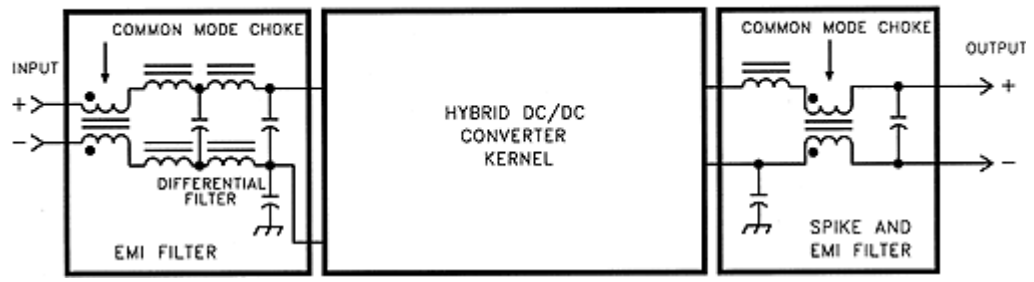
DC Power Input Considerations

EMI Filter Characteristics

The MDI full featured DC-DC Converters incorporate an integral input EMI filter that reduces the conducted emissions below the level of CE03 of MIL-STD-461C. The EMI filter also attenuates the effects of input CS06 spikes and CS01/CS02 conducted susceptibility. It is a very challenging task to construct an EMI filter of very small dimensions and it is also difficult when the filter is located very close to the noise source. MDI has overcome these challenges in the design of the full featured DC-DC Converters.

The filter consists of elements that block the conducted emissions from the power leads. In addition, the filter has elements that provide low impedance shunt paths for unwanted current. The general filter schematic is shown in Figure 1. The output common mode filter is a most important adjunct to the input filter. Without the output common mode filter, uncontrolled conducted emissions will exit from the output leads of the converter. Some portion will flow back through chassis grounds and appear on the input leads.

Figure 1
General Filter Schematic



Within the DC-DC Converter, conducted emissions can be differential mode or common mode. Differential mode emissions appear primarily on one input power lead, whereas common mode emissions appear on both because of the nature of the sources that generate the emissions, differential noise is more common below 1-2 MHz, where common mode noise is more prevalent at higher frequencies.

The input EMI filter in MDI's full featured converters is constructed with three inductive and three capacitive elements. A common mode inductor, or balun is connected to the input pins. This two winding inductor has a low differential inductance, but a high inductance for common mode currents. Following the common mode inductor are two LC "L" section differential filters. At the output of the final "L" section, there is a shunt capacitor to the hybrid case.

The common mode filter thus consists of the input common mode inductor and the shunt capacitor to the case. The differential mode filter consists of the two "L" sections.

Because of close proximity to switching noise sources, each of the differential filters have two windings, not one. Half the winding is placed in the positive power leg, half in the negative leg. By splitting the winding into two sections, radiated noise that would otherwise couple into the inductor is cancelled out.

The consequence of the split winding of the differential EMI filters is that the negative power return is not at the same AC potential as the return of all the input side connections. This mandates the need for care in using the input side pins so as to not upset the converter during dynamic transient events that cause a voltage drop across the negative leg of the input filter. Circuit techniques that are recommended for overcoming this fact are discussed when the control pins are reviewed.

The input EMI filter has a resonant rise of approximately 10-15 dB at a typical resonant frequency between 5 kHz and 10 kHz. 40 watt and 80 watt DC-DC Converters incorporate a damping network to reduce the magnitude of the resonant rise.

Emissions from multiple DC-DC Converters on the same power source may be additive and require additional filtering to meet MIL-STD-461. This is especially true when multiple DC-DC Converters are externally synchronized.

MIL-STD-461D, E and F

MIL-STD-461 D, E and F differs from MIL-STD-461C in many ways. However, as it relates to DC-DC Converters, the principal difference relates to the way conducted emissions are measured and also the limits for conducted emissions.

MIL-STD-461C uses a current measurement of EMI. The DC-DC Converters power inputs are connected to the power source through 10 microfarad feedthrough capacitors, and the current emissions are sampled by a current probe. The units of emission are dB above a microampere.

Conversely, in MIL-STD-461 D, E and F, the DC-DC Converter inputs are connected to the power source through LISN's (Line Impedance Stabilization Network) and emissions are measured by the voltage dropped across a 50 ohm resistor. The units of emission are dB above a microvolt.

The EMI filter design is different, depending on the type of measurement specified. Since MIL-STD-461C is measured by the current flowing into the 10 microfarad test feedthrough capacitor, the EMI filter works best with an input inductor. Conversely, with MIL-STD-461D, E and F, the EMI filter works best with an input capacitor.

In addition, because of lower limits at the switching frequencies, a MIL-STD-461D, E and F filter requires more attenuation than a MIL-STD-461C filter. In turn, this requires additional filter components.

MDI has developed and plans to incorporate MIL-STD-461D, E, F EMI filters in its DC-DC Converter power range, starting with 80 watt parts.