Digital Power Conversion – Benefits of a Programmable Soft Start Characteristic

Abstract

Power supplies with digital control are gaining in popularity. However the term 'digital control' is commonly applied to two quite different meanings. "Digital power management" where customers communicate with the power supply to monitor status and adjust certain parameters remotely such as voltage, current limit etc. and "Digital power conversion", which is still in its infancy in terms of products available commercially, involving replacement of the common power supply analogue control loop with a digital control loop.

Introduction

Flexibility is one of the major advantages of power supplies using digital power conversion, where customer specific optimisations can be achieved without the time and expense of changing the hardware. Andrew Skinner, Chief Technology Officer of TDK-Lambda UK explains how simply reprogramming the AC-DC power supply soft start characteristic can ensure that DC-DC converters run smoothly in a typical distributed power application.

The flexibility of the programmable soft start characteristic of the TDK-Lambda EFE series of power supplies is mostly used where a system has DC-DC converters being powered by the product. There are two distinct inrush current problems that can arise with DC-DC converters powered from AC-DC supplies; the first is the high inrush current required to charge the large input filter capacitance required by most DC-DC converters, the second is the inrush current created when they start up. This second in-rush occurs when the supply voltage to them rises above their under voltage lockout threshold (UVLO) and the converters try to quickly charge their output capacitance, which can result in a large current at their input.

Depending on how the over current protection of the AC-DC supply works, dictates on what happens next – most power supplies would have some form of constant current protection for a short period of time during which the output voltage may stay flat or it may even go down (causing a non-monotonic rise) due to the DC-DC converter inrush current. The worst case scenario, as far as the DC-DC converter is concerned, is that the output voltage of the power supply drops below the UVLO threshold of the DC-DC converter, because of the current being demanded, and the DC-DC converter switches off. This condition can become cyclic and precisely what that looks like and how long it takes is quite dependent on the specified AC-DC power supply and the DC-DC converter.

Fig. 1 shows an EFE300 starting up into five Point Of Load (POL) DC-DC converters and 7000µF of low impedance capacitors connected on their inputs. The EFE300 output current measurement has 50A per division; the POL converters are paralleled to provide two output voltages with a controlled soft start, resulting in only a small second inrush. In this example, after the initial peak, approximately half the rated current of the EFE300 (25A) is being used to charge the input filter capacitors of the converters.

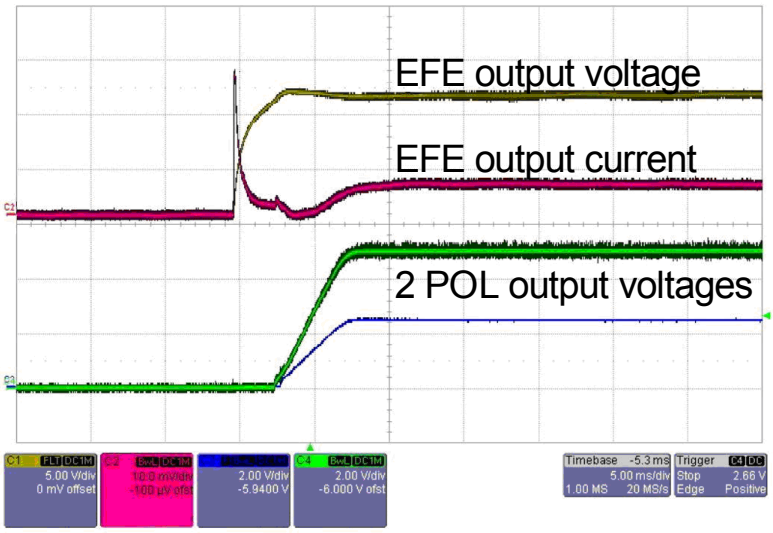

Fig.1 Start-up of EFE300 driving POL converters

With the EFE series of power supplies, the soft-start characteristics include soft-start time, current limit thresholds, allowed current limit on-time and output-voltage level at which control is handed over to the main control loop. The handover point can all be tailored on a customer specific basis, if needed. Looking at Fig. 1, if the voltage at which the POL converters start up were lower, then the second in-rush could coincide with the first in-rush causing the over-current protection to operate. In situations like this, the current limit characteristics of the EFE series power supply could be modified to enable the application to function correctly during soft-start without affecting the normal operating limits and the customer still has the benefit of receiving standard hardware. The programmable soft start characteristic can also be beneficial for other applications involving non linear loads such as fans, motors and drives.

Skinner says: “Optimising the power supply performance in this way has become possible due to our strategic decision to develop our own digital power conversion intellectual property from scratch rather than use some of the proprietary devices now available. You need to understand the algorithms involved in order to fully maximise the flexibility that digital power conversion can bring.”

He adds: ‘’Unfortunately, these kinds of start-up issues often materialise late in the design because they are often not really considered in the initial design phase. The way the load starts is a very important attribute and one that some people don’t consider when they are specifying a power supply. The good thing with digital power conversion is that we can often do something about it. Certainly, not having to make hardware changes with the EFE series means that we can send out modified samples quickly and we can be shipping production quantities straight away.’’

For further information

To learn more about the EFE series, please visit:
http://uk.tdk-lambda.com/efe

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