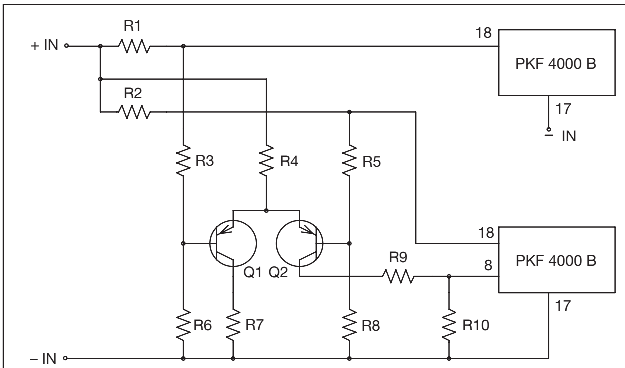
Paralleling of PKF 4000B series power modules

Introduction

Ericsson's PKF 4000B series of power modules feature low output voltages and achieve very high efficiency by means of synchronous rectification. Output currents of 4 to 5 amps are available from this family of converters. Occasionally there is a need of higher output currents for a given application so that paralleling of converters for increased power output is desired. This application note addresses a useful technique for paralleling two PKF 4000B converters. If two of these power modules are directly paralleled without any external circuitry, the desired result will not be achieved. The module with the higher output voltage can force reverse conduction through the output rectifiers of the lower voltage module resulting in possible damage to the module. Paralleling will only be successful if the two power modules have very nearly the same output voltage. The paralleling technique presented here functions by equalizing the output voltage of the two modules so that direct paralleling is possible and output currents from 8 to 10 amps are available. This technique will apply to all of the PKF 4000B series of power modules.

Paralleling Circuit

The output voltage of the PKF series may be trimmed in either direction by application of a current to pin 8. The circuit shown in figure 1 takes advantage of this capability to adjust the output voltage of the lower PKF 4000B to be nearly equal to the output voltage of the upper module so that direct paralleling with output current sharing is possible. The circuit consists of a differential pair composed of discrete transistors Q1 and Q2. The input current to each converter is sensed with the 1 W resistors R1 and R2. The circuit is configured so that the current to pin 8 of the lower power module is adjusted such that the input currents of the two converters are equal. This condition represents output current sharing and an approximately equal output voltage between the two converters. In effect, the circuit forms a "master/slave" arrangement with the upper power module determining the output voltage of both devices. The adjustment range of this circuit is approximately ± 8%. This will be more than sufficient to accommodate the variation in initial output voltage set point of the converters, which is less than ± 2.5%. Most of the components in the circuit are conventional small-signal surface mount devices. Some attention should be paid to the selection of the sense resistors R1 and R2. In addition to the accuracy requirement, the power dissipation during start-up of the converters should be considered. The worst case transient power dissipation will occur with an input voltage of 75V as it charges the 1.4 µF input capacitance of the PKF power module. The parts list in figure 1 provides a suggested component type for these resistors.



R 1, 2	1Ω, 1W, KOA, NPR1
R 3, 5 ,10	10 k
R 4	4,7 k
R 6, 8	220 k
R 7, 9	100 k
Q 1, 2	2SA1587, 2SA,1579

All resistors 1% tolerance, 1/4W, unless stated otherwise.

Figure:1

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Other Considerations

The circuit described above should be a useful solution in many applications. There are, however, some limitations that should be kept in mind when using this approach. This solution is applicable to only two paralleled converters, and cannot be extended to additional power modules. Also note that the paralleling as accomplished by this circuit is only for the purpose of additional power output. It will not provide redundancy in the event of the failure of one converter. That is, if either converter fails it should be assumed that the output voltage will be unusable. The overall conversion efficiency will be reduced by up to 0.5% from the typical datasheet value due to the voltage drop across the sense resistors in series with the input voltage source. The ramp-up time of the output voltage will be approximately twice the datasheet value for a single module. When the circuit is operated at less than 50% load, the output voltage may exhibit a non-monotonic ramp during start-up as shown in Figure 2. In this example, two 3.3 volt power modules are operated at a total output current of 2.2 amps (27% of maximum load). Figure 3 shows the same set of modules operating at 6.6 amps of output current (82% of maximum load). The circuit now produces only a "flat spot" in the output voltage ramp. This behavior is due to the power modules transitioning from voltage mode control to current mode control at higher output load current. Since most applications of this circuit will be for situations with a requirement for an output current of more than that of a single power module, this characteristic may not be a concern for most users.

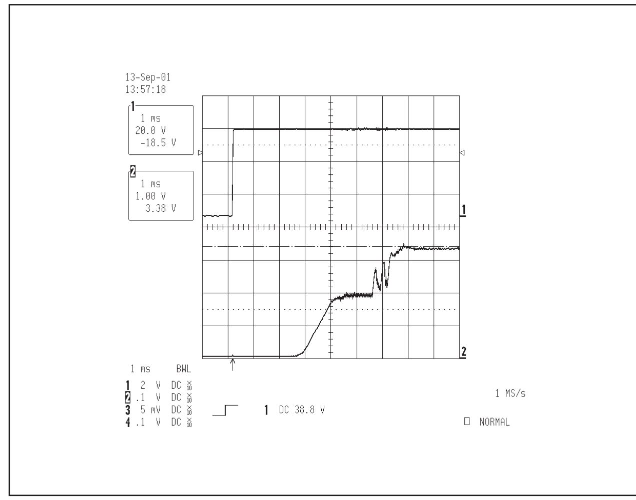

Figure: 2 Start up with 2.2 amps load

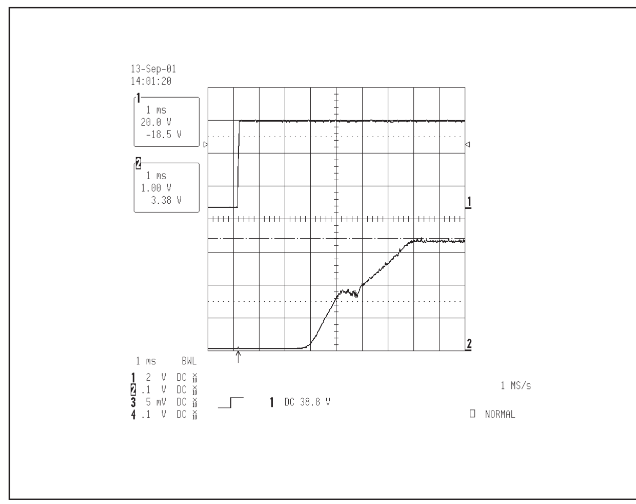

Figure: 3 Start up with 6.6 amps load

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Application Note
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