

APPLICATION NOTE



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BOP
004

When to Use BOP Standard or Optimized (L or C Suffix) to Drive Reactive Loads

I — INTRODUCTION

Kepeco's linear BOP 100W, 200W and 400W Series has options for versions that are optimized for inductive loads (L Suffix) and capacitive loads (C Suffix). This application note explains what this means and offers guidance as how to decide whether the optimized option is right for your application.

II — THE PROBLEM.

Kepeco's linear BOP 100W, 200W and 400W Series are power amplifiers. All amplifiers have problems maintaining stable, oscillation-free, operation when driving reactive loads. This is especially true of BOP driving inductive loads in current mode and capacitive loads in voltage mode. Even voltage mode operation with inductive loads or current mode operation with capacitive loads is not absolutely stable, because while in voltage mode operation the BOP can reach its current limit, or while in current mode operation it can reach its voltage limit.

The reason for instability is straightforward. The reactive load will change the BOP-to-Load transfer factors such as amplitude and phase. Depending on the load's characteristics, this can make the application unstable.

In a simplistic way, for example, it will be a fight between the amplifier in current mode trying to maintain a constant current and the inductive load opposing current changes. Similarly, the amplifier in voltage mode tries to maintain a constant voltage while the capacitive load opposes voltage changes.

III — DRIVING REACTIVE LOADS WITH A STANDARD BOP

Many parameters play a part in determining BOP stability while driving reactive loads:

- Load parameters and the equivalent electrical schematic.
- Input programming signal characteristics, including amplitude, shape, frequency and timing.
- The BOP's 3-dB bandwidth for voltage mode and current limit and for current mode and voltage limit.
- Programming source connection. Do not use input return as the tap point for the load's return. Use a twisted pair or a shielded twisted pair cable with shield connected to Chassis-GND.
- Load connection. Among the BOP, programming source, and load, only one must have its return connected to Earth-Chassis-GND. Using a twisted pair or wires tied together to connect the load is recommended.

As described in the BOP 100W, 200W, 400W Operator Manual in Section 1 under Load Reactance, there are some methods that can be used to improve standard BOP stability while driving reactive loads. The Operator manual can be downloaded from the Kepco website at:

www.kepcopower.com/support/opman1s.htm#bop

These methods include connecting other external reactive components or circuits either in parallel or in series with the load. This changes the load's equivalent schematic, thus making it close to resistive in the operating frequency bandwidth. Another

approach described in the Operator manual which may be more appropriate is to reduce the BOP's bandwidth.

Using external reactive components across the load has the following disadvantages:

- It has limited applications, each solution working for a particular defined load and frequency range with a unique BOP input/ output signal.
- It can create a resonant circuit with the load's components, resulting in instability in some instances.
- It does not always work when the BOP goes into limit mode operation.
- With AC operation it distorts the load's signal. For example, in current mode a capacitor in parallel with an inductive load will change the load's AC current.

Another approach described in the BOP 100W, 200W, 400W Operator manual which may be more appropriate is to reduce the BOP's bandwidth:

- In current mode, when driving inductive loads, attach a ceramic capacitor in the range 0.0022uF to 0.1uF (correlated with the load's inductance) between pins 16 and 18 of the rear programming connector
- In voltage mode, when driving capacitive loads, attach a ceramic capacitor in the range 0.0047uF to 0.47uF (correlated with the load's capacitance) between pins 12 and 14 of the rear programming connector

IV — THE SOLUTION: BOP L AND C SUFFIX OPTIONS

The L suffix option was created to allow Kepco's linear BOP 100W , 200W and 400W units to drive inductive loads in a stable manner, while operating in both current mode and in voltage mode while reaching current limit.

Similarly, the C suffix option was created to allow the BOP to drive capacitive loads in a stable manner, while operating both in voltage mode and in current mode while reaching voltage limit .

The L and C options include compensation that has been tested and verified to allow them to operate stably within the published specifications for reactive loads. These options eliminate the possible detrimental effects of using the suggested compensation methods with the standard BOP and take the guess-work out of stable operation with reactive loads. The bandwidth reduction mentioned in the previous section, can be applied as well for L and C options.