
Particle Analysis and Display System (PADS): Fog Monitor 100 (FM 100) Module Manual

DOC-0285 Rev A

PADS 3.6.0

FM 100 Module 3.6.0



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For similar reasons, DMT recommends that you do not install or run other software on the dedicated instrument computer. Although the installation of some software may be unavoidable, it is particularly important not to run other software while the computer is acquiring data.

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1.0 Introduction

The Particle Analysis and Display System (PADS) is a software package that interfaces with instruments produced by Droplet Measurement Technologies (DMT) and other leading instruments used in the atmospheric sciences. This manual describes the PADS Fog Monitor 100 (FM 100) module version 3.6.0.

For an explanation of the basic PADS setup and instructions on how to acquire data using PADS, consult the *PADS Overview Manual*, DOC-0300. Definitions and calculations used in the FM 100 module are also described in the *PADS Overview Manual*.

2.0 Configuration

Using PADS, you can configure both the software settings for the instrument and the instrument's data display in PADS. The following two sections explain how to do this. Configuring the instrument's software and display affects the default settings PADS uses when starting up. Some parameters can also be changed while PADS is running, but doing so affects the current session only.

2.1 Configuring the FM 100

Your FM 100 and data system should arrive preconfigured from DMT. In some cases, however, you may want to change the software configuration for the instrument. To do this, follow the steps below. *Note: Droplet Measurement Technologies STRONGLY recommends that customers contact our office prior to changing any of the parameters in the instrument configuration. Improper changes can result in communication failure and/or changes in PADS computation algorithms, which can compromise data validity.*

1. Click on the “FM 100” tab.
2. From the **Configure** menu, select **Configure Instrument**. You will see the following window.

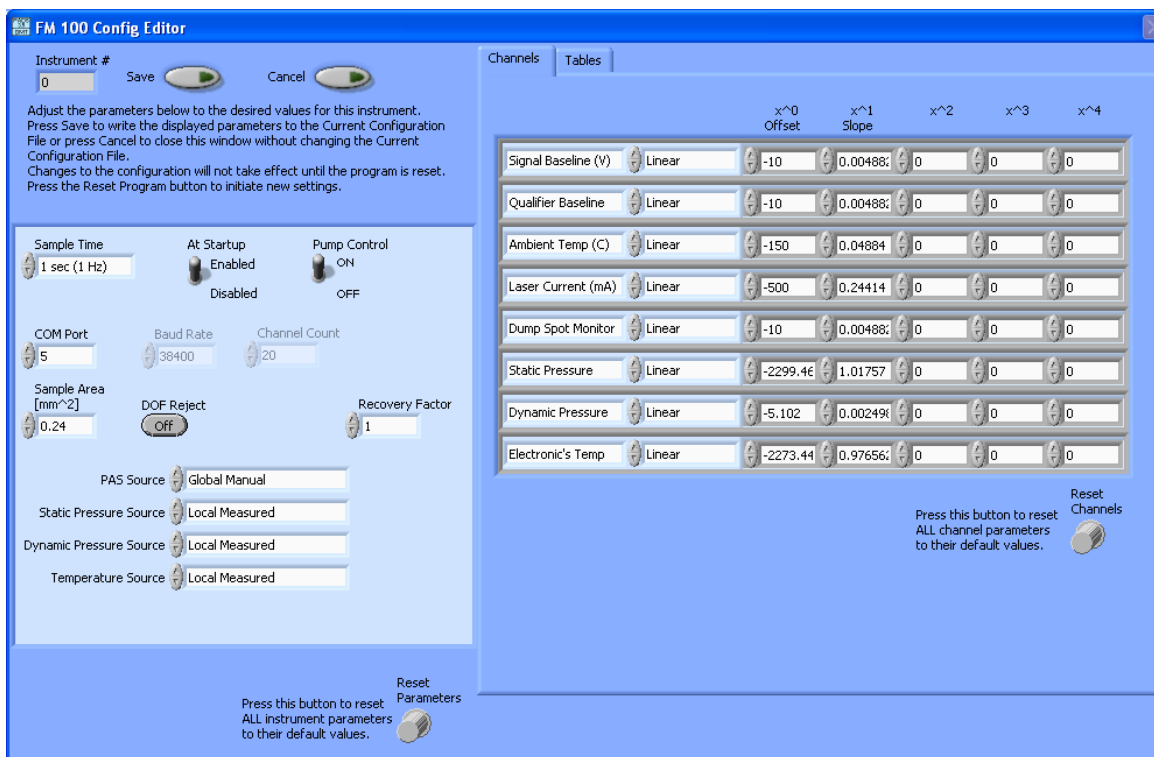


Figure 1: FM 100 Configuration Editor Window

3. Now you can configure the instrument parameters to your desired specifications. See the definitions below for explanations of individual parameters. If at any time you would like to revert to the previously saved values for the FM 100 parameters, press **Cancel** to exit the window without saving changes. Pressing **Reset Parameters** reverts parameters to their DMT-supplied default values.
4. When you are done configuring the FM 100 parameters, press **Save** at the top of the Config editor window. Then press the green **Reset Program** button for the new configuration to take effect. Note that pressing the **Reset Program** button will clear any data currently being displayed.

2.1.1 FM 100 Parameters

Instrument #: This lists the number corresponding to the instrument you are viewing, in this case the FM 100. If your FM 100 has been assigned instrument number one, you will see “1” in this field. You should not need to modify the instrument number, and in fact you are unable to do so from within PADS.

Sample Time: This parameter shows the time interval you'd like between samples. You can have the probe sample at intervals between 0.04 and 20 sec (25 to 0.05 Hz). Note that if you increase the sample time, you will still collect data for the same number of particles. This is because the probe collects data continuously and relays cumulative data at each sampling

interval. For example, say you have the sample time set to .5 seconds. You might see four particles of size 25 μm during the first sample, and five particles of this size during the second sample. If you had set your sample time to one second instead of .5 seconds, you would instead get one sample that showed nine particles of size 25 μm . *Note:* Sample Time is most often set to 1 Sec. Higher sample rates may or may not work on a given data system, depending on the computer performance and the number and types of instruments PADS is configured to use.

At Startup Enabled / Disabled: If you want the FM 100 to acquire data when PADS begins sampling, make sure this parameter is in the “Enabled” mode. In some cases, such as if the FM 100 is inoperative, you may want to use this control to disable the probe. Disabling the FM 100 allows data to transmit from other instruments without interference. Data will still be written to the disabled instrument’s output file, but PADS will write “NaN” to all fields.

Pump Control: This control specifies whether the FM 100’s pump should turn on when PADS starts acquiring data. The default setting is on. In some cases, such as if the FM 100 is being calibrated, the technician may want to use this control to turn off the pump.

COM Port: This is the serial communications port that the FM 100 uses to connect with the computer. This number should match the computer hardware configuration for the particular computer you are using. If you are not using multiple computers, this number should not be changed.

Baud Rate: The baud rate for the probe is defined at manufacture. This parameter has been grayed out and you should not need to change it. If you reconfigure your hardware, however, the baud rate may change. If this occurs, contact DMT for help in changing your baud rate in PADS.

Channel Count: This number indicates how many sizing bins the FM 100 uses to categorize particles. This number has been grayed out because it is preconfigured for your instrument and should not change.

Sample Area: This is the physical area in which particles are detected. FM 100 sample area is a constant regardless of particle size. This value is preconfigured to match your instrument, so it is strongly suggested that you do not change it.

DOF Reject: The DOF reject button tells the FM 100 whether to reject particles that fall outside the FM 100's depth of field. The default value is ON, and you should not need to change it. During probe calibration and alignment, DMT sets DOF Reject to false, so that the probe will report all particles it detects. (For a definition of Depth of Field, consult Appendix A of the *PADS Overview Manual*.)

Recovery Factor: This parameter is used in calculating ambient temperature from measured temperature. PADS uses Bernoulli's equation for this calculation. For more information on this equation and the recovery factor, see the "Ambient Temperature" entry in Appendix B of the *PADS Overview Manual*. By default, Recovery Factor is set to 1.0.

The **Source controls** allow you to set the source for airspeed-related parameters that can be measured by instruments or entered manually. (Note that for the FM 100, "air speed" refers to flow rate.) For instance, the **PAS Source** control specifies from which of the following sources the system should obtain the applied probe air speed (Applied PAS):

- 1.) A specific instrument in the system (this can be any instrument capable of measuring air speed)
- 2.) A manually entered value:
 - a. A "Local" value, which at start-up is the value entered in the box to the right of the source control. This number can be changed from the instrument display while the program is running.
 - b. A "Global" value entered on the **Setup** tab

Applied PAS is used to calculate sample volume. In normal conditions, you will typically want to use the FM 100 as the air speed source. However, if there are problems with the pump or pitot tube, you can use a manual source. If the PAS source is a manually entered value, PADS will still calculate air speed and store the result in the **PAS (m/s)** channel.

Similarly, you can instruct the system to use different sources for the static pressure, dynamic pressure, and temperature variables used in calculating air speed. For pressure and temperature sources, "Local Measured" uses the instrument's measurement, while "Local Manual" uses manually entered values—initially the ones to the right of the source controls, which can be changed from the instrument display when the program is running.

2.2 Configuring the FM 100 Display

To configure the FM 100 display, click on the FM 100 tab if you have not already done so. Then select **Configure** from the menu bar and click on **Configure Display**. This will bring up the following window.

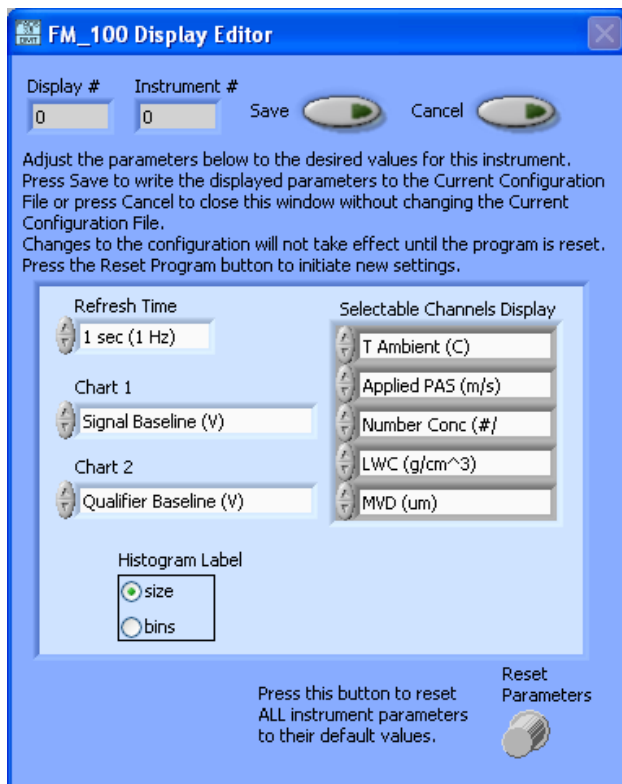


Figure 2: FM 100 Display Editor Window

You do not need to modify the **Display #** or **Instrument #**.

Changing the **Refresh Time** allows you to set the time intervals for data display during acquisition mode; you can choose any time that is equal to or greater than the sample time. (Choosing a time less than the sample time is not useful, since the same data will be displayed multiple times.)

Chart 1 and **Chart 2** allow you to configure the channels on the FM 100's selectable graphs. To change these channels, click on the arrow buttons to scroll between available options for the channels. You can also click on the white fields to bring up a list of all the available options, from which you can then choose the channel you want.

Histogram Label: This control allows you to specify the units for the x-axis of the histogram, which can either be size in μm or bin numbers.

The **Selectable Channels Display** controls which channels PADS displays in the upper right of the FM 100 window.

Pressing the **Reset Parameters** button resets all parameters to their DMT-supplied default values.

When you are done, click on **Save** to update the configurations or **Cancel** to revert to the previous configuration. After you reset PADS, you will be able to see any changes. Note that clicking **Reset Program** will clear out any data currently being displayed.

Configuring channels in the **Display Editor** will change the display upon start-up. Once PADS has started, you can change many of these settings from within the main FM 100 tab.

3.0 The FM 100 Window

The following sections describe the different sections of the FM 100 Window: the channel tab, the chart displays, and the histogram display.

For explanations of the **Enable** button, **COM Port** indicator, and **Fault/No Fault** button, see the “Instrument Tabs” section of the *PADS Overview Manual*.

3.1 Sub-Tabs

The FM 100 window has six sub-tabs, discussed below.

3.1.1 Data Tab

The **Data** tab displays the current values for many of the FM 100 data channels. For more information on these channels, see Appendices A and B of the *PADS Overview Manual*.

3.1.2 LWC / # Conc and LWC / MVD Tabs

The **LWC / # Conc** tab displays a time-trace chart of calculated liquid water content in g/m^3 (shown in green) and **# Conc** in $\text{particles}/\text{cm}^3$ (shown in blue). The **LWC /# MVD** tab

displays a time-trace chart of calculated liquid water content in g/m^3 (green) and MVD in μm (blue). A red cursor shows the current moment in time.

3.1.3 Selectable Chart Tab

This tab displays time-trace charts of two user-selectable channels. The charts are overlaid on each other, with the left axis (in green) corresponding to the channel listed in the above left of the chart, and the right axis (in blue) applying to the channel listed in the above right. To change these channels, click on the names of the currently displayed channels, which will bring up a list of options. If you would like to permanently change the **Selectable Charts** channels, as opposed to simply changing them for the current session, you can do so by selecting **Configure > Configure Display** and making the desired changes.

3.1.4 Particle Count Tab

The **Particle Count** tab displays a time-series chart of total particle counts over time.

3.1.5 Tools Tab

The Tools tab lists various **Source** controls. If these controls are grayed out, click on **Press to Enable Source Changes** to enable them.

The **Source controls** allow you to set the source for airspeed-related parameters that can be measured by instruments or entered manually. (Note that for the FM 100, “air speed” refers to flow rate.) For instance, the **PAS Source** control specifies from which of the following sources the system should obtain the applied probe air speed (Applied PAS):

- 1.) A specific instrument in the system (this can be any instrument capable of measuring air speed)
- 2.) A manually entered value:
 - a. A “Local” value, which at start-up is the value entered in the box to the right of the source control. This number can be changed from the instrument display while the program is running.
 - b. A “Global” value entered on the **Setup** tab

Applied PAS is used to calculate sample volume. In normal conditions, you will typically want to use the FM 100 as the air speed source. However, if there are problems with the pump or pitot tube, you can use a manual source. If the PAS source is a manually entered value, PADS will still calculate air speed and store the result in the **PAS (m/s)** channel.

Similarly, you can instruct the system to use different sources for the static pressure, dynamic pressure, and temperature variables used in calculating air speed. For pressure and

temperature sources, “Local Measured” uses the instrument’s measurement, while “Local Manual” uses manually entered values. You can enter these manual values in the boxes that appear when “Local Manual” is selected. Global manual values are entered on the **Setup** tab.

Changing the source settings here changes them for the current session only. (To change the default values used upon start-up, do so from the **Configure > Configure Instrument** menu.) After you have finished specifying new sources, click on the **Press to Lock Source Changes** button to disable further changes.

3.2 Pump Control

In the upper right of the FM 100 window, you will see the pump control and flow indicator, as shown in Figure 3.

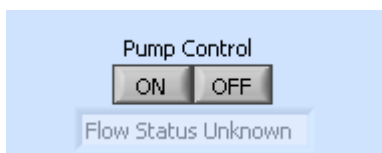


Figure 3: Pump Control and Flow Status Indicator at PADS Start-up

The pump control indicates whether the FM 100’s pump is on or off. When you first open PADS, the control will not indicate the pump’s status. Instead, both buttons will be gray, as in Figure 3. (The pump itself may be either on or off, depending on how it was last set.) Once you instruct the pump to turn on or off using the buttons, however, they will reflect the pump’s status until the time you close PADS. For instance, if you press “ON,” the display should appear similar to that in Fig. 4.

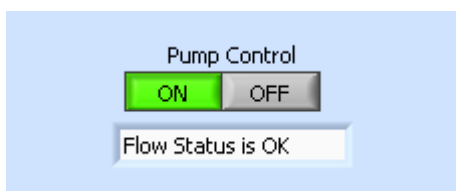


Figure 4: Pump Control and Flow Status Indicator when Pump is Operating

The flow status indicator has three possible values: “Flow Status Unknown,” “Flow Status is Okay,” and “Flow Status is Low.” “Flow Status Unknown” indicates that the program is not currently acquiring data from the probe, and hence the value of the flow cannot be known. “Flow Status is Okay” indicates that the program is acquiring data and that the pump is generating a flow of at least 5 m/sec. “Flow Status is Low” indicates that the

probe is on, but the pump is generating a flow of under 5 m/sec, indicating a possible problem with the pump, flow path, or flow sensor.

3.3 Selectable Channels

The upper right of the FM 100 window displays current data for five user-selectable channels. New channels can be selected by clicking on the name of a current channel and selecting a replacement from the drop-down list. To make permanent changes to this list, edit the settings on the FM 100 Display Editor (select **Configure > Configure Display**).

3.4 Histogram

The bottom half of the FM 100 window contains the histogram display of particle data. The number in the upper right of the histogram shows the total particle count across the entire histogram.

The x-axis labels indicate the upper boundary of each bin. A bin's lower boundary is the upper boundary of the previous bin, except for the first bin. You can view and modify the lower boundary of this bin—and other bins—by selecting **Configure > Configure Instrument** and then clicking on the **Tables** tab.

To the right of the histogram are buttons that control the scaling and display of the histogram data. **Auto-scale** controls let you control how the x and y scales are set. If you enable autoscaling, PADS will automatically select an appropriate scale with which to display the current data. For instance, if the probe is not currently detecting many particles, the y-axis range will decrease. On the other hand, if you disable autoscaling, the scale of the axes will remain constant. In this case, the range will always be the same as it was when autoscaling was disabled. The minimum and maximum values can then be changed manually by typing new numbers into these fields.

When you turn on the **Log-Scale** buttons, PADS scales the appropriate axis logarithmically rather than linearly. Autoscaling can be enabled or disabled with this option.

If you click on the **Normalized** button, PADS will scale the particle data so that each bin of data is divided by the width of that bin in μm . Normalization is useful when the widths of the size bins are not constant, as is often the case when an optical spectrometer has to cover a large size range or if some size bins are made larger to decrease uncertainty due to operational limitations. Without normalization, the concentrations from one size bin cannot be compared quantitatively from those in another size bin of different width. For example, if 8 particles are counted in a size bin that is 2 μm wide and 8 particles are counted in the next larger channel that is 4 μm wide, the size distribution would appear flat and we would assume that it was equally probable to measure particles of either

size. This is a biased sample, however, since the larger size bin is twice as wide as the smaller. If we normalize by the width, however, we find that the smaller size category has 4 particles per μm and the larger size bin only has 2 particles per μm . This is now an unbiased sample.

The **size / bin number** radio buttons allow you to change the x-axis units. When the x-axis displays bin number, each bin's upper size limit in μm is displayed above each data bar.

4.0 Zooming In and Out

There are several ways to zoom in or out on CAS charts and the histogram. As described in the *PADS Overview Manual*, you can use the time-range controls (Figure 5) to zoom. To zoom in on the data, move the green and red controls close to the white control, which will narrow the range of displayed data. To zoom out, move the two colored controls away from the white control.

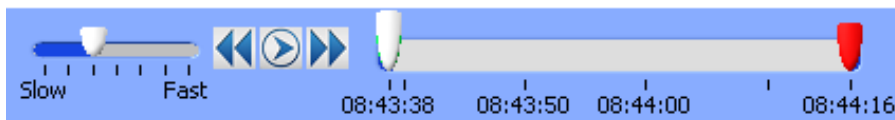


Figure 5: Time-Range Controls

On the chart itself, you can also type numbers directly into the first and last labels on the x and y axis to change the scaling.

Note: Do not right-click on chart and change the auto-scaling using the drop-down menu. This can interfere with the chart display. PADS autoscales most charts automatically. You can turn off autoscaling on the histogram using the buttons in the lower right of the window.

Appendix A: FM 100 Channels

A list of channels for a 20-bin FM 100 appears below. The FM 100 output file will contain data values for each channel for each sampling instance. You can also plot each of these channels as a function of time using the FM 100 Selectable Charts tab.

For definitions of the channels, consult *Appendix A: Definitions* in the *PADS Overview Manual*.

| | |
|-------------------------------|----------------------------------|
| End Seconds | <i>Static Press (mbar)</i> |
| Day Of Year | <i>Dynamic Press (mbar)</i> |
| Year | <i>Electronics Temp (C)</i> |
| Status | Spare 1 – 8 |
| DOF Reject Counts | T Ambient (C) |
| Unused | PAS (m/s) |
| Unused | Number Conc (#/cm ³) |
| Unused | LWC (g/cm ³) |
| Unused | MVD (um) |
| ADC Overflow | ED (um) |
| <i>Sizer Baseline (V)</i> | Applied PAS (m/s) |
| <i>Qualifier Baseline (V)</i> | Bin 1 – 20 |
| <i>Recovery Temp (C)</i> | UTC Seconds / GPS Time |
| <i>Laser Current (mA)</i> | Date |
| <i>Dump Spot Monitor (V)</i> | Time |

FM 100 channels fall into several categories

- Time channels
- Housekeeping channels (see below)
- Bin channels (for particle-size data)
- Statistical channels
- Calculated Channels (e.g. Number Conc, LWC, MVD, and ED)

Housekeeping Channels: The FM 100 has 8 A/D housekeeping channels that have a 0-20 V range measured by a 12-bit A/D converter that gives integer values from 0 to 4095. Several of the housekeeping channels store data that indicate whether the probe is functioning properly. Housekeeping channels appear in italics in the list above.

Appendix B: Modifications to FM 100 Housekeeping Channel (for Probes Manufactured before June 2009)

On FM 100s manufactured prior to June 2009, housekeeping channel #5 stores the temperature (°C) on the instrument's optical block. However, since later versions of the instrument use housekeeping channel #5 to store the Dump Spot Monitor, PADS is configured to display this channel and scale it in volts. To reconfigure PADS so that it displays the channel properly as the Optical Block temperature, follow the steps below.

- 1.) Load your configuration file using the **Load Configuration** menu item.
- 2.) Click on **Configure > Edit Custom Equations**.
- 3.) Enter the following equation in the top white box that is available:

$$((1/((1/3900)*\ln((4096/(VAR-2048))-2)+1/298)))-273$$

See Figure 6.

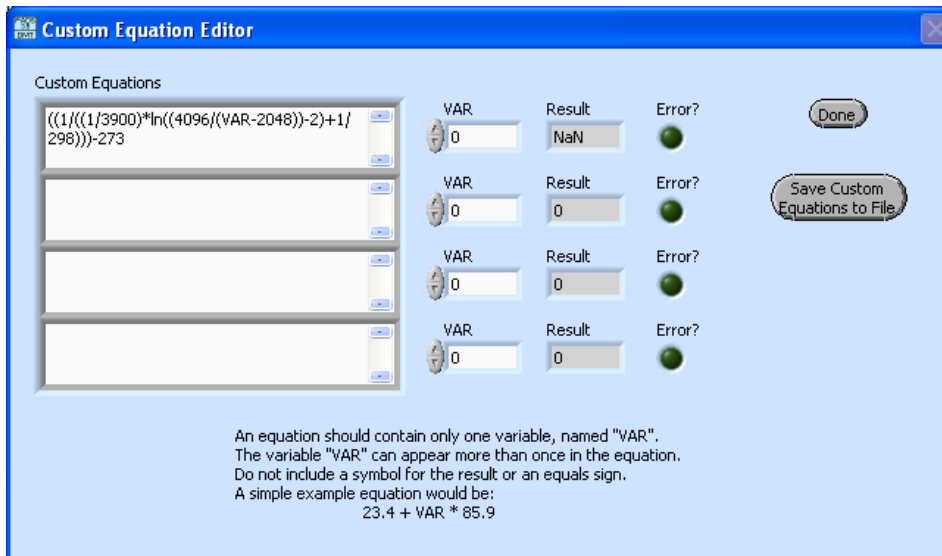


Figure 6: Entering in Optical Block Temperature Conversion Equation

- 4.) Click **Done**.
- 5.) Click on **Configure > Configure Instrument**.

- 6.) In the Channels table, find the **Dump Spot Monitor**. Replace “Dump Spot Monitor” with “Optical Block Temp (C).”
- 7.) Change “Linear” to “Custom[X],” where [X] is the number of the equation (1-4) entered in step 3.
- 8.) Click on **Save**.
- 9.) Click **Reset Program**.

The channel should now be configured so that it displays properly. *NOTE:* If you click on **Reset Channels** and save and reset the program, Optical Block Temp will revert to displaying as Dump Spot Monitor.

Appendix C: Revisions to Manual

This manual replaces DOC-0181, the *FM 100 PADS Operator Manual* for PADS version 2.X. All sections have been updated.