DC Power Input Considerations

Input Spikes and Surges

Virtually every use of a DC-DC Converter that operates from vehicle power (including spacecraft, aircraft, missiles, ground vehicles and marine applications) is subjected to surges in input voltage and voltage spikes of one sort or another. Surges are voltage increases that are of relatively long duration from sources with relatively low source impedance. Spikes are of much shorter duration, have higher amplitude than surges, may be of either polarity and are usually limited in energy.

Older style hybrid DC-DC Converters have neglected the spike and surge issue entirely, limiting the input voltage to an absolute maximum value. This leaves the entire job of protecting the unit from failing due to spikes and surges to the customer, who is usually not happy about having this assignment. Separate surge suppressing modules using linear pass stages are available, but are generally not reliable, cost effective or electrically efficient. EMI filter modules containing spike suppressing shunt zener diodes are also available from several vendors. These parts address the spike issue, but generally ignore the concomitant surge requirement.

The ideal solution to the spike and surge problem is found in the MDI full featured DC-DC Converters, which have built in spike and surge resistance that allows them to operate directly from the vehicle power. This systems approach offers the customer a single solution to the system compatibility problem.

Spikes and surges are governed by several sometimes conflicting specifications. One group of specifications limits the magnitude of the disturbance that a power using device may cause on the power bus. A second group of specifications mandates the size of disturbances that a power using device must ignore while still performing its requirement. There is normally a guardband between the effects (or emissions) that a power using device generates and the amount of effect that will not upset it (or resistance to susceptibility).

In some instances, such as MIL-STD-461, both groups of requirements are contained within the same document.

In aircraft applications, the most common power requirement is MIL-STD-704, which has revisions A through E. Revisions A and C are most severe, with 28 VDC nominal systems experiencing 80 VDC surges for up to 50 milliseconds. The applicable revision depends on the vintage of the aircraft's electrical system. The corresponding requirement for commercial aircraft is RTCA D0160. Other specifications exist for unique requirements.

For ground vehicle requirements, the most commonly used specification is MIL-STD-1275. This 28 VDC nominal specification imposes 100 VDC surges for up to 100 milliseconds.

Spacecraft and missile applications tend to have small electrical systems, so the spike and surge requirements are generally unique for each application. However, missiles that are launched from an aircraft or ground vehicle may have a combination of requirements.

Spike amplitudes and durations are governed by numerous specifications. MIL-STD-461C has a CS06 spike test. MIL-STD-461D has an equivalent spike test via cable bundling. Other specifications with input spike requirements are MIL-STD-704, DO160, MIL-STD-1275, MIL-STD-1399 and MIL-E-6051.

The differing nature of surges versus spikes leads to different approaches to living with them. For example, the time duration of the typical surge requirement is quite long compared to the energy storage capability in an input filter. This implies that the basic DC-DC Converter circuitry, not only the input filter, must be able to withstand the applied voltage. The full featured parts are designed to operate through the surge conditions, which is a conservative design approach that offers the highest reliability in system applications. The price paid for such wide operating ranges is a slight fall off in efficiency due to the use of higher voltage semiconductors.

Spike suppression is generally easier than surge suppression since the time durations are much shorter. Input spike suppression within the full featured parts relies on the EMI filter components to spread the energy without loss within the spike to a waveform of lower amplitude and longer time duration.