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BDX-613-1920 (Rev.)

TEMPERATURE VERSUS TIME CURVES FOR
MANUAL AND AUTOMATED SOLDERING PROCESSES

by M. A. Trent

Published August 1978

R. S. Morris, Project Leader

Prepared for the United States Department of Energy
Under Contract Number EY-76-C-04-0613.

**Kansas City
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Printed in the United States of America

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Price: Microfiche \$3.00
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5.25

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BDX-613-1920 (Rev.), UNCLASSIFIED Supplemental Report, Published August 1978

Prepared by M. A. Trent

Temperature-versus-time curves for various components during pre-tinning, hand soldering, and drag soldering operations were recorded to determine temperature ranges encountered by electronic components.

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**A prime contractor with the United
States Department of Energy under
Contract Number EY-76-C-04-0613**

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SUMMARY

Temperature-versus-time curves were recorded for various electronic components during pre-tinning, hand soldering, and drag soldering operations to determine the temperature ranges encountered. The component types investigated included a wide range of electronic assemblies.

The data collected in this volume has been arranged by process and will help engineers

- Predetermine the thermal profile to which various components are subjected during the soldering operation,
- Decide--on the basis of component heat sensitivity and the need for thermal relief--where hand soldering would be more feasible than drag soldering, and
- Determine the optimum drag solder control parameters.

DISCUSSION

SCOPE AND PURPOSE

This collection of thermal profiles was gathered from data generated during an evaluation of techniques for drag soldering printed wiring assemblies.

ACTIVITY

Time-versus-temperature profiles were recorded for various components by monitoring the heat encountered during pre-tinning, hand soldering, and drag soldering. Circuit locations were chosen which could be expected to require the greatest time-temperature relationship. For all profiles, time zero for the soldering process occurs at the leading edge of the curve when the temperature begins to rise from ambient. Profiles with more than one cycle have a separate time zero for each cycle.

Standard Type K thermocouples were used because they matched the temperature range expected in these applications. The 0.127 mm (0.005 inch) diameter thermocouples were used to minimize the thermocouple mass relative to the component lead and to allow accurate measurement of the time-temperature relationship on the inside of the heat sensitive components.

An opposed electrode resistance welder was used to connect the welded ball of the thermocouple to the component lead. For tests where the thermocouple was connected inside the component package, 63:37 tin-lead eutectic solder was used for attachment.

ACCOMPLISHMENTS

Although most hand soldering irons produce a tip temperature of about 400°C (750°F), few components experience a heat extreme of more than half of this. Drag soldering exposes components to the same heat range encountered during hand soldering. However, because of the preheat cycle, the components do not undergo sudden thermal shock as they do during hand soldering.

Examination of past component failures has shown that the failure mode of components classed as heat sensitive is the melting of the solder at the lead-body interface. The components used in these studies include those determined to be "worst case" for this type of failure. These components are typically small bodied and mounted flush on the board with the lead-body interface within 2.54 mm (0.100 in.) of the solder joint.

Automated drag soldering controls the time-temperature relationship of components during the soldering process. These profiles show that near the lead-body interface the heat encountered is insufficient to cause low temperature solder to melt.

Pretinned in 287°C Solder Pot

Diode: D07 Style (SA1819) With 0.508 mm (0.020 in.) Leads

TC on Lead Inside Component Package, Tweezer Held

TC on Lead Inside Component Package, Hand Held

Capacitor: Z-Size Tantalum

TC on Lead Inside Component Package

Capacitor: CK12 Style Ceramic

TC on Tinned Lead Inside Component Package

TC on Opposite Lead Inside Component Package

Transistor: T048 With 0.4572 mm (0.018 in.) Kovar Leads

TC on Lead Inside Component Case

TC on Substrate Inside Component Case

Hybrid Ceramic Package

TC on Lead

Dual Inline Package: 0.254 by 0.4318 mm (0.010 by 0.017 in.) Kovar Leads

TC on Lead Inside Package

TC on Lead Inside Package, Three Dips Made

TC on Substrate Inside Component Package

Hand Solder

Resistor: 0.05 W Metal Film With 0.381 mm (0.015 in.) Copper Leads

TC on Lead 5.08 mm (0.200 in.) From Solder Joint,
0.813 mm (0.032 in.) PWB, Normal Cycle

TC on Lead 5.08 mm From Solder Joint, 0.813 mm PWB,
Extended Cycle

TC on Lead 5.08 mm From Solder Joint, 0.813 mm PWB,
Shunt Heatsink

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 1.5748 mm (0.062 in.) PWB,
Solder and Rework, Normal Cycle Time

TC on Lead 1.27 to 1.905 mm From Solder Joint,
1.5748 mm PWB, Solder and Rework,
Extended Cycle Time

Diode: D07 Style (SA1819)

TC on Lead Inside Component Package

Diode: D014 Style

TC on Lead 5.08 mm (0.200 in.) From Solder Joint,
Solder and Rework, Normal Cycle

TC on Lead 5.08 mm From Solder Joint, Solder
and Rework, Extended Cycle

Capacitor: Z-Size Tantalum

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint

TC on Lead Inside Component Package

Capacitor: CK12 Style Ceramic

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 0.7874 mm (0.031 in.) PWB, Shunt Heatsink

TC on Lead Inside Component Package

Transistor: T018 on 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint

TC on Lead Inside Component Case

TC on Substrate Inside Case,
Body 1.27 mm (0.050 in.) off PWB

Hybrid Ceramic Package: On 1.5748 mm (0.062 in.) PWB

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint

TC on Lead Inside Case

Dual Inline Package: On 0.7874 mm (0.031 in.) PWB

TC on Lead Inside Package

TC on Substrate Inside Package

Dual Inline Package: On 1.5748 mm (0.062 in.) PWB

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, Normal Cycle

TC on Lead 1.27 to 1.905 mm From Solder Joint,
Extended Cycle

TC on Lead Inside Component Package

TC on Substrate Inside Component Package

TC on Lead, Extended Cycle

Drag Soldered, Standard Machine Settings

Standard Machine Settings:

0.7874 mm (0.031 in.) PWB

Enter	40
Exit	14
Pot	249°C (480°F)
Preheat	70
Dwell	0.0

1.5748 mm (0.062 in.) PWB

Enter	40
Exit	14
Pot	249°C
Preheat	90
Dwell	0.0

Resistor: 0.05 W Metal Film

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm (0.062 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm PWB, Shunt Heatsink

Resistor: 0.05 W Carbon Composition

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm (0.062 in.) PWB

Diode: D014 Package

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm (0.062 in.) PWB

Capacitor: Z-Size Tantalum

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.7874 mm (0.031 in.) PWB

TC on Lead Inside Component Package, 0.7874 mm PWB

TC on Lead Inside Component Package,
1.5748 mm (0.062 in.) PWB

TC on Lead Inside Component Package,
With Component 1.27 mm (0.050 in.) off PWB,
1.5748 mm PWB

Capacitor: CK12 Style Ceramic

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.7874 mm (0.031 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 0.7874 mm PWB, Shunt Heatsink

TC on Lead Inside Component Package,
0.7874 mm PWB

TC on Lead Inside Component Package,
1.5748 mm (0.062 in.) PWB

TC on Lead Inside Component Package,
1.27 mm (0.050 in.) off PWB

Capacitor: Film Foil Mylar, 0.22 μ F With 0.813 mm (0.032 in.) Copper Leads

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.813 mm (0.032 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm (0.062 in.) PWB

Transistor: T018 Package

TC on Lead 1.27 to 1.905 mm (0.050 to 0.075 in.)
From Solder Joint, 0.7874 mm (0.031 in.) PWB

TC on Lead 1.27 to 1.905 mm From Solder
Joint, 1.5748 mm (0.062 in.) PWB

TC on Lead Inside Package,
Component 1.27 mm (0.050 in.) off PWB

TC on Substrate Inside Package,
Component 1.27 mm off PWB

Hybrid Ceramic Package

TC on Lead Outside Package

TC on Lead Inside Package

TC on Substrate Inside Package

Dual Inline Package

TC on Lead Outside Component Package

TC on Lead Inside Component Package, 0.813 mm (0.032 in.) PWB

TC on Lead Inside Component Package,
1.5748 mm (0.062 in.) PWB

TC on Substrate Inside Component Package,
0.813 mm (0.032 in.) PWB

TC on Substrate Inside Component Package,
1.5748 mm (0.062 in.) PWB

Printed Wiring Board

0.813 mm (0.032 in.) PWB

1.5748 mm (0.062 in.) PWB

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ELECTRICAL: Soldering

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