

# Application Notes

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## ScanEM<sup>®</sup> Probes in Repair and Service

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**AN104**

### **Problem**

Circuit boards are getting more and more complex and the effort of troubleshooting and correcting defects in them is getting more and more expensive. It is nearly impossible for a repair technician to fully understand operation on a component level of all the numerous circuits he has to service. The result is increasing cost of repair and high ratio of rejected boards since there is no method of identifying defects quickly.

### **Traditional Approach**

Typical troubleshooting scenario includes lengthy process of checking each component and trace with a multimeter and an oscilloscope. There are specialized tools, such as Huntron testers, that help repair technician identify components that do not conform to “acceptable” electrical signature. Typically, such repair is based on guesswork since a typical technician may not be intimately familiar with the schematic and operation of every product that the factory is producing and/or repairing.

Though traditional approach does work at the end, it is time-consuming and results in high costs.

### **Another Look at Fault Identification**

Another method of identifying problems in digital circuits is based on characterizing the pattern of electromagnetic emission generated by the electronics components during their operation. Each component, especially each IC, generates specific pattern of electromagnetic emission that changes when this component is malfunctioning. The pattern of electromagnetic emission depends on the type of the digital signal present and on the process taking place in the circuit. Needless to say, the emission pattern of a “dead” component will be radically different from that of a functional one; emission from a broken or shorted trace emission will be very different from that of the good one. By checking pattern and magnitude of electromagnetic emission one can easily identify components and traces that behave differently from known good parts. Electromagnetic emission method identifies defects even in the most complex circuits in seconds.

Typical defects that such method can easily identify are faulty ICs, bad solder joints, solder bridges, missing components, broken traces, etc. Once such identification is made, completing of repair becomes a trivial task. No understanding of operation of the circuit is required.

This approach is used in high-volume production functional testers built by GenRad, HP, Teradyne and Northern Telecom. These testers place electromagnetic field sensors over each component of the board under test. The emission patterns are compared with the stored in memory patterns of the known good board. Should the emission pattern of a component under test differ significantly from the one on the good board, it is a clear indication where to look for problems.

The big drawback of these testers is their high price and need to create a custom setup for each PCB configuration. Costs can run into thousands of dollars just for the setup not to mention capital investment in the tester. Obviously not every assembly facility has such equipment and not every PCB commands creation of the custom setup.

## ScanEM as Troubleshooting Tool For the “Masses”

ScanEM probes bring the power of such functional testers to the bench of every engineer and technician whose task is to identify defects in faulty boards. ScanEM probes detect electromagnetic pattern from ICs and other components and traces without complicated setup. They can be used by everyone in any production environment.

### Specifics of ScanEM Applications in Repair

#### *Typical Behavior Observed with ScanEM*

Effect	Probable Cause
Indication of Continuous Emission	Continuous digital stream, i.e. clock signal, etc.
“Chirping” sound, pulsating LEDs	Data present
No emission	No digital signal present

It may be necessary to adjust Level dial on ScanEM in order to detect data stream. If ScanEM LED bar is fully lit, lower Level dial to see if the emission is truly continuous or ScanEM is simply overloaded. If the emission level is strong (a common occurrence), adjust the ScanEM dial counterclockwise to reduce sensitivity and you will be able to see the changes in the emission pattern. Typical pattern is that one or two LEDs are “jumping” up and down.

#### *Which ScanEM Probe to Use?*

The most suitable probes for troubleshooting are ScanEM-E/EC and ScanEM-H/HC probes. They are part of probe kits CTK010 (no output) and CTK015 (RF and DC output). ScanEM-H/HC and ScanEM-E/HC probes are equally important for diagnostics of the problems. ScanEM-E/EC probes can be used for characterization of low-power components where current is very low, while ScanEM-H/HC probes are suitable for locating broken traces, loose connections, etc. If in doubt, start with ScanEM-H/HC probe.

#### *Use of ScanEM with an Oscilloscope*

Oscilloscope is a common tool on a work bench. Connecting ScanEM-EC or –HC to an oscilloscope could enhance ability to characterize emission pattern and will accelerate troubleshooting procedure. Oscilloscope shows the waveform of the signal in the circuit and also, with properly set timebase, an envelope of the data stream.

#### *Limitations*

ScanEM is applicable for fault location in digital circuits. It may not detect low frequency (i.e. mains frequency, audio, etc.) signals. It will ignore DC voltages and currents.



## Process Recommendations

### *Known good board is available*

#### Establishing Reference

- Place a known good board so that it is convenient to place tip of ScanEM probe over components and traces
- Power up a board
- Set ScanEM Level dial per its instruction guide
- Place tip of ScanEM over each IC on a good board and record in a lab book typical emission pattern. ScanEM probe shows emission pattern on its built-in LED bar graph and via built-in speaker as certain “blinking” pattern and “chirping.” ScanEM-C probes can be connected to an oscilloscope and the waveform can be easily recorded.

#### Testing Board in Question

- Replace reference board with the board “under suspicion.”
- Examine board in question in the same way as the reference board. By comparison with the good board records the discrepancies can be easily found and defective components and traces can be easily identified, replaced and repair verified – all in a matter of minutes.

### *No known good board is available*

Even if no “known good board” is available, ScanEM probes can still locate defects on the boards by identifying ICs that exhibit no emission patterns (an indication that they are not working). Examine board in questions in the same manner as in the previous section. Absence of emission indicates that no digital signal is being conducted or processed. Continuous emission (see table above) typically indicates clock signals, “chirping” indication shows data. Typically, most of digital ICs do process data in some fashion. Notable absence of data signals may indicate problems, absence of emission may indicate dead IC, solder bridges, etc.