





**Corporate Headquarters**

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**DMS, Incorporated**

1155 Rose Road  
Lake Zurich, IL 60047

Phone: 847-726-2828  
Fax: 847-726-9292

**Toll Free Sales and Technical Support**  
1-800-655-7882

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**Foil Hot Stamp Unit Information**

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Hot Stamp Unit Model Number **FRXXX**

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Hot Stamp Unit Serial Number

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Foil Printing Controller Model Number **HP-3002**

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Foil Printing Controller Serial Number

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TorKit Die Pressure Gauge Serial Number **N/A**

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Factory Ship Date **10/19/05**

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Notes

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Purchase Order No.

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## Foil Printing Controller Manual

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The DMS Foil Printing Controller is a custom microprocessor based controller. The Die Temperature, Set Point, and a Status Display are shown on the left side of the front panel. **Die Temperature** is the temperature of the die as measured by a J-type thermocouple or infrared temperature sensor. The **Set Point** is the temperature of the die that the controller tries to maintain throughout the run cycle. The **Status Display** can display several useful parameters including power input to the die, the status of the press slave line, alarm codes, and overheat cooling time.

On the front of the controller panel are four green LED's. Each LED with an explanation of its significance is listed in the table below:

| <u>LED</u> | <u>Description</u>  |
|------------|---|
| Cooling    | When lit the controller is cooling the die with compressed air. |
| Run        | When lit the base roll is raised, and the die is stamping.      |
| Overheat   | When lit a special <i>Overheat Mode</i> is active.              |
| Tuning     | When lit the <i>Parameter Change Mode</i> is active.            |

### Setting the Set Point

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On start up the Set Point is off. That is, the controller is not trying to maintain the die at any preset temperature. This is shown by three dashes (---) in the Set Point display field. By pressing the UP button the Set Point will increase from 60 °F. By holding the *Up* button in the Set Point will increment upwards. The *Enter* button must be pushed before the new Set Point becomes active. If the *Enter* button is never pushed the Set Point will revert back to its original value. The Set Point can be turned off by depressing the *Down* button until three dashes appear in the Set Point display, followed by pressing the *Enter* button.

**WARNING: DO NOT EXCEED 425°F ON THE SET POINT.** This will cause overheating and possible error readout.

### Raising the Impression Roll

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Raising the impression roll to begin stamping can be accomplished two different ways. The first mode is fully automatic. To be in this mode the impression mode parameter (L9) should be set to 1, and the impression switch on the front panel set to auto. When the press starts the impression roll will move up. When the press stops the impression roll will move down. If the impression switch is set to off, the impression roll will move down.

The second mode is manual start with automatic stop. To be in this mode the impression mode parameter (L9) should be set to 2. When the press starts, the impression roll will not move up until the operator switches the impression switch to auto. If the impression switch is in auto when the press starts the operator must cycle the switch to off then to auto again to raise the impression roll. The impression roll will automatically move down when the press stops. The impression roll can only be manually raised with the impression switch when the press is running.

For set-up purposes only, the impression roll can be raised and lowered completely manually.

The operator should use caution when manually raising the impression roll. When the impression roll is stationary a hot die should not be in contact with the impression roll for more than a few seconds, or damage will result.

For complete manual control of the impression roll, hold the enter button in for approximately four seconds. This will cause the controller to enter the parameter change mode. The set point display will read "P1". The Up and Down buttons can be used to manually raise and lower the impression roll. To leave the parameter change mode press Enter 11 more times to cycle through the rest of the parameters. See "Changing Parameters" for additional information.

*Note:* In the parameter change mode the controller will not heat or cool the die. Complete manual control of the impression roll should only be used for set-up purposes.

While using the fully automatic impression roll control (Impression Mode Parameter set to 1), the user can set the amount of time delay between when the press starts and the impression roll moves up. The length of the time delay is adjusted by the impression delay parameter (P2). The units of the impression delay parameter are in 1/10<sup>th</sup> of a second. For example, if P2 is set to 15 the length of time delay from press start to the impression roll moving up is 1.5 seconds. This time delay option is only available when using the fully automatic impression roll control.

## Cooling

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When the die is stationary the controller will turn the cooling air on when the Die Temperature is at a preset value over the Set Point. This value (P10, Cooling Threshold) can be adjusted by the user (See the Changing Parameters Section). The overheat mode will also cause the cooling air to come on.

## The Alarm Switch

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The audio alarm is preset at the factory to come on when the die temperature is 20 °F above or below the set point. The alarm switch turns this function on and off. The audio alarm signifying an abnormal condition cannot be turned off with this switch.

## Overheat Mode

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When the die has been running for some time and the press stops, the die tends to overheat because of the large change in heat dissipation rate. The DMS Foil Printing Controller compensates for this problem by using a specially designed overheat mode. When the die has been running for a certain length of time (the overheat activation time, L11) and the press stops, the controller will switch into overheat mode. The overheat mode causes the controller to stop all heating of the die and cool it with air for a preset length of time (overheat cooling time, L12). When the controller enters the overheat mode the status display will start counting down the number of seconds left for the overheat cooling time. The overheat mode will not become active if the die temperature is more than the overheat activation temperature (L13) under the set point.

The overheat mode can be exited on demand by pressing Enter. Overheat activation time, overheat cooling time, and overheat activation temperature can be adjusted by the user. If the overheat ON/OFF parameter is set to 0, the overheat mode is disabled.

## Abnormal Condition Alert

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The microprocessor is continually monitoring the foil printing process using a sophisticated algorithm capable of detecting abnormal conditions. The abnormal conditions it checks for are:

- A. A sudden unexplainable drop in temperature
- B. A large power input to the die with little temperature increase.
- C. Or both A and B will occur when the temperature sensor is no longer sensing the correct die temperature.

This situation may cause the die to overheat which will create a very unsafe condition. The DMS Foil Printing Controller attempts to minimize this danger by alerting the operator as soon as it detects an abnormal condition.

When the controller detects an abnormal condition the audio alarm comes on, a flashing “E” appears in the status display, and the heater will be turned off. The audio alarm for the abnormal condition alert is different from the temperature out of range alarm, and will sound regardless of the position of the alarm switch. The operator should inspect the temperature sensor for proper placement and operation, and then the Enter button should be pressed to reset the controller. If the controller continually gives false alarms, consult Appendix A.

## Changing Parameters

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The DMS Foil Printing Controller has many features that can be easily customizable by changing one or more parameters. The parameters are divided into two levels. The first level contains the most commonly changed parameters. These parameters are designated as P1 through P10. The second level contains the more complicated parameters that are less likely to be changed by the operator. These parameters are designated L1 through L20.

To enter the parameter change mode, hold down the enter button for approximately 4 seconds. The tuning mode LED will light and “P1” will appear in the set point display. While in the parameter change mode, the set point display reads the parameter number and the status display reads the parameter itself. The up and down buttons are used to change the parameter. Enter is used to proceed to the next parameter number. There are a total of 10 “P” parameters. The 11<sup>th</sup> “P” parameter is a key for access to the second level of parameters. If “P11” is set to 1 and then Enter is pushed access to the second level of parameters will be gained. If “P11” is left at zero and Enter is pushed the parameter change mode will be exited. There are a total of 20 “L” parameters.

Each parameter number, its description, the operating range, and defaults are listed in table on the following page. Detailed descriptions of each parameter are given after the table.

## Foil Printing Controller Parameters

| Number | Description   | Range         | Default         |
|--------|---|---------------|-----------------|
| P1     | Manual Impression                                   | 0 – 1         | 0               |
| P2     | Impression Roll Delay                               | 0 – 100       | 0               |
| P3     | Alarm Lower Limit                                   | 1 to 100 °    | 20 °            |
| P4     | Alarm Upper Limit                                   | 1 to 100 °    | 20 °            |
| P5     | Thermocouple Slope 1 (J-type leaf) or active (IR)*  | -199 to 199   | 90 °F or 56 °C  |
| P6     | Thermocouple Offset 1 (J-type leaf) or active (IR)* | -199 to 199   | 5 °F or -4 °C   |
| P7     | Thermocouple Slope 2 (passive I.R.-type)*           | -199 to 199   | 126 °F or 70 °C |
| P8     | Thermocouple Offset 2 (passive I.R.-type)*          | -199 to 199   | 50 °F or -18 °C |
| P9     | Thermocouple Parameter Set                          | 1 – 2         | 1               |
| P10    | Cooling Threshold                                   | 5 to 100 °    | 20 °            |
| P11    | “L” Parameter Access                                | 0 – 1         | 0               |
| L1     | Kp – Stationary Die                                 | 0 - 199       | 31              |
| L2     | Ti – Stationary Die                                 | 0 - 199       | 64              |
| L3     | Td – Stationary Die                                 | 0 - 199       | 170             |
| L4     | Kp – Running Die                                    | 0 - 199       | 78              |
| L5     | Ti – Running Die                                    | 0 - 199       | 35              |
| L6     | Td – Running Die                                    | 0 - 199       | 110             |
| L7     | No Heat Threshold                                   | 1 to 100 °    | 10 °            |
| L8     | Integral Wind Up Limit                              | 1 to 199      | 25              |
| L9     | Impression Switch Mode                              | 1 – 2         | 1               |
| L10    | Status Display                                      | 1 – 9         | 4               |
| L11    | Over-Heat Activation Time                           | 1 to 199 secs | 60 secs         |
| L12    | Over-Heat Cooling Time                              | 0 to 199 secs | 30 secs         |
| L13    | Over-Heat Activation Temperature                    | 0 to 199 °    | 15 °            |
| L14    | Over-Heat Off/On                                    | 0 – 1         | 1               |
| L15    | A.C. Activation Temperature                         | 1 to 199 °    | 75 °            |
| L16    | A.C. Heat Threshold                                 | 0 to 100%     | 75%             |
| L17    | A.C. Temperature Change                             | -199 to 199 ° | 10 °            |
| L18    | A.C. Reset Timer                                    | 1 – 199       | 20              |
| L19    | A.C. Temperature Loss                               | 0 to 199 °    | 75 °            |
| L20    | A.C. Off/On   | 0 to 1        | 1               |

\*Active (IR) denotes a 12 volt powered detector, identified by two 3 conductor plugs, one yellow, one black attached.

\*Passive (IR) is an un-powered sensor, identified by a 2 conductor plug, black in color.

### **P1 – Manual Impression**

When set to “1” the impression roll will be raised. When set to “0” the impression roll will be lowered. When the parameter mode is exited this parameter will be reset to “0” automatically. Manually raising the impression roll should only be used for set-up purposes.

### **P2 – Impression Delay**

This parameter sets the length of time in tenths of a second that the raising of the impression roll is delayed. For example, if parameter P2 is set to 15 there will be a 1.5 second delay in the raising of the impression roll. When parameter L9 is set to 2, the raising of the impression roll will never be delayed.

### **P3 – Alarm Lower Limit**

The number of degrees below the set point the die temperature has to be in order for the audio alarm to activate.

### **P4 – Alarm Upper Limit**

The number of degrees above the set point the die temperature has to be in order for the audio alarm to activate.

**P5 thru P8 – Two sets of slope and offset parameters for the temperature sensor input**

Set #1 is preset at the factory for a J-type thermocouple. Set #2 is preset at the factory for an infrared thermocouple sensor.

**P9 – Thermocouple Parameter Set**

Selects which Slope/Offset set is active. If a J-type thermocouple is used set #1 should be active (default). If an infrared sensor is used, set #2 should be active.

**P10 – Cooling Threshold**

The number of degrees above the set point the die has to be in order for the cooling air to come on. The cooling air will never come on when the die is running.

**P11 – “L” Parameter Access Key**

If this parameter is set to 1, access to the “L” parameters will be allowed after pressing enter.

**L1 thru L6 – PID Gains**

Two sets of PID gains are used to control the temperature of the die. One set is used while the die is stationary and the other is used while the die is running. The stationary set is less aggressive than the running set. For more information see Appendix B.

**L7 – No Heat Threshold**

The number of degrees above the set point the die has to be in order for the controller to cut off all heating to the die when the die is stationary. When the die is running the not heat threshold is automatically doubled.

**L8 – Integral Wind Up Limit**

Limits the amount of integral control will saturate when the temperature is below the set point.

**L9 – Impression Mode.**

When set to 1, the impression roll is in fully automatic mode. The impression roll will only move up when the press starts and the impression switch is set to auto. The raising of the impression roll will be time delayed depending on the value of the impression delay parameter (P2). The impression roll will lower when either the press stops or the impression switch is turned off. When this parameter is set to 2, the impression roll is in manually start/auto stop mode. The impression roll will move up only when the press has started and the operator cycles the impression switch to the auto position. The impression roll will lower automatically when the press stops or the impression switch is turned off.

**L10 – Status Display**

The status display can display several different internal control variables. By changing this parameter different variables will be display. Parameter 4 is preset from the factory.

| “L10” Number | Display Description                                    |
|--------------|--|
| 1            | Percentage of heat into die over a 5 second interval.  |
| 2            | Percentage of heat into die over a 20 second interval. |
| 3            | Percentage of heat into die over a 60 second interval. |
| 4            | Heater On or Off (1=On, 0=Off) – Preset from factory   |
| 5            | Press Slave Line (1=On, 0=Off)                         |
| 6            | Proportional Control Amount                            |
| 7            | Integral Control Amount                                |
| 8            | Derivative Control Amount                              |
| 9            | Blank  |



**L11 – Overheat Activation Time**

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The length of time in seconds which the die has to be running in order for the overheat mode to become active when the press stops.

**L12 – Overheat Cooling Time**

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The length of cooling the overheat mode will provide. If overheating when the press stops is a problem, increase this parameter.

**L14 – Overheat On/Off**

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When “1” the overheat mode will function normally. When “0” the overheat mode cannot be activated.

**L15 – Abnormal Condition Activation Temperature**

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See Appendix A.

**L16 – Abnormal Condition Heat Threshold**

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See Appendix A.

**L17 – Abnormal Condition Temperature Change**

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See Appendix A.

**L18 – Abnormal Condition Reset Timer**

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See Appendix A.

**L19 – Abnormal Condition Temperature Loss**

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See Appendix A.

**L20 – Abnormal Condition On/Off**

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See Appendix A.



## Appendix A: Abnormal Condition Detection

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The controller detects two different types of abnormal conditions. The first is a large drip in temperature over a short period of time. Under normal conditions a typical die can only lose heat so fast. Therefore a large temperature drop will be characteristic of something wrong. The controller will signal an abnormal condition when the die temperature drops L19 (*abnormal condition temperature loss*) degrees over one minute.

The second type of abnormal condition is more complicated. Four separate conditions must be met simultaneously in order for the controller to signal an abnormal condition. The conditions are as follows:

1. The temperature is L15 or more degrees below the set point.
2. The controller is supplying L16% or more power to the heater.
3. The temperature gain over a minute is L17 degrees or less.
4. L18 \* 5 seconds or more has elapsed since last alert reset (Enter was pushed)

If all four of these conditions are met the controller will signal an abnormal condition. If the controller continually signals false alarms try changing one or more of the following parameters:

Increase L15, Increase L16, or Decrease L17.

When the controller signals an abnormal condition the following happens: The audio alarm will sound, a flashing "E" will appear in the status display, and the heater will be turned off. The operator should inspect the temperature sensor to make sure everything is in order, and then press enter to reset the controller. To disable the abnormal condition detection algorithm L20 should be changed to "0".



## Appendix B: Suggested PID Values

PID stands for Proportional, Integral, and Derivative. The words come from the form of the control equations the microprocessor uses to decide the amount of heat to send to the die. The controller is set-up at the factory to work well for a variety of dies. However, in some cases better performance can be obtained by adjusting the PID values. This appendix is intended as a general guide to adjusting the PID values.

A set of PID values with a fast rise time and a large amount of over shoot is said to be more aggressive than a set with a slow rise time and little over shoot. Because of the large difference in heat dissipation rate when the die is stationary and when it is running the controller uses two sets of PID values, one for each situation. The level of aggressiveness of the stationary set of PID values should be adjusted so that on initial start up the die increases from room temperature to the set point quickly, but with limited over shoot. That is, as aggressive as possible without causing a large amount of over shoot.

The running set of PID values should be more aggressive than the stationary set. When the die is running heat dissipation is high and over shoot is not a large problem. The aggressiveness of the running set of PID values will limit the temperature drop when the press starts running.

Below is a set of PID values starting from less aggressive to more aggressive. These sets can be used as a guide when adjusting the aggressiveness of the controller.

**PID Values for Controller Aggressiveness**

|                            | <b>Kp</b> | <b>Ti</b> | <b>Td</b> |
|----------------------------|-----------|-----------|-----------|
| <b>LESS<br/>AGGRESSIVE</b> | 17        | 89        | 200       |
|                            | 26        | 71        | 176       |
|                            | 35        | 59        | 156       |
| ↓                          | 45        | 51        | 141       |
|                            | 54        | 45        | 129       |
| ↓                          | 64        | 40        | 119       |
|                            | 73        | 36        | 111       |
| ↓                          | 83        | 33        | 104       |
|                            | 91        | 31        | 98        |
| ↓                          | 100       | 29        | 93        |
|                            | 108       | 27        | 89        |
| ↓                          | 116       | 25        | 86        |
|                            | 124       | 24        | 82        |
| ↓                          | 131       | 23        | 80        |
|                            | 138       | 22        | 77        |
| <b>MORE<br/>AGGRESSIVE</b> | 145       | 21        | 75        |
|                            | 151       | 20        | 73        |
|                            | 157       | 19        | 71        |

