MMS3000-RTD6™

Owner's Manual

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1. Introduction

THIS MANUAL COVERS MODEL: MMS3000-RTD6.

The **RTD6** module allows the user to simultaneously take six channels of temperature measurement for temperatures ranging from -200 to +850°C (-328 to +1562°F) depending on RTD sensor type.

2. Features

C   24-bit A/D converter providing high precision measurements

C   128 kilobyte non-volatile memory capable of storing 100,000 sample points

C   User-reprogrammable **MMS3000** internal firmware

C   240 x 128 pixel graphical liquid crystal display (LCD)

C   Electro-luminescent LCD backlight

C   Built-in battery charger and conditioner

C   Ni-Cad battery pack

C   RS232 interface

C   Battery-backed clock / calendar

C   Time and date stamped recordings

C   **MAS-3000**: Windows® based **Measurement Analysis Software**

3. Standard Accessories

The **MMS3000-RTD6** kit consists of the following:

C   **MMS3000** main unit

C   **RTD6** module for temperature recording

C   **MAS-3000**: Windows® based **Measurement Analysis Software**

C   AC/DC power transformer for battery charging

C   RS232 serial interface cable

C   Owner's manual (incorporating **MAS-3000**)

4. Optional Accessories

C   Pt100 RTD sensor

C   Car adapter charger lead

5. Safety Notes

Warning: To avoid damage to the **MMS3000** and electrical shock, do not allow more than 10VDC between RTD sensor inputs and do not connect any probes or sensors to any live surface (voltage which exceeds 50VDC or 32VAC or the "safety extra low voltage" (SELV) defined by your local power authority).

6. Unit Start-up and Initialization

Note: Before powering up the **MMS3000**, ensure that the battery pack and **RTD6** module are attached securely to it. Ensure that the screws are tightened (but do not over-tighten).

C   PRESS the **[ON/OFF]** button. The **MMS3000** *Initialization* screen appears, confirming the firmware revision number and the current module installed (**RTD6**). If the **MMS3000** does not recognize the module, PRESS **[ON/OFF]** to power down the **MMS3000** and re-secure the module.

C   PRESS the **[MENU]** button once. The *Main Menu* screen will appear displaying 8 function choices, in addition to LCD screen contrast adjustment. Pressing **[MENU]** from most screens returns you to the *Main Menu* screen.

LCD Screen Contrast
C   From the *Main Menu* screen, PRESS and HOLD the **[v]** or **[w]** keys until the desired contrast is achieved.

C   To return to the default contrast setting, PRESS **[SHIFT]** then **[RESET]**.

The LCD contrast (which varies with temperature) is automatically compensated based on the internal temperature of the **MMS3000**. However, if the LCD temperature is rapidly changed, the automatic compensation may not ensure optimum contrast. Typically, the default contrast is optimal if the **MMS3000** temperature has been allowed to stabilize.

HELP
C   Help instructions are available at some screens by pressing **[SHIFT]** then **[HELP]**.

7. General Operation

Backlight

C   Once the **MMS3000** is powered up, PRESS **[SHIFT]** then **[LIGHT]** from any screen to turn the backlight on or off.

If the battery level is less than 20%, turning the backlight on may cause the **MMS3000** to turn off automatically. The backlight draws a relatively high current and may drain a nearly-flat battery quickly. To check the battery level, see Section 9.

Power Saver

Every time the **MMS3000** is powered up, the "power saver" mode is turned on by default.

With the "power saver" mode turned on, the LCD and backlight (if it is on) will automatically turn off after 8 minutes if no keys are pressed (although the **MMS3000** will still be functioning). If any key is then pressed, the LCD and backlight (if it was on before) will turn on again.

If the "power saver" mode is turned on, the **MMS3000** will shut down automatically after 15 minutes if no keys are pressed. **If a *recording* is being taken, only the display will shut off – all *recording* functions will continue.**

•   To turn the "power saver" mode off, access the *Main Menu* screen and press **[8]** to access the *Battery Management* screen. Then press **[2]** to toggle the "power saver" mode off.

With the "power saver" mode turned off, the **MMS3000** will function continuously until the battery voltage drops to 5.5V (after which the **MMS3000** will shut down).

Resetting the MMS3000

The **MMS3000** keypad is read by an internal microcomputer. If the microcomputer should lose control for some reason (e.g. due to electrostatic discharge exceeding 8kV), the **MMS3000** will not respond to any keys and the user will not be able to turn the **MMS3000** on or off.

If this situation arises the **MMS3000** should be reset as soon as possible to prevent the batteries from being run down (battery current is drawn continuously until the circuitry is turned off by the microcomputer). Keystrokes are ignored because the microcomputer does not execute the normal program and instead ignores all keys. Consequently, pressing the **[ON/OFF]** key cannot turn off the **MMS3000**.

To **reset** the hardware:

C   While HOLDING down the **[ON/OFF]** key, PRESS and release the **[RESET]** key.

C   Release the **[ON/OFF]** key and normal operation should resume.

8. Date & Time

C   From the *Main Menu* screen, PRESS **[7]** to access the *Date & Time* screen.

C   To edit the date and time, PRESS the **[ENTER]** key. The date field begins to flash
     meaning that it is in edit mode.

C   Pressing the **[v]** or **[▪]** key changes the numeric date (holding the key down scrolls
     the date rapidly).

C   Once you have selected the desired date, PRESS the **[ENTER]** key.   This will
     cause the month field to flash. Again use the **[v]** or **[▪]** keys to change the month.

C   Repeat the process until you have selected and changed the date and time.

C   If an error is made, PRESS the **[ENTER]** key repeatedly and the prompt will cycle
     back to each field.

C   When you have finished, PRESS **[MENU]** to return to the *Main Menu* screen.

9. Battery Management

The **MMS3000** is powered by a rechargeable Nickel-Cadmium battery pack. The
battery pack can be removed without loss of any data or settings because a secondary
internal battery backs up the clock and memory. To minimize current drain on the
internal battery, **do not remove** the battery pack for **more than 2-3 hours.**

The **MMS3000** will operate normally when the battery voltage is above 6.0V. While this
is true, it is recommended that the batteries be recharged before a *recording* is initiated
if the remaining capacity is below 20%. If the battery voltage falls below 5.5V while the
MMS3000 is operating it will automatically shut down.

**If the [ON/OFF] key is pressed and the unit does not appear to activate, it may
be that the battery voltage has dropped below 5.5V**. If this occurs, recharge the
battery pack (see the "Charging Battery Pack" instructions in this section).

WARNING: Constantly charging the battery when it is not fully drained will create a
"*Memory*" effect and eventually shorten the amount of charge that the battery can hold.
Battery reconditioning is the process of first discharging and then charging batteries.
It reduces the undesirable memory effect in Ni-Cad batteries. The battery pack should
be reconditioned when it is first used (for its capacity to be displayed correctly) and
monthly thereafter (to prevent battery degradation).

Battery Check

C From the *Main Menu* screen, PRESS key **[8]** to access the *Battery Management* screen which displays the battery voltage and the percentage of battery capacity remaining.

If the battery pack has been replaced, it is necessary to discharge and then recharge (i.e. recondition) the battery pack in order for the capacity displayed to be accurate - see the "Reconditioning the Battery Pack" instructions in this section.

C PRESS the **[MENU]** key to return to the *Main Menu* screen.

Charging the Battery Pack

The **MMS3000** has built-in battery charging circuitry. The power transformer supplied in the kit provides a DC voltage to the charger circuitry. The charger circuitry will accept a 13.5 ± 1.5VDC input. When charging from a mains power outlet, use only an approved **MMS3000** AC/DC power transformer. The optional car adapter charging lead facilitates charging the **MMS3000** from a vehicle with a 12V negative chassis power system.

Note: Before using the power transformer, ensure the voltage and frequency of your mains AC power matches that of the power transformer.

Charging with Unit Powered Down

C Plug the power transformer into a standard AC power outlet.

C Insert the connector of the power transformer into the charger socket on the **MMS3000**. If the **MMS3000** was off, it will automatically power up and commence charging and the *Battery Management* screen will be displayed.

Note: If the unit fails to power up when a charger is connected, it may be necessary to reset the **MMS3000** (see Section 7 for reset instructions).

C The battery pack voltage and percent of capacity will be displayed and the word "CHARGING" will flash indicating that battery charging is in process.

C Charging will cease automatically when complete or you can PRESS the **[START/STOP]** key while the *Charger Control* screen is displayed.

C The battery pack will be fully charged in approximately 2.5 hours or if a recording is being taken, 10 hours.

Charging with Unit Powered Up

C Plug the power transformer into a standard AC power outlet and insert the connector of the power transformer into the charger socket on the **MMS3000**.

C Access the *Main Menu* screen by pressing the **[MENU]** key.

C PRESS key **[8]** to access the *Battery Management* screen.

C PRESS key **[1]** to access the *Charger Control* screen.

C PRESS key **[1]** to start charging the **MMS3000** battery pack.

C   If there is no power coming from the power transformer a flashing message "NO CHARGER" will appear on the screen. If power is connected correctly the flashing message reads "CHARGING".

C   Charging will cease automatically when complete or you can PRESS the **[START/STOP]** key at any time while in the *Charger Control* screen.

C   The battery pack will be fully charged in approximately 2.5 hours or if a recording is being taken, 10 hours.

Reconditioning the Battery Pack

Battery pack reconditioning means putting the battery pack through a cycle of discharging and charging.

It is necessary to regularly recondition the Ni-cad battery pack in order to reduce the "memory effect" in it.

The battery pack should be reconditioned:

C   when you use the **MMS3000** for the first time;

C   when you have just replaced the battery pack on the **MMS3000**; and

C   at least once a month (to reduce the "memory effect").

To recondition the **MMS3000** battery pack the power transformer must be plugged in and power applied. Discharging and/or charging can only be carried out when the **MMS3000** is turned on.

Note: Turning the **MMS3000** off, or removing the power transformer will stop the unit from charging or discharging the battery pack.

C   Access the *Main Menu* screen by pressing the **[MENU]** key.

C   PRESS key **[8]** to access the *Battery Management* screen.

C   PRESS key **[1]** to access the *Charger Control* screen.

C   PRESS key **[2]** to begin reconditioning the battery pack.   The word "DISCHARGING" will appear and flash. Once the internal **MMS3000** battery charger has discharged the battery pack, it automatically switches to charging.

C   PRESS **[ENTER]** to return to the *Battery Management* screen.

C   PRESS **[MENU]** to return to the *Main Menu* screen.

Note: All functions of the **MMS3000** are usable while the battery pack is being charged or reconditioned.

Note: Battery capacity and life degrade with increased ambient temperature.

10. Measurement Setup

The **MMS3000-RTD6** is capable of simultaneous measurements of up to six channels of temperature data.

<div align="center">

WARNING

</div>

Never allow voltages of more than 10VDC between any two RTD sensor inputs. This may damage the **MMS3000**. It is recommended that isolated RTD sensors be used. See Application Note 1 in Appendix 3.

C   Plug the RTD sensor connectors into the RTD sensor sockets on the **MMS3000**, noting carefully the polarity of the pins (see the connector diagram in Appendix 2).

C   Access the *Main Menu* screen by pressing the **[MENU]** key.

C   PRESS key **[1]** to access the *Measurement Setup* screen.

C   PRESS keys **[1]** through **[6]** to toggle the selection of channels 1 to 6.

C   Select the RTD sensor type by pressing the arrow keys to cycle the selection through the two supported RTD sensor types: 385 (α = 0.00385) and 392 (α = 0.00392).   It is not possible to simultaneously use different RTD sensor types.

C   PRESS **[SHIFT]** then **[+]** to toggle the mains frequency setting between 50 and 60 Hertz as needed. This selects the appropriate filter to reject mains power interference as defined by your local power authority.

C   PRESS **[ENTER]** to begin measuring.

This screen, hereafter referred to as the *Measure Without Recording* screen, allows the verification of proper setup.

11. Measure Without Recording

Measure Without Recording - Screen Options

C   Pressing key **[2]** at the *Main Menu* screen will cause the **MMS3000** to begin measuring and displaying the channels selected.

C   To modify the parameters or display options, PRESS **[SHIFT]** then **[HELP]** to access the *Help* screen that allows modification of parameters and options as detailed below. **All keys displayed in the *Help* screen also operate from the *Measure Without Recording* screen.**

1 - Measurement Units

C   PRESS key **[1]** to toggle the temperature unit between Celsius and Fahrenheit. Changing the unit does not affect the data recorded. User settings are saved even when the **MMS3000** is turned off.

2 - Key **[2]** - No function assigned.

3 - Measurement Setup

C   PRESS key **[3]** and the *Measurement Setup* screen reappears allowing the channel selection to be changed (see Section 10).

4 - Display Options

C   PRESS key **[4]** and the *Display Options* screen appears allowing changes to the way data is displayed. Display changes do not affect the data recorded.

C   PRESS key **[1]** to toggle the display between digital and graphic.

Digital

C   When digital is chosen each channel selected in the *Measurement Setup* screen will be displayed in an alphanumeric format in the *Measure Without Recording* screen. Either temperature or resistance values can be displayed. PRESS key **[5]** in the *Display Options* screen to toggle between displaying (1) the present, minimum, and maximum temperature readings, and (2) the resistance between the positive and ground RTD terminals, between the negative and ground RTD terminals, and of the RTD element alone.

C   If temperature is displayed, you can press **[SHIFT]** then **[RESET]** in the *Measure Without Recording* screen to reset the minimum and maximum values.

Graphic

C   When graphic is chosen, PRESS key **[2]** to toggle between an X-Y plot and a bar graph display.

Note: The X-Y option displays only a single channel of data at any given time even when multiple channels are being recorded. Changing display options does not affect the data being recorded.

X-Y Plot
- C PRESS key **[3]** and the display option toggles between a single <u>line</u> of data and a <u>solid</u> shaded area indicating sample magnitudes of the channel being displayed.

- C PRESS key **[4]** to cycle through all selected recording channels.

- C Key **[5]** - No function assigned.

- C PRESS key **[6]** to toggle the "auto scale" function on or off. This function causes the scale of the Y-axis on the X-Y plot to be automatically set according to the present data values.

Bar Graph
- C If the <u>bar graph</u> option is selected, each channel selected at the *Measurement Setup* screen will be displayed simultaneously with constantly updated horizontal bars for each channel.

- C PRESS key **[6]** to toggle the "auto scale" function on or off.

- C PRESS **[ENTER]** to return to the *Measure Without Recording* screen.

5 - New *Recording*
- C PRESS key **[5]** and the *New Recording* screen will appear allowing the initiating of a new recording session without returning to the *Main Menu* screen (see Section 12 for instructions).

6 - Key **[6]** - No function assigned.

7 - Key **[7]** - No function assigned.

8 - Key **[8]** - No function assigned.

9 - Key **[9]** - No function assigned.

0 - Zero Position
- C PRESS key **[0]** to cycle the placement of the zero point of the bar graph. Choices are "left", "right", and "center".

Adjust Scale (<u>bar graph</u> and <u>X-Y plot</u> displays)
- C While **holding down [SHIFT]**, PRESS either **[v]** or **[w]** to adjust the scale on the bar graph, or the Y-axis scale on the X-Y plot.

Scroll Y-Axis (<u>X-Y plot</u> display ONLY)
- C PRESS and HOLD either of the **[v]** and **[w]** keys, while in the *Measure Without Recording* screen, to scroll the Y-Axis without affecting the scale.

12. New Recording

Definitions: ***Recording*** represents the data collected during a single measurement session regardless of the number of channels selected during that session. The maximum number of samples that can be collected in any *recording* is 9999 per channel (up to a maximum of 6 channels).

Data set is a collection of up to 50 *recordings* (or data collection sessions). The unit will store up to 50 *data sets* in memory allowing for a total of 2500 *recordings* to be stored.

Note: The standard system memory of 512 kilobytes will allow for a total of approximately 100,000 measurement data points to be stored. This number reflects the total number of individual data points which can be measured and recorded by each channel. Memory can quickly be used up if *recordings* of long duration and multiple channels are taken (i.e. one *recording* of 6 channels at 9999 samples equals 59,994 data points and approximately 15% usage of memory).

Note: Specifying the number of samples to be recorded before beginning to record will optimize memory usage.

New Recording Screen
C PRESS key **[3]** at the *Main Menu* screen to access the *New Recording* screen. This screen allows for the measurement *and* recording of data with user-definable parameters entered, such as *data set* ID, size of *recording*, sampling interval, "auto size", and beep alert settings. The following options are listed according to menu choice.

1 - Measurement Setup
C PRESS key **[1]** to access the *Measurement Setup* screen to verify or change the channel selection.

2 - *Data Set* Number (assign *data set* number for storing the new *recording*)

Note: By default, when a new *recording* is initiated, the *data set* in which the unit selects to store the new *recording* is the first "empty" *data set*. However, any *data set* can be chosen for a new *recording* (even one that already contains *recordings*) by performing the steps outlined below.

C PRESS key **[2]** and a complete list of *data sets* are displayed with their numbers and user-entered ID's.

C PRESS the **[v]** or **[▪]** keys to highlight the specific *data set* you wish to use for the new *recording*. *Data sets* with no *recordings* associated with them are tagged "available". Any of the 50 *data sets* can be selected.

C Once the desired *data set* is highlighted, PRESS **[ENTER]** to select it.

3 - *Data Set* **ID**

Note: **Different *data sets* can share the same user-entered ID, however this is best avoided to prevent confusion.**

C   PRESS key **[3]** to access the *Edit Name* screen.

To Enter a New ID
C   PRESS **[SHIFT]** then **[RESET]** to clear the ID field of all characters to the right of the underlined character, if necessary.

C   PRESS **[v]** or **[■]** to cycle the underlined character through all alphabetic characters. Numeric characters can be entered using the digit keys. Repeated presses of the digit keys enter the alphabetic characters shown on top of the digit keys. Pressing **[0]** or **[1]** twice enters a space character. To toggle a character from upper case to lower case, press **[■]**, and to toggle it otherwise, press **[v]**. To delete the character, press **[SHIFT]** then **[-]**, and to insert a character before it, press **[SHIFT]** then **[+]**. Up to 16 characters can be entered for each ID.

C   PRESS **[ENTER]** to move forward or **[SHIFT]** then **[BACK]** to move backward through the other ID characters and edit them.

C   PRESS **[MENU]** to save the new ID and return to the *New Recording* screen or press **[START/STOP]** to quit the edit process and return to the *New Recording* screen with the ID remaining unchanged.

To Enter a Previously Used ID
C   PRESS **[SHIFT]** then **[NEXT]** for a list of the 10 most recently used ID=s.

C   PRESS **[v]** or **[■]** to highlight the ID you wish to use and then PRESS **[ENTER]** to confirm the selection. The ID may now be edited.

C   PRESS **[MENU]** to save the new ID and return to the *New Recording* screen or press **[START/STOP]** to quit the edit process and return to the *New Recording* screen with the ID remaining unchanged.

4 - Size (number of samples)
C   PRESS key **[4]** to enter the number of samples to record. The number of samples previously stored for that *data set* will be displayed. If the number of samples has not been previously set, a "? samples" message is displayed.

C   Type in the number of samples (up to 9999). If an entry error is made, press the **[0]** key repeatedly until the "?" appears again.

C   PRESS **[ENTER]** when finished to return to the *New Recording* screen.

Note: If the number of samples is set, the *recording* will automatically be terminated when that number of samples is collected. If the number of samples is not set (i.e. left as "? samples") then the *recording* must be terminated manually, otherwise 9999 samples will be recorded.

5 - *Recording* **Number**

C   PRESS key **[5]** and then press the **[v]** or **[▪]** keys to select the appropriate number to assign to this *recording*. A number for a *recording* with data already stored cannot be chosen. To overwrite a previously stored *recording* the *recording* must first be erased (see Section 14 for instructions on erasing *recordings*).

6 - Sampling Interval

C   PRESS key **[6]** to access the *Sampling Interval* screen.

C   PRESS the **[v]** or **[▪]** keys to cycle through interval ranges: milliseconds, seconds, minutes, or hours.

C   Type with the keypad the desired sampling interval. Milliseconds must be entered in increments of 100. Please refer to the specification sheet (Appendix 1) regarding limitations on sampling intervals.

C   PRESS **[ENTER]** when finished, to return to the *New Recording* screen.

7 - *Recording Options* **Screen**

C   Press key **[7]** to access the *Recording Options* screen.

C   Press key **[1]** to toggle "auto size" on or off. If the *recording* is manually stopped while "auto size" is turned on, the sample size of the *recording* will be stored and re-used for the next *recording*.

C   Press key **[2]** to toggle the "sample beep" on or off. This provides an audible alert when each sample is taken.

Note: While *recordings* are taken, the sample beeper may be turned on or off by pressing key **[2]**.

C   Press **[ENTER]** when finished, to return to the *New Recording* screen.

8 - Measure Without Recording

C   PRESS key **[8]** to access the *Measure Without Recording* screen to verify proper settings, as necessary (see Section 11). PRESS key **[5]** to return to the *New Recording* screen.

9 - Display Options

C   PRESS key **[9]** to access the *Display Options* screen to verify proper display settings, as necessary.

Note: Display options may be changed from the *Help* screen while a *recording* is being taken (see Section 11).

Start Recording

C   PRESS **[START/STOP]** once to begin taking the *recording*.

Stop Recording

The *recording* will automatically terminate once the preset number of samples has been recorded. If no number was entered in the "size" setting, the measurement must be halted manually, otherwise 9999 samples will be recorded.

To manually stop a *recording*, whether or not the number of samples has been preset:

C   PRESS **[START/STOP]** at the moment you wish the *recording* to stop, and no further samples will be taken.

Return to *Main Menu* Screen

C   PRESS **[MENU]** to exit the *New Recording* screen and to return to the *Main Menu* screen.

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13. Review Data Set

You can review the *recordings* that are stored in the **MMS3000**.

Review Data Set Screen

C   PRESS key **[4]** from the *Main Menu* screen to access the *Select Data Set* screen (which displays the ID's of all *data sets* stored in memory).

C   PRESS the **[v]** or **[▪]** keys to highlight the *data set* you wish to review.

C   PRESS the **[ENTER]** key to select the highlighted *data set*.

Reselect *Data Set*

C   If you wish to change your selection, PRESS key **[1]** to return to the *Select Data Set* screen which allows you to change the selection.

Edit *Data Set* ID

C   To edit and replace the ID of the *data set* that you are currently reviewing PRESS key **[2]** to access the *Edit Name* screen from where you may edit the *data set* ID (see Section 12 for ID editing instructions).

Select *Recording*

C   PRESS key **[3]** to select from the *data set*, the *recording* to be reviewed. Each *recording* is identified by a *recording* number (ranging from 1 to 50) and a time and date stamp.

C   PRESS the **[v]** or **[▪]** keys to highlight the *recording* you wish to review.

C   PRESS **[ENTER]** to select the highlighted *recording*.

Display Options
C   PRESS key **[4]** to access the *Display Options* screen and configure the display options for the visual review of the data. The option settings used for the last *recording* are the default settings.   For instructions on how to configure display options, see Section 11.

Note: It is not possible to turn on "auto scale" when reviewing data.

Transfer Data (optional)
C   PRESS key **[5]** to access the *Transfer Data Set* screen. This screen allows the transferring of data to a PC that has **MAS-3000** (**Measurement Analysis Software**) installed and running (see Section 19).

Start At Option
C   PRESS key **[6]** to select a specific sample to start reviewing from. This feature is useful in avoiding having to scroll through a large number of samples in order to look at a sample in the middle of a long *recording*.

C   After typing in the desired sample number, PRESS **[ENTER]** to continue. If the number typed is larger than the *recording* size a "?" will be displayed and the **MMS3000** will beep, prompting for another entry.

Start Reviewing Data
C   PRESS the **[START/STOP]** key to begin reviewing the data.

C   PRESS the **[ENTER]** key to scroll through the data. Each press of the **[ENTER]** key scrolls the data one sample. Holding the **[ENTER]** key down will scroll the data progressively faster.

Once the final sample in the *recording* is reached the internal beeper sounds and the display stops. To restart, PRESS the **[START/STOP]** key twice.

During review, if the scale factor is too large or small, PRESS **[SHIFT]** and then the **[v]** or **[▪]** keys to either increase or decrease the scale of the display. This feature is useful if there are very small variations in the recorded data that you wish to review. This feature can also be used while taking a *recording*.

If digital display was selected, the minimum and maximum values are updated as the data is reviewed. If the "start at" option was selected, the data prior to the start sample is not included in determining the minimum and maximum.

Stop Reviewing Data
C   To stop reviewing data, PRESS the **[START/STOP]** key. The *Review Data Set* screen will be displayed.

Return To *Main Menu* screen
C   To return to the *Main Menu* screen, PRESS the **[MENU]** key.

14. Memory Management

You can find out the percentage of memory currently used on the **MMS3000**. You can also erase (permanently) *recordings* and *data sets*, or simultaneously erase (permanently) all *data sets* from the memory.

Displaying Memory Usage
C   From the *Main Menu* screen, PRESS key **[6]** to access the *Memory Management* screen. The screen displays the number of *data sets* (if any) in memory and the memory size. The memory currently used is displayed as a percentage of the total available. If memory usage reaches 99%, some data will need to be erased before further *recordings* can be taken.

C   PRESS **[MENU]** to return to the *Main Menu* screen.

Erase Individual *Recordings*
C   From the *Main Menu* screen, PRESS key **[6]** to access the *Memory Management* screen.

C   PRESS key **[1]** to access the *Erase Data* screen. By default, the *data set* with the *recording* most recently stored in memory will be the selected *data set*.

C   PRESS key **[1]** to view a list of all *data sets* in memory.

C   PRESS the **[v]** or **[▪]** keys to highlight the *data set* which contains the *recording* to be erased.

C   PRESS **[ENTER]** to select the *data set* and to return to the *Erase Data* screen.

C   PRESS key **[2]** to access the *Erase Recording* screen. The screen displays the ID of the selected *data set* and a list of all the *recordings* in the *data set*. Each *recording* is identified by a *recording* number and a date and time stamp.

Note: If the *data set* displayed is not the one required, PRESS the **[MENU]** key to return to the previous screen.

C   PRESS the **[v]** or **[▪]** keys to highlight the individual *recording* to be erased.

C   PRESS **[SHIFT]** and **[RESET]** simultaneously to erase the highlighted *recording*. The *recording* has now been erased from memory.

Note: Once the *recording* has been erased the next *recording* (if any) is highlighted.

C   PRESS **[ENTER]** to return to the *Erase Data* screen.

C   PRESS **[ENTER]** again to return to the *Memory Management* screen.

C   PRESS **[MENU]** to return to the *Main Menu* screen.

Erase Entire *Data Set* (ALL *Recordings* in ONE *Data Set*)
C   From the *Main Menu* screen, PRESS key **[6]** to access the *Memory Management* screen.

C   PRESS key **[1]** to access the *Erase Data* screen. By default, the *data set* with the *recording* most recently stored in memory will be the selected *data set*.

C   PRESS key **[1]** to view a list of all *data sets* in memory.

C   PRESS the **[v]** or **[▼]** keys to highlight the *data set* to be erased.

C   PRESS **[SHIFT]** and **[RESET]** simultaneously to erase the highlighted *data set*. The *data set* has now been erased from memory.

C   PRESS **[ENTER]** to return to the *Erase Data* screen.

C   PRESS **[ENTER]** again to return to the *Memory Management* screen.

C   PRESS **[MENU]** to return to the *Main Menu* screen.

Erase ENTIRE Memory (ALL *Recordings* in ALL *Data Sets*)
C   From the *Main Menu* screen, PRESS key **[6]** to access the *Memory Management* screen.

C   PRESS key **[1]** to access the *Erase Data* screen.

C   PRESS **[SHIFT]** and **[RESET]** simultaneously and you will be asked "Are you sure?" to make sure that you really intend to erase all data in memory.

C   PRESS **[SHIFT]** and **[RESET]** simultaneously again to **permanently erase all data** in memory.

The requirement to PRESS two separate keys simultaneously is designed to prevent accidental erasure of valuable data. When all data has been erased, the screen will display "No data sets" in memory confirming that the erasure has been completed.

15. Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
Will not start when **[ON]** key is pressed	Low/dead battery	Charge battery pack
	Electrostatic discharge exceeding 8kV	Reset instrument
Turns off when backlight turned on	Low/dead battery	Charge battery pack
"*Low Battery*" displayed	Battery capacity is low	Charge battery pack
"*Module Fault*" displayed	Module loose	Tighten
	Module damaged	Send in for servicing
Will not transfer, "*No PC?*" displayed	Serial cable not properly secured	Check cable connections
	Unit and cable connected to wrong port	Test COM port function with **MAS-3000**.
"*Insufficient Memory*" displayed	Insufficient memory left for the *recording*	Erase unwanted *recordings* and/or reduce sample size
"*Memory Full*" displayed	No compatible *data sets* left for *recording*	Erase obsolete *recordings*
"*Memory Partition Full*" displayed	The current *recording* has filled a memory partition and requires another partition to continue (a *recording* cannot be stored in more than one partition)	Erase obsolete *recordings*
"*Memory Error*" displayed	Battery failure during *recording*	Transfer all data and erase all data from memory
	Backup battery flat	Charge battery pack
"*No Sensor*" displayed	RTD sensor not connected to selected channel	Connect RTD sensor to selected channel
Locks up when touched	Electrostatic discharge exceeding 8kV	Reset instrument
Data lost when battery pack replaced	Low/dead backup battery	Send in for servicing

In the PC-based analysis software that comes in the kit (**MAS-3000**), there is a provision for generating error report files that help **COMMTEST INSTRUMENTS** engineers to quickly diagnose and solve problems related to your **MMS3000**.

In the **MAS**-*3000 Main* window, click on **[Tools]** and then on **[MMS Diagnostics]**, and follow the instructions outlined in the *MMS Diagnostics* window.

16. ANALYSIS SOFTWARE

Recordings made on your instrument can be transferred to the **MAS** software running on a Windows ® based PC. **MAS** stands for **M**easurement **A**nalysis **S**oftware. **MAS** can be used to store, graph, analyse, print & export your recordings.

It is assumed that the user of **MAS** is already familiar with basic Windows ® commands. Please refer to the appropriate literature on Windows ® if clarification is needed on mouse and keyboard commands.

Note   Throughout **MAS**, pressing F1 on your keyboard will bring up a comprehensive topic-specific Help screen. Also, clicking the right mouse button anywhere in **MAS** will bring up a pop-up menu of the applicable commands.

WARNING: Read section 1.4 before operating your instrument .

17. INSTRUCTIONS

Warnings
In this manual, the word **WARNING** is displayed where certain actions may lead to damaging consequences. Please heed all such warnings.

Names
In this manual, window and screen names are *italicized*. These names refer to the names appearing at the top of windows/screens.

MAS *Window*
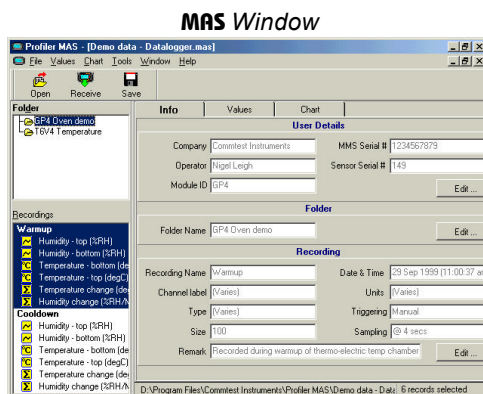
The PC key names are shown as normal text, e.g. Shift refers to the Shift key on the PC keyboard.

Keys on the instrument are shown as they appear on the instrument keypad, e.g. SHIFT refers to the Shift key on the instrument.

Some instrument keys have more than one function, e.g. the `ON OFF` key which is used as either the *ON* key or the *OFF* key depending on the state the instrument is operating in.

Instruction Sequences
The ▶ symbol is used to indicate the sequence of menu selections.

Instruction	Meaning
Click *File* ▶ *Save*.	Select the *File* menu and then select *Save*.

Instruction Types
The word "press" refers to key presses or menu selections on the instrument.

The word "click" refers to menu selections on the PC, and "push" refers to key presses on the PC keyboard.

Instruction	Meaning
Click *File* ▶ *Export*.	Select *File* and then *Export* in **MAS**-3000 software.
Push the Esc key.	Push the Esc key on the PC keyboard.

Some operating instructions are illustrated with examples. Such instructions are marked with the word **EXAMPLE**.

18. INSTALLING MAS-3000

License Agreement
Please read the license and warranty agreement printed on the CD cover found in the jewel case that the MAS CD-Rom was supplied in. MAS is licensed for individual use and for installation on one computer. The software contained on the CD-Rom remains the intellectual property of COMMTEST INSTRUMENTS who retain the title and ownership of the software.

PC System Requirements
The following are the minimum system requirements for installing MAS:

- Pentium processor or better

- 32MB RAM (64MB recommended)

- 10MB hard disk space

- CD-Rom drive

- Windows® 95, 98, Me, NT or 2000 operating system

- Windows® compatible display and printer

- Windows® compatible mouse or other pointing device

- Unused COM Port for communication with the instrument

Installing MAS on PC
- Close all programs on your PC.

- Insert the MAS CD-Rom into the CD-Rom drive.

- Wait for the MAS Installation program to automatically start (or run Setup.exe located on the CD-Rom).
  OR
  Run the MAS Setup.exe program located on the CD-Rom.

- Follow the instructions given to complete the installation.

19. STARTING UP MAS

Starting up
- Click *Start* ▸ *Programs* ▸ *MAS-3000* ▸ *MAS-3000 5.00*

Configuring PC COM port
- To allow data transfer between the instrument and the PC, you must first configure your PC COM port as follows:

- Connect the instrument to one of the COM ports using the data-transfer cable and power up the instrument .

- Click *Tools* menu ▸ *Configure COM port*.

- Select the COM port that the instrument is connected to.

- Select a baud rate. The baud rate is the speed (in bits/second) at which data is transferred. The lower the baud rate, the less likely are data-transfer errors. *Automatic* is the default choice as it is sufficient for normal transfers.

- Click *Test port*

- Click *Yes* in the *Confirm* window to test the connection. Connection failure may be due to the selection of the wrong COM port in MAS, the instrument being not powered up, connectors being not plugged in properly, or the PC serial port being not set up properly. If the connection is good, continue as follows:

- Click *OK* in the second confirm window to acknowledge that the instrument is attached to the COM port.

- Click *OK* to leave the MAS *Configuration* window.

20. TRANSFERRING DATA TO THE PC

Data transferred to the PC is stored in **MAS** *files*. These are text files and have the .mas extension.
To transfer data from the instrument to the PC:

- Check the instrument battery capacity and if it is less than 30%, charge the battery pack.

- Connect the RS232 port of the instrument to the configured PC COM port using the data-transfer cable.

- On the instrument , press *File* menu ▶ *Examine Files…* Use the arrow keys to select the individual recording or folder to be transfered. If a folder is highlighted, all recordings within the folder will be transferred.

- On the PC, click the *Receive* button. If you have a **MAS**-3000 file open, the data about to be transferred will be appended to the open file. If no files are open, the data will be transferred into a new file.

- On the instrument press ⌨7 *SndToPC.* Once the data-transfer is complete, the data will appear in the current file in **MAS** or if no files were open, the data will appear in a new file.

- To append more data from the instrument to the current data folder, click *Receive* button.

- To save the data transferred to the current data folder, click the *Save* button, name the file and click *Save* to save the file. If the file was an already existing file, clicking the *Save* button will automatically save the file under the same name and in the same location on the PC.

21. MANAGING DATA

Opening a File
- Click *Open* button and select the file.

Merging Two Files
- Open one of the files.

- Click *File* menu ▸ *Import & Merge a file…* and select the other file to be merged into the open file.

The merged data can be viewed but is not automatically saved on the computer. To save it, click *File* menu ▸ *Save* or *File* ▸ *Save As*.

Using the Navigator
When a file is open, the navigator that consists of two boxes is displayed on the left side of the screen. The top box shows all the folders in the file. The bottom box shows all the recordings in the selected (highlighted) folder in the top box.

Deleting Data from a Folder
- Select the folder in the *Folder* section of the navigator.

- Using the navigator, select the individual recordings and/or channels to be deleted.

- Click *File* ▸ *Delete,* or press the *Delete* key. You will then be prompted to confirm that you wish to delete the selected recordings/channels

Editing Recording Details
- Select the folder, and then the recordings and/or channels to be edited.

- Click the *Info* tab to access the *Info page* where you can edit the *User Details* (eg. Company Name, instrument serial number…), *Folder Name*, and the *Recording Details* (eg. recording name, remarks, channel labels and units…).

- From the *Edit User Details* screen there is access to edit the *Default User Details*. These values are written to all future recordings, while they are transferred from the instrument .

Viewing and Printing Data
- Open the file and using the navigator, select the recordings and/or channels to be viewed and/or printed.

- Click the *Values* tab. The data in the selected recordings and/or channels can now be viewed.

- To change the value in a cell, click the cell and type in the new value.

- To reduce the amount of data by averaging, click the *Average* button.

- To print the data, click the *Print* button.

- To copy the values to a spreadsheet program, click the *Copy* (to clipboard) button, go to the Spreadsheet program and use its' "*Paste*" command.

- To print a report on the data, click *File* ▸ *Summary Report*[*] or *Full Report*[†] and select the print option in the *Data Summary* or *Report Generator* window that appears.

Exporting data
- In the Navigator select the folders or recordings to be exported as a .mas file.

- Click *File* ▸ *Export* and select the option required.

- Provide the name and location of the export file to be produced and then click the *Save* button.

---

[*] The Summary report produces a data summary about the selected recordings/channels. For more information consult the **MAS** help file.
[†] The Full report produces an exact printout of the pages selected in the report generator window. For more information consult the **MAS** help file.

22. CALCULATING DATA

You can perform calculations on your recorded data by creating new "calculated" channels:

- Open the file and using the navigator, select the recordings and/or channels to be used in calculations.

- Click the *Values* tab to display the data and click the *Calculate* button to access the *Calculate* window.

- Each channel is automatically given a "**tag**" character that is used to identify the channel. It is a letter of the alphabet that can be used to reference the values of a recording for use in calculations.

- Expressions can then be derived using the provided functions and the channel tags[‡].

> eg. TempChange = ChangePerHr(B) with units degC/hr
>
> This example will create a channel called "*TempChange*" which is calculated as the rate of change per hour of the channel which has tag *'B'*.

- Constants can also be used in calculations. You may need to use constants in your expressions, for example:

To find the "difference from the mean value" for a particular channel, say the channel represented by "**tag**" *'D'*.

> A constant should be defined to provide the mean value of channel '*D*', "K0 = Mean(D)"

> This constant is then used in the expression, "DiffFromMean = D – K0"

---

‡ See appendix 4 for a complete list of functions available.

23. PLOTTING DATA

Plotting Single and Individual Charts

- Open the file and using the navigator, select the recordings and/or channels to be plotted.

- Select the *Chart* tab and click the *Plot* button. You can also plot a recording or channel by double-clicking it in the navigator.

- To display the selected recordings and/or channels on individual charts, click the *Individual* button.

- To change the format of charts, click the *Adjust* button to access the *Adjust Axes & Colors* window. This window allows for changes to be made to the axes and colors of the plotted recordings displayed on the chart.

- To clear all plotted recordings, click *Chart* menu ▶ *Clear Chart*. To retain existing plots when adding to the chart, click the *Hold* button. A maximum of 16 plots can be displayed at a time

To enlarge a chart, you can hide the legend by clicking *Chart* menu ▶ *Show Legend*. You can also Hide the navigator by clicking *Window* menu ▶ *Show Navigator*.

24. Zooming & Panning

To zoom in on any part of a chart:
- Click a point to the left of that part of the chart and drag a rectangle across and down to the right over the section to be enlarged (while holding down the left mouse button). Release the mouse button to perform the zoom.

To zoom in horizontally:
- Proceed as above, but only move the mouse directly up or down to select the area to be enlarged. Two horizontal lines will be displayed across the chart to indicate the selection.

To zoom in vertically:
- Proceed as above, but only move the mouse directly left or right to select the area to be enlarged. Two vertical lines will be displayed across the chart to indicate the selection.

To unzoom from any view:
- Left click on any point in the chart and drag a rectangle up and to the left to display a rectangle with a cross in it. When the mouse button is released all zooming will be undone and the chart will be returned to its original view.

Panning
- The chart displayed can be dragged in any direction to display sections that are hidden from the current view. To pan around the chart click and hold down the right mouse button in the chart display. The cursor will turn into a pointing hand icon. Drag the mouse pointer in the direction that you wish to move the chart.

Note: If you move the cursor off the chart, you will have to release the right mouse button and return it to within the chart boundaries to continue panning.

25. Printing Charts

- Click *Print* while the chart is displayed.

26. Reading and Comparing Values

To place cursors on charts to read the data values on curves:

- Plot the recordings and/or channels on a single chart.

- To place a cursor at a particular point on a curve, place the mouse cursor at that point, follow the curve until a crosshair appears, and then click the left mouse button. If the default cursor options are used, the cursor comprises a horizontal and a vertical dashed line, and the values indicated by the cursor are displayed at the edge of the chart next to the dashed lines.

- To move the cursor to a different point on the same curve, press the horizontal arrow keys. To move in small steps, hold down the Ctrl key when pressing the horizontal arrow keys. You can also move the cursor by clicking the left mouse button on the new point (first allowing a crosshair to appear).

- To move the cursor to a different curve, push the vertical arrow keys. Alternatively, click the left mouse button on the new curve, or on the appropriate symbol on the legend.

- To place a second cursor on the chart, place the mouse cursor at the point of interest, follow the curve until a crosshair appears, and then click the right mouse button. If the default cursor options are used, the difference between the values indicated by the cursors is shown at the top right corner of the chart. Cursor A corresponds to left mouse button and cursor B to the right.

- To toggle the focus between the cursors, push the space bar - a cursor must be focused before it can be moved using the arrow keys. A cursor is focused if it has a rectangular target.

- To clear the cursors, push the Esc key.

- To change cursor options, click *Chart* menu ▸ *Cursor Options...*.

EXAMPLE: a two-channelled temperature recording with both cursors displayed (using the default cursor options).
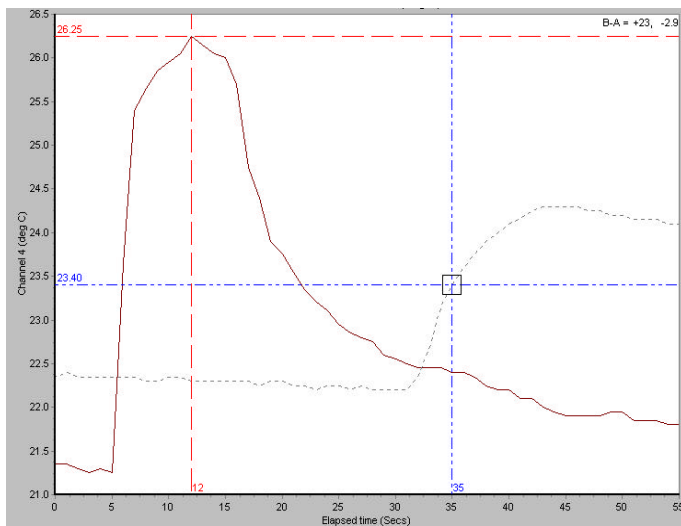

Each cursor displays the x and y axis values and the difference in both the x and y axis values of the two cursors in the top right hand side of the chart.

27. Plotting Waterfall Charts

- Plot the recordings and/or channels on a single chart.

- Click *Chart* menu ▸ *Waterfall Chart* and select the depth required.

Waterfall charts are useful for trending data behaviour. As on ordinary charts, cursor and zooming functions can be used on waterfall charts.

EXAMPLE: the four curves on the waterfall chart below correspond to three sets of data pertaining to the same measurement point. It can be seen that the peak value has a rising trend.
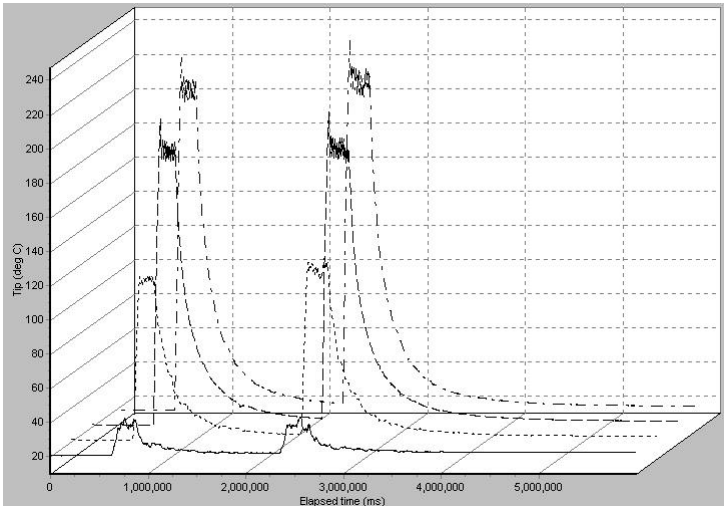
28. UPGRADING FIRMWARE

When an upgraded instrument firmware version is available, it will be posted on the COMMTEST INSTRUMENTS website. Once you have obtained the firmware file, the firmware can be upgraded using the PROFLASH procedure below.

WARNING: Upgrading the firmware erases all data in the instrument.

- Check the instrument battery capacity and if it is less than 30% charge the battery pack.

- Connect the RS232 port of the instrument to the configured PC COM port using the data-transfer cable.

- Power up the instrument and transfer any data you wish to keep to **MAS** on a PC.

- In **MAS** click *Tools* menu ▸ *PROFLASH MMS*. In the *PROFLASH* window click the *PROFLASH* button ▸ *Automatic search*.
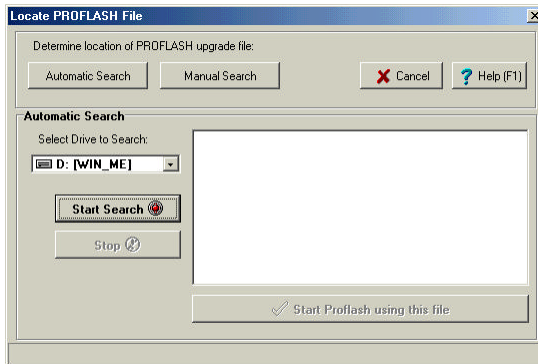
- Click *Select Drive to Search* and select the drive where the new firmware version is located.

- Click *Start Search*, and when the search is completed select the new firmware file.

- Click *Start proflash using this file*.

Once the proflashing is complete, the instrument will beep and the Initialisation screen will appear. If an error occurs, check that the data-transfer cable has been connected properly and that the instrument is powered up.

29. Appendix 1   Specifications

Specifications	Model: **MMS3000-RTD6** Incorporating 6 RTD Channels (3-Wire)		Remarks
Temperature Range	-328 to +1562°F (-200 to +850°C)		Operating temperature range is determined by operating range of Pt100 RTD sensor.
Temperature Resolution	0.1°F or °C		
Temperature Accuracy	±0.1% of reading ±0.2°F (0.1°C) ±1 least significant digit		The **MMS3000-RTD6** is calibrated to the standard RTD temperature vs. resistance table given in IEC 751 (α = 0.00385; α = 0.00392 also supported). Temperature measurement accuracy depends on **MMS3000-RTD6** and RTD accuracy. Only **MMS3000-RTD6** accuracy is given here.
Minimum Sampling Interval	Number of channels selected (user-selectable)	Minimum sampling interval (seconds)	Minimum time to scan all selected channels - not each channel.
	1	0.2	
	2	0.3	Sampling interval is programmable from 0.2 seconds t o60 hours.
	3	0.5	
	4	0.6	
	5	0.7	
	6	0.8	
Data Logging Data Storage Format Data Storage *Data Set* Name	Up to 50 named *data sets* Up to 50 *recordings* per *data set* Up to 9,999 samples per *recording* 128 kilobytes – approximately 100,000 individual samples Up to 16 alphanumeric characters		User-specified name entered from keypad. Each *recording* has unique time/date stamp. Each sample contains data for all selected channels. Non-volatile memory (battery backup). Number of samples depends on number of *data sets* and *recordings*.
Display Resolution Viewing Area Backlight	LCD with graphic capabilities 240 x 128 pixels 4.3" x 2.3" (110mm x 60mm) Electro-luminescent		
PROFLASH	Allows internal firmware to be upgraded via built-in serial port		
Communications Baud Rate	RS232 9600, 19200, 57600 bits per second		15kV ESD protected. Cable with DB9 connector included. Automatic baud rate selection.
RTD Inputs Connector Sensor Excitation Current	Sockets accept MTP miniature 3-blade RTD plug 350 – 420µA (nominal 380µA)		Current switched between selected channels.
Battery Type Voltage Capacity Operating Time	Custom Nickel-Cadmium pack 7.2V nominal 1500mAh nominal 13 hours nominal with backlight off, 7 hours nominal with backlight on		
Charger & Conditioner Fast Charge Rate Discharge Rate	Built-in dual rate charger – automatic and manual control 0.7A nominal 0.5A nominal		Power transformer (13.5 ± 1.5VDC, 1A output) included in kit. 2.5 hours for complete charge nominal. Combats Ni-Cad battery memory effect.
Mechanical Size Weight	9.7" W x 6.1" L x 3.0" H (247mm x 154mm x 75mm) 4.4lb (2kg)		Including protective boot. Including protective boot and strap.
Environmental Temperature/Humidity Operating Storage EMC	32°F to 122°F (0°C to 50°C) / 80% RH 32°F to 86°F 70% RH 32°F to 122°F 14°F to 140°F (-10°C to 60°C) / 95% RH EN50081-1 EN50082-1		Non-condensing. Non-condensing. Radiated and conducted emissions. ESD immunity and RF field immunity (EMI).

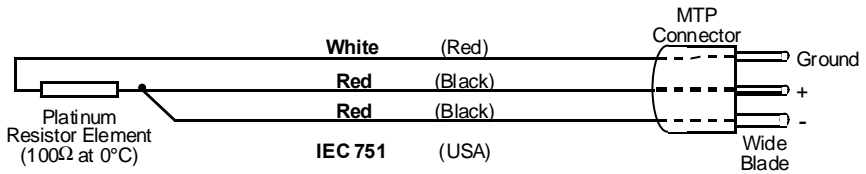The manufacturer reserves the right to modify specifications (Rev. 1.06)

30. Appendix 2   RTD6 Module Connector Diagram

RTD Channels 1, 2, 3, 4, 5, and 6.
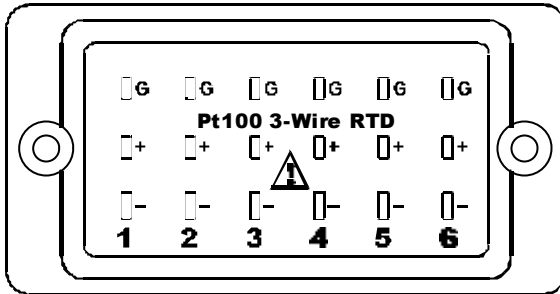
3-Wire RTD Sensor Connection Diagram

Notes:

1. The two red (or black) wires are identical and interchangeable.

2. When using RTD elements it is important to keep the resistance of all wires from the element to the MTP connector equal. Any variation will show up as a temperature error of approximately 2.6°C/Ohm (4.7°F/Ohm).

3. Lead resistance should be kept as low as possible with a maximum of 10 Ohms per wire. Lead resistance above 10 Ohms will reduce the maximum possible reading.

31. Appendix 3   Application Notes

Application Note 1

RTD6 Module Operation and Voltage Isolation

The six channels of the **RTD6** module are multiplexed i.e. the excitation current is switched into one RTD channel at a time and the voltages across that RTD channel are switched into the A/D converter so that resistance can be calculated.

The input processing circuitry has a nominal 500VDC electrical isolation from the **MMS3000** data processing circuitry including the battery and serial cable to the computer.

The six channels are not isolated from each other, however most RTD sensors are electrically isolated i.e. the internal platinum resistor is electrically isolated from any external metal sheath.

WARNING: **Connecting non-isolated RTD elements onto surfaces of different voltages will cause incorrect readings, and may cause damage to the RTD6 module circuitry.   It is recommended that isolated RTD sensors be used. Check the RTD manufacturer's isolation specification before connecting a sensor to any surface.**

WARNING: **Connecting any probe to a "live" surface may cause electric shock to the operator and/or damage to the MMS3000 (see Section 5).**

Application Note 2

Use of RTD Sensors in Electrically Noisy Environments

In an industrial environment, it is common to have AC and/or DC voltages between conductive surfaces that are not bonded together. Conductors that are assumed to be isolated may in fact have a DC leakage, a 50Hz/60Hz AC voltage from inductive or capacitive coupling, or a continual presence or bursts of r.f. voltage.

Where sensors are being used in such an electrically noisy environment, it is recommended that leads be kept as far as possible from noise sources such as power cabling, switch gear, electric motors, and radio antennae.

(a) Use of Cable Shielding

A standard precaution for signal wiring in noisy environments is to use shielded cable, with the shielding extending from the sensor to the instrument (i.e. the MTP connector) and grounded at one point at the instrument end.
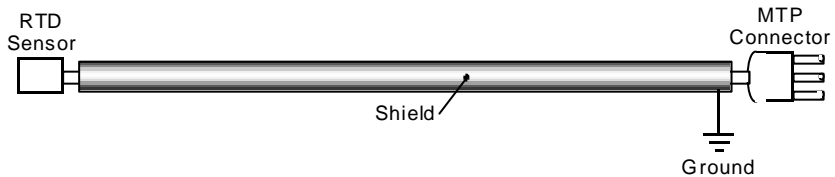

Note that the ground terminal (G) on the MTP connector connects to the isolated "common" supply of the **RTD6** module, but this is isolated from true ground. If the shielding of each lead was connected to the ground terminal of the MTP connector, then one such terminal would also need to be connected to a true ground. In this case however, the RTD elements are no longer isolated from ground. Care must be taken to avoid "ground loops" i.e. grounding the cable at both ends, or having the shield contact ground in an intermediate position.

The above is effective where the noise is mainly electric field i.e. capacitively coupled. Braided copper wire, or metalized plastic sheath may be used for shielding. Where the noise is due to the presence of very large currents (i.e. inductively coupled) the shield needs to be iron conduit, and both ends should be tied to ground.

(b) Use of Non-Isolated RTD Sensors

In an industrial environment, it is recommended that any metal surface to which the non-isolated RTD sensor is connected, be grounded.

Example: Connecting non-isolated RTD sensor to conductive surfaces in a noisy environment where shielding is not used.
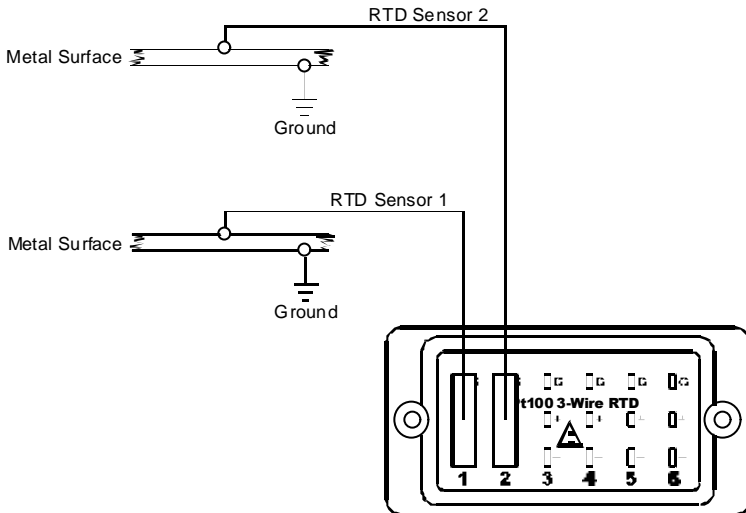
WARNING: It is however not recommended that non-isolated sensors be connected to conductive surfaces or immersed in conductive fluids.

Application Note 3

Environment Issues and Care of Connectors

Although the RTD connectors in the **RTD6** module are nickel-plated, the industry standard connector for RTD sensors has unplated copper contacts.

Oxidation and corrosion of contacts will cause measurement errors. It is recommended therefore that the instrument and sensors be stored in a dry, non-corrosive atmosphere.

Where sensors are left in a corrosive atmosphere, it is recommended that the connector contacts be inspected before use. The copper contacts can be cleaned by lightly rubbing with a very fine emery paper. If the contacts show signs of corrosion, and need to be cleaned, it is recommended that the screw termination of the wire to the connector (underneath the plastic cover) be also inspected and cleaned as necessary.

32. Appendix 4   MAS-3000 MATH

The following are the mathematical functions and operators that can be used in MAS-3000 calculations.

The symbols A,B,C,… represent channel tags; and L1, L2, …, Ln represent logical expressions (e.g. int(A) > 3).

The notation used for functions and operators is similar to that used in common computer-programming languages and spreadsheet programs.

FUNCTIONS

Mathematical Functions

Function	Meaning
Abs(A)	Absolute value
Cos(A)	Cosine
Deg(A)	Convert from radians to degrees
DegC_to_DegF(A)	Converts Celsius to Fahrenheit
DegF_to_DegC(A)	Converts Fahrenheit to Celsius
Exp1	Base of natural logarithm, e (constant)
Exp(A)	Exponent
Frac(A)	Fractional part
Int(A)	Integer part
Ln(A)	Natural logarithm
Log(A)	Base 10 logarithm
Max(A, B, …)	Return the maximum value
Min(A, B, …)	Return the minimum value
N	Sample number (starting from zero)
Pi	π (constant)
Power(*base*, *power*)	*base* to the power of *power* e.g. Pow(A,3) gives A^3 Pow(3,k1) Pow(A,B)
Rad(A)	Convert from degrees to radians
Round(A)	Rounded value
Sgn(A)	Sign (-1 if negative; +1 if positive; 0 if zero)
Sin(A)	Sine

Function	Meaning
Sqr(A)	Square
Sqrt(A)	Square root
Tan(A)	Tangent
ChangePerDay(A)	Rate of change (differentiation)
ChangePerHrs(A)	e.g. If channel 'A' changes smoothly from 10 to 25 over a 1 minute period, then ChangePerMin(A) will be 15 over that period.
ChangePerMin	
ChangePerSec	
SumOverDays	Summation over time (integration)
SumOverHrs	e.g. If channel 'A' is a 2hr recording with all values = 3.5, then SumOverHrs(A) changes smoothly from 0 to 7 over the recording.
SumOverMins	
SumOverSecs	

Iterative Functions

The following iterative functions can be used for constants only. Cell level expressions cannot contain iterative functions.

Function	Meaning
Count(A)	Number of samples
Maxsample(A)	Maximum sample value
Mean(A)	Mean
Minsample(A)	Minimum sample value
Stddev(A)	Standard deviation
Sum(A)	Sum

Logical Functions

Function	Meaning
AND(L1, L2, …, Ln)	Logical AND e.g. AND(n = 10, k2 > 0.5, k3 > 0.5, k2 <> k3)
False	Logical constant, has value 0
OR(L1, L2, …, Ln)	Logical OR e.g. OR(k0 = True, k1 < 3, n >= 30)
True	Logical constant, has value 1
AOR(L1, L2, …, Ln)	Logical AOR (exclusive OR) e.g. AOR(k0 = True, k1 < 3, n >= 30)
NOT(L1, L2, …, Ln)	Logical NOT e.g. NOT(k1 =True, k2< 10, n>30)

Conditional Functions

Function	Meaning

IF(L1, *true result*, *false result*)	If logical expression L1 is true, execute *true result*, otherwise execute *false result* e.g.
	
	IF(k2 > k3, k2*A, k3*A)
	
	IF(k0 = True, n, n*2)
	
	IF(n < 10, n, Log(n))

Date and Time Functions

In **MAS**-3000, the date and time value of when a sample is taken is a floating-point number. The integer part of the number represents the date: it is the number of days since the first day of 1 AD. The fractional part of the number represents the time: it is the proportion of time that has passed since the beginning of the day.

Function	Meaning
Date(*year*, *month*, *day*)	Return the date in **MAS**-3000 format e.g. Date(1999, 07, 25)
Time(*hour*, *minute*, *second*, *ms*)	Return the time in **MAS**-3000 format e.g. Time(16, 59, 31, 965)
Elapsed(*sample number*)	Return the date and time of the sample in **MAS**-3000 format e.g. DAT(36)
SampleDate(n)	Date of the nth sample
SampleTime(n)	Time of the nth sample

OPERATORS

Logical Operators

Operator	Meaning
<	Less than
<=	Less than or equal to
<>	Not equal to
=	Equal to
>=	Greater than or equal to
>	Greater than

Arithmetic Operators

Operator	Meaning
+	Addition
–	Subtraction
/	Division
*	Multiplication

The order of precedence is as in standard arithmetic (i.e. /, *, +, –). An operand between two operators of different precedence is bound to the operator with higher precedence. An operand between two equal operators is bound to the one on its left. Expressions within parentheses are evaluated before being treated as a single operand.