SURGE TESTING

There are four critical points in any surge test program:

1. Properly-selected, repeatable wave characteristics.
2. An effective system to deliver the wave to the equipment under test without mangling it, in accordance with prescribed coupling and driven-line impedances.
3. Measurements, rather than simply blind surging.
4. Prevention of fail-positive results—indication that the device under test passed, due to inadequate coupling or poor connections limiting the strength or effect of the test wave.

Wave shapes and energies given in previous sections are typical of those required to test in-board electronic equipment for withstand capabilities for a wide range of transients, as set forth in references already cited. These transients include both lightning-induced and switching transients, as well as some of presently-unknown origin.

Delivering The Wave

It is unlikely that a coupler will ever be developed to permit connection of a generalized surge into a generalized, fully-operational system without some level of engineering required to design the test program. There are several techniques that have broad applicability, however. It is up to the protection engineer to select and apply the one or the combination that seems most suitable for the specific surge and circuit involved.

Capacitor Coupling

One technique that is simple and often sufficient is capacitor coupling. For the higher-frequency ringing waves—a few tens of kHz on up—a few mfd or less will be sufficient, and power lines, whether ac or dc, will be relatively unaffected by the extra capacitance. Of course, the same lines may supply equipment that isn't being surge-tested, so that the lines being surged must be isolated from those that aren't.

Figure 5 shows capacitor coupling for a surge generator driving ac or dc power lines. One line (A) is being driven with respect to the other (B), so the setup is called a normal-mode connection. (Depending on the branch of technology involved, it may also be called series-, differential-, transverse- or even metallic-mode, the last deriving from the fact that only metal—i.e., no ground—is involved.)

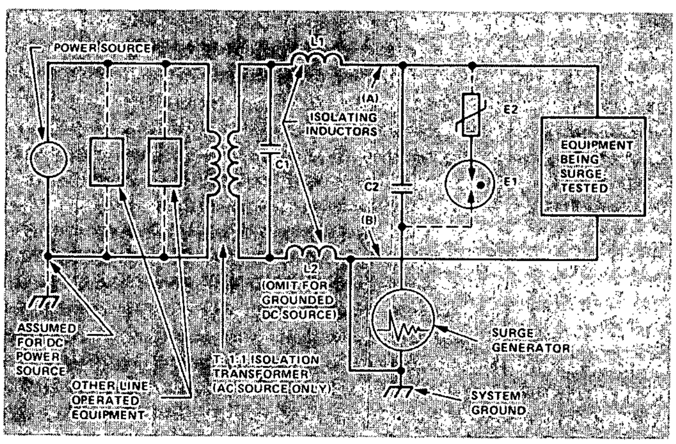

Figure 5
Surge-Generator AC/DC Line Coupling
Normal (Differential) Mode

Gas-Tube Coupling

When the circuit or lines under test—i.e., being surged—can't tolerate even a few tenths of a mfd in normal operation, or when the wave being coupled is of such long duration that capacitor values become unreasonable even for the 115-volt line then coupling via other means may have to be considered.

One method that finds application under these circumstances is use of a gas-tube protector—a breakdown or crowbar device. It acts as an open circuit until the surge exceeds its voltage breakdown level—which is rate-of-rise-dependent of course—at which time it conducts high currents with a drop of only tens of volts.

A disadvantage of gas-tube coupling (shown in Figure 5 as tube E1 connected in-circuit *instead* of capacitor C2 via the optional, dotted lines), is that once it has started conducting, like an SCR, it must see almost zero voltage across its terminals before it will turn off. Thus it must be used with care, since some circuits have standing potentials greater than the arc or breakdown sustaining voltage of the tubes.

Other Methods

Varistors and silicon avalanche devices can, of course, be used without gas tubes for coupling in some applications. And for common-mode testing, in which both lines are driven with respect to system (or device-under-test) ground, matched devices and/or three-terminal gas tubes can be used to advantage. Figure 7 shows a three-terminal gas tube, E3, with series silicon avalanche devices E4-E7, used for common-mode surge coupling.

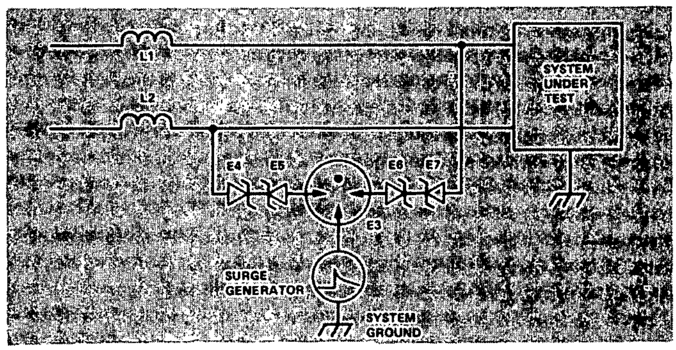

Figure 7
Common-Mode Coupler

Measuring The Results

Slamming an electronic device or system with even a well-defined wave and considering the test successful if the system doesn't fail is an inadequate, unscientific approach.

For one thing, unless the effects of the surge within the system are known, it may very well be that the surge itself weakened the system's ability to withstand future surges in the real world. In effect, the surge test the circuit "successfully" passed may be its last! One obvious way for this to happen is for the surge protection to be inoperative—failed or just husky enough to take a few tests.

The only way to insure that the device under test is performing in accordance with its designed-in surge capability is to measure the results of the surge, electronically, at critical points within the circuit. If a protector is incorporated or if a filter is supposed to isolate a portion from the major brunt of the surge, then at the protector or past the filter there should be a calculable, repeatable reduction in peak voltage compared to the surge test input. It is this reduction that must be designed in, verified, and finally, production- and maintenance-tested, to insure initial and continued existence of *real* surge protection.

This article was written by Mr. Peter Richman, President, Keytek Instrument Corp. It is a condensation of the original article which appeared in ITEM '79.