APPLICATION NOTE AN-125

IEC Compliance, Surge, Fast Transient, ESD and RF Immunity

Keywords: **IEC, Surge, Fast Transient, ESD, Immunity**

Specifications Reference: **IEC 61000-4-2, 61000-4-3, 61000-4-4, 61000-4-5**

Scope: **BPSX, BPWX and BPH Modules**

Reference Application Notes: **AN-126, AN-128**

Introduction:

The Bias Power BP series modules have an extremely small footprint with unparalleled EMI/EMC filtering. As a result, they are commonly placed directly on the mains in commercial buildings and/or industrial areas that may be highly susceptible to surge and electrical fast transient (EFT) events. Bias products are not immune to these events. As such, Bias Power recommends EFT and surge protection should be considered for all installations to maximize reliability and service life.

All devices connected to line voltage are commonly subjected to electrical disturbances that vary in frequency, duration and amplitude. The International Electrotechnical Commission (IEC) has characterized these line events in Standards 61000-4-5 for electrical surge, and 61000-4-4 for EFT. Additional relevant, but not entirely line-related, effects are identified in 61000-4-3 for RF field, and 61000-4-2 for electrostatic discharge.

While these standards are widely used, they may not fully represent the disturbances encountered by mains-connected equipment in every application. Further, it is easy to underestimate the level of protection necessary to provide immunity for a given application, especially across a wide range of operating locations and environments.

This Application Note is intended to present examples of protection design to address 61000-4-4/5 events. For the most reliable designs, complete understanding of the level for actual threats is required, and mitigation approaches may need to be expanded beyond the circuit diagrams included here.

Application:

When facing the requirement to enhance product reliability of mains-connected equipment, designers generally understand the existence of power quality problems and often look to the suite of IEC Standards for guidance. While this work is a powerful resource, it is not all inclusive for all cases of product design and development where mains power is used. Therefore, it is important to note that a complete understanding of the electrical environment is key to robust product design; whether those insights come from standards or empirically.

Many times, the source of electrical transients affecting product designs are completely unrelated to the product. Examples would include electric utilities switching of capacitor banks, upgrade operations, and normal maintenance. Also common are abnormally occurring faults, overloads, lightning and storm failures, and the attendant repair and recovery operations. Often the source comes from large equipment or motors inside the facility of installation. These events are generally well covered by the IEC Standards.

In some cases, line disturbances affecting product life are caused by the product itself. Figure 1 is a generalized control device which compares a set point with a sensor to turn a motor on and off through a pilot relay, Relay 1. Where the product switches inductive and/or heavy AC loads, the transients caused by these actions, especially as they are physically and electrically "close" to the product, can exceed the energies identified by the IEC standards. In such cases, either additional protection and/or mitigation at the source is required.

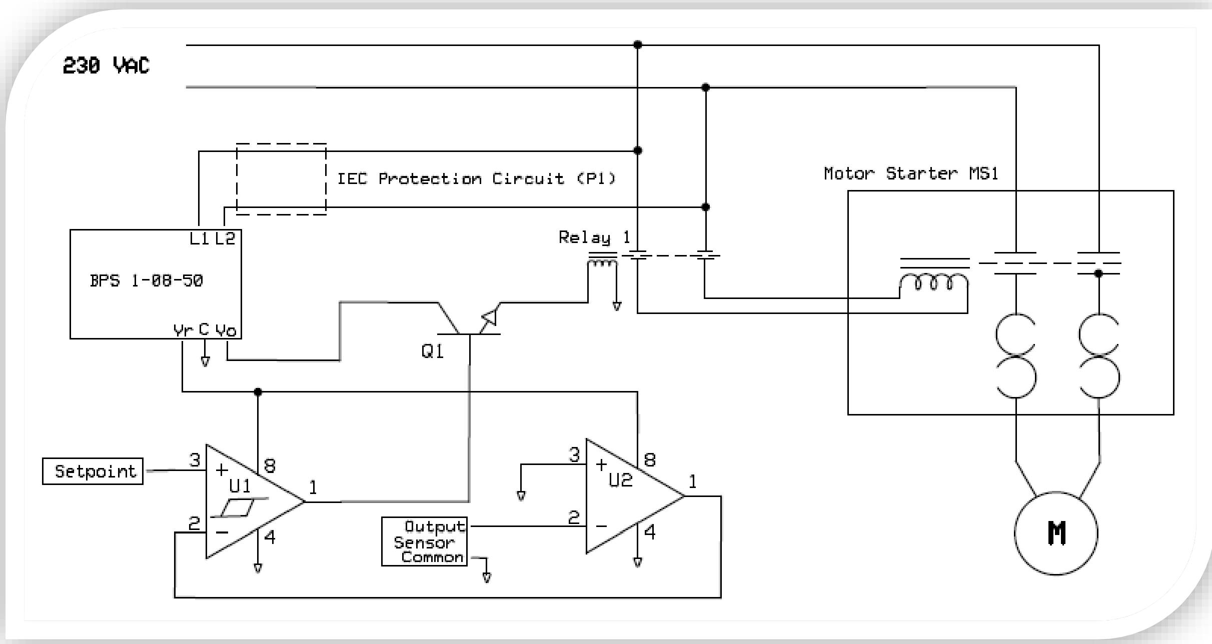

Figure 1: Example circuit with multiple sources of self-induced transients

There are three sources of self-induced electrical transients in Figure 1:

A. the collapsing field of the coil when Relay 1 is de-energized

B. the collapsing field of the coil when MS1 is de-energized

C. the collapsing field of induction Motor M when it is de-energized.

The IEC Protection circuit provides protection for B and C effects, as long as the frequency, magnitude and duration of the transients are less than what is identified by the IEC Standards. (See Application Note AN-126 for specific coverage of A.) Note that all of these effects may be magnetically coupled as well as conducted. Therefore layouts and organization of circuit boards, components and devices can all bypass the protection of the IEC Protection circuit. Mitigation of magnetically coupled effects is beyond the intended scope of this Application Note.

Should the electrical transients of controlled devices exceed IEC Standards, the following should be considered:

1. A potential mitigation method is to switch these loads at zero-crossing of the AC line. In addition to the threat reduction, this technique increases product life (and/or load life). Application Note AN-441 describes a zero-crossing detector which can be used for these purposes.

2. Another mitigation method is snubbing. Understanding the type of transient occurring (line-to-line, line- to-neutral or line-to-ground) will determine whether a filter approach or a ground-shunt approach should be used. In either case, any snubbing circuit should be placed as close to the source of the transient as possible.

<u>Examples of IEC 61000-4-x Protection circuits for use with the Bias products:</u>

The following examples are circuits designed to provide varying levels of 61000-4-x protection for BPWX models, starting with the most basic and continuing on to high level immunity. Note that traces between components should be as short as possible and at least 2mm wide. Results are not guaranteed, your results may differ and testing for conformance still required. Variations in test methods, layout, adjacent components and devices will alter results.

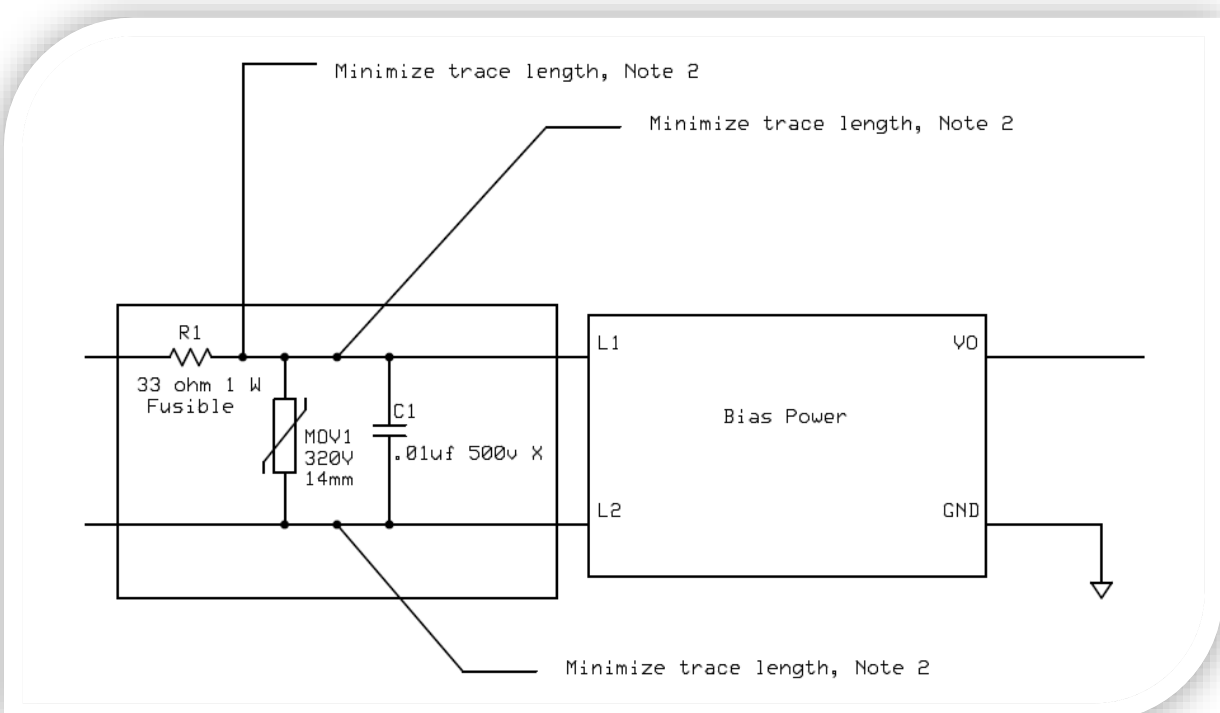

Figure 2: Basic IEC protection circuit

Examples of IEC 61000-4-x Protection circuits for use with the Bias products (cont.):

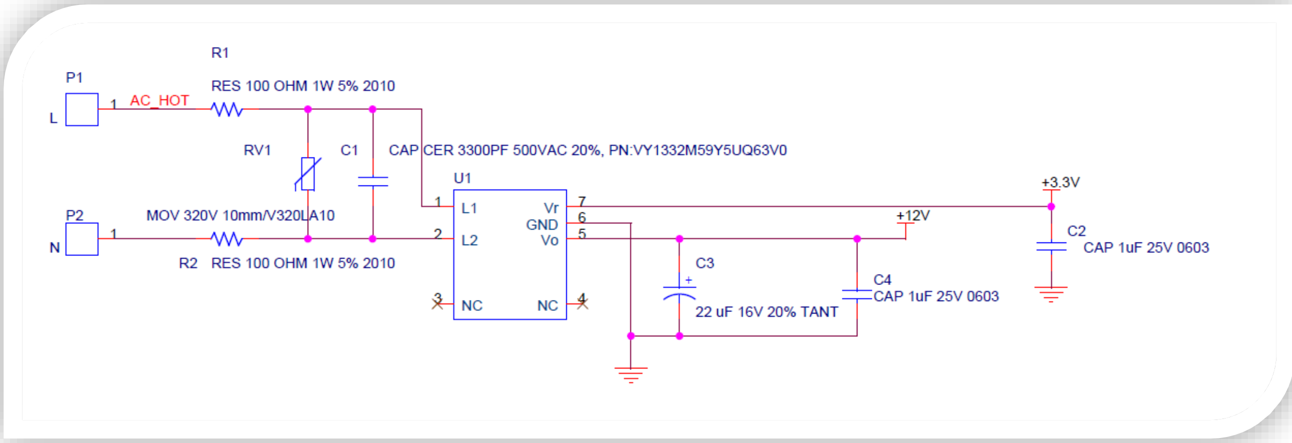

Figure 3: Scenario for 4kV Surge Circuit

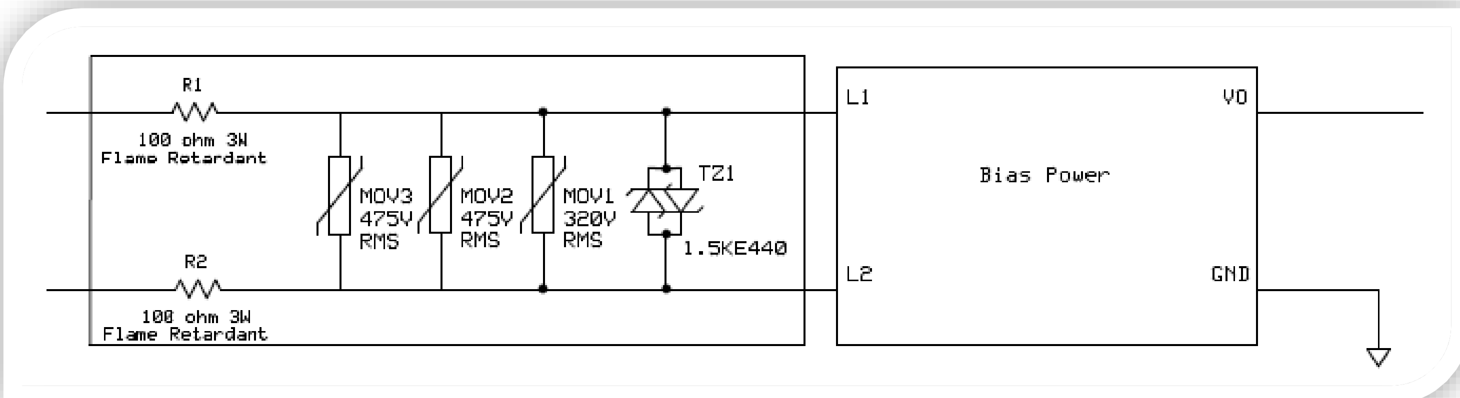

Figure 4: Fully protecting IEC (ANSI 12.19, Line Surge Test #17 @10kV)

Notes:

1. *BPSX, BPWX, BPH peak clamping voltage <1000V*
2. *Recommended MOV: Littelfuse LA Varistor Series*