



A Different Method to Measure Output Current

Through the use of digital control, the light load behaviour of a converter can be significantly improved, and once the target has been achieved, additional functionality can be implemented.

Let's consider for a moment the output current measurement, a very important and crucial parameter in converter design. In fact, every converter includes one or more current measurement circuits for which there are multiple ways to measure: current sense resistor and hall effect sensor. As well there are different currents to measure: primary current, mosfets current and real output current. The information gleaned from these measurements has various purposes.

As always, the final specification is driving the precision of the current information, and understanding which is the necessary precision required for the converter can suggest an alternative measuring technique to be used, such as the one described in this paper.

Typically we need precise current information starting from 10% of the maximum load. For example, if the measurement is in the current sharing circuitry, we want to have good sharing when the output load is consistent, but it is less important if the power supply doesn't share below 10% of load.

For other applications, it could be useful to get an approximate idea of the converter's real load. Consider the following case study which simulates an uncommon customer request, based on a 3Kw, 3 phases digitally controlled, telecom converter.

The measurement we need is when the output power falls below 1w, indicating that the system is not supplying any power, the result of which is very inefficient operation. Even if two of the three phases have already been switched off, there are some fixed losses that cannot be cancelled unless we shut down the converter completely. These losses could be in the range of 3-5w as the single phase has been designed for an output power of 1Kw for driving big mosfets, which are protected using snubbers and clamping circuits, the end result of which is power dissipation.

A traditional approach will implement a range commutation and insert a sense resistor only when the load is below a certain power level, which can be a very precise method. The downside of this approach is that you need to short out the resistor once the output power begins to increase, using 6 - 8 mosfets in parallel to avoid an excessive power dissipation of the mosfets at full load creating a loss in efficiency!

Now imagine that we can drive the system specifications, rather than the reverse. Ideally we would like to have a fixed output capacitance at the output of our converter which, if applicable at system level, then our alternative technique could be successfully applied.

This converter's design utilizes true digital control so that the output voltage can be programmed directly. The ucontroller also captures an indirect estimation of the output current by reading the primary current. Using the output current estimation we can decide to activate the subroutine needed to measure current if the output power is below 1w.

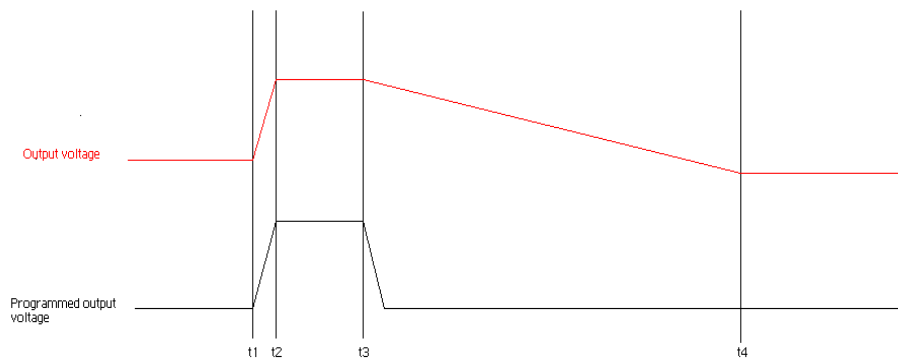
Once activated, the subroutine will pulse the output voltage 1% higher than the nominal regulation for a few milliseconds; the voltage change has to be accomplished in a smooth way to avoid over-under shoots.



After the output voltage has been raised by 1%, we must return back to the nominal regulation. By raising the output voltage 1% higher, we have actually boosted the output capacitors to a different voltage, so if we suddenly move back the reference voltage, the converter will not be supplying any power to the load. Instead all the energy stored in the output capacitors is supplying the load causing a negative ramp.

By reading how much time is required for the capacitor to discharge back to its original value, the ucontroller will be able to calculate the value of the output current.

The following picture is a graphic representation of the technique explained above:



From instant t1 to t2, the programmed voltage from the ucontroller drives the output voltage to change from its original value to the new one.

From instant t2 to t3 the ucontroller is holding the output voltage to the new value, in order to be sure that a stable condition has been reached.

At instant t3 the programmed voltage is going back to the original value and, at the same time, a counter is activated until the output voltage returns to the nominal at instant t4. The difference in time between t4 and t3 will allow the ucontroller to understand which was the output load during that time, and decide whether or not to switch off the converter.

The precision of this measurement depends mainly on the type of capacitors used, and consequent tolerance; for example, for an electrolytic type capacitor it will be +/- 20%, and for a ceramic type it drops down to 5%.

By employing this mode of operation, the efficiency of a converter will be higher than a traditional one. As an anthropologist, consultant of ROAL Electronics once said, "Companies today have to take position, and since we are dealing with energy we have to find different ways to save it; ROAL is living energy".

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