

# Current limiting circuit breakers

## ABB Tmax XT changes the rules



Explore the significant performance advantages offered by current-limiting circuit breakers compared to standard non-current-limiting breakers.

—  
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Current-limiting circuit breakers have been around for some time, but recent advances by ABB in current-limiting circuit breaker technology and performance have changed the rules for protection of sensitive power electronics. Variable-frequency drives, soft starters, inverters and other equipment using sensitive power electronic components often require the use of current-limiting fuses for proper short-circuit protection. ABB Tmax XT current-limiting circuit breakers, provide short-circuit protection without the need for current-limiting fuses.

Tmax XT breakers provide substantial performance advantages over standard non-current limiting circuit breakers. The Tmax XT2 and XT4 frames exhibit high interrupting ratings and amazing performance characteristics.

UL defines a current-limiting circuit breaker in its standard for molded case circuit breakers, molded case switches, and circuit breaker enclosures, UL489. It describes a current-limiting breaker as “one that does not employ a fusible element and,

when operating within its current-limiting range, limits the let-through  $I_2t$  to a value less than the  $I_2t$  of a 1/2-cycle wave of the symmetrical prospective current.”

As part of the certification process to qualify as a UL current-limiting circuit breaker, the breaker must be subjected to short-circuit testing at three levels: the threshold current, the intermediate point and the maximum interrupting rating. The device’s conformance tests are witnessed and verified by a UL representative, and the results are UL certified to meet the current-limiting requirements of the standard.

The amount of current limitation depends on the time needed for the circuit breaker to open the contacts and extinguish the arc. This clearing time is a very important consideration, because even though the circuit breaker contacts have opened, the current flow continues in the circuit until the arc is fully extinguished. ABB Tmax XT2 and XT4 frame circuit breakers not only meet the required performance criteria but exceed them.

Tmax XT molded case circuit breakers are the ideal solution for all distribution levels, from the main low-voltage switchboard to panelboards throughout the installation. They feature high specific let-through current peak and energy limiting characteristics that allow the circuits and equipment on the load side to be sized optimally. Tmax XT circuit breakers with thermomagnetic trip units protect against short circuits and overloads; while circuit breakers with electronic trip units can also provide additional protection, such as ground fault and short time delay for maximum flexibility and selective coordination in low-voltage distribution networks.

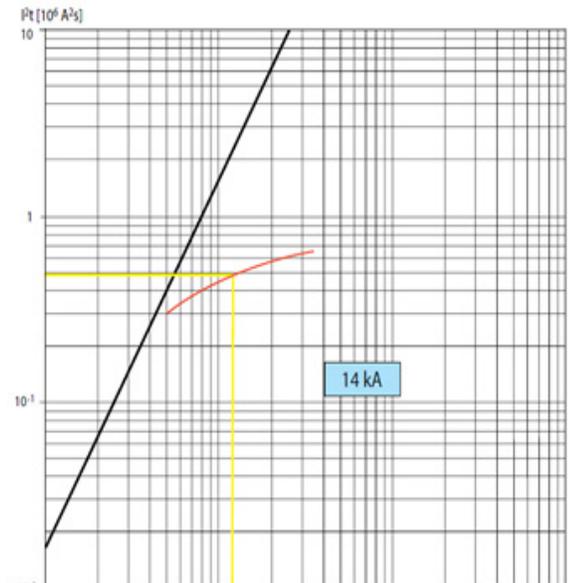
All circuit breakers are not created equal. Circuit breakers from different manufacturers and even breakers from the same manufacturer can have different performance characteristics. The UL 489 standard is used to verify that circuit breakers, regardless of manufacturer, comply with the minimum performance requirements defined by the product standard. Circuit breaker manufacturers may have different product designs, use different materials or employ different manufacturing techniques that make their products unique, allowing manufacturers to differentiate their products in terms of price, physical size, performance and value. For comparison, we used the performance delivered by the ABB Tmax XT2 and XT4 circuit breakers as examples of current-limiting circuit breakers and used the ABB Tmax XT3 as an example of a standard, or non-current-limiting, circuit breaker.

#### Selection of Overcurrent Protective Device (OCPD)

When selecting an overcurrent protective device for the protection of a panel or load containing sensitive devices, it is important to follow the recommendations of the manufacturer of the device(s) being protected. Often these recommendations are based on short-circuit testing made by the device manufacturer. Other times the selection is based on the I<sub>2t</sub> or A<sub>2s</sub> rating of the component and the let-through energy values of the OCPD. Comparing examples of the current-limiting performance of the current-limiting circuit breakers to that of ABB's standard circuit breakers may help illustrate the proper selection of overcurrent protective device when protecting sensitive loads.

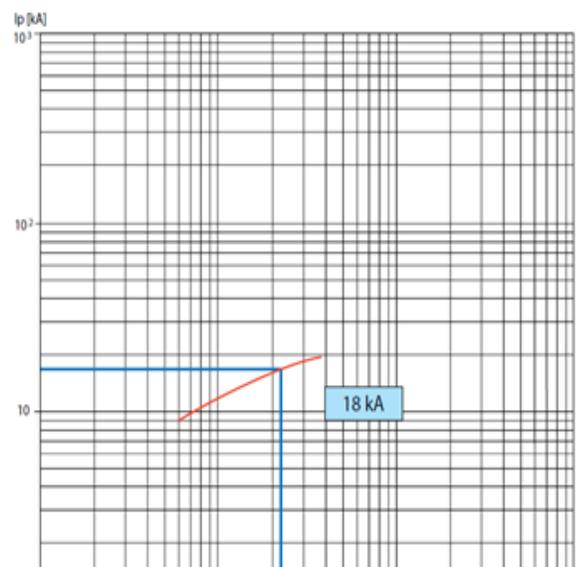
#### Example – Understanding specific let-through energy curves

This figure shows the specific let-through energy of the XT2H 125 circuit breaker at 240V. The short-circuit current is indicated on the X-axis, and the specific let-through energy, expressed in A<sup>2</sup>s, is shown on the Y-axis. The circuit breaker lets through a value of I<sub>2t</sub> equal to 0.42 X 10<sup>6</sup> A<sup>2</sup>s relative to a short-circuit current of 14kA.



#### Example – Understanding current limitation curves

This figure shows the current-limitation curves of the XT2L 125 circuit breaker. The short-circuit current is indicated on the X-axis of the diagram, whereas the peak value corresponding to the prospective short-circuit current is indicated on the Y-axis. For a current value of 22kA, the XT2L circuit breaker with a thermomagnetic trip unit, I<sub>n</sub> = 125A, limits the peak prospective short-circuit current to 18kA at a voltage of 600V.



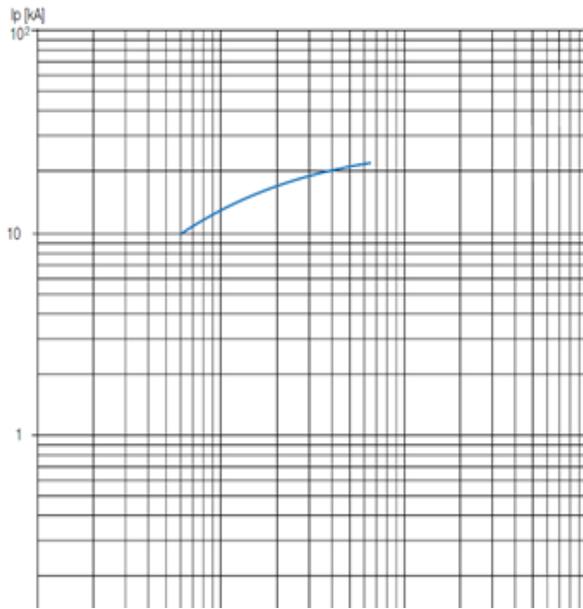


Figure 1 – XT2H 480V Current Limitation Curve

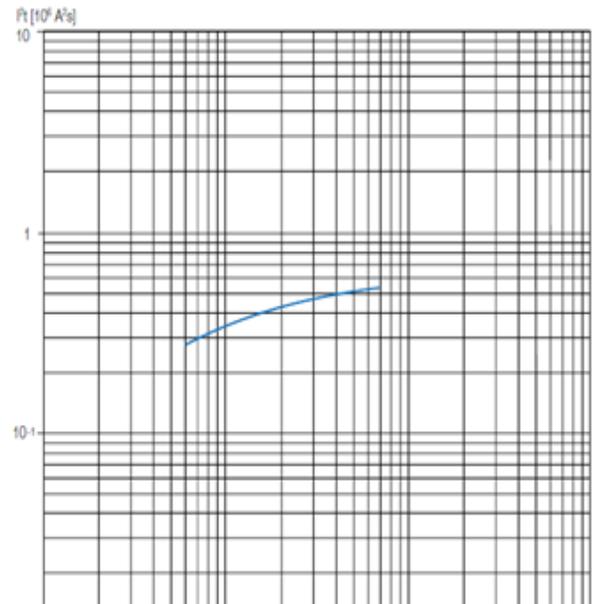


Figure 2 - XT2H 480V Specific Let-through Energy Curve

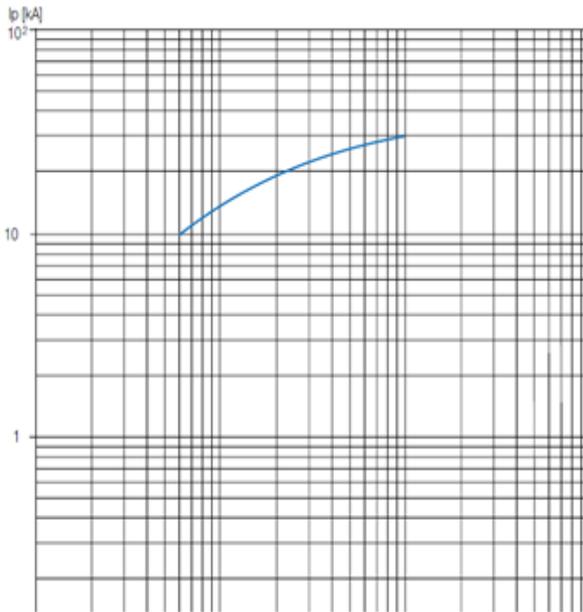


Figure 3 - XT2L 480V Current Limitation Curve

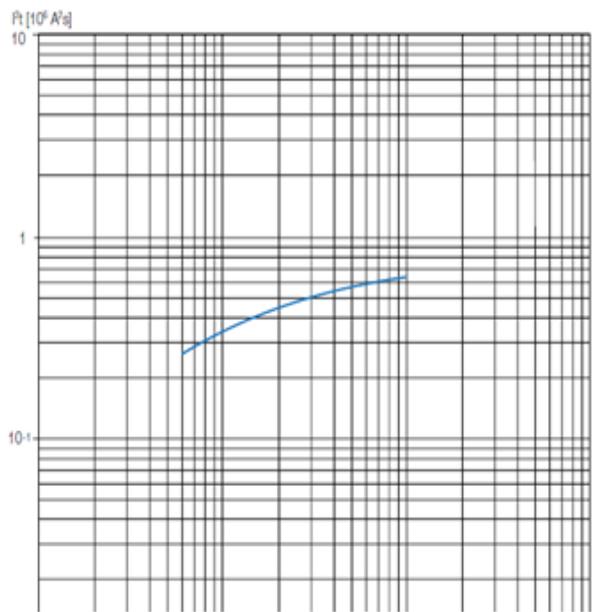


Figure 4 - XT2L 480V Specific Let-through Energy Curve

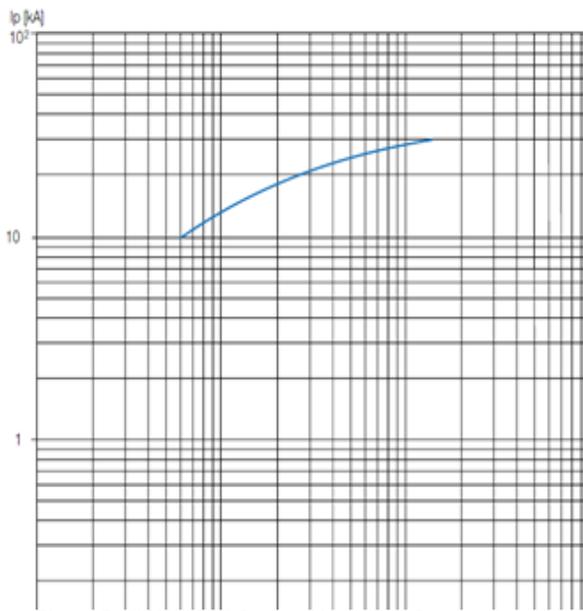


Figure 5 – XT2V 480V Current Limitation Curve

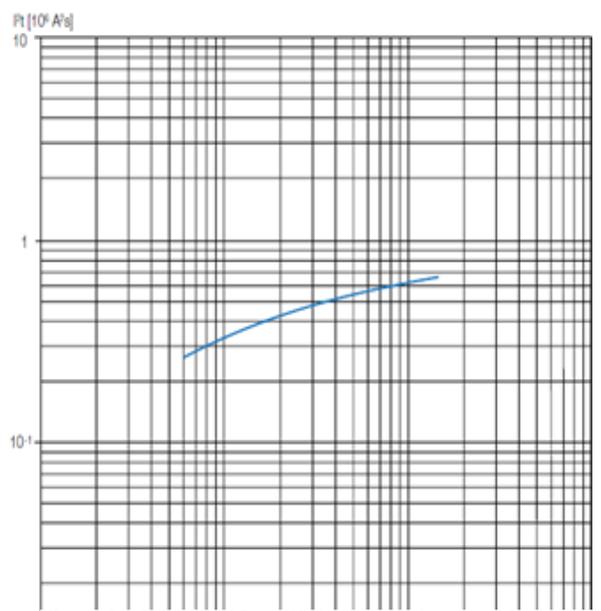


Figure 6 - XT2V 480V Specific Let-through Energy Curve

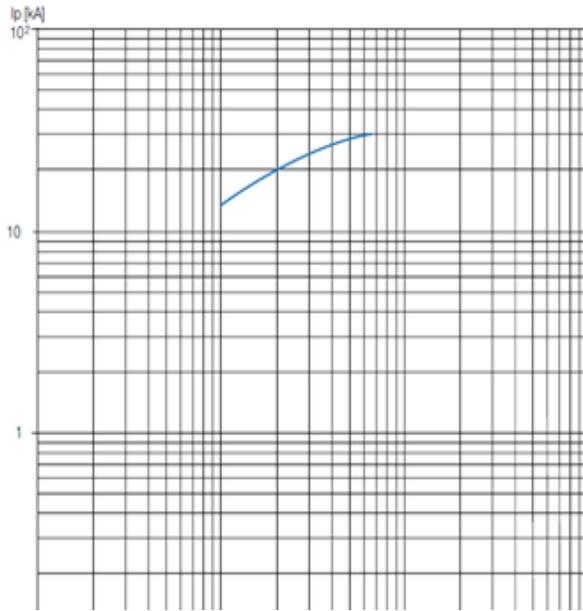


Figure 7 – XT4H 480V Current Limitation Curve

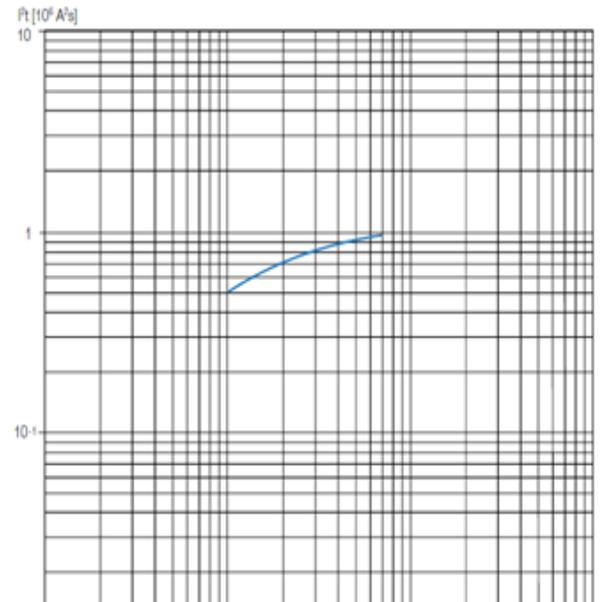


Figure 8 – XT4H 480V Specific Let-through Energy Curve

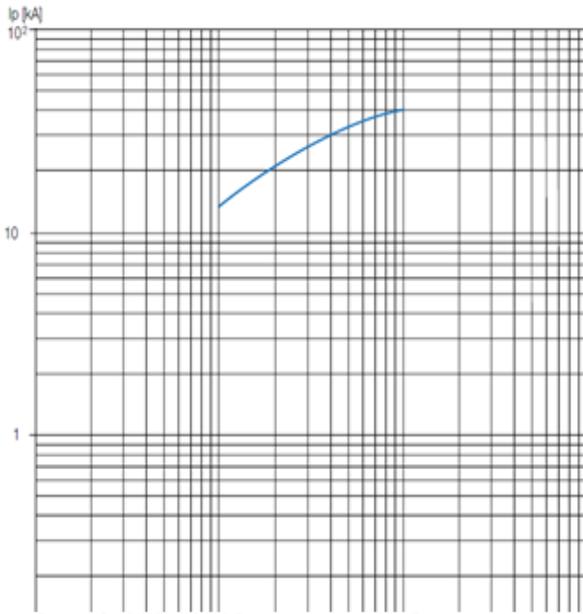


Figure 9 – XT4L 480V Current Limitation Curve

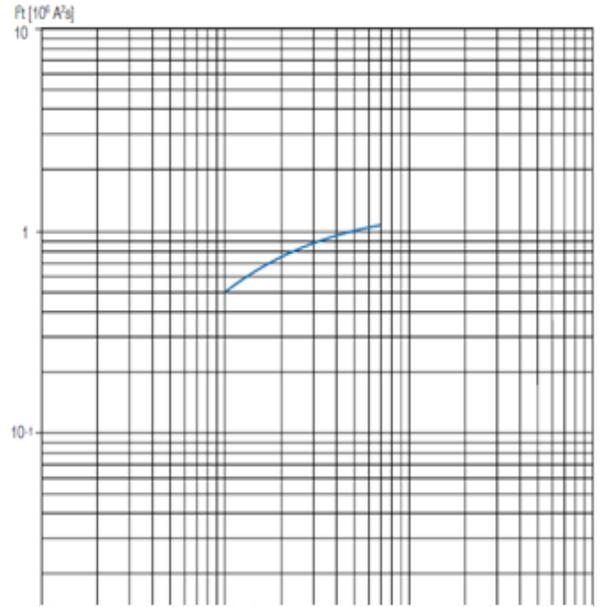


Figure 10 – XT4L 480V Specific Let-through Energy Curve

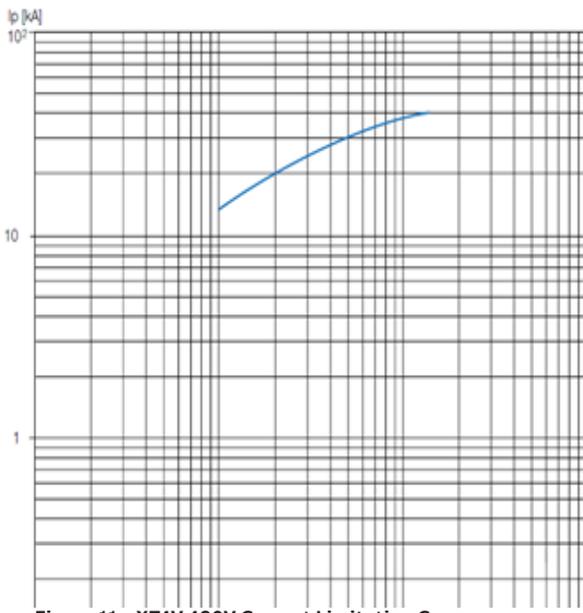


Figure 11 – XT4V 480V Current Limitation Curve

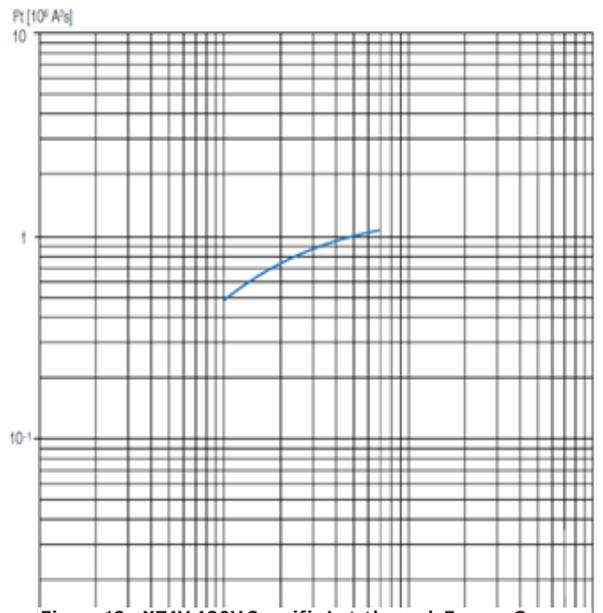


Figure 12 – XT4V 480V Specific Let-through Energy Curve

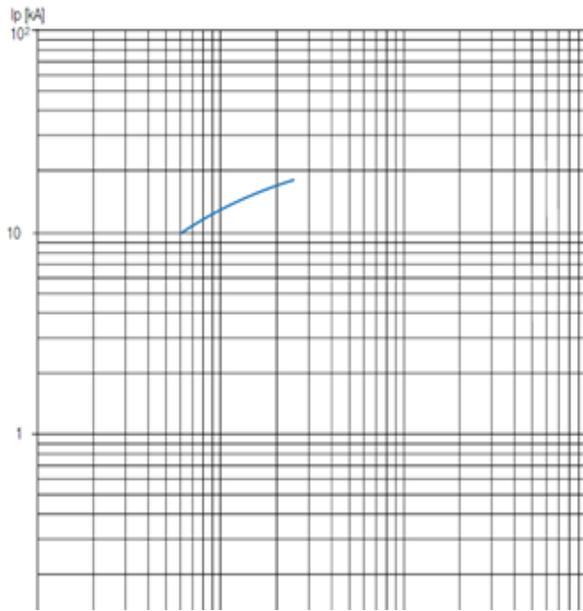


Figure 13 – XT2H 600V Current Limitation Curve

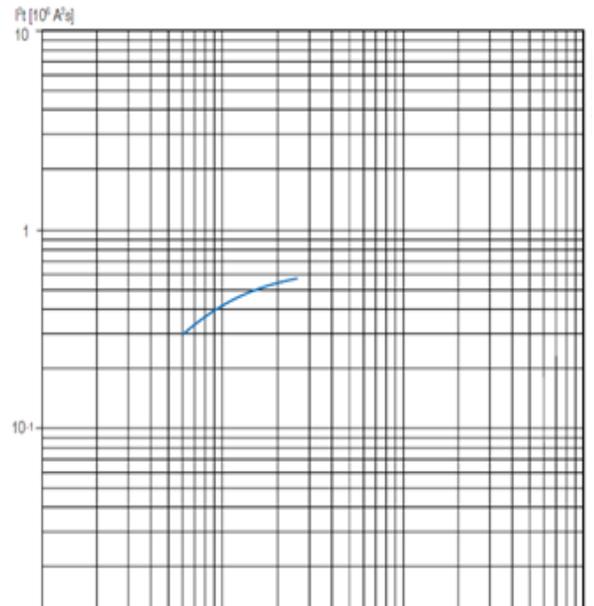


Figure 14 – XT2H 600V Specific Let-through Energy Curve

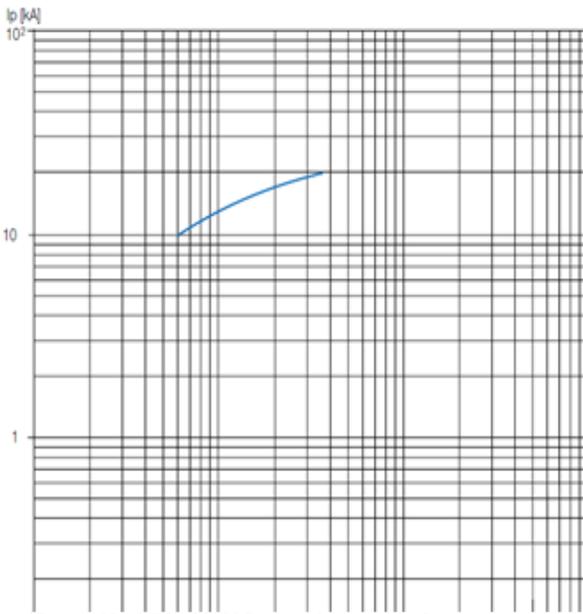


Figure 15 – XT2L 600V Current Limitation Curve

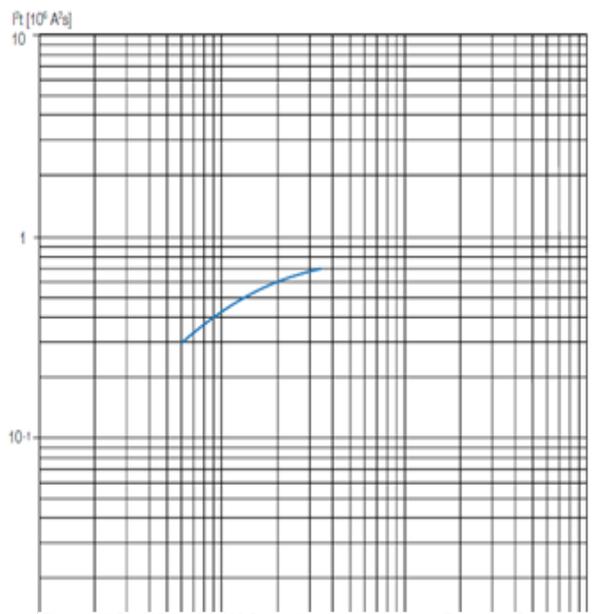


Figure 16 – XT2L 600V Specific Let-through Energy Curve

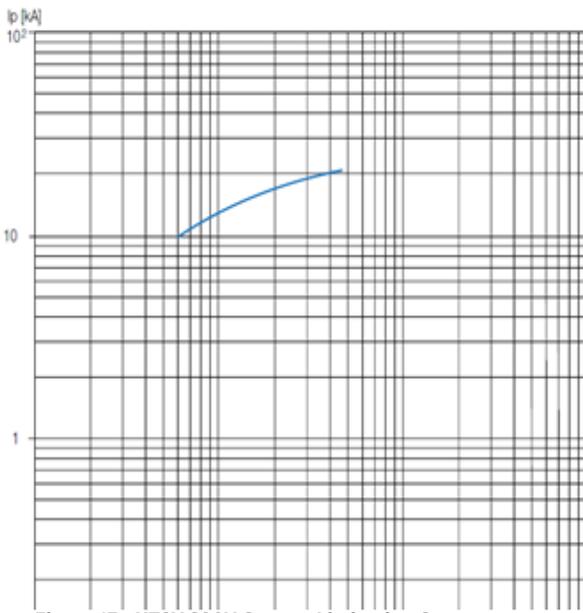


Figure 17 – XT2V 600V Current Limitation Curve

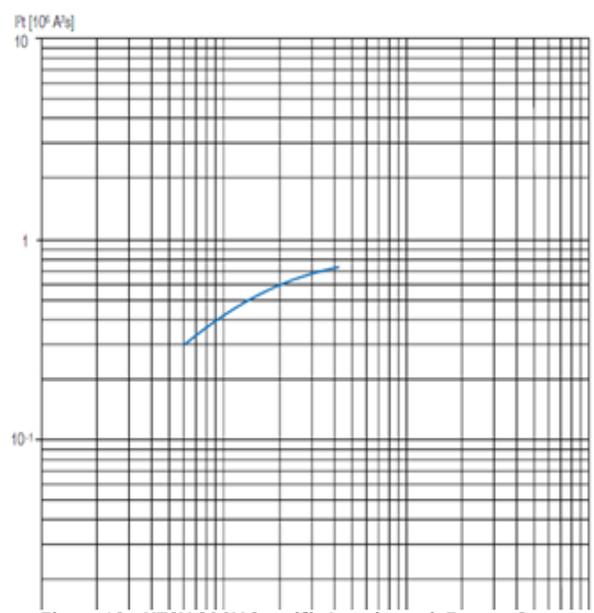


Figure 18 – XT2V 600V Specific Let-through Energy Curve

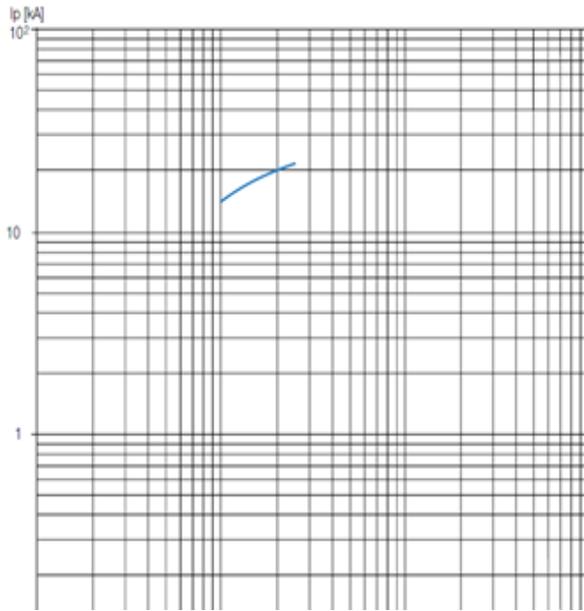


Figure 19 – XT4H 600V Current Limitation Curve

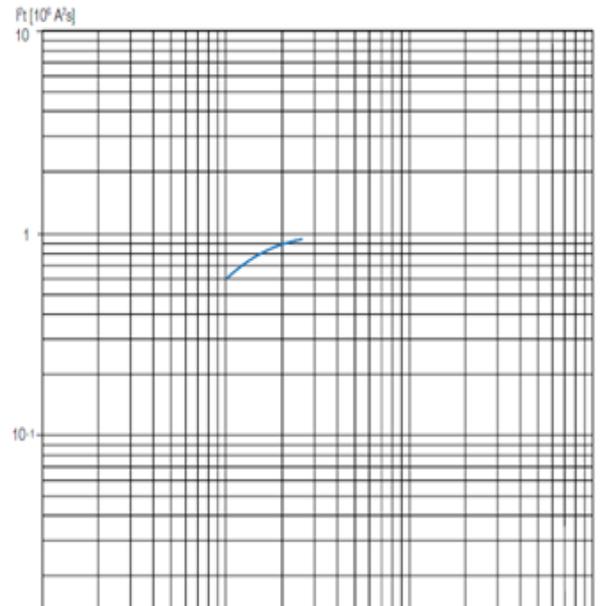


Figure 20 – XT4H 600V Specific Let-through Energy Curve

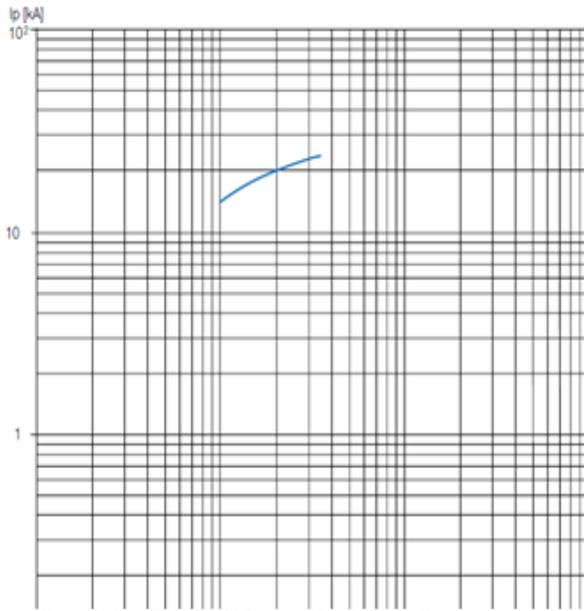


Figure 21 – XT4L 600V Current Limitation Curve

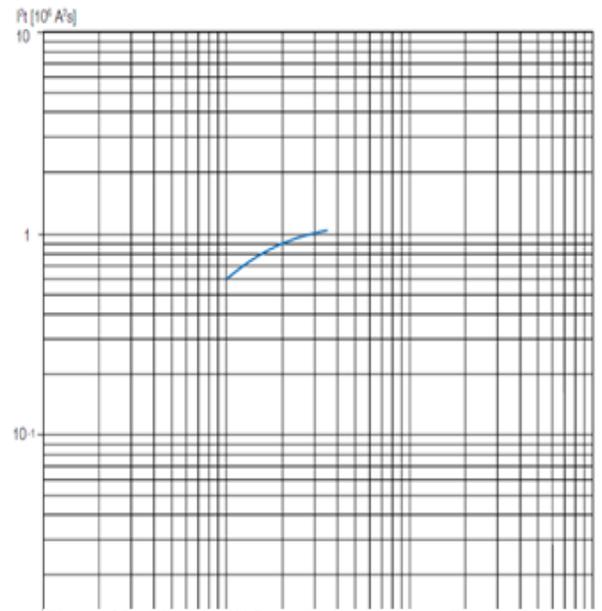


Figure 22 – XT4L 600V Specific Let-through Energy Curve

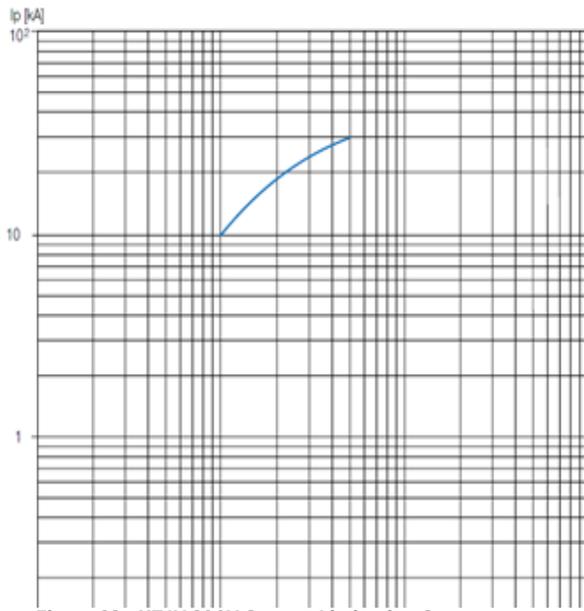


Figure 23 – XT4V 600V Current Limitation Curve

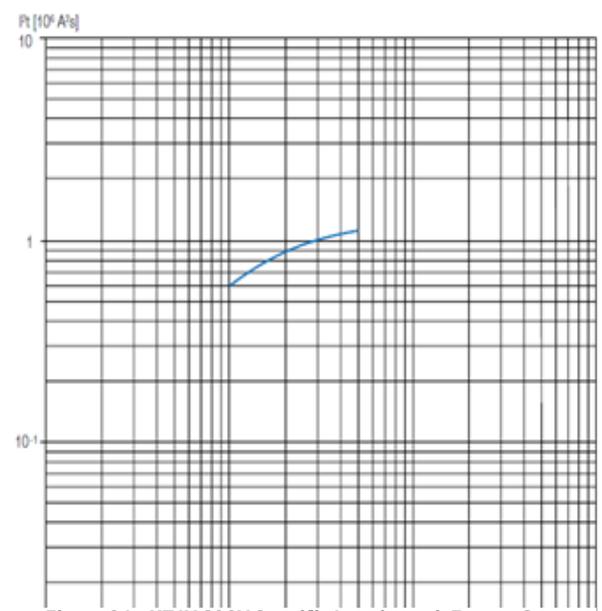
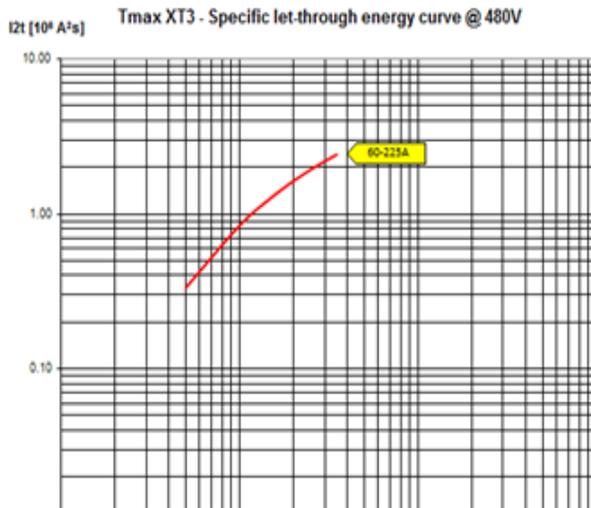


Figure 24 – XT4V 600V Specific Let-through Energy Curve

### Example 1 – Specific Let-through Energy Comparison. Tmax XT3 to Tmax XT2 or XT4



The Tmax XT3 circuit breaker is a standard or non-current-limiting circuit breaker with continuous current ratings ranging from 60 to 225 amps. Using the standard (S) interrupting rating of 35kA @ 480 volts, the specific let-through energy is  $2.42 \times 10^6$  A<sup>2</sup>s. Figure 2 shows the Tmax XT2H, applied at the same 35kA @ 480 V, has a specific let-through energy of approximately  $0.48 \times 10^6$  A<sup>2</sup>s, which is about one-fifth (20 percent) of the let-through energy of the Tmax XT3. For load requirements greater than 125 A, the Tmax XT4H (figure 8) protects up to 250 amps and has a let-through energy at 35kA - 480V of  $0.85 \times 10^6$  A<sup>2</sup>s. While this is considerably higher than the let-through energy of the Tmax XT2, it is still only about one-third (33 percent) of the let-through energy of the standard Tmax XT3 non-current limiting circuit breaker. This substantial reduction in energy greatly reduces the thermal and electrodynamic forces to which the system is subjected during a short-circuit event, providing more protection to the equipment, when needed.

### Example 2 – Current Limitation Curves Tmax XT2 to Tmax XT4

In some applications, the peak current available may be the important circuit parameter to consider, reduce or limit. A current-limiting circuit breaker can offer performance advantages here, as well. Figures 15 and 21 show Tmax XT2L at 22kA- 600 V limits the peak current to 18 KA, while a Tmax XT4L at 22kA - 600V limits the peak current to 22.3kA. Standard circuit breakers, because they are not UL489 current-limiting circuit breakers, cannot provide a peak current level.

ABB offers a full line of innovative, high-performance UL489 molded case circuit breakers with the value and features you need for every application. The Tmax XT1 and XT3 are each a great value that provides cost savings on the most common applications, while the current-limiting-rated XT2 and XT4 provide advanced features for robust applications where protecting sensitive devices is critical.

## Tmax XT Current Limiting Performances

|  |                                    | XT2                       |      |      |         |     |      | XT4                       |      |      |         |      |      |
|--|------------------------------------|---------------------------|------|------|---------|-----|------|---------------------------|------|------|---------|------|------|
| Trip Units                             |                                    | TMF, TMA, EKIP            |      |      |         |     |      | TMF, TMA, EKIP            |      |      |         |      |      |
| In                                     |                                    | Up to 125A <sup>(1)</sup> |      |      |         |     |      | Up to 250A <sup>(2)</sup> |      |      |         |      |      |
| Voltage Rating                         |                                    | 480V AC                   |      |      | 600V AC |     |      | 480V AC                   |      |      | 600V AC |      |      |
| Breaking Capacities                    |                                    | H                         | L    | V    | H       | L   | V    | H                         | L    | V    | H       | L    | V    |
| <b>Threshold Current</b>               |                                    |                           |      |      |         |     |      |                           |      |      |         |      |      |
| Irms                                   | [kA]                               | 6                         | 6    | 6    | 6       | 6   | 6    | 10                        | 10   | 10   | 10      | 10   | 10   |
| Ip                                     | [kA]                               | 10                        | 10   | 10   | 10      | 10  | 10   | 14,4                      | 14,4 | 14,4 | 13,7    | 13,7 | 13,7 |
| I <sup>2</sup> t                       | [10 <sup>6</sup> A <sup>2</sup> s] | 266                       | 266  | 266  | 301     | 301 | 301  | 499                       | 499  | 499  | 582     | 582  | 582  |
| <b>Intermediate Point <sup>®</sup></b> |                                    |                           |      |      |         |     |      |                           |      |      |         |      |      |
| Irms                                   | [kA]                               | 30                        | 50   | 65   | 14      | 22  | 25   | 42                        | 50   | 65   | 18      | 22   | 30   |
| Ip                                     | [kA]                               | 19                        | 21   | 23,2 | 14,1    | 18  | 18   | 26,4                      | 26,4 | 30   | 19,1    | 22,3 | 24,2 |
| I <sup>2</sup> t                       | [10 <sup>6</sup> A <sup>2</sup> s] | 480                       | 486  | 512  | 472     | 655 | 655  | 853                       | 853  | 980  | 791     | 990  | 1058 |
| <b>Interrupting Rating</b>             |                                    |                           |      |      |         |     |      |                           |      |      |         |      |      |
| Irms                                   | [kA]                               | 65                        | 100  | 150  | 25      | 35  | 42   | 65                        | 100  | 150  | 25      | 50   | 50   |
| Ip                                     | [kA]                               | 23,2                      | 31,1 | 31,1 | 18      | 20  | 21,4 | 30                        | 44,5 | 44,5 | 22,3    | 30,4 | 30,4 |
| I <sup>2</sup> t                       | [10 <sup>6</sup> A <sup>2</sup> s] | 512                       | 704  | 704  | 655     | 650 | 691  | 980                       | 1142 | 1142 | 990     | 1162 | 1162 |

<sup>1</sup> Includes TMF, TMA with In = 15-125A and Ekip with In= 10, 25, 60, 100, 125A

<sup>2</sup> Includes TMF, TMA with In = 25-250A and Ekip with In= 40, 60, 100, 150, 225, 250A

## References

1SXU200095C0201, Tmax XT UL Technical Catalog, May 2015

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