A. ANALOG SIGNATURE ANALYSIS

Analog signature analysis (ASA) is a "power off" troubleshooting technique that applies a sinewave (AC) stimulus to a component creating a voltage vs. current signature. The signature is displayed on a CRT or computer monitor for analysis. This technique allows a trained technician to locate damaged and marginal components.

All ASA signatures are made up of four basic components; resistance (any value from an open to a short), capacitance, inductance, and semiconductance. Understanding the basic signatures simplifies the analysis of composite signatures. Voltage is displayed horizontally and current is displayed vertically. An open circuit draws no current so it is represented by a horizontal line on the CRT. A short circuit draws maximum current so it is displayed as a vertical line. Resistors have a constant voltage/current ratio causing a linear diagonal signature with the angle of slope being directly proportional to the resistance value. Capacitors and inductors cause a phase shift between voltage and current producing a circle or elliptical signature directly proportional to the amount of capacitance or inductance. Diodes, the simplest semiconductive device, allow current to flow in one direction and not the other. These signatures are displayed by a horizontal line that goes vertical just after the center axis of the display.

Complex or composite signatures are combinations of the four basic signatures. Integrated circuits are made up of transistors (which are a combination of diodes), resistors, and capacitors. The signatures displayed by ICs are composites signatures. These devices have built-in protection circuits which allow current to flow in both directions displaying a signature that is vertical in the bottom half, then horizontal, then vertical in the top half. These signatures are typically called "chair patterns". Common zener diodes will display a chair pattern that has a vertical break-over point at .6 volts (the conducting voltage of a silicon device) and a second break-over point at the rated voltage for the zener diode. Variations of this signature found in ICs are due to resistive and capacitive elements. CMOS integrated circuits are built with capacitors causing their signatures to display a loop in the "back" of the chair pattern.

Leakage current is indicated by curvature of the linear portions and the rounding of corners in the diode or chair pattern. Gaps in the signature indicate that the current path is being interrupted. Resistive (diagonal) portions of a signature not found in a good device indicate damage to the component. Capacitive signatures that flutter, vary in size, and change shape indicate a possible problem in the dielectric.

Integrated circuits of the same type (e.g.7404) but differing in manufacturer can display slight differences because of the various ways in which the components are constructed. This is a normal condition and should not be confused with a device failure. The multiple signature storage and merge features in the Huntron Workstation for Windows software can compensate for this by allowing the computer to store several serialized signature sets to compare against.

The user should attempt to relate the degree of the failure to the type of signature being sought. For example, a catastrophic PCB failure can be expected to be caused by a failed device with a dramatic signature difference from that of the same device in a known good PCB. A marginally operating or intermittent board may have a failed component that indicates a small signature difference from a known good board.

Internally shorted bipolar (TTL) ICs will produce a resistive signature. This will be a near straight line pivoting to the one o'clock position. A catastrophic short will exhibit this effect in the LOW range and results from a resistive value of four to ten ohms.

It should be kept in mind that leakage current, the most common IC failure, will increase with an increase in temperature. Most boards run at a higher temperature than they are tested at, so a small leakage current can be a real problem. Leakage current shows up as a rounded transition (corner) or as a curvature in a normally straight line.

There are parallel and loading effects on signatures of components that are in-circuit. The lowest impedance device will tend to dominate that signature so analyze these signatures carefully looking for tell-tale indications of the four basic signatures previously discussed.