WHITE PAPER:

Differences and Similarities Between K Curve and D Curve Breakers

E-T-A®
ENGINEERING TECHNOLOGY

A COMPARISON OF THERMAL & MAGNETIC
Tripping Characteristics

A Miniature Circuit Breaker (MCB) is a resettable protective device that prevents electrical circuits from catching fire and causing damage to personnel and property. It is a device designed to isolate a circuit during an overcurrent event without using a fusible element.

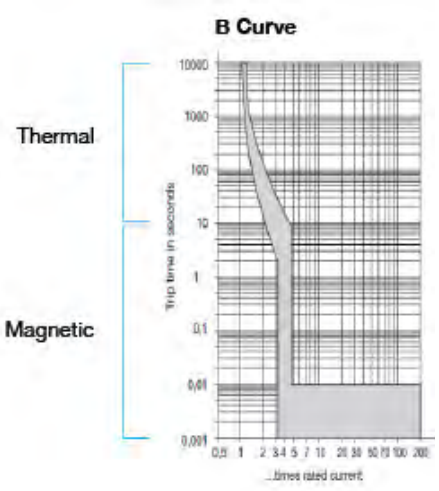
There are two types of overcurrent events; a thermal overload and a short circuit.

Thermal Overload: A thermal overload is a slow and small overcurrent situation that causes the ampacity and temperature of the circuit to gradually increase. This type of event is characterized by a slight increase in the load (ampacity) on the circuit and is interrupted by the thermal trip unit of the breaker.

Short Circuit: A short circuit is an intense overcurrent situation that causes the ampacity of the circuit to increase. This type of event is characterized by a dramatic increase in the load (ampacity) on the circuit and is interrupted by the magnetic trip unit of the breaker. MCB's tripping characteristics are represented graphically in a trip curve chart. The chart shows the response of the thermal and magnetic trip element to various overload and short circuit situations.

Components of a Trip Curve:

- *Thermal Region:* Region of the trip curve representing the tripping characteristics of the bi-metal trip unit. The tripping region is sloped due to the gradual overload, heating, and bending nature of the thermal element overtime.
- *Magnetic Region:* Region of the trip curve representing the tripping characteristics of the magnetic trip unit. The tripping region is not sloped due to the instantaneous nature of the magnetic element during a short circuit.



EXAMPLES OF TRIP CURVE INTERPRETATION

Reading Trip Curves

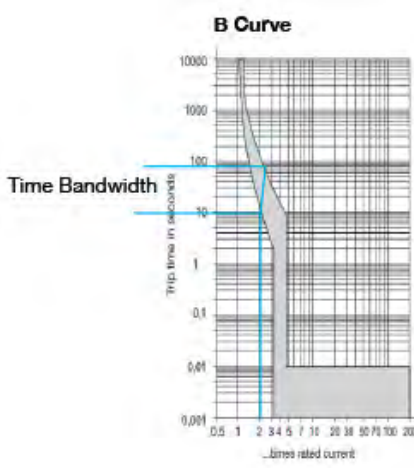
Example 1
Thermal Tripping Characteristic:

- 10A B Curve Breaker
- Thermal Overload at 20A

To determine the time it takes for the breaker to trip with a 20A load

- Find 20A on the bottom of the curve - 20A breaker @ 2X current is 20A
- Follow the ampacity line up to the „time“ tripping region of the curve

The breaker will trip under a thermal overload between 10 and 100 seconds. The breaker is guaranteed to not trip before 10 seconds and will not take longer than 100 seconds to trip. The breaker may trip at any time between 10 and 100 seconds.



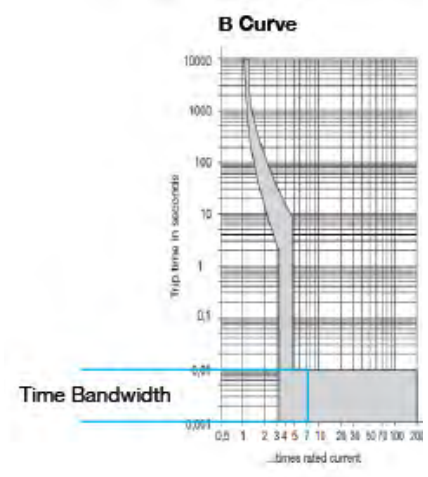
Example 2
Magnetic Tripping Characteristic:

- 10A B Curve Breaker
- Short Circuit at 70A

To determine the time it takes for the breaker to trip with a 70 short circuit.

- Find 70A on the bottom of the curve - 10A breaker @ 7X current is 70A
- Notice the „time“ at the bottom left corner of the chart axis

The breaker will trip under a short circuit between .001 and.01 seconds. The breaker is guaranteed to trip no later than .01 seconds for any short circuit equal to 70A.



COMMON MCB TRIP CURVES

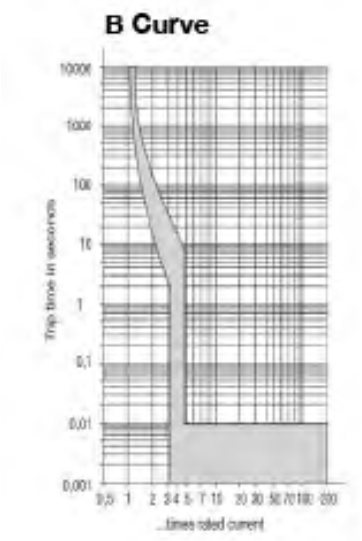
B Curve | C Curve | D Curve

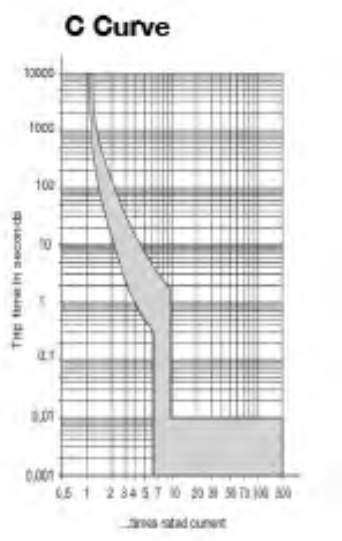
There are several types of MCB curves that manufacturers provide for applying circuit protection in different applications. The most common curves are B, C, and D. One MCB manufacturer also produces a K and Z curve.

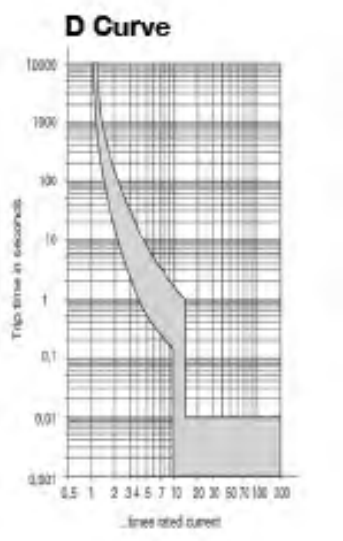
B curve breakers: Trip between 3-5 times rated current in a short circuit situation. B curve MCBs should be applied where loads are resistive and do not have in-rush current. The ideal application is lighting or electronic circuits.

C curve breakers: Trip between 6-10 times rated current in a short circuit situation. C curve MCBs should be applied where the loads have a small amount of in-rush current on start-up. The ideal application is a circuit with a small transformer load.

D curve breakers: Trip between 10-15 times rated current. D curve MCBs should be applied where loads have a high level of in-rush current on start-up. The ideal application is a circuit with a motor load.







K CURVE MCBS VS. D CURVE MCBS

A Comparison

The K and D curve breakers are both designed for motor applications where ampacity rises quickly and momentarily during “start-up.” Both curves can “ride through” the momentary inrush of current and prevent nuisance tripping while providing protection to the circuit.

The K and D curve MCB have almost identical tripping characteristics. The magnetic element tripping characteristics are identical between the two curves and the thermal element tripping characteristics have a slight variation.

E-T-A THERMAL D CURVE VS. THERMAL K CURVE

An Example

- 10A D Curve Breaker
- Thermal Overload at 20A

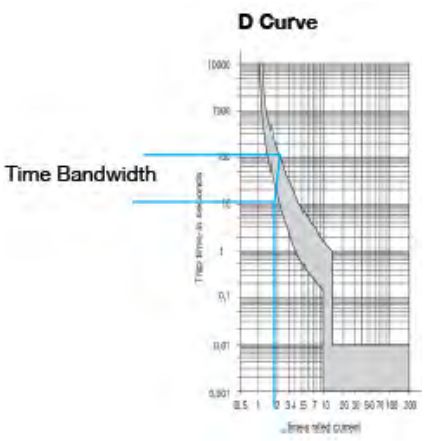
To determine the time it takes for the breaker to trip with a 20A load.

- Find 20A on the bottom of the curve - 10A breaker @ 2X current is 20A
- Follow the ampacity line up to the „time“ tripping region of the curve

The breaker will trip under a thermal overload between 10 and 100 seconds. The breaker is guaranteed to not trip before 10 seconds and will not take longer than 100 seconds to trip. The breaker may trip at any time between 10 and 100 seconds.

Let‘s now compare this to a 10A K Curve Breaker with a Thermal Overload at 20A

The K Curve Breaker will trip under a thermal overload between 6 and 350 seconds. The breaker is guaranteed to not trip before 6 seconds and will not take longer than 350 seconds to trip. The breaker may trip at any time between 6 and 350 seconds.

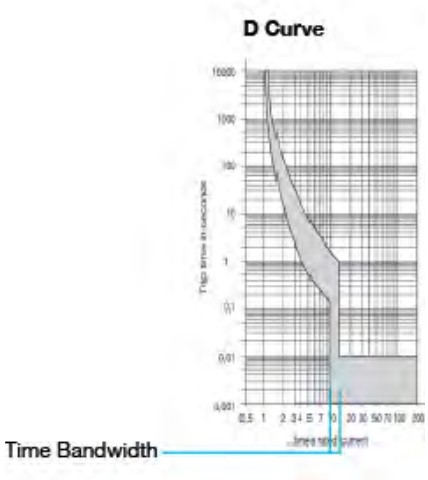


E-T-A MAGNETIC D CURVE VS. MAGNETIC K CURVE

An Example

- 10A K Curve Breaker and 10A D Curve Breaker
- Short Circuit at 100A

Both breakers have an element that will trip between 10 and 15 times rated current. Both breakers will trip under a short circuit between .001 and .01 seconds. And both breakers are guaranteed to trip no later than .01 seconds for any short circuit equal to 100A or greater.



K and D Curve Analysis:

- *Magnetic Element:* The magnetic element of the K curve and D curve MCBs are identical. Both breakers interrupt a short circuit at 10X the rated current (or greater) in no later than .01 seconds.
- *Thermal Element Minimum Tripping:* The D curve MCB will interrupt an overload at 2X rated current in 10 seconds or greater. The K curve MCB will interrupt an overload at 2X rated current in 6 seconds or greater. The D curve is delayed by 4 seconds when compared to the K curve. The additional 4 seconds allows a circuit more time to “ride through” high in-rush at start-up and prevent nuisance tripping.
- *Thermal Element Bandwidth:* The K curve tripping bandwidth at 2X rated current is between 6 and 350 seconds. The D curve tripping bandwidth at 2X rated current is between 10 and 100 seconds. The differences between the bandwidths demonstrate calibration and quality control accuracy. The D curve breaker from E-T-A has a much smaller tolerance bandwidth and requires a higher level of adjustment during manufacturing and quality control validation.

FEATURED PRODUCT

UL 489 & UL 1077 4230-T Miniature Circuit Breaker

The 4230 is a thermal-magnetic MCB in a standard enclosure in accordance with DIN 43880. Its conformity with the relevant standards IEC 60947-2, UL1077 and UL 489 makes the 4230-T ideally suitable for worldwide use. Due to its high rupture capacity of 63 A, the 4230 is suitable for use as »Branch Circuit Protection« and also as »Sup plementary Protector«. Later product extensions with add-on modules, such as auxiliary contact modules or working current modules, offer high flexibility for the user. In addition, the device features reliable switching behaviour through snap action mechanism and is positively trip-free.

Typical applications:

- Standard applications in machine cons-truction and process control, process industry, apparatus engineering and infrastructure
- Protection of AC and DC circuits, also with direct connection to the electrical grid

Approvals and standards:

- UL 1077
- UL 489
- IEC/EN 60947-2

Technical Data	
Rated Current	1.0 ... 63 A
Voltage Ratings	AC 240 V, 3 AC 415 V, DC 80 V,(UL: AC 480Y/277 V, DC 60 V)
Number of Poles	1-pole, 2-pole, 3-pole, 4-pole
Auxiliary Contacts	1 changeover contact, to be fitted on the side
Mounting Method	DIN Rail
Installation Width	17.6 mm

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