Output Considerations

Achieving Ultra Low Output Ripple

Most MDI DC-DC converters produce an output ripple that is 40-60 dB below the DC output value. This level of ripple voltage is sufficient for most applications, but some critical applications require additional attenuation of ripple voltage. A typical additional attenuation requirement is -20dB (a factor of 10:1).

It is difficult to obtain this additional attenuation in the same package as the DC-DC converter because the small physical size of the DC-DC converter allows the high frequency ripple to bypass or "jump around" the filter components.

For this reason, when ultra low output ripple is needed, the user must provide supplemental filtering outside the DC-DC converter package. This can take several forms.

A set of discrete filter components can be added on a circuit board.

A ripple filter contained within a hybrid module can be used.

A filter inductor in combination with coaxial feedthrough capacitors can be used.

The output ripple has both differential and common mode content. The lower frequency ripple, at the DC-DC converter's switching frequency and its harmonics, is primarily differential. The higher frequency spikes are primarily common mode. Therefore, to be effective, the inductive element of the filter should attenuate both differential and common mode signals.

The capacitive element should have low ESR, such as a four wire Kelvin connected ceramic capacitor, or, ideally, be a high capacitance ceramic multi-layer feedthrough capacitor. When using a feedthrough capacitor, it should be mounted on an adjacent chassis wall that provides shielding.

A single LC stage is generally quite effective in achieving 20-30 dB of attenuation. The filter resonant frequency can be in the 30 to 40 kHz. range.

Achieving ultra low output ripple in the presence of audio modulation:

Audio modulation on the input of the DC-DC converter can feed through to the outputs. Applying the audio signal causes the DC-DC Converter's output to be modulated at the audio frequency. Thus, the output of the DC-DC Converter has the normal high frequency ripple with the audio superimposed.

The MDI full featured DC-DC Converters have excellent rejection of conducted susceptibility due to their current mode inner loop. The basic converter has a loop gain of greater than 50 dB. The typical EMI resonance is in the 5 kHz to 10 kHz area, where a peaking of approximately 10-12 dB can occur. This peaking amplifies the conducted susceptibility, so it subtracts from the basic audio rejection of the converter. Beyond this point, the filter adds attenuation.

In MDI's standard triple output converters, one output (usually 5 VDC) is the main regulated output. Only the main regulated output will exhibit conducted susceptibility effects. The other two outputs are linear regulated. In this event, there is virtually no discernible effect on the linear regulated outputs arising from the conducted susceptibility. The reason for this is the additional voltage rejection of the linear regulators themselves.

Relatively low frequency audio components cannot be attenuated by the small, high frequency filters required to achieve ultra low output ripple. Therefore, in applications where audio modulation is present on the input of the DC-DC converter, one of the three solutions, each of which provides "double regulation", should be considered:

Use only the linear regulated outputs (found in MDI’s triple output converters).

Feed the input of the DC-DC converter from the output of another DC-DC converter of the appropriate power rating.

Feed the input of the DC-DC converter from the output of a DC-DC booster of the appropriate power rating.

Use of remote sensing pins in conjunction with ultra low output ripple filters

When the Remote Sense feature is used, there is a chance of instability when sensing beyond an external output filter. The poles introduced by the filter inductance and capacitance could cause the voltage loop to go unstable. Therefore, while use of the remote sense connections before any external post filter is acceptable, the remote sense connections should not be tied to the output of the post filter.

To maintain load regulation, the resistance within the filter should be appropriately minimized.