DETRIMENTAL ELECTRICAL ENERGY FROM SOLDERING TOOLS

Suitability of soldering equipment for use on high reliability circuitry should be based on logical engineering factors. In addition to the obvious need for performance of adequate thermal transfer, the soldering equipment should be free from damaging side effects commonly encountered when soldering many modern sensitive circuits and components.

These damaging effects include:

- I. MAGNETIC FIELD
- II. TRANSIENT VOLTAGE SPIKES
- III. STATIC ELECTRIC CHARGES
- IV. R F INTERFERENCE
- V. STEADY STATE LEAKAGE
- VI. THERMAL DAMAGE

Discussion of these effects will include their application with the two general types of soldering equipment. “Temperature controlled” is one type and is defined as equipment with some means to switch or adjust thermal output according to requirement of the soldering task. The other type is “Steady output” irons with no built-in adjustment. These standard, conventional irons maintain uniform wattage and idling temperatures without the use of any temperature control devices.

I. MAGNETIC FIELD

Some temperature-controlled irons exhibit strong magnetic fields. The most damaging effect is from permanent magnet used by curie-effect tools as part of mechanical switching apparatus located in barrel of soldering tool only one inch from the tip. The strength of this magnet can be measured by picking up paper clips, as well as the classic “iron filing” profile pattern easily demonstrated on this paper.

Steady output irons may also produce magnetic fields from the peculiar effect of a single layer element winding. This field is greatly magnified when reinforced by coil element winding on a steel core body. Good design eliminates this by “reverse coil winding” with two layers, which effectively balances out the magnetic field. Use of non-ferrous, high copper, high heat alloy eliminates the “iron core effect”.

II. TRANSIENT VOLTAGE SPIKES

Any temperature control soldering tool must switch on and off in response to variable thermal demand from the workload. Most means for switching involve some type of make-or-break mechanical switch. These switches use metallic contacts, which cycle thousands of times per day. Arcing of contacts is inevitable at high current levels used in heating elements. Each arc is like a tiny broadcast transmitting voltage spikes thought the tip of the iron directly to the component being soldered, through the air, and back through the AC power line.

Measurement of voltage magnitude and duration requires a sophisticated recording oscilloscope, which is capable of capturing transients in the nanosecond time range and magnitudes in the 200 volt range. Commonly used soldering equipment often throws spikes measured at 150 volts peak to peak. Most metal oxide semiconductor field effect transistors (MOS-FETS) and C MOS components in present use, and even thinner layers required for denser packages of the future can be destroyed by voltage spikes of this magnitude.

The consequence of using equipment with mechanical switching and voltage spikes is random component failure. This common symptom is often blamed on other causes, but the problem won’t go away until the offending soldering equipment is replaced by other tools designed to solder safely.

III. STATIC ELECTRIC CHARGES

Static charges are present in varying degrees in all insulating materials, including the human body. They are generated by friction between surfaces such as leather shoes on a rug, a comb run through dry hair or even nylon clothing against the skin. Much documentation has been written about means to prevent transmission of these static charges from the body or from loading and handling equipment to static sensitive components.

Elimination of static damage through steady output or temperature controlled soldering tools is accomplished very simply by means of grounding the iron with a three-conductor cord and plug. Such a method of grounding all metallic parts of the soldering tool, and especially the tip, does effectively "drain-off" any static charge before it has time to accumulate to a level where it may become damaging.

Static electric charges, which can be damaging to components, are built up in certain types of steady output soldering tools with ceramic encased elements. In this design the soldering tip is electrically isolated from other metallic parts of the tool. Any static charges present in the tip will be transferred directly to the component. These irons are made in two-wire design only, as there is no easy way to ground the tip or to attach a three-wire cord and plug. This is the only type of soldering tool where static charges can cause damage.

IV. R F INTERFERENCE

This type of electrical energy is produced as an undesirable side effect from transformers and arcing of contacts on mechanical switches. Sensitive panel instruments nearby the soldering work place may suffer deflection of normal readings or permanent damage if inductive fields are used in their design.

Most temperature-controlled stations cause RF Interference from unshielded transformers in thermoplastic housings. Arcing of switches commonly causes RFI also.

Prevention of RFI is accomplished by shielding transformer inductive field within a suitable metal housing. Zero voltage switching eliminates all mechanical arcing problems.

RFI may be detected by several means. The simplest way is to "de-tune" a pocket radio placed on the bench within a few feet of the soldering station. The level of noise created each time the unit switches indicates frequency and intensity of damaging RF energy.

V. STEADY STATE LEAKAGE

Steady state leakage is generated in the element of any efficient tool with a heating element. This occurs in temperature controlled, as well as steady output irons. This is the voltage leakage transferred through the element insulating material to the grounded tip and other metal parts, and is generally at a higher level when the tool is at full operating temperature. Friction fit or screw threads will develop high resistance oxide layers due to long time at high soldering temperatures. Ungrounded tools, or those with grounding design, which will degrade over extended duty cycling, will introduce levels of steady state leakage of 10 to 20 volts peak to peak and component damage may easily occur at these levels.

There is a technique for positive certified method of grounding both element and soldering tip with a welded ground strip soldered directly to the ground lead of the three-conductor cord. In this way there is assurance that the ground connection will not degrade from oxidation of surfaces or loosening of threads throughout the useful life of the soldering tool. Measurements show in the microvolt range (10^{-6} volts) peak to peak between a properly equipped tool and ground. This value is far below damaging level of steady state leakage to any voltage sensitive component.

VI. THERMAL DAMAGE

Poor heat control, either too high or too low, can ruin components and also cause solder joint failure.

To reduce thermal damage, soldering must be done with minimum tip contact or "dwell time". Good dwell time should be ¾ seconds for typical PC boards or 1-1/2 seconds for miniature turret-type terminals with a maximum of 5 seconds. Common reasons for damage from too much dwell time are insufficient heat reserve in soldering tool, temperature controlled equipment cycling too low, tip surface or diameter too small for connection, and tip maintenance poor – no solder on working surface.

Corrective action includes measurement of heat output of tools, including temperature-controlled equipment, to assure adequate supply under full production rates. Choose the proper tip size and keep properly tinned with a bright, smooth layer of solder for fast heat transfer.

High-temperature damage can be caused by the use of a soldering tool with the tip temperature too high and long dwell time. On miniature printed wiring circuits too much heat may cause delamination of layers or degradation of substrate compounds or ruin components.

Determination must be made of the most sensitive part of the circuit being soldered and what is the maximum temperature allowed. Choice of maximum tip temperature will depend also on length and diameter of component lead, size of terminal or printed wiring surface and thickness of board. Normal soldering tip temperatures for small PC boards are 700° to 750°F and for small terminals such as ¼" turrets, 800° to 850°F.

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