors	Mac Products
QS4-35TS-1/0-350	1/0 to 2/0			
	1/0 to 3/0	SAC3/0R1/0	YRB27U25	MLCR 3/0-1/0
	1/0 to 4/0	SAC4/0R1/0		
	2/0 to 3/0		YRB27U26	
	2/0 to 4/0	SAC4/0R2/0	YRB28U26	MLCR 4/0-2/0
	3/0 to 4/0			
	2/0 to 250	SAC250R2/0		
	3/0 to 250	SAC250R3/0		
	4/0 to 250	SAC250R4/0	YRB29U28	MLC 250 + AAR 250-4/0 Adapter
	3/0 to 350			
	4/0 to 350	SAC350R4/0	YRB31U28	MLCR 350-4/0
250 to 350	SAC350R250	YRB31U29	MLC 350 + AAR 350-250 Adapter	
300 to 350				
QS4-35TS-350-1000	350 to 500	SAC500R350	YRB34U31	MLC 500 + AAR 500-350 Adapter
	350 to 600		YRB36U31	
	500 to 600		YRB36U34	
	350 to 750	SAC750R350		MLC 750 + AAR 750-350 Adapter
	500 to 750	SAC750R500	YRB39U34	MLCR 750-500
	500 to 1000	SAC1000R500		MLCR 1000-750 + AAR 750-500 Adapter
	750 to 1000	SAC1000R750		MLCR 1000-750

3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000

Shelf-Life This product has a 3-year shelf life from date of manufacture when stored in a humidity controlled storage (10°C / 50°F to 27°C / 80 °F and <75% relative humidity).

Availability 3M™ Cold Shrink QS4 Integrated Splice Kits QS4-35TS-1/0-350 and QS4-35TS-350-1000 are available to splice 35 kV tape shield, wire shield, UniShield® and longitudinally corrugated (LC) power cables. The connectors can be either ordered with the kit or provided separately. Standard dimension copper (Cu) or aluminum (Al/Cu) compression (crimp type) connectors are suitable for use with these splice kits, as are 3M™ Shearbolt Connectors QCI Series. These kits are available from your local authorized 3M electrical distributor.

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