

EXPLORING THE CAPACITOR TECHNOLOGIES NEEDED IN ELECTRIC VEHICLES



The electrical power systems in most modern technologies, like electric vehicles (EVs), are complex. In EVs specifically, power systems are responsible for performing many tasks such as converting AC to DC and DC to AC as well as managing changing power levels in DC/DC conversion. When performing these tasks, manipulating AC voltages and removing noise from DC voltage requires passive components such as capacitors, to perform many “jobs” inside the power system. But no single capacitor type can perform all these jobs since each one has different requirements for voltage, size, temperature, and reliability. Therefore, a variety of capacitor technologies, such as ceramic, film, and aluminum, are required to meet all these needs.

As a starting point to understanding what technology to use, let's look at the graph in Figure 1 to see the capacitance and voltage ranges covered by each capacitor type. In general, you can expect to see the following capacitance ranges:

Key Functional Components in Radar Systems

We can learn a lot about radar systems by looking at the functional components and what specific tasks they perform. In the diagram below, we treat each function as a separate block, even though these functions can be combined or divided across several circuits.

- [Multilayer ceramic capacitors](#) (MLCCs) from under a picofarad to hundreds of microfarads
- [Film](#) from under a nanofarad to tens of millifarads
- [Aluminum](#) from under a microfarad to several farads

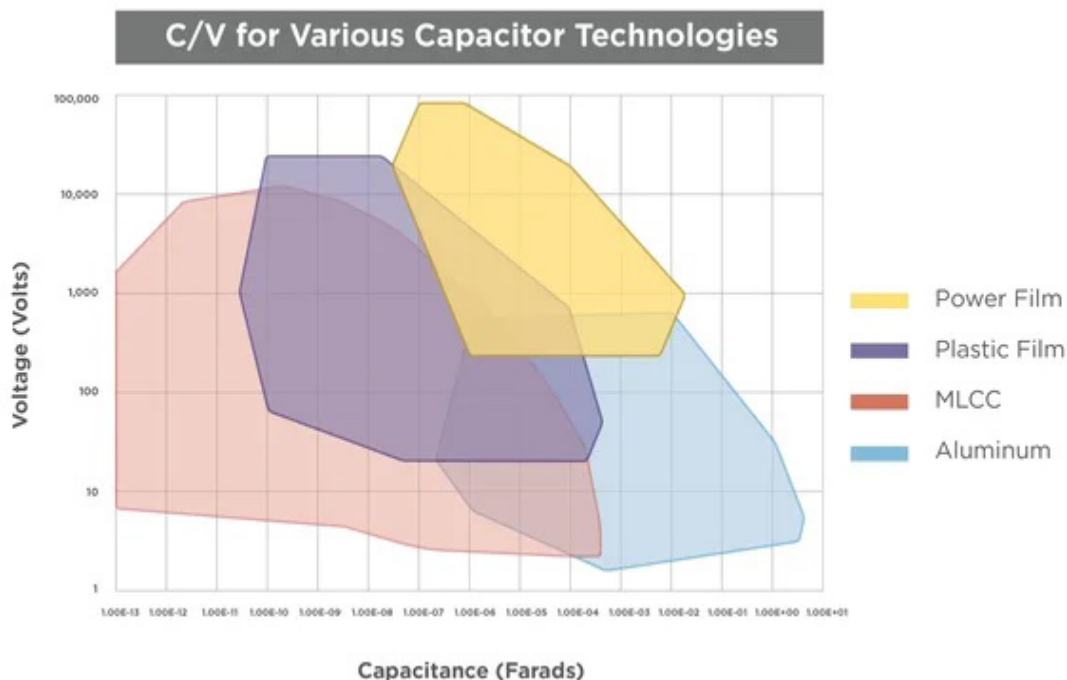


Figure 1. The capacitance and voltage ranges covered by common capacitor technologies.

As you can see, each technology's range overlaps with the other, which means you need to truly understand the specific application and its voltage, size, temperature, and reliability requirements before you can select the best option. Let's now look at some of the common applications where capacitors are required inside the EV, the different jobs capacitors must take on, and the capacitor technologies commonly used for those jobs. where capacitors are required inside the EV, the different jobs capacitors must take on, and the capacitor technologies commonly used for those jobs.

The Roles of Capacitors in EV Power Systems

Power systems within EVs must reliably handle large amounts of fluctuating power. While Figure 2 shows all the different functional blocks in an EV power system, we will focus specifically on the roles capacitors play in the following functions:

- Traction inverter (DC to AC)
- Onboard charger (AC to DC)
- DC/DC converter

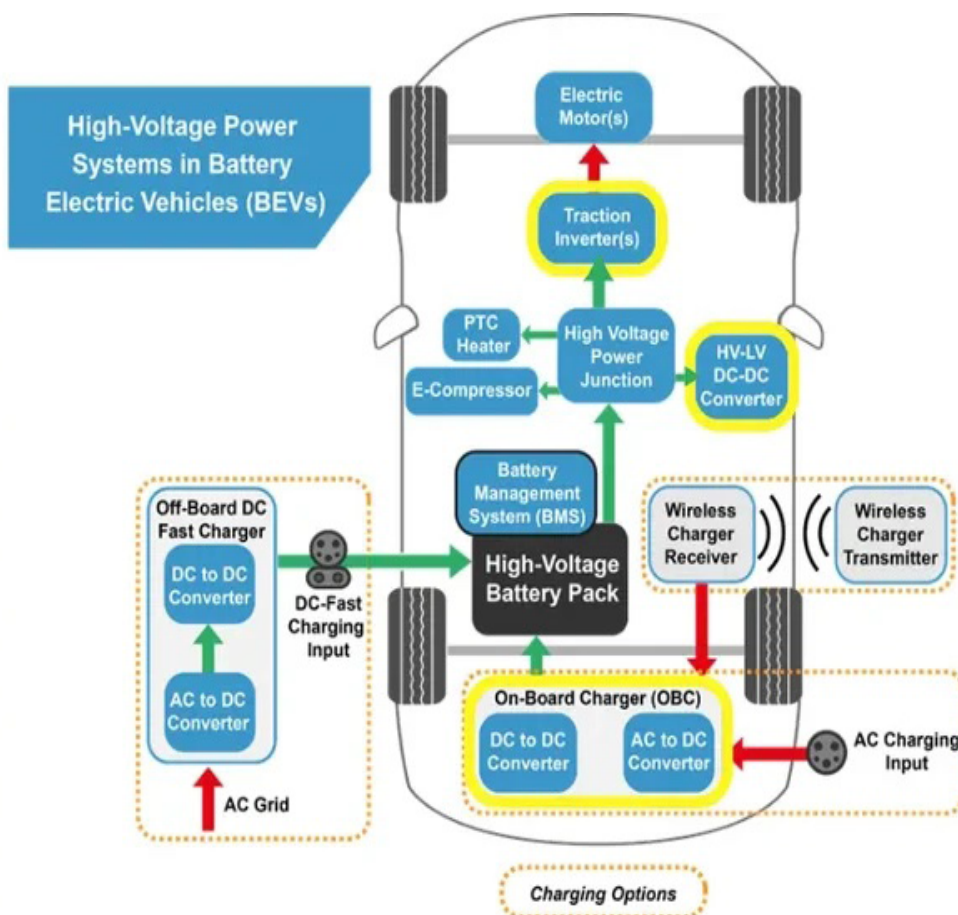


Figure 2. A diagram highlighting the different functional blocks in a high-voltage power system in an EV. The three functions we will discuss in this post are highlighted in yellow.

Traction Inverter

The function of an inverter is to convert DC power to AC. This function is commonly required in the traction inverter in an EV where battery DC is converted to AC for the motor. The major capacitor roles required here include the following (Figure 3):

- [DC link capacitors](#)
- [DC filtering capacitors](#)
- [Snubber capacitors](#)
- [AC filtering capacitors](#)

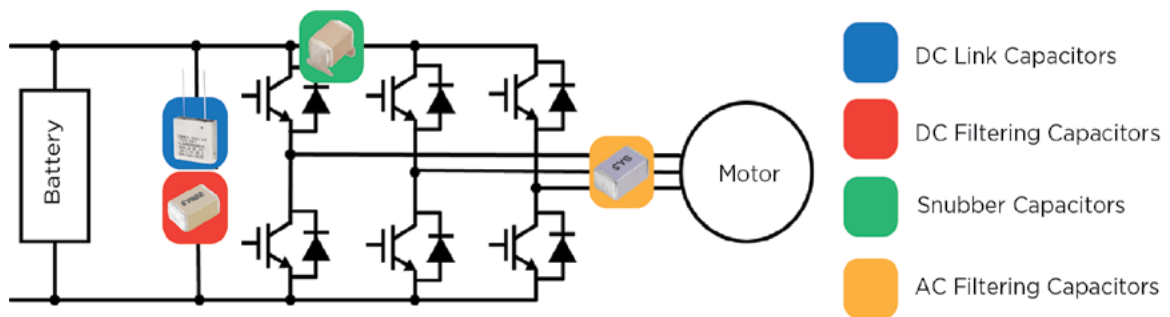


Figure 3. A diagram of a traction inverter with the locations of the various capacitors called out.

On-Board Charger

An on-board charger takes AC power and converts it to DC to charge the battery. The major capacitor roles here include the following (Figure 4):

- [DC link capacitors](#)
- [DC filtering capacitors](#)
- [Snubber capacitors](#)
- [Resonant capacitors](#)
- [AC filtering capacitors](#)

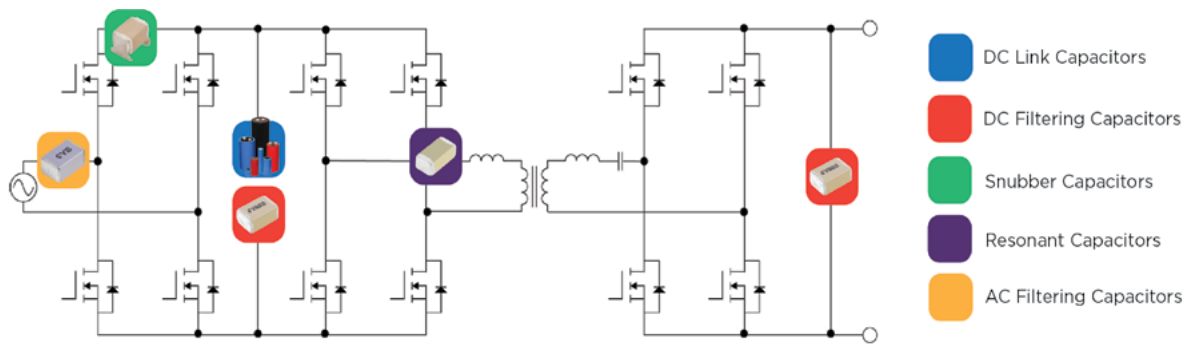


Figure 4. A diagram of an on-board charger with the locations of the various capacitors called out.

DC/DC Converter

The DC/DC converter takes the high-voltage battery power and converts it to a lower voltage. The major capacitor roles here include the following (Figure 5):

- [DC link capacitors](#)
- [DC filtering capacitors](#)
- [Snubber capacitors](#)
- [Resonant capacitors](#)

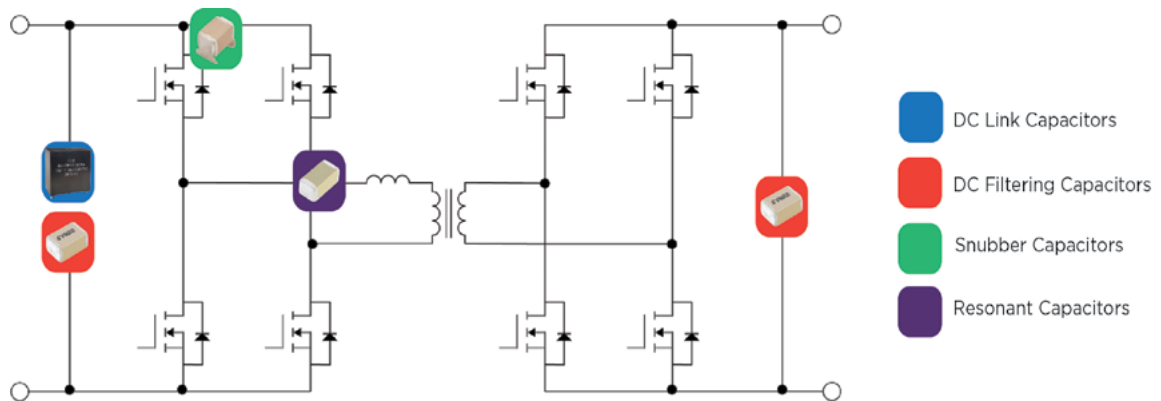


Figure 5. A diagram of a DC-DC converter with the locations of the various capacitors called out.

So now you're probably wondering, of the different capacitor technologies, which one is the best option for each of these jobs? As mentioned, the type of capacitor technology you will need depends on the specific voltage, size, temperature, and reliability requirements of the application, but there are some overall trends we are seeing:

- [Film](#) and [aluminum](#) are typically used for [DC link capacitors](#)
- [Film](#) and [MLCCs](#) are typically used for [filtering capacitors](#)
- [Film](#) and [MLCCs](#) are typically used for [resonant capacitors](#)
- [Film](#) and [MLCCs](#) are typically used for [snubber capacitors](#)

[Contact us today](#) to discuss your application needs in more detail with one of our EV capacitor experts or learn more about the [many ways we work with EV OEMs and manufacturers here](#).

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