Designation: F 1444 – 00 (Reapproved 2004)

Standard Test Method for Determining Dynamic Thermal Response of Direct Thermal Paper-Label Printer Method[1]

This standard is issued under the fixed designation F 1444; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the thermal response of direct thermal papers to determine uniformity within and between lots. This test method may also be used to test direct thermal products other than paper.

1.2 The Hobart 18VP Thermal Label Printer[2] described in this test method may be used for specification acceptance, product development or research applications, or both, and manufacturing control.

1.3 Although a specific manufacturer has been identified for this equipment, any thermal label printer with equivalent signal output capabilities and sample size requirements would be suitable.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses, are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (**Warning—**This test method requires making power adjustments and trigger printing while the protective cover is off, thereby exposing the user to electrical hazards.)

2. Referenced Document

2.1 *ANSI Standards:*[3]

IT 2.16–1995

IT 2.17–1995

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *dynamic thermal response curve*—the graphical representation of the response characteristic of a thermal printing system over a given range of print energies. The *y*-axis of the graph is optical density (reflectance density), while the *x*-axis is calibrated in terms of print energy or energy density. Typical units for print energy are watts/dot or millijoules (mj), whereas the units for print density are millijoules per square millimetre, mj/mm^2.

3.1.2 *dynamic thermal sensitivity*—the generation of the thermal response of thermal paper within a given printing system over a specific operating range of energy levels.

4. Summary of Practice

4.1 This practice is intended to determine the dynamic thermal sensitivity of direct thermal papers. The energy versus image density relationship obtained is a characterization of a given coating and base paper. Curves can be used to determine uniformity within and between direct thermal paper lots. The test equipment and test procedures are not intended to simulate thermal response under actual end use conditions in a facsimile machine.

4.2 To determine the dynamic thermal sensitivity of direct thermal facsimile, chart, or label papers, a 2.5 in. (6.35 cm) wide sample is fed into the printer (minimum 11 in. (27.94 cm) length is suggested).

4.3 A voltage controller on the power board allows the adjustment of the power to the thermal head (watts per dot). Voltage squared is a function of energy usually expressed in watts/dot or millijoules (mj).

4.4 The thermal response or density saturation curve can be obtained by generating one of six available label patterns on test samples using a range of energy levels.

5. Significance and Use

5.1 This test method enables dynamic thermal response comparisons between direct thermal papers.

5.2 This test method makes comparisons between and within thermal paper production lots from the same manufacturer.

[1] This test method is under the jurisdiction of ASTM Committee F05 on Business Imaging Products and is the direct responsibility of Subcommittee F05.06 on Carbonless and Thermal Imaging Products.

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[2] The sole source of supply of the apparatus known to the committee at this time is Hobart Canada Inc., Don Mills, Ontario, M3A 1B1.. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee [1], which you may attend.

[3] Available from American National Standards Institute, 25 West 43rd St., 4th Floor, New York, NY 10036.

6. Interferences

6.1 Wide variations in environmental conditions (temperature/RH) could impact the image density obtained with the use of this test method.

6.2 The length of elapsed time following imaging and subsequent image density measurements should be controlled. For best results, density measurements should be made within 5 min of imaging. The exact time selected should remain constant for all samples to be compared.

6.3 Since the thermal facsimile papers are sensitive to prolonged exposure to light, samples should be covered or otherwise protected prior to actual image testing. Excessive exposure to light can affect final test results.

6.4 Since differences in the basis weight and stiffness may have a significant effect on the results, comparisons should be made between materials with similar physical properties.

6.5 This test method does not predict performance in thermal printers but characterizes the coating sensitivity.

6.6 Any residue or coating buildup on the printhead resistor elements (dots) may result in inaccurate test values and reduce printhead life.

7. Apparatus and Materials

7.1 *Hobart 18VP Thermal Label Printer*. [2]

7.2 *Electrical Wire and Electrical Insulated Box*, to move power supply voltage test point outside the printer housing.

7.3 *Digital Display Multimeter*.

7.4 *Macbeth Model RD-517 Densitometer*, or equivalent.

8. Sampling, Test Specimens, and Test Units

8.1 The test specimen shall be a sheet or roll of thermal product handled only by their edges prior to testing.

8.2 Samples should be cut into individual strips 2.5 in. (6.35 cm) wide with a recommended minimum length of 11 in. (27.94 cm). At least ten sample strips will be needed for each curve generated.

9. Calibration

9.1 In calibrating the test instrument, the use of solid area density control charts using specific power settings and thermal product with a known sensitivity level has been found to be the best calibration method.

9.2 Calibrate the densitometer according to manufacturers' instructions.

10. Conditioning

10.1 Although no special conditioning of thermal paper samples is required, it would be prudent to compare only tests run under the same environmental and aging conditions.

11. Procedure

11.1 *Establishing the Voltage Test Points*:

11.1.1 Be sure the printer is unplugged, before opening the printer cover. Connect test leads to the backside of the logic board 1J5 connector at 1J5-1 (+) and 1J5-10 (–) points. Using insulated wire, bring the leads to an insulated electrical box suitable for multimeter lead connections.

11.1.2 If the resistance value is not visible, the thermal head may be removed from the printer. Following equipment manufacturers' instructions remove the thermal head and record the stamped resistance value (see Fig. 1). Reinstall the thermal head following equipment manufacturers' instructions.

11.1.2.1 With the thermal head resistance value (Ω), calculate the voltages for the various watts/dot levels using the following formula:

$$voltage = \sqrt{(watts/dot) \times (resistance\ of\ head)} + 1.5\ V \qquad (1)$$

The number of test points required may vary but a minimum of ten ranging from 0.3 to 1.8 W/dot is recommended as a starting range. These calculations need only be made once for a given printhead. Table 1 shows a typical table of test points.

11.1.3 Load the test sample into the printer following the loading instructions listed on the inside cover of the printer.

11.1.4 With the power on, and the multimeter attached to the test leads, adjust the voltage to the highest calculated test point using the control pot on the power supply board. Be sure to use a nonconducting alignment tool to adjust the voltage potentiometer to avoid shorting out components on the power board. The potentiometer is located in the center of the printer power supply board (see Fig. 2). Thermal head supply voltage levels which exceed manufacturers' recommended maximum level on the thermal head may shorten its life.

11.1.5 Trigger the diagnostic switch (SW1) on the printer logic board to print a test pattern. If a test pattern is not printed after the second time the trigger is hit, the label detection pot (1J2) on the printer logic board may have to be adjusted until a print is obtained (see Fig. 2). Although program switches on the logic board allow the user to obtain six different test patterns, all contain the six square blocks used to create the density curves (see Fig. 3).

11.2 *Generating the Thermal Response Curves*:

11.2.1 It is recommended that at least three test prints on each paper be run at each voltage setting. This will give eighteen density blocks per paper type per voltage setting. Record one density reading on each of the six density blocks for each of the three test patterns.

11.2.2 Plot the average of the eighteen readings on graph paper with watts per dot on the "*x*-axis" and density on the "*y*-axis" (see Fig. 4 and ANSI IT2.16 and IT2.17.).

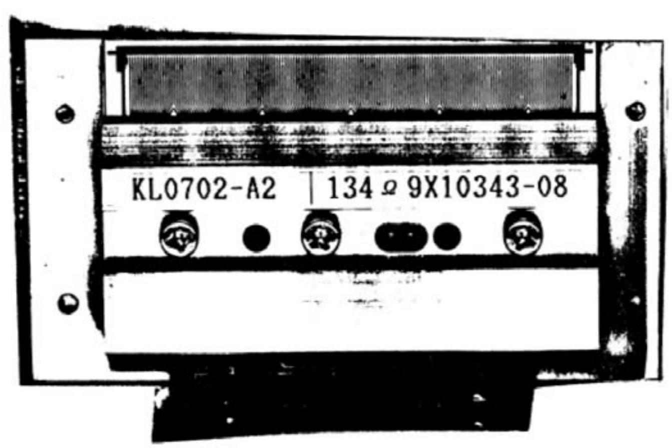

FIG. 1 Hobart 18VP Thermal Printer,[2] Thermal Head

TABLE 1 Hobart Thermal Tester,[2] Watts/Dot to Voltage Comparison

NOTE 1—Resistance (Ω) will be stated on the thermal head. The 1.5 V is the line loses from the voltage test points to the thermal head.

Watts/Dot	Voltage
1.8	17.03
1.6	16.14
1.4	15.20
1.2	14.18
1.0	13.08
0.8	11.85
0.7	11.19
0.6	10.47
0.5	9.69
0.4	8.82
0.3	7.84

$$voltage = \sqrt{(watts/dot) \times (resistance\ of\ head)} + 1.5\ \text{V}$$

$$head\ resistance = 134\ \Omega$$

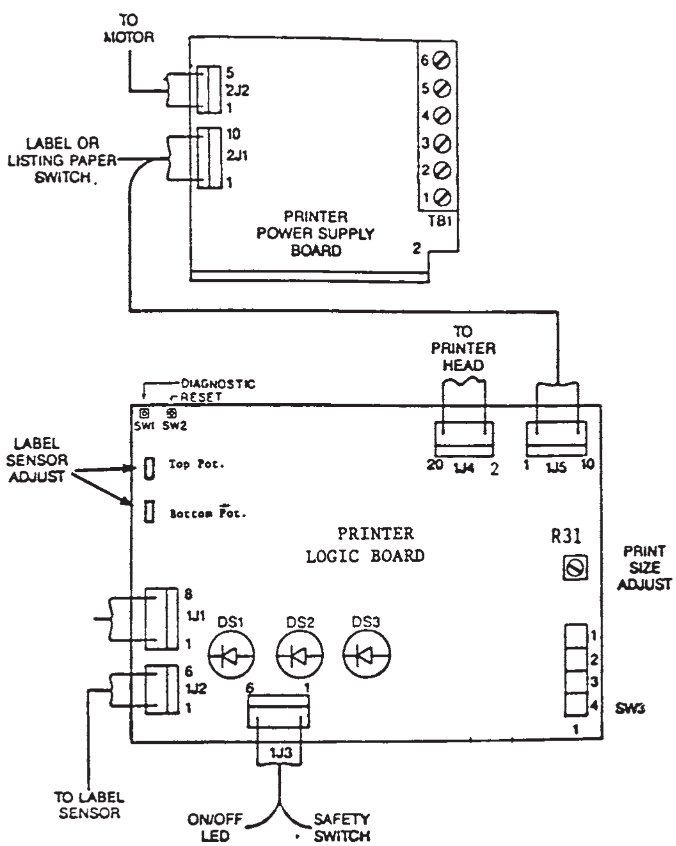

FIG. 2 Hobart 18VP Thermal Printer,[2] Circuit Boards

11.2.3 Change the voltage setting, run another series of samples, read the density and plot the average density value against the watts/dot.

11.2.4 Repeat 11.2.1-11.2.3 for each test sample.

11.2.5 A minimum of ten different test points (voltage levels) should be used for density curve generation. However, additional points will better define the curve in the critical region, that region in which small increases in head temperature result in significant image density increases.

FIG. 3 Hobart 18VP Thermal Printer,[2] Diagnostic Test Pattern

12. Report

12.1 Report the following information:

12.1.1 *Sample Identification*:

12.1.1.1 Coated roll batch or lot number,

12.1.1.2 Manufacturer and product code,

12.1.1.3 Date or time of manufacture, or both, if available, and

12.1.1.4 The voltage determined in 11.1.2.1. The exposure time is established by the traversing mechanism of the printer and is not adjustable.

12.1.2 Report the temperature and humidity of the ambient test conditions.

12.1.3 Report the density data obtained in tabular form or as curves such as those shown in Fig. 4.

12.1.4 The density versus watts/dot curves generated by the test samples may be compared with the rate at which they reach saturation (maximum density), the maximum density obtained and the watts per dot at which the density starts to drop off.

13. Precision and Bias

13.1 Repeatable measurements on the same paper and same test equipment should agree within ± 2 % of density for all points on the thermal response curve. This precision and bias statement is based on the equipment listed in the Apparatus and Materials section of this test method.

13.2 Measurements between laboratories may not be reproducible because of different test equipment and testers. A

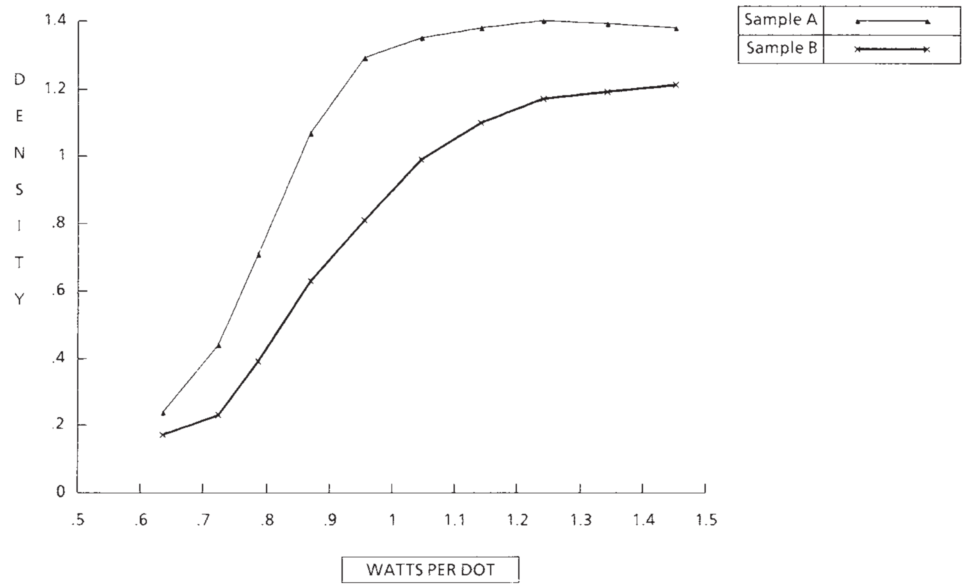

FIG. 4 Dynamic Thermal Response Curve

laboratory correlation test may be used to minimize differences between test equipment and establish a correlation between laboratories.

13.3 The precision of this test method is dependent upon the skill or experience of the operator, or both.

13.4 The precision of this test method is not affected, provided that:

13.4.1 The same test equipment is used,

13.4.2 Calibration procedures and frequency of calibration are the same,

13.4.3 The proper sample loading procedure is used, and

13.4.4 Ambient conditions are similar.

14. Keywords

14.1 direct thermal paper; dynamic thermal response; dynamic thermal response curve; thermal printer; thermal sensitivity