WHITE PAPER:
CBEMA AND ITIC CURVES

Contributed by Wayne LaFleur February 2013

ABSTRACT

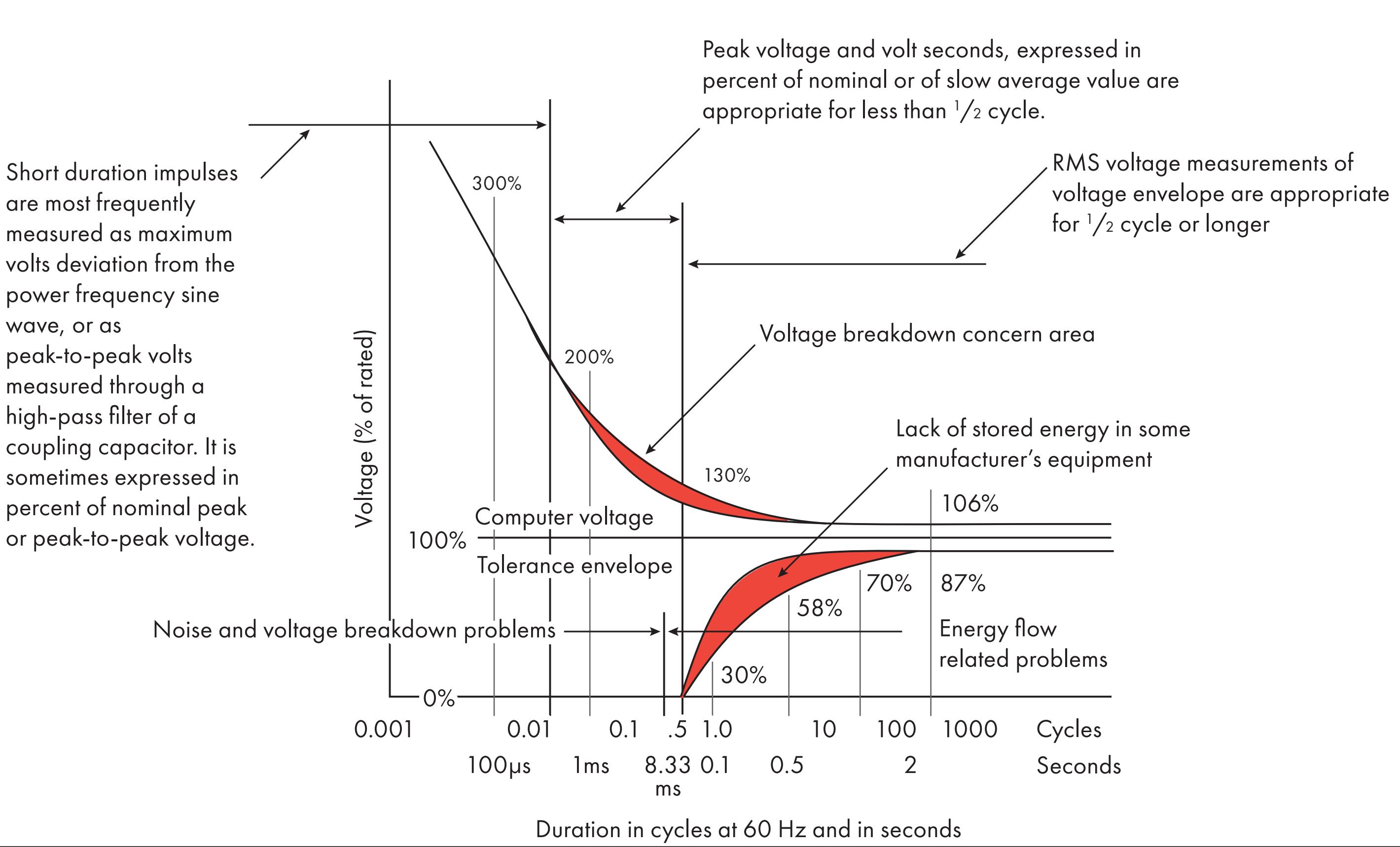
The CBEMA and ITIC curves are both used to visibly represent voltage events. The terms and associated curves are used somewhat interchangeably even though there are subtle differences between the two. The CBEMA (Computer Business Equipment Manufacturers Association) curve was originally created in the 1970's. It defines various regions based on input voltage where computer equipment may encounter operational issues. The ITIC (Information Technology Industry Council) curve is a modified version of the CBEMA curve created in the 1990's. It also defines regions based on input voltage but in a clearer fashion with discrete steps. Either can be used to create a visual representation of voltage acceptability by plotting the magnitude and duration of voltage events.

CBEMA CURVE

The boundaries of the CBEMA curve itself were created by using real world measurements from mainframe computers of the day. The boundaries were further refined by experimentation. A typical representation of the curve is shown in Figure 1.

The CBEMA curve defines various regions based on voltage deviations from norm (magnitude plus duration). The horizontal (x) axis represents the duration of an event and the vertical (y) axis indicates the percentage of nominal voltage being applied. The center of the graph in the area between the upper and lower lines is the so called acceptable region. Voltage values above the envelope could cause damage to connected equipment while voltage values below the envelope are likely to cause equipment malfunctions or cause it to shut down completely. If the supply voltage stays within the acceptable region of the graph then the

Figure 1. The CBEMA curve was originally derived from both experimental and historical data.



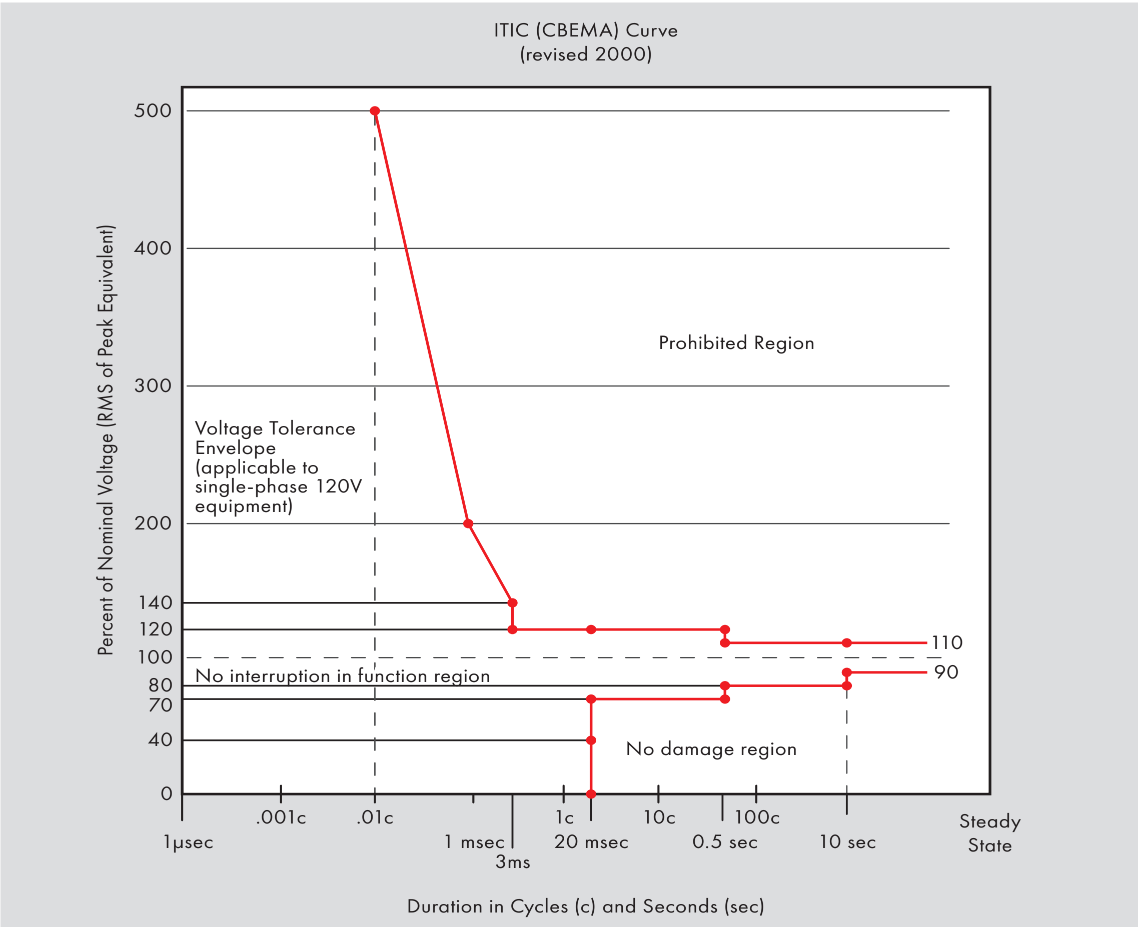


Figure 2. The ITIC curve is a modified version of the CBEMA curve.

connected equipment should operate properly.

ITIC CURVE

As stated above, the ITIC curve is a modified version of the CBEMA curve but the concept remains the same. It was developed by a working group of the CBEMA which later changed its name to the Information Technology Industry Council (ITIC). A typical representation of the curve is shown in Figure 2.

The basic layout and functionality of the graph is identical to the CBEMA version. However, compared to the CBEMA curve, the ITIC curve has an expanded acceptable region which is also more linear in nature with discrete steps for each voltage and duration zone. As with the CBEMA curve, a plot of voltage events on the ITIC curve can be used to evaluate the general voltage acceptability of a system.

USES

The ITIC and CBEMA curves define an input voltage region based on 100% of the nominal RMS voltage and increasing time durations. Voltage events that fall into this defined region can typically be tolerated by most IT equipment. The curves are not intended to be used as design specifications for products or for voltage distribution systems. However, events plotted on the graph do show a general overview of the existing voltage acceptability. The curves define both steady-state and transitory regions for events, some of which are defined below.

Voltage Swell. This type of event describes an RMS voltage of 110% to 120% of nominal with duration of up to 0.5 second. Magnitudes higher than 120% of nominal are allowed for less than one half of a cycle. Voltage swells may occur when large loads are removed from the power system or when voltage is supplied from sources other than the electric utility. A voltage swell event is an RMS measurement over time with higher magnitudes being tolerated for only very brief periods before exceeding the ITIC limits.

Voltage Sag. Two different RMS voltage sag thresholds are defined on the graph. Sags down to 70% of RMS nominal voltage are acceptable when the duration does not exceed 0.5 second while sags down to 80% of RMS nominal voltage are acceptable for a period of up to 10 seconds. Voltage sags can be caused by the application of heavy loads on the power system as well as fault conditions. Similar to voltage swells, a sag event is an RMS voltage measurement over time with lower magnitudes being allowed for only brief periods before exceeding the ITIC limits.

Low Frequency Decaying Ringwave. This type of event is a decaying ringwave transient that typically results from the connection of power factor correction equipment. The frequency of this type of transient may range from 200 Hz to 5 kHz. The magnitude is expressed as a percentage of the peak 60 Hz nominal voltage (not the RMS value). The amplitude of the transient will vary from 140% to 200% across the frequency range with a linear increase in amplitude with increasing frequency.

High Frequency Impulse and Ringwave. A type of transient that typically occur due to lightning strikes. Transients are detected based on deviations from the expected waveform rather than using a simple RMS measurement. This makes these types of events more difficult to detect and plot and results in some ambiguity as to the beginning and end of the event.

Dropout. Voltage dropouts include both severe RMS voltage sags (less than 70% of RMS nominal voltage) and complete interruptions of the applied voltage. These are typically followed by immediate restoration of the nominal voltage. This type of event is only acceptable for 1 full cycle before exceeding the ITIC limit.

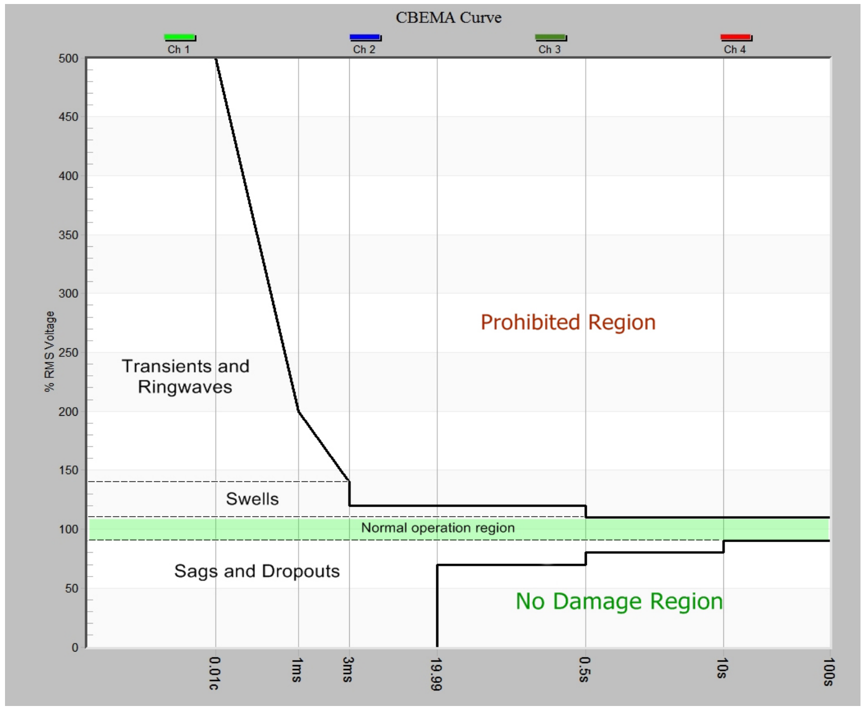


Figure 3. CBEMA graph from a Revolution

Damage Region. Events in this region include sags and dropouts of longer duration than those specified in the preceding event descriptions. This region also pertains to steady state voltages less than 90% of RMS nominal voltage. Normal functioning of connected equipment is not expected but no damage should result.

Prohibited Region. Events in the prohibited region include any swell of longer duration than described above. This region also pertains to steady state voltages greater than 110% of RMS nominal voltage. Connected equipment could be damaged due to voltages in this region.

Some of these event definitions are well defined and the associated regions are easily identified on the graph. These include the swell, sag and dropout type of events. The other event types are less obvious since the events themselves may not have an easily identified beginning and end. These are the low frequency decaying ringwave and the high frequency impulse which are deviations from the expected waveform and not a simple RMS measurement. Figure 3 shows the CBEMA graph from a Revolution with the various regions identified.

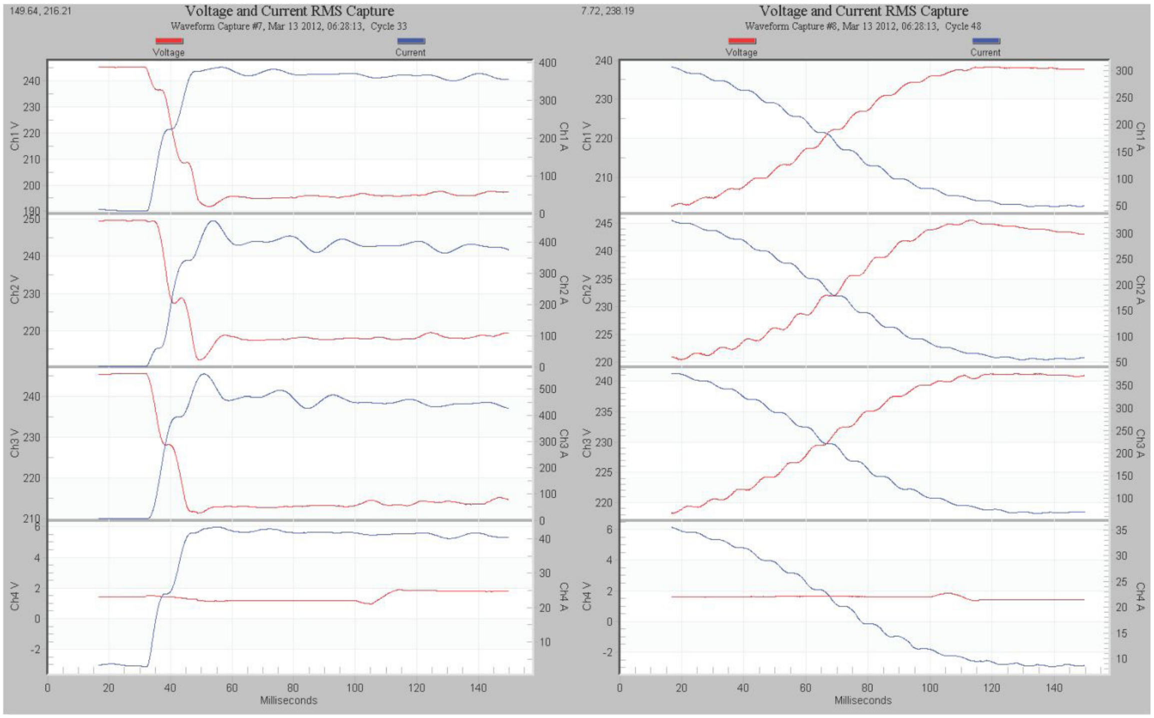


Figure 4. Waveform capture example

REAL WORLD EXAMPLE

In the white paper "[Computing Event Duration With Interval Data](#)," a real world file was used to show how event duration could be determined using a combination of inputs including a stripchart, an interval voltage report, a significant change report and a waveform capture graph. The event described was determined to have lasted approximately 12 cycles at 79% of nominal RMS voltage. The associated waveform capture (Figure 4) is shown in white paper 79, linked previously.

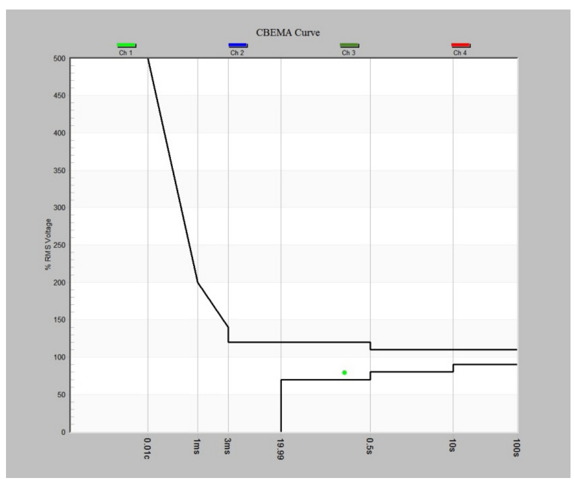


Figure 5. The event shown in Figure 4 does not exceed ITIC limits.

Note that this particular waveform is based on 240 volt nominal voltage. The beginning of the sag event is captured in cycle 33 and the ending is captured in cycle 48. This event would have been shown on the CBEMA graph in Provision if captured and downloaded via a properly configured Revolution. This event does not exceed the ITIC limits and the graph reflects this finding at a glance. A sample graph with the single equivalent data point from this example is shown in Figure 5. It would not have taken very much for this particular event to exceed the curve as can be seen on the graph. If the sag had lasted another 18 or 19 cycles it would have exceeded the 0.5 second (30 cycles) duration limit or if the sag had been less than 70% of nominal voltage then it would have exceeded the lower boundary after only 1 to 2 cycles.

CONCLUSION

The ITIC and CBEMA curves both serve the same function. The ITIC curve has better defined voltage and duration levels for detection and graphing of voltage events. The Revolution has the capability to detect and record each type of anomaly based on the ITIC regions. Once downloaded into Provision these recorded events will be graphed onto a representative CBEMA (ITIC) curve for a visual representation of the overall voltage acceptability.

Wayne LaFleur
Senior Engineer
wlafleur@powermonitors.com
https://www.powermonitors.com
(800) 296-4120