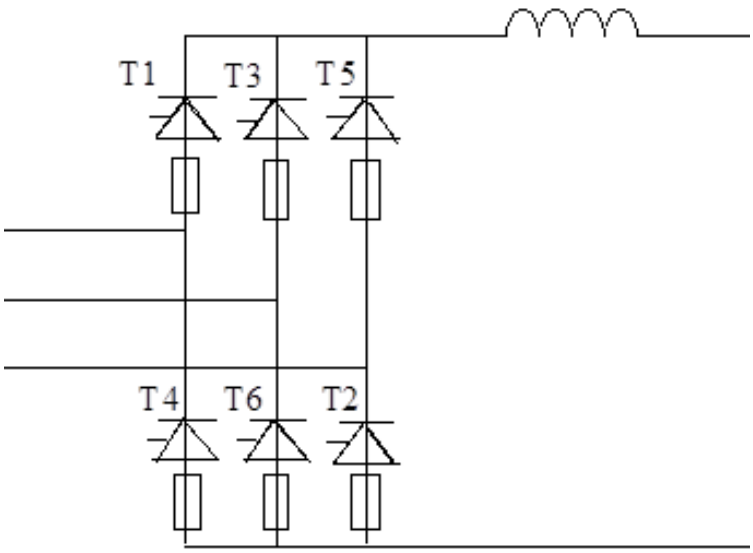
## ELEC-E8421 Tehoelektroniikan komponentit

Harjoitus 5.

1. Figure 1. shows six-pulse thyristor bridge, where each thyristor has a $I^2t$-rating of 90 000 $A^2s$ and voltage rating of 1500 V. 3 phase input mains voltage is 400 V ± 10 %. fuse nominal constant rating is 300 A. in additional following overloading may occur:

    500 A, max 60s duration once per hour
    700 A, max 10s duration 2 times in a week
    700 A, max 20s duration once a month
    1200 A, max 0.5s less than once a month.

Will fuse 170M3669 work accordingly? Fuse is in a cabin with 60 C ambient, cabin is naturally cooled (not cooled in any way).




2. Three thyristors are connected in series. During turn off reverse recovery current Irr charge in a thyristor can vary between 160-400 uC. RC-snubber capacitor capacitance is 0.47 uF. How much can the voltage over individual thyristor vary when comparing to a situation with equal charge.

Start by drawing an equivalent circuit

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## Square Body – US Style
# 690V/700V (IEC) 40-2000A

| Size | Rated Current RMS-Amps | I²t (A²S) Pre-arc | I²t (A²S) Clearing at 660V | Watts Loss | -FU/- Without Indicator | -FKE/- Type K Indicator for Micro | -FU/115 Without Indicator | -FKE/115 Type K Indicator for Micro | Carton Qty. | Carton Weight (kg) | See Page or (Datasheet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 40 | 270 | 9 | 170M3608 | 170M3658 | 170M3708 | 170M3758 | | | |
| | 50 | 77 | 515 | 11 | 170M3609 | 170M3659 | 170M3709 | 170M3759 | | | |
| | 63 | 115 | 770 | 14 | 170M3610 | 170M3660 | 170M3710 | 170M3760 | | | |
| | 80 | 185 | 1250 | 18 | 170M3611 | 170M3661 | 170M3711 | 170M3761 | | | |
| | 100 | 360 | 2450 | 21 | 170M3612 | 170M3662 | 170M3712 | 170M3762 | | | |
| | 125 | 550 | 3700 | 26 | 170M3613 | 170M3663 | 170M3713 | 170M3763 | | | |
| | 160 | 1100 | 7500 | 30 | 170M3614 | 170M3664 | 170M3714 | 170M3764 | | | page 71 |
| | 200 | 2200 | 15000 | 35 | 170M3615 | 170M3665 | 170M3715 | 170M3765 | | | |
| 1* | 250 | 4200 | 28500 | 40 | 170M3616 | 170M3666 | 170M3716 | 170M3766 | 1 | 0.340 | (720089) |
| | 315 | 7000 | 46500 | 50 | 170M3617 | 170M3667 | 170M3717 | 170M3767 | | | |
| | 350 | 10000 | 68500 | 55 | 170M3618 | 170M3668 | 170M3718 | 170M3768 | | | |
| | 400 | 15000 | 105000 | 60 | 170M3619 | 170M3669 | 170M3719 | 170M3769 | | | |
| | 450 | 21000 | 140000 | 65 | 170M3620 | 170M3670 | 170M3720 | 170M3770 | | | |
| | 500 | 27000 | 180000 | 70 | 170M3621 | 170M3671 | 170M3721 | 170M3771 | | | |
| | 550 | 34000 | 230000 | 75 | 170M3622 | 170M3672 | 170M3722 | 170M3772 | | | |
| | 630 | 48500 | 325000 | 80 | 170M3623 | 170M3673 | 170M3723 | 170M3773 | | | |
| | 200 | 1650 | 11500 | 45 | 170M4608 | 170M4658 | 170M4708 | 170M4758 | | | |
| | 250 | 3100 | 21000 | 55 | 170M4609 | 170M4659 | 170M4709 | 170M4759 | | | |
| | 315 | 6200 | 42000 | 58 | 170M4610 | 170M4660 | 170M4710 | 170M4760 | | | |
| | 350 | 8500 | 59000 | 60 | 170M4611 | 170M4661 | 170M4711 | 170M4761 | | | |
| | 400 | 13500 | 91500 | 65 | 170M4612 | 170M4662 | 170M4712 | 170M4762 | | | page 71 |
| | 450 | 17000 | 120000 | 70 | 170M4613 | 170M4663 | 170M4713 | 170M4763 | | | |
| 1 | 500 | 25000 | 170000 | 72 | 170M4614 | 170M4664 | 170M4714 | 170M4764 | 1 | 0.500 | (720090) |
| | 550 | 34000 | 230000 | 75 | 170M4615 | 170M4665 | 170M4715 | 170M4765 | | | |
| | 630 | 52000 | 350000 | 80 | 170M4616 | 170M4666 | 170M4716 | 170M4766 | | | |
| | 700 | 69500 | 465000 | 85 | 170M4617 | 170M4667 | 170M4717 | 170M4767 | | | |
| | 800 | 105000 | 725000 | 95 | 170M4618 | 170M4668 | 170M4718 | 170M4768 | | | |
| | ‡900 | 155000 | ‡850000 | 100 | 170M4619 | 170M4669 | 170M4719 | 170M4769 | | | |
| | 400 | 11000 | 74000 | 65 | 170M5608 | 170M5658 | 170M5708 | 170M5758 | | | |
| | 450 | 15500 | 105000 | 70 | 170M5609 | 170M5659 | 170M5709 | 170M5759 | | | |
| | 500 | 21500 | 145000 | 75 | 170M5610 | 170M5660 | 170M5710 | 170M5760 | | | |
| | 550 | 28000 | 190000 | 80 | 170M5611 | 170M5661 | 170M5711 | 170M5761 | | | |
| | 630 | 41000 | 275000 | 90 | 170M5612 | 170M5662 | 170M5712 | 170M5762 | | | page 72 |
| 2 | 700 | 60500 | 405000 | 95 | 170M5613 | 170M5663 | 170M5713 | 170M5763 | 1 | 0.630 | (720091) |
| | 800 | 86000 | 575000 | 105 | 170M5614 | 170M5664 | 170M5714 | 170M5764 | | | |
| | 900 | 125000 | 840000 | 110 | 170M5615 | 170M5665 | 170M5715 | 170M5765 | | | |
| | 1000 | 180000 | 1250000 | 115 | 170M5616 | 170M5666 | 170M5716 | 170M5766 | | | |
| | 1100 | 245000 | 1600000 | 120 | 170M5617 | 170M5667 | 170M5717 | 170M5767 | | | |
| | 1250 | 365000 | 2400000 | 130 | 170M5618 | 170M5668 | 170M5718 | 170M5768 | | | |
| | 500 | 14000 | 95000 | 95 | 170M6608 | 170M6658 | 170M6708 | 170M6758 | | | |
| | 550 | 19500 | 135000 | 100 | 170M6609 | 170M6659 | 170M6709 | 170M6759 | | | |
| | 630 | 31000 | 210000 | 105 | 170M6610 | 170M6660 | 170M6710 | 170M6760 | | | |
| | 700 | 44500 | 300000 | 110 | 170M6611 | 170M6661 | 170M6711 | 170M6761 | | | |
| | 800 | 69500 | 465000 | 115 | 170M6612 | 170M6662 | 170M6712 | 170M6762 | | | |
| | 900 | 100000 | 670000 | 120 | 170M6613 | 170M6663 | 170M6713 | 170M6763 | | | page 72 |
| 3 | 1000 | 140000 | 945000 | 125 | 170M6614 | 170M6664 | 170M6714 | 170M6764 | | | |
| | 1100 | 190000 | 1300000 | 130 | 170M6615 | 170M6665 | 170M6715 | 170M6765 | 1 | 0.950 | (720092) |
| | 1250 | 290000 | 1950000 | 140 | 170M6616 | 170M6666 | 170M6716 | 170M6766 | | | |
| | 1400 | 370000 | 2450000 | 155 | 170M6617 | 170M6667 | 170M6717 | 170M6767 | | | |
| | 1500 | 460000 | 3100000 | 160 | 170M6618 | 170M6668 | 170M6718 | 170M6768 | | | |
| | 1600 | 580000 | 3900000 | 160 | 170M6619 | 170M6669 | 170M6719 | 170M6769 | | | |
| | †1800 | 880000 | †5250000 | 165 | 170M6620 | 170M6670 | 170M6720 | 170M6770 | | | |
| | ‡2000 | 1150000 | ‡6350000 | 175 | 170M6621 | 170M6671 | 170M6721 | 170M6771 | | | |

- Interrupting rating 200kA (Estimated 300kA) RMS Symmetrical.
- Watts loss provided at rated current.
- Rated voltage (IEC) †600V ‡550V (Consult Bussmann for U.L. Recognition/ CSA Component Acceptance status.)
- Microswitch indicator ordered separately. See accessories on pages 68-69.

1 kg = 2.2 lbs. 1 lb = 0.45 kg

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**Square Body – US Style**

# 690V/700V (IEC) 40-2000A

## Electrical Characteristics

### Total Clearing $I^2t$

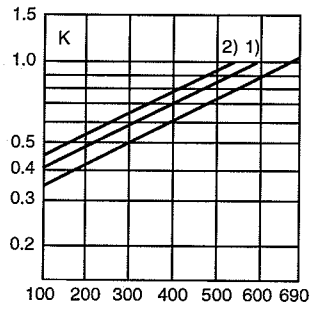
The total clearing $I^2t$ at rated voltage and at power factor of 15% are given in the electrical characteristics. For other voltages, the clearing $I^2t$ is found by multiplying by correction factor, K, given as a function of applied working voltage, $E_g$, (RMS).

### Arc Voltage

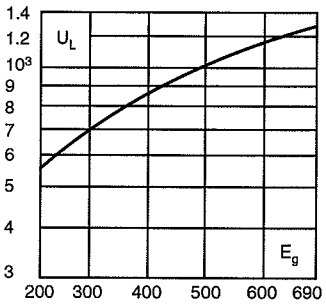
This curve gives the peak arc voltage, $U_L$, which may appear across the fuse during its operation as a function of the applied working voltage, $E_g$, (RMS) at a power factor of 15%.

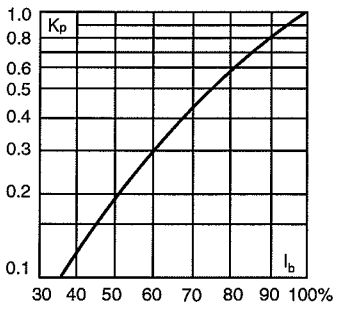
### Power Losses

Watts loss at rated current is given in the electrical characteristics. The curve allows the calculation of the power losses at load currents lower than the rated current. The correction factor, $K_p$, is given as a function of the RMS load current, $I_b$, in % of the rated current.




1) Rated voltage 600V
2) Rated voltage 550V



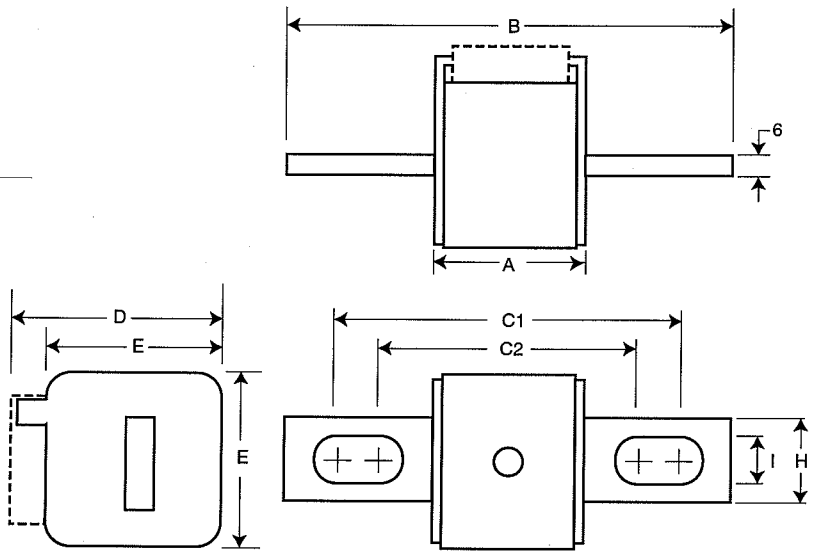




## Dimensions

US Style: Type -FU/-, -FKE/-, FU/115-, -FKE/115

| Size | A | B | B§ | C1 | C1§ | C2 | C2§ | D | E | H | I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1* | 50 | 110 | 148 | 85 | 123 | 72 | 110 | 59 | 45 | 20 | 10 |
| 1 | 50 | 136 | 157 | 104 | 126 | 78 | 100 | 69 | 53 | 25 | 14 |
| 2 | 50 | 135 | 159 | 105 | 125 | 78 | 99 | 77 | 61 | 25 | 14 |
| 3 | 51 | 135 | 155 | 106 | 125 | 77 | 97 | 92 | 76 | 36 | 16 |

§Valid for fuses type -FU/115 & -FKE/115
Dimension in mm.
1mm = 0.0394" 1" = 25.4mm



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Square Body

# Applications

## Maximum Permissible Load Current

The rated current value of Bussmann fuses is based on the ambient temperature in the space immediately below the fuse of 20°C. The following graph gives correction factors (k) for a range of temperatures (–40°C to +80°C). Maximum permissible continuous load currents can be calculated by applying the following formula:

$I_b \leq I_n \times k \times (1 + 0.05\ V) \times K_b$

where

**$I_b$ = Maximum permissible continuous load current**
**$I_n$ = Rated current of fuse**
**k = Temperature correction factor**
**v = Velocity of cooling air in m/s (max. 5 m/s).**
**$K_b$ = Fuse load constant 1.0**

The maximum permissible continuous load current $I_b$ of a fuse can be checked empirically (i.e., by satisfying the formula below) by making simple voltage and temperature measurements under actual operating conditions after the fuse has been installed in its operating location and loaded at the calculated $I_b$ value:

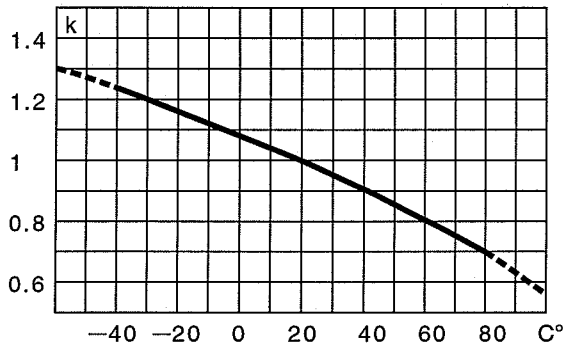
$\frac{E_2}{E_1} \times (0.92 + 0.004t) \leq N$

where

**$E_1$ = Voltage drop across fuse after 5 seconds**
**$E_2$ = Voltage drop across fuse after 2 hours**
**t = Air temperature at start of test (°C)**
**N = Constant**

| Fuse Rated Voltage (IEC) | N |
|---|---|
| 690 | 1.5 |
| 1250 | 1.6 |

**Temperature Correction Curve**




## Body Cross Section

Standard fuse program includes barrels with different cross sections.

| Size | 000 | 00 | 1* | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| Maximum Cross-section mm | 21 × 36 | 30 × 47 | 45 × 45 | 53 × 53 | 61 × 61 | 76 × 76 | 105 × 105 |

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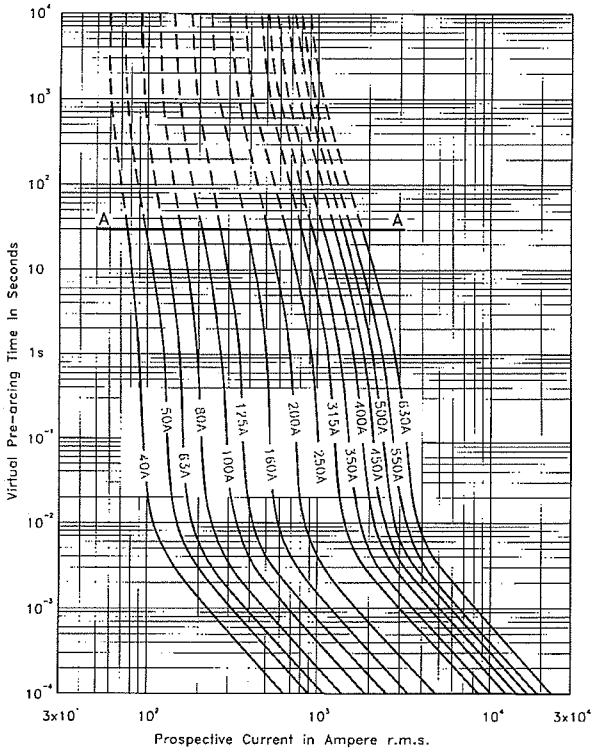
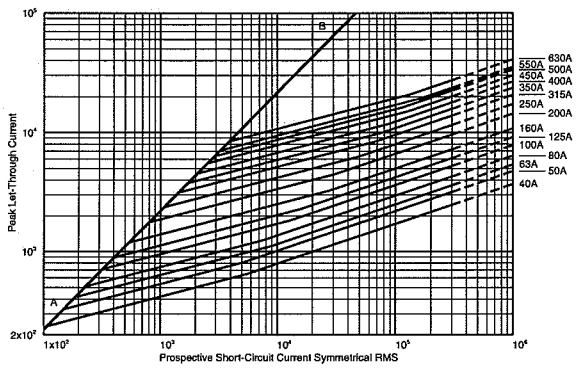
Square Body
# Curves

## Size 1*: 690V (40-630)A
### Time-Current Curve

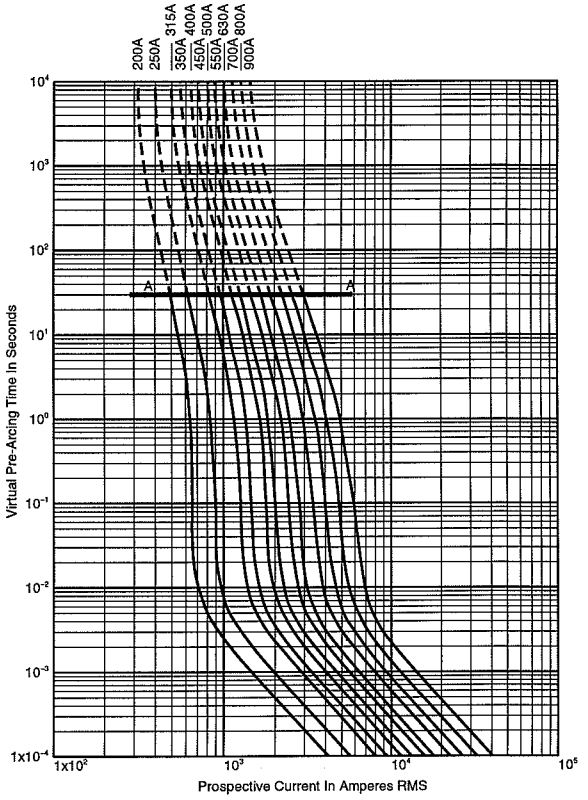
400A käyrä selvempänä seur. sivulla!



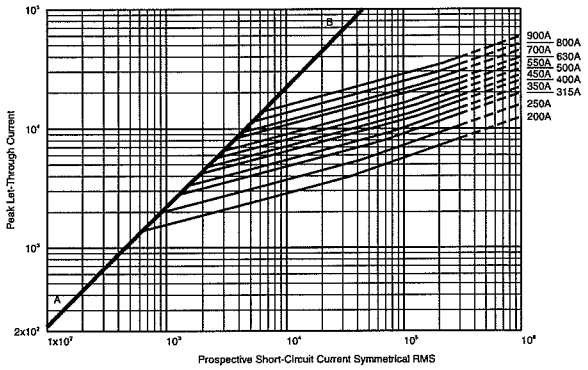

### Peak Let-Through Curve




## Size 1: 690V (200-900)A
### Time-Current Curve



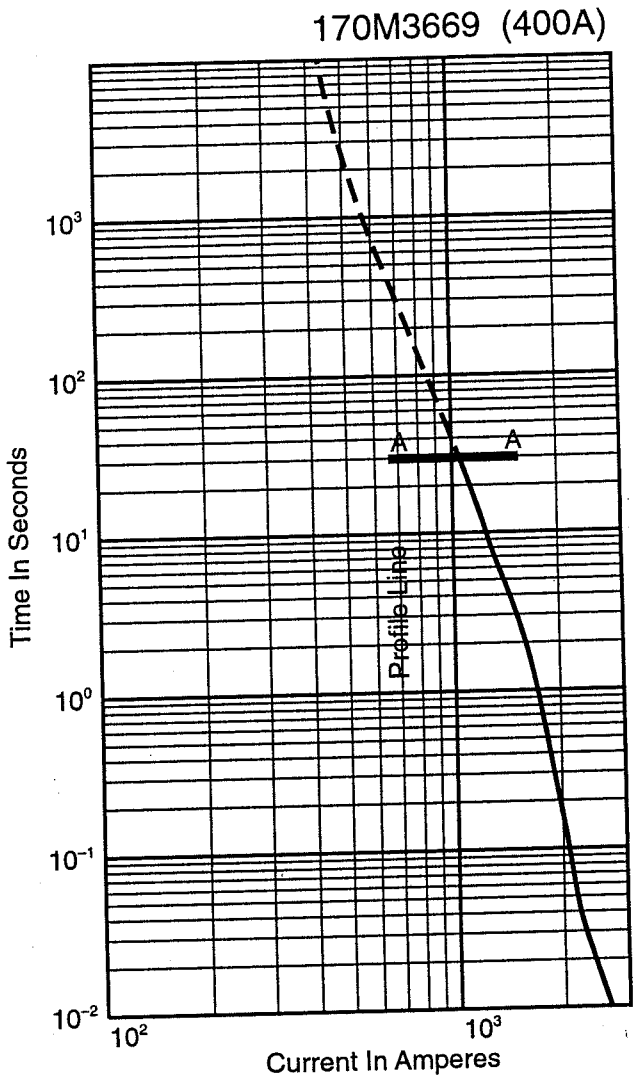

### Peak Let-Through Curve




900 amp fuse is derated to 550V (IEC).

*BIF document: 17056314*

*BIF document: 17056316*


170M3669 (400A)
Time In Seconds
$10^3$
$10^2$
$10^1$
$10^0$
$10^{-1}$
$10^{-2}$
A
A
Profile Line
$10^2$
$10^3$
Current In Amperes