THE DATASHEET OF

ECL155-40E

Medium Voltage Fuses

General

Fuses above 600V are classified under one of three classifications as defined in ANSI/IEEE C37.40.

1. General Purpose Current-Limiting Fuse: A fuse capable of interrupting all currents from the rated interrupting current down to the current that causes melting of the fusible element in one hour.
2. Back-up Current-Limiting Fuse: A fuse capable of interrupting all currents from the maximum rated interrupting current down to the rated minimum interrupting current.
3. Expulsion Fuse: A vented fuse in which the expulsion effect of gasses produced by the arc and lining of the fuse holder, either alone or aided by a spring, extinguishes the arc.

One should note that in the definitions above, the fuses are defined as either expulsion or current-limiting. A current-limiting fuse is a sealed, non-venting fuse that, when melted by a current within its interrupting rating, produces arc voltages exceeding the system voltage, which in turn forces the current to zero. The arc voltages are produced by introducing a series of high resistance arcs within the fuse. The result is a fuse that typically interrupts high fault currents within the first ½ cycle of the fault. In contrast, an expulsion fuse depends on one arc to initiate the interruption process. The arc acts as a catalyst, causing the generation of de-ionizing gas from its housing. The arc is then elongated, either by the force of the gasses created or a spring. At some point, the arc elongates far enough to prevent a restrike after passing through a current zero. Therefore, an expulsion fuse may take many cycles to clear.

Construction

Current-limiting fuses have four parts common to all designs: tube, end ferrules, element, and arc quenching filler.

The tube must have a high burst strength to withstand the pressures generated during interruption. The most common materials used are fiberglass reinforced epoxy and melamine tubing. End ferrule designs are usually dictated by the application. For example, a clip mounted fuse would have a silver-plated ferrule with a large surface area to insure good contact. In contrast, a stud mounted fuse may be cast bronze with very little surface area. In both designs it is very important that a good seal be provided between the tube and end ferrules. This is most commonly done with a gasket and magna-forming process, or with epoxy and screws. Fuse elements are typically made from silver. Silver is the most common material used for high voltage fuse elements because of its predictable melting properties. To achieve this low current operation, it is necessary to either add a series element of different material or reduce the melting temperature of the silver by adding an "M" spot. Finally, an arc quenching filler is added to aid in the interruption process. During interruption the arc quenching filler is changed into an insulating material called a fulgurite.

Application

Many of the rules for applying expulsion fuses and current-limiting fuses are the same, but because the current-limiting fuse operates much faster on high fault currents, some additional rules must be applied. Three basic factors must be considered when applying any fuse. These are: 1) Voltage, 2) Continuous Current Carrying Capacity, and 3) Interrupting Rating.

Voltage

The fuse must have a voltage rating equal to or greater than the normal frequency recovery voltage which will be seen across the fuse under all conditions. On three-phase systems, it is a good rule of thumb that the voltage rating of the fuse be greater than or equal to the line-to-line voltage of the system.

Continuous Current-Carrying Capacity

Continuous current values that are shown on the fuse represent the level of current the fuse can carry continuously without exceeding the temperature rises as specified in ANSI C37.46. An application that exposes the fuse to a current slightly above its continuous rating but below its minimum interrupting rating, may damage the fuse due to excessive heat. This is the main reason overload relays are used in series with back-up current-limiting fuses for motor protection.

Interrupting Rating

All fuses are given a maximum interrupting rating. This rating is the maximum level of fault current that the fuse has been tested to safely interrupt. Back-up current-limiting fuses are also given a minimum interrupting rating. When using back-up current-limiting fuses, it is important that other protective devices are used to interrupt currents below this level.

Additional Rules

Expulsion Fuses: When choosing a fuse, it is important that the fuse be properly coordinated with other protective devices located upstream and downstream. To accomplish this, one must consider the melting and clearing characteristics of the devices. Two curves, the minimum melting curve and the total clearing curve, provide this information. To insure proper coordination, the following rules should be used.

1. The total clearing curve of any downstream protective device must be below a curve representing 75% of the minimum melting curve of the fuse being applied.
2. The total clearing curve of the fuse being applied must lie below a curve representing 75% of the minimum melting curve for any upstream protective device.

Current-Limiting Fuses

To insure proper application of a current-limiting fuse it is important that the following additional rules be applied.

1. As stated earlier, current-limiting fuses produce arc voltages that exceed the system voltage. Care must be taken to make sure that the peak voltages do not exceed the insulation level of the system. If the fuse voltage rating is not permitted to exceed 140% of the system voltage, there should not be a problem. This does not mean that a higher rated fuse cannot be used, but points out that one must be assured that the system insulation level (BIL) will handle the peak arc voltage produced.
2. As with the expulsion fuse, current-limiting fuses must be properly coordinated with other protective devices on the system. For this to happen the rules for applying an expulsion fuse must be used at all currents that cause the fuse to interrupt in 0.01 seconds or greater.

   When other current-limiting protective devices are on the system it becomes necessary to use I^2t values for coordination at currents causing the fuse to interrupt in less than 0.01 seconds. These values may be supplied as minimum and maximum values or minimum melting and total clearing I^2t curves. In either case, the following rules should be followed.

   1. The minimum melting I^2t of the fuse should be greater than the total clearing I^2t of the downstream current-limiting device.
   2. The total clearing I^2t of the fuse should be less than the minimum melting I^2t of the upstream current-limiting device.

For fusing medium voltage motor branch circuits, see Medium Voltage Motor Circuits section.

Medium Voltage Fuses

R-Rated (Motor Circuit)

JCK, JCK-A, JCK-B, JCH, JCL, JCL-A, JCL-B, JCG, JCR-A, JCR-B

2R to 24R, 2400V: JCK & JCH, 4800V: JCL & JCG, 7200V: JCR-A & JCR-B, IR: 50,000AIR ac

R-Rated medium voltage fuses are back-up current-limiting fuses used in conjunction with medium voltage motors and motor controllers.

Current-limiting fuses may be designated as R-Rated if they meet the following requirements:

- The fuse will safely interrupt all currents between its minimum and maximum interrupting ratings.
- The fuse will melt in a range of 15 to 35 seconds at a value of 100 times the “R” number (ANSI C37.46).

Cooper Bussmann R-Rated current-limiting fuses are designed for use with medium voltage starters to provide short circuit protection for the motor and motor controller. These fuses offer a high level of fault current interruption in a self-contained, non-venting package which can be mounted indoors or in an enclosure.

Available styles are: Standard, Ampgard Hookeye, Haz. Location, Bolt-in

Open fuse indication is on all fuses.

Data Sheet No. 6001

E-Rated (Potential & Small Transformers)

JCD: 2400V, ½-5E, JCW: 5500V, ½-5E,
JCQ: 4800V, ½-10E, JCI: 7200V, ½-10E
JCT: 14.4kV, ½-10E

IR: 80,000AIR ac

Low amperage, E-Rated medium voltage fuses are general purpose current-limiting fuses. The E-rating defines the melting- time-current characteristic of the fuse and permits electrical interchangeability of fuses with the same E-Rating. For a general purpose fuse to have an E-Rating, the following condition must be met:

- The current responsive element shall melt in 300 seconds at a RMS current within the range of 200% to 240% of the continuous current rating of the fuse, fuse refill, or link. (For fuses rated 100E or less)(ANSI C37.46).

Cooper Bussmann low amperage, E-Rated fuses are designed to provide primary protection for potential, small service, and control transformers. These fuses offer a high level of fault current interruption in a self-contained non-venting package which can be mounted indoors or in an enclosure.

Data Sheet No. 6002

E-Rated (Transformer & Feeder Protection)

JCX: 2400V (½-250E), JCY: 4800V (½-450E), JCU: 4800V (10-750E), JDZ: 7200V (20-350E), JCZ: 7200V (15-200E), JDN: 14.4kV (15-250E), JCN: 14.4kV (20-300E), IR: 63,000AIR ac

Cooper Bussmann E-Rated medium voltage fuses are general purpose current-limiting fuses. The E-rating defines the melting-time-current characteristic of the fuse. The ratings are used to allow electrical interchangeablity among different manufacturers. For a general purpose fuse to have an E-Rating, the following condition must be met:

- The current responsive element shall melt in 300 seconds at a RMS current within the range of 200% to 240% of the continuous current rating of the fuse unit (ANSI C37.46).
- The current responsive element above 100 amps shall melt in 600 seconds at a RMS current within the range of 220% to 264% of the continuous current rating of the fuse unit (ANSI C37.46).

Cooper Bussmann E-Rated fuses are designed to provide primary protection of transformers, feeders, and branch circuits. They are non-venting fuses which must be mounted indoors or in an enclosure. Their current-limiting ability reduces the short circuit current energy (I^2t) that the system components must withstand.

CL-14 (Clip Lock)

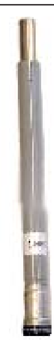
ECL055: 10E-600E, ECL155: 10E-300E

5.5kV & 15.5kV

Interrupting Ratings: ECL055: 63kA,
ECL155: 63kA (10-200A) & 50kA (250-300A)

See description for E-Rated “Transformer & Feeder Protection” fuses.

Data Sheet Nos. 9002, 9004



Boric Acid

BBU17: 17kV, 14kAIR, E (5 to 200), SE (15 to 200), K (3 to 200)

BBU27: 27kV, 12.5kAIR, E (5 to 200), SE (15 to 200), K (3 to 200)

BBU38: 38kV, 10kAIR, E (5 to 200), SE (15 to 200), K (3 to 200)

E (Standard), K (Fast) & SE (Slow)

Boric acid fuses vent during clearing process; for indoors, use muffler option.

See description for “E-Rated Transformer & Feeder Protection” fuses

Data Sheet No. 1123

E-Rated (Full Range)

MV055: 5E-450E, MV155: 5E-200E

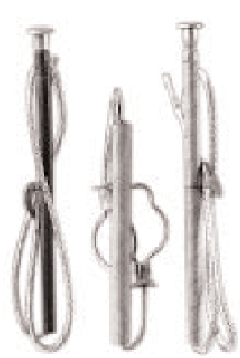
5.5kV & 15.5kV, IR: 50,000AIR ac

See description for “E-Rated Transformer & Feeder Protection” fuses.

Satisfies additional ANSI C37.40 for full-range protection fuse.

A full-range fuse is capable of interrupting all currents from the rated interrupting rating down to the minimum continuous current that causes melting of the fusible element.

Data Sheet No. 6700 6701



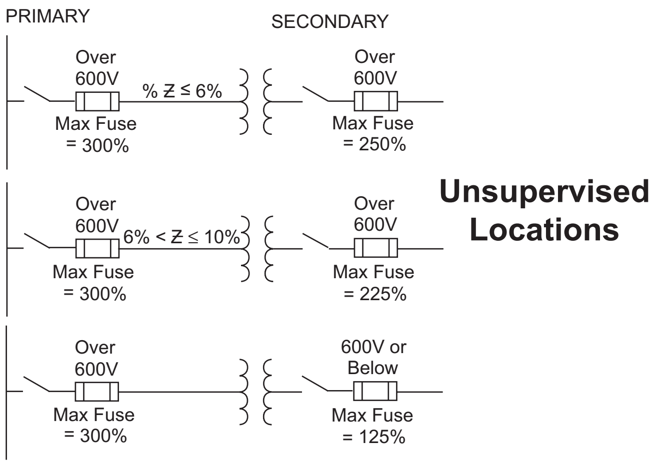
Medium Voltage Fuse Links - 27kV

FL11H:	1 to 8
FL11K:	1 to 200
FL11T:	1 to 200
FL3K:	1 to 200
FL3T:	1 to 200

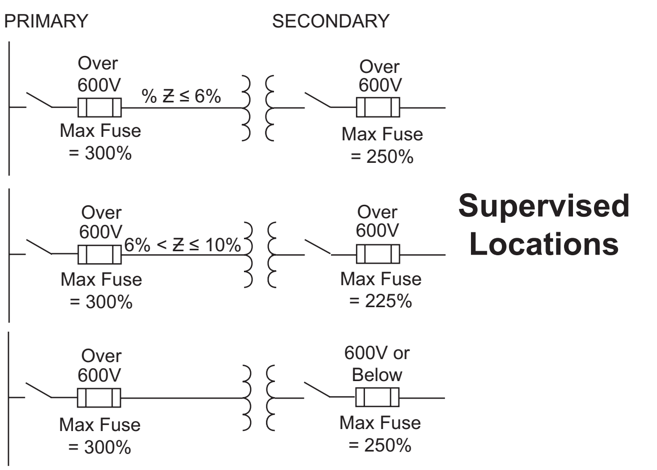
Transformers — Over 600V

Primary and Secondary Protection

In unsupervised locations, with primary over 600V, the primary fuse can be sized at a maximum of 300%. If the secondary is also over600V, the secondary fuses can be sized at a maximum of 250% for transformers with impedances not greater than 6% or 225% for transformers with impedances greater than 6% and not more than 10%. If the secondary is 600V or below, the secondary fuses can be sized at a maximum of 125%. Where these ratings do not correspond to a standard fuse size, the next higher standard size is permitted.



In supervised locations, the maximum ratings are as shown in the next diagram. These are the same maximum settings as the unsupervised locations except for secondary voltages of 600V or less, where the secondary fuses can be sized at maximum of 250%.



Primary Protection Only

In supervised locations, the primary fuses can be sized at a maximum of 250%, or the next larger standard size if 250% does not correspond to a standard fuse size.

Note: The use of “Primary Protection Only” does not remove the requirements for compliance with Articles 240 & 408. See (FPN) in Section 450.3, which references 240.4, 240.21, 240.100 and 240.101 for proper protection for secondary conductors.

E-Rated Fuses for Medium Voltage Potential & Small Power Transformers

Low amperage, E-Rated medium voltage fuses are general purpose current-limiting fuses. A general purpose current-limiting fuse is capable of interrupting all current from the rated interrupting current down to the current that causes melting of the fusible element in 1 hour (ANSI C37.40). The E rating defines the melting-time-current characteristic of the fuse and permits electrical interchangeability of fuses with the same E Rating. For a general purpose fuse to have an E Rating the following condition must be met:

The current responsive element shall melt in 300 seconds at an RMS current within the range of 200% to 240% of the continuous current rating of the fuse, fuse refill, or link (ANSI C37.46).

Cooper Bussmann low amperage, E-Rated fuses are designed to provide primary protection for potential, small service, and control transformers. These fuses offer a high level of fault current interruption in a self-contained non-venting package which can be mounted indoors or in an enclosure.

Application

As for all current-limiting fuses, the basic application rules found in the fuseology section of this brochure should be adhered to. In addition, potential transformer fuses must have sufficient inrush capacity to successfully pass through the magnetizing inrush current of the transformer. If the fuse is not sized properly, it will open before the load is energized. The maximum magnetizing inrush currents to the transformer at system voltage, and the duration of this inrush current varies with the transformer design. Magnetizing inrush currents are usually denoted as a percentage of the transformer full-load current, i.e., 10x, 12x, 15x, etc. The inrush current duration is usually given in seconds. Where this information is available, an easy check can be made on the appropriate Cooper Bussmann minimum melting curve to verify proper fuse selection. In lieu of transformer inrush data, the rule of thumb is to select a fuse size rated at 300% of the primary full-load current and round up to the next larger standard size.

Example:

The transformer manufacturer states that an 800VA 2400V, single phase potential transformer has a magnetizing inrush current of 12x lasting for 0.1 second.

A. I_{FL} = 800VA/2400V = 0.333A

Inrush Current = 12 x 0.333 = 4A

Since the voltage is 2400 volts we can use either a JCW-1E or JCD-1 E.

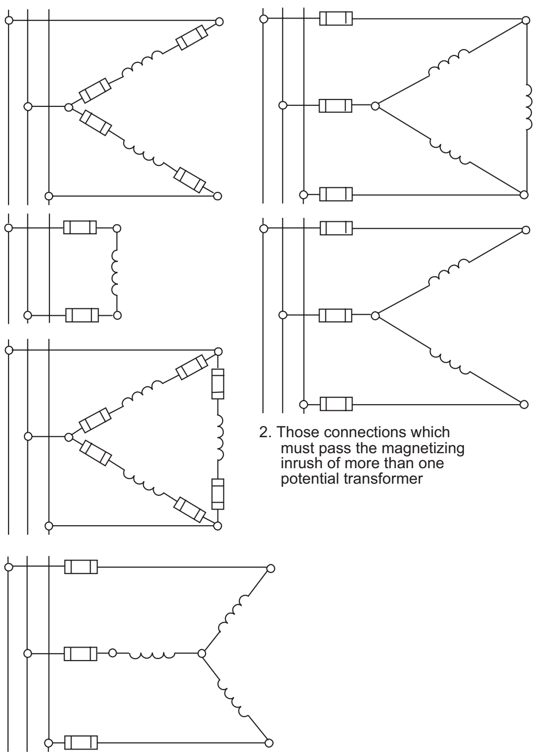
B. Using the rule of thumb–300% of 0.333A is 0.999A.

Therefore we would choose a JCW-1E or JCD-1E.

Transformers — Over 600V

Typical Potential Transformer Connections

The typical potential transformer connections encountered in industry can be grouped into two categories:



1. Those connections which require the fuse to pass only the magnetizing inrush of one potential transformer

2. Those connections which must pass the magnetizing inrush of more than one potential transformer

E-Rated Fuses for Medium Voltage Transformers & Feeders

Cooper Bussmann E-Rated medium voltage fuses are general purpose current-limiting fuses. A general purpose current-limiting fuse is capable of interrupting all currents from the rated interrupted current down to the current that causes melting of the fusible element in 1 hour (ANSI C37.40). The fuses carry either an 'E' or an 'X' rating which defines the melting-time-current characteristic of the fuse. The ratings are used to allow electrical interchangeability among different manufacturers' fuses.

For a general purpose fuse to have an E rating, the following conditions must be met:

1. 100E and below - the fuse element must melt in 300 seconds at 200% to 240% of its rating (ANSI C37.46).
2. Above 100E - the fuse element must melt in 600 seconds at 220% to 264% of its rating (ANSI C37.46).

Cooper Bussmann E-Rated Medium Voltage Fuse.

A fuse with an 'X' rating does not meet the electrical inter-changeability for an 'E' rated fuse but offers the user other ratings that may provide better protection for a particular application.

Application

Transformer protection is the most popular application of E-Rated fuses. The fuse is applied to the primary of the transformer and is used solely to prevent rupture of the transformer due to short circuits. It is important, therefore, to size the fuse so that it does not clear on system inrush or permissible overload currents. See section on transformers over 600V for applicable sizing recommendations. Magnetizing inrush must also be considered when sizing a fuse. In general, power transformers have a magnetizing inrush current of 12x the full-load rating for a duration of 1⁄10 second.

Three-Phase Transformers (Or Transformer Bank)

Transformer kVA Rating	System Voltage 2.4kV Full-load Amps	Fuse	4.16kV Full-load Amps	Fuse	4.8kV Full-load Amps	Fuse
9	2.17	**JCX-7E**	1.25	**JCY-5E**	1.08	**JCY-5E**
15	3.6	**JCX-10E**	2.08	**JCY-7E**	1.8	**JCY-7E**
30	7.3	**JCX-20E**	4.2	**JCY-15E**	3.6	**JCY-10E**
45	10.8	**JCX-25E**	6.2	**JCY-15E**	5.4	**JCY-15E**
75	18.0	**JCX-40E**	10.4	**JCY-25E**	9.0	**JCY-20E**
112.5	27.0	**JCX-65E**	15.6	**JCY-40E**	13.5	**JCY-30E**
150	36.0	**JCX-65E**	20.8	**JCY-40E**	18.0	**JCY-40E**
225	54.0	**JCX-100E**	31.2	**JCY-65E**	27.0	**JCY-65E**
300	72.0	**JCX-125E**	41.6	**JCY-80E**	36.0	**JCY-65E**
500	120.0	**JCX-200E**	69.4	**JCY-125E**	60.0	**JCY-100E**
750	—	—	104.0	**JCY-150E**	90.0	**JCY-125E**
1000	—	—	139.0	**JCY-200E**	120.0	**JCY-200E**
Single-Phase Transformers						
3	1.25	**JCX-5E**	0.72	**JCY-3E**	0.63	**JCY-3E**
5	2.08	**JCX-7E**	1.20	**JCY-5E**	1.04	**JCY-5E**
10	4.17	**JCX-15E**	2.40	**JCY-7E**	2.08	**JCY-7E**
15	6.25	**JCX-15E**	3.61	**JCY-10E**	3.13	**JCY-10E**
25	10.4	**JCX-25E**	6.01	**JCY-15E**	5.21	**JCY-15E**
37.5	15.6	**JCX-40E**	9.01	**JCY-20E**	7.81	**JCY-20E**
50	20.8	**JCX-40E**	12.0	**JCY-25E**	10.4	**JCY-25E**
75	31.3	**JXC-65E**	18.0	**JCY-40E**	15.6	**JCY-30E**
100	41.7	**JCX-80E**	24.0	**JCY-80E**	20.8	**JCY-40E**
167	70.0	**JCX-100E**	40.0	**JCY-100E**	35.0	**JCY-65E**
250	104.0	**JCX-150E**	60.0	**JCY-125E**	52.0	**JCY-100E**
333	139.0	**JCX-200E**	80.0	**JCY-125E**	69.5	**JCY-100E**
500	—	—	120.0	**JCY-200E**	104.0	**JCY-150E**
667	—	—	—	—	139.0	**JCY-200E**

R-Rated Medium Voltage Fuses

R-rated medium voltage fuses are back-up current-limiting fuses used in conjunction with medium voltage motors and motor controllers. These fuses are designed for short-circuit protection only and do not protect themselves or other components during extended overloads. Thus, this type of fuse does not have an amp rating, but rather an R-rating. Current-limiting fuses may be designated as R-rated if they meet the following requirements:

1. The fuse will safely interrupt an currents between its minimum and maximum interrupting ratings,
2. The fuse will melt in a range of 15 to 35 seconds at a value of 100 times the “R” number (ANSI C 37.46).

Cooper Bussmann R-rated current-limiting fuses are designed for use with medium voltage starters to provide short-circuit protection for the motor and motor-controller. These fuses offer a high level of fault current interruption in a self-contained, non-venting package which can be mounted indoors or in an enclosure. All of the R-rated product comes with open fuse indication. Some of the product is available with a hookeye option. A hookstick can be used for non-loadbreak isolation.

Application

Medium voltage motors are efficiently protected by overload relays applied in conjunction with back-up current-limiting fuses which are intended to open the circuit for high fault conditions. The overload relay is chosen to interrupt currents below the minimum interrupting rating of the fuse. Since multiple devices are used to provide protection it is very important that they be properly coordinated. The motor starter manufacturer typically chooses the proper fuse R-rating, overload relay, and contactor. The following guideline can be used to insure proper coordination.

Guideline for Applying R-Rated Fuses

The current-limiting fuse should be selected so that the overload relay curve crosses the minimum melting curve of the fuse at a current greater than 110% of the locked rotor current of the motor being utilized.

A preliminary choice is obtained through the following formula:

$$\frac{6.6 \times \text{Full Load Current}}{100} = \text{R rating of fuse}$$

This value is rounded up to the next R-rating fuse.

Example:

A 2300V motor has a 100 amp full load current rating and a locked rotor current of 600 amps.

The preliminary choice is

$$\frac{6.6 \times 100}{100} = 6.6$$

Thus one rounds up to the next standard R-rating, 9R. But this must be checked with the appropriate time-current characteristics curves.

The overload relay being used has the time-current characteristic as shown in the adjacent Figure. To choose the proper fuse one must plot 110% of the locked rotor current and the family of fuses on the same graph as the overload relay.

The fuse that should be selected is the smallest fuse whose minimum melting characteristic crosses the overload relay at a current greater than 110% of the locked rotor current. In this example, it would be a 2400V 9R fuse. This agrees with the quick selection choice. Depending on the type of installation and starter being used, a JCK-9R, JCK-A-9R, or JCH-9R would be the correct choice.