Profiler Operator's Appendices:
- **MP-3000 A**
- **MP-2500 A**
- **MP-1500 A**

MCM-C Hardware Configuration

Radiometrics Corporation

4909 Nautilus Court North, Suite 110

Boulder, CO 80301 USA

1+303 449-9192 (tel)   1+303 786-9343 (fax)

http://radiometrics.com

Revision G

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Appendix A: EZ-Tripod Assembly

CAUTION

Incorrectly securing and weighting the EZ-Tripod may void the Warranty support obligation and place the owner/operator at risk for personal safety. If incurred damages require Radiometrics support or repair, Radiometrics will invoice these services to you at our normal hourly support rates.

Unpack and inspect the EZ-Tripod parts for signs of damage or missing pieces. The following parts should be included:

(3 ea.) Foot Plate
(3 ea.) Leg Assembly
(3 ea.) Elevation Screw Assembly
(3 ea.) Strut
(1 ea.) Triangular Top Plate with eyebolt
(1 ea.) Hardware Kit containing:

> **Elevation Screw Assembly ("ESA")**
> (12) 5/16-24 x 7/8" cap screws
> (12) 5/16 flat washers
>
> **(1) Ground Clamp**
>
> **Cross Strut Hardware:**
> (6) 3/8"x 1" cap screws
> (6) Lock nuts
>
> **Top Plate Hardware:**
> (6) 3/8"x 3/4" cap screws

(1 ea.) Center Pull Anchor Kit Containing:
(3) SS oval threaded connector
(1) SS turnbuckle
(1) SS eyebolt (may be pre-installed on Top Plate)
(3') SS 3/16" corrosion resistant chain

(1 ea.) Tool Kit Containing:
(1) ¼" Allen wrench
(1) 5/16" Allen wrench
(1) 9/16" box / open-end wrench
(1) 9" Magnetic bubble level

Figure A-1. Radiometrics EZ-Tripod, Unassembled

Assembly Instructions

Refer to Figure A-3 for details on the assembly procedures described below.

1. Remove all components from box. Remove the top jam nut and washer from the ESA and thread into the Delrin sleeve nut at the bottom of the leg assembly, repeat for all three legs. Replace the top washer and jam nut. See Figure A-2.

Figure A-2. Delrin Sleeve Nut Installed

2. Attach (1) foot assembly to each leg assembly using (4) 5/16-24 x 7/8" cap screws and (4) 5/16 flat washers. DO NOT TIGHTEN the screws at this step.

3. Attach the other end of each leg assembly to the triangular top plate using (2) 3/8" x 3/4" SS cap screws for each leg. DO NOT TIGHTEN the screws at this step.

4. Attach the (3) cross struts to the leg brackets using (2) 3/8" x 1" cap screws and (2) 3/8" lock nuts on each cross strut.

5. Tighten all screws using 5/16" Allen wrench and 9/16" box wrench.

6. Install ground clamp on cross strut.

**Figure A-3. EZ-Tripod Assembly Components.
Cross Strut, Top Plate, and ESA (exploded views)**

7. Adjust to desired height as follows:

   a. Place the level on the Triangular Top Plate so that it is in line with the plane of a leg, if the level is not within 1/8th of a bubble, adjust ESA on one or more legs as necessary.

   b. Place a 9/16 wrench on the ESA and turn to adjust. Repeat this step for each leg as required to level the tripod. When finished tighten the jam nuts against the Delrin sleeve nuts

For more detail on leveling the Tripod, see Section 3.5 of the Profiler Operator's Manual.

Securing the EZ-Tripod

The EZ-Tripod can be secured using any of the following combinations:

- Center-Pull Anchor Chain *and* Anchor Bolts (supplied by Customer)
- Center-Pull Anchor Chain *and* Tent Stakes (supplied by Customer)

- Center-Pull Anchor Chain *and* Sand Bags (supplied by Customer)

Center-Pull Anchor Chain

The supplied center-pull anchor chain and turnbuckle assembly provides a robust way to secure the Tripod to the surface below using a single eyebolt. If a single secure anchor bolt can be located directly under the Tripod, follow these steps:

1. Position the Tripod directly over the anchor bolt.

2. Attach the oval threaded connector of the pull chain assembly to the eyebolt on the triangular top plate.

3. Attach the other end of the chain to the anchor bolt using the threaded chain link, (moved to the required position on the chain).

4. When the chain is attached at both ends and the Tripod is leveled at the desired height, take up the slack with the turnbuckle. A downward force of 23 kg / 50 lb is sufficient.

Alternatives to a secure anchor bolt directly under the EZ-Tripod

Until permanent securing can be arranged, a 23 kg / 50 lb weight can be suspended from the eye bolt in the top plate. Suggestions for weight might be suspending the following from a bucket capable of carrying a minimum of 23 kg / 50 lb:

- Sand
- Concrete
- Stones/bricks/blocks

A. **Center-Pull Anchor Chain and Anchor Bolts:** Use (4) anchor bolts to secure each Tripod foot, via the small holes. The bolts should be ≥ 3/8″.

B. **Center-Pull Anchor Chain and Tent Stakes:** Use (4) tent stakes or similar securement pieces to secure each Tripod foot, via the large holes. Tent stakes must be of metal construction and long enough to ensure minimal pull out.

C. **Center-Pull Anchor Chain and Sand bags:** Apply (3) 50 lb sand bags or similar dead weight to each of the Tripod feet.

Figure A-4. Tripod fully assembled

ISOMETRIC VIEW
SMALLER THAN SHEET SCALE

FRONT VIEW
SMALLER THAN SHEET SCALE

PAD(S) MUST BE
LEVEL WITHIN 6°

HEIGHT
MAX. 29.4
MIN. 25.9

5.26
[133.7]
MAX PAD
ELEVATION
DIFFERENCE

6°

1.60 EYEBOLT OFFSET
[40.6]

PARTIALLY BROKEN OUT SECTION
SHOWING HIDDEN HOLE

Ø50.46 BOLT CIRCLE
[1281.7]

Ø49.97 BOLT CIRCLE
[1269.3]

Ø57.40 BOLT CIRCLE
[1458]

49.34 TYP
[1253.2]

Ø64.35 BOLT CIRCLE
[1634.6]

Ø63.97 BOLT CIRCLE
[1624.9]

R4.95 BOLT CIRCLE
[125.7]

R3.50 BOLT CIRCLE
[88.9]

4X Ø.880
[22.35]

4X Ø.438
[11.13]

(7.00 SQ.)
[177.8]

45.00°

45.00°

FOOT PLATE HOLE REFERENCE
LARGER THAN SHEET SCALE

radiometrics corporation
4909 Nautilus Court North, Suite 110 Boulder, CO 80301
(303) 449-9192   FAX: (303) 786-9343

TITLE:
EZ TRIPOD ASM
SITE PLAN

DWG. NO.
129-0058

REV
B

SIZE
B

SCALE: 1:6   DO NOT SCALE DRAWING   SHEET 1 OF 1

D:\Engineering\MP3000B\EZ_Tripod\

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES.
GEOMETRIC TOLERANCES INTERPRETED
PER ANSI Y14.5M-1994

TOLERANCES:
FRACTION: ± 1/64
ANGLES: ± 1°
X.X   ± .03
X.XX   ± .01
X.XXX   ± .005

THIRD ANGLE
PROJECTION

	NAME	DATE
DRAWN	D. HAGLER	10/21/2014
CHECKED	J. BRUNER	10/21/2014
APPROVED	V. MARKIN	10/21/2014

MATERIAL:

FINISH:
NONE
SEE NOTES 2 & 3

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REVISIONS

REV	DESCRIPTION	ECN	REVISED BY	APPROVED	DATE
B	CHANGE TO PRESS FITTINGS ON LEG TUBES AND CROSS TUBE WITH PLATED ASSEMBLIES RATHER THAN PIECE PLATING. PANEL RETAINER FOR DRAIN PLUG IN EVALUATION. ASSEMBLIES CHANGED TO REFLECT WHAT GOES INTO THE SHIPPING CONTAINER. INDENTED BOM, SH2, REVISION COLUMN ADDED.		D. HAGLER	E. PLOMONDON	05/19/2016

DRW NO. 129-0058-B, SH 1/1

Appendix B: VizMet-B ver. 3.1xx User's Guide

Overview:
This appendix describes several processes involving VizMet-B.

I.   General Information

This description applies to version 3.1.xx of the VizMet-B software. VizMet-B is a browser-based control and display software for the Radiometrics MP-Series Microwave Profiling Radiometers (MP-3000A, MP-2500A, and MP-1500A). VizMet-B turns the radiometer Control Computer into a powerful web server, providing interactive access to the instrument from any remote computer connected by LAN or the Internet without installing any special software on the remote computer. VizMet-B uses Java technology to enable any modern Windows, Mac, UNIX, or LINUX computer to connect and display the Graphical Users Interface (GUI). Remote computers only require a browser (e.g., Chrome or Firefox) and Java. The VizMet-B color GUI simplifies and automates radiometer configuration, control calibration, and monitoring.
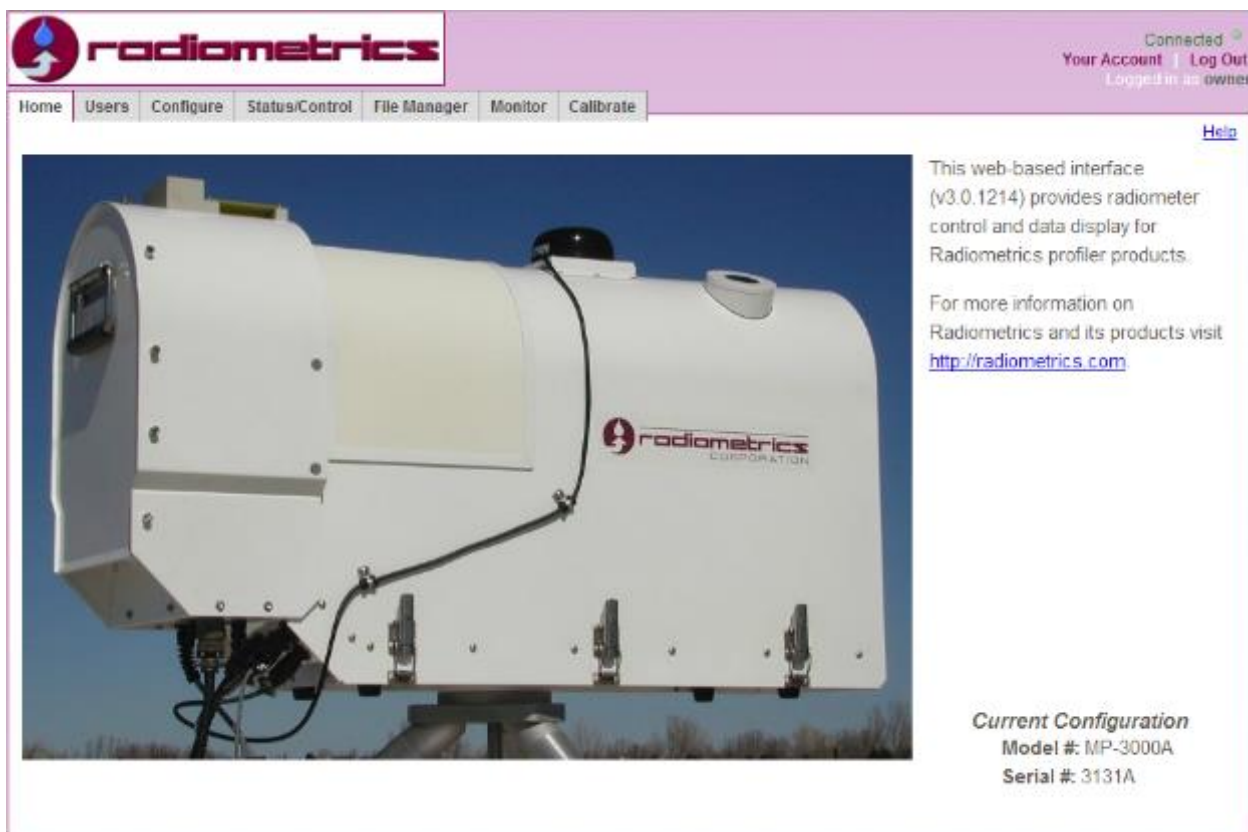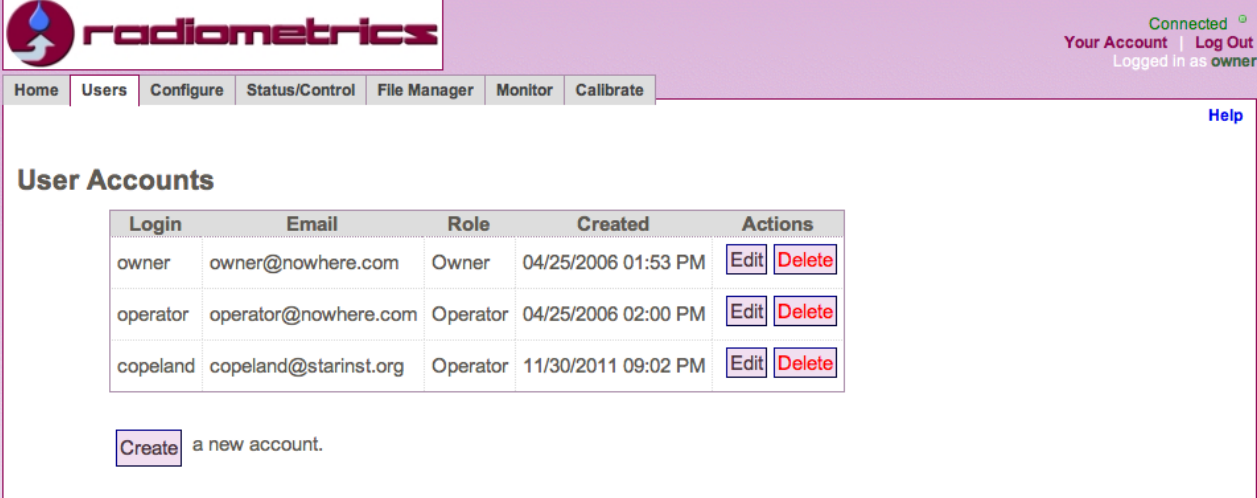
Figure B-1. Home page and login for radiometer

Above is pictured radiometer model MP-3000A, serial # 3131A. To login, click on the "Log In" text in the upper right corner, and then enter **User Name** and **Password**.

II.   Starting VizMet-B

VizMet-B will start automatically when the computer starts. To login from the Control Computer, open a browser window with "localhost" as the address. (Chrome and Firefox are recommended browsers.) If the Control Computer is connected to a LAN or WAN, VizMet-B can be operated from a remote computer on the network by entering the fixed IP address of the Control Computer in a browser.

Users (Accounts and Privileges) Tab

Figure B-2. Users tab

The Owner controls accounts and privileges, via the Users tab. A User with full privileges (Owner) can manage users and access all of the tabs in Figure B-2. A User with limited privileges (Operator) can access only the **Home**, **File Manager** and **Monitor** tabs.

III.   Configure Tab

Figure B-3. The Configure tab

The radiometer mp.cfg file can be viewed, edited and transferred on this tab. The mp.cfg file determines a variety of radiometer calibration and configuration parameters. Additional information on the mp.cfg file can be found in the **Operator's Manual**.

IV.   Status/Control Tab

Figure B-4. That Status/Control tab

The **Status/Control** tab allows the user (with owner privileges) to select procedure files that control the radiometer, as described in detail in the **Operator's Manual**. This tab also displays radiometer status, selected radiometer parameters and measurements, and recent errors (if any).

Time indicates the running time from the control computer's internal clock.

Output File(s) indicate the files in the operational directory that are recording the current data being measured by the radiometer. Every time a new procedure is started, whether automatically by the scheduled tasks or manually by a user, a new set of files are created with the date and time stamp in which the procedure is started.

Status indicates the current status of the radiometer.

Error Status will have the Value **OK**, unless there have been errors. In case of errors, the line will indicate:
a. device reporting the error
b. number of errors
c. error codes, as will fit on the line
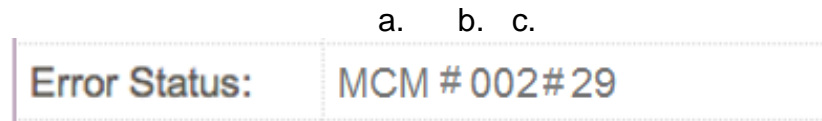
Figure B-5. Sample error message

So, the sample message shown in Figure B-5 indicates:
a. the Main Control Module (MCM)
b. reported two errors (002)
c. error codes 2 and 9

See **Appendix C: Error Messages for A-Series Radiometers, Version 6.xx Operating Code** for additional information on error messages.

NOTE:
In the event of an error, VizMet-B will continue to display an error code until the daily restart occurs, or until the procedure is stopped and restarted. However, current system status is displayed in the **Monitor** tab, under **Options and Health Status**.

RCVR0 Tnd indicates the temperature of the K-band receiver. It should always be very near 323K (50C) for the radiometer to work correctly.

RCVR1 Tnd indicates the temperature of the V-band receiver. It should always be very near 323K (50C) for the radiometer to work correctly.

Tbb is the temperature of the blackbody component inside the radiometer. In most climates, this temperature should be roughly 5-15C warmer than the outside ambient temperature.

Tamb indicates the outside ambient temperature measured by the HC2-S3 surface sensor.

RH indicates the outside ambient relative humidity measured by the HC2-S3 surface sensor.

Pressure is the measured barometric pressure at ground level (AGL).

Tir indicates the measured temperature by the KT-15 infrared thermometer. This temperature will give a good indication of the temperature where the base of the lowest cloud layer is present.

Rain is the measured voltage seen across the rain sense board.

LN2 Calibration indicates the date and time of the last time an LN2 calibration data set was transferred in the Calibrate tab of VizMet-B.

TIP Calibration indicates the date and time of the last time a TIP calibration data set was transferred in the Calibrate tab of VizMet-B.

V.   File Manager Tab

Figure B-6. The File Manager tab

Use the **File Manager** to view or modify the contents of the operating directory. Files can be displayed by name, file type, date modified, or size. Click on a column header to sort files and subdirectories located in the operating folder. Use the **Filter** text box to list only the files specified by the filter. The character "*" is a wild card character.

Controls are provided to download and delete files, and to browse for and upload files from other local computer directories. Any or all files can be downloaded without affecting normal operation. Double click on any file to open a copy on the local computer.

VI.   Monitor Tab

This tab allows display of radiometer observation and retrieval time series. Use the **3D**, **Profiles**, and **2D Line** tabs to select the corresponding data display. And use the **Options and Health Status** tab to display Health Status.

3D Color: color time series, Level 2 output
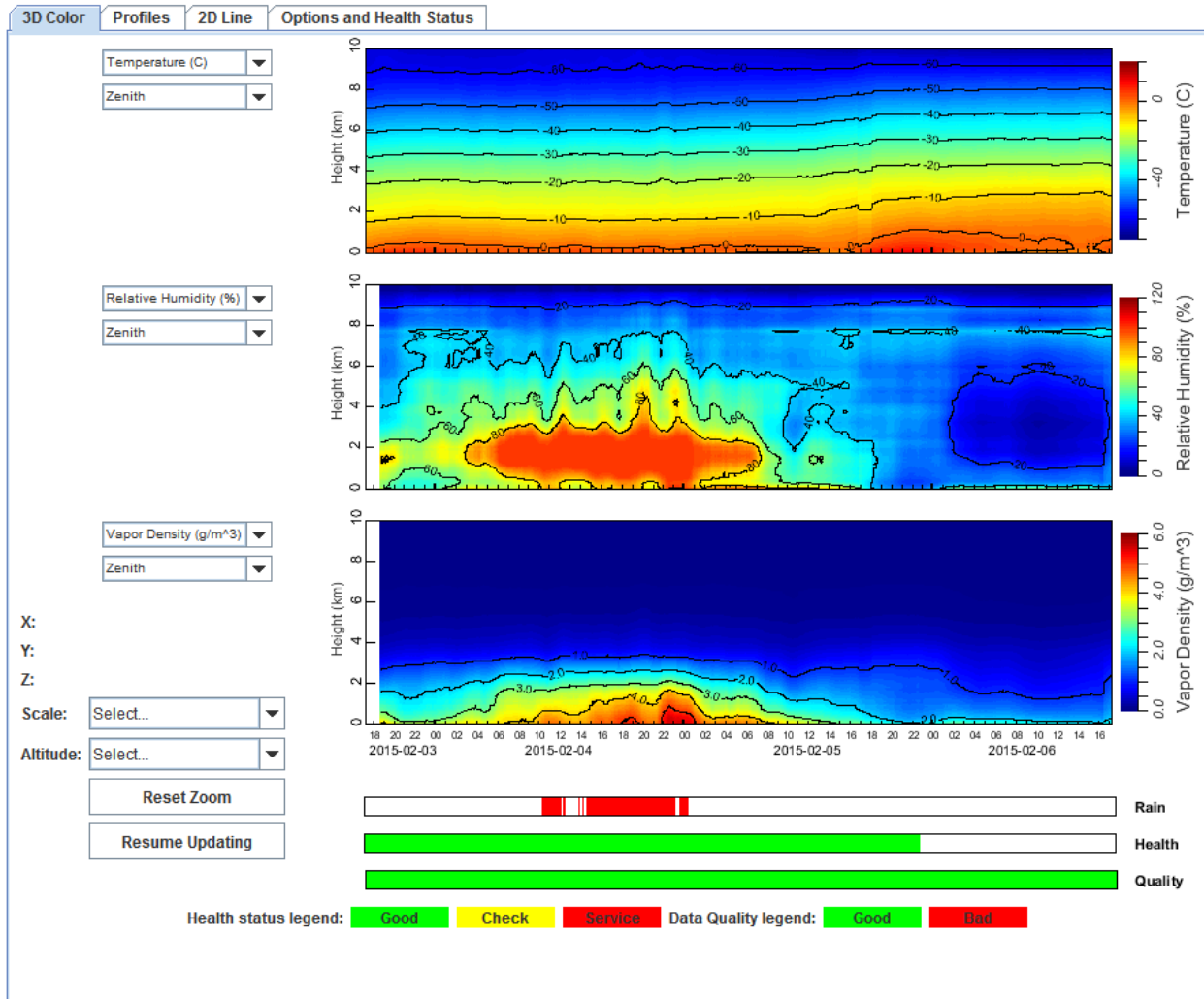
Figure B-7. The Monitor tab (3D Color tab selected)

The **3D Color** sub-tab provides 3 independent color contour time series. Each time series is selectable by two drop-down menus to its left.
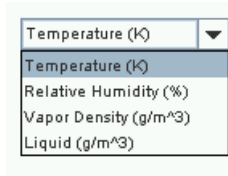
The first drop-down menu allows users to select the radiometer parameter they want to view.
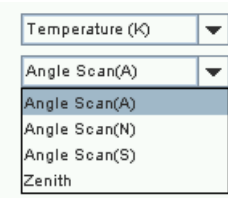
The second drop-down menu allows users to select the observation direction. Standard directions are Zenith, Nominal (N), Supplemental (S), and Average (A).

Users may see other options, depending on the procedure file being run.
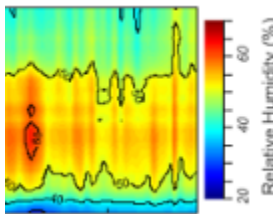
The color scale to the right of each time series plot provides a key for the graphed parameter. The software autoscales the display, based on the minimum and maximum of the data during the set time scale, discussed below.
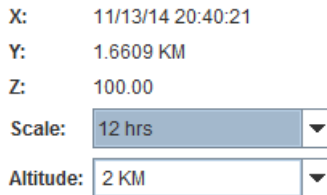
Place cursor within any of the time series, and numerical coordinates (X, Y, and Z) display at the lower left (see Figure **B-7**), pertaining to where the cursor is in that time series.

X gives the date and time within the time series.
Y gives the altitude, based on the altitude scale.
Z gives the parameter value, in this case 100% humidity.
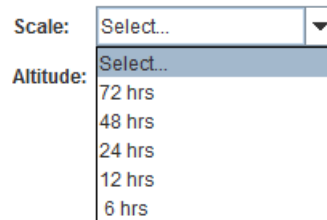
These are time periods of 6, 12, 24, 48 and 72 hours. Users can use the click-and-zoom mouse capabilities to change the displayed time scale.

X
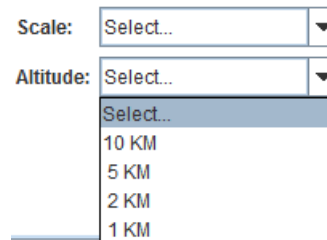
These scanning altitudes of 1, 2, 5 and 10 kilometers. Users can use the click-and-zoom mouse capabilities to change the displayed altitude scale.

Y

| Reset Zoom | Click **Reset Zoom** to restore the default time scale. |
| Pause Updating | Click **Pause (Resume) Updating** to control real time data display. |

With click-and-zoom mouse capability, users can select and expand specific time scales and features on the contour plots. The XYZ values to the lower left of the screen show the value where the cursor is.

Three indicator bars appear below the 3D plots:

- Rain
- Health (Status)
- (Data) Quality

The **Rain** indicator bar gives information from the rain sense board.

The **Health** indicator bar shows the health of the overall radiometer system. Refer to page B-14 for more explanation.

The **Quality** indicator bar shows the data quality of the Level 2 data.

Profiles: LV2 output, profiles 0-10 km Temp, RH, Vapor and Liquid

The Profiles sub-tab displays profile data from a single observation (see Figure B-8). By default, the displayed profiles are from the most recent observation. There are three profile plots; the data displayed in all three plots is from a single observation. Each plot has two pull-down menus below it.

| Temperature (K) |
| Relative Humidity (%) |
| Vapor Density (g/m^3) |
| Liquid (g/m^3) |
| Temperature (K) ▼ |
| Angle Scan30(N) ▼ |
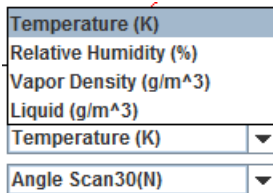
The upper drop-down menu allows users to select the radiometer parameter they want to view.

| Angle Scan30(A) |
| Angle Scan30(N) |
| Angle Scan30(S) |
| Angle Scan31(A) |
| Angle Scan31(N) |
| Angle Scan31(S) |
| Zenith31 |
| Angle Scan30(N) ▼ |
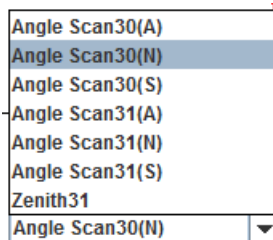
The lower drop-down menu allows users to select the desired observation direction. Standard directions are Zenith, Nominal (N), Supplemental (S), and Average (A).

Users will see other options, depending on whether they are using an Azimuth drive and/or custom procedures.

Users can observe time evolution of retrieved profiles by clicking the **Pause Updating** button and adjusting the slider. The displayed date and time change as the slider moves.
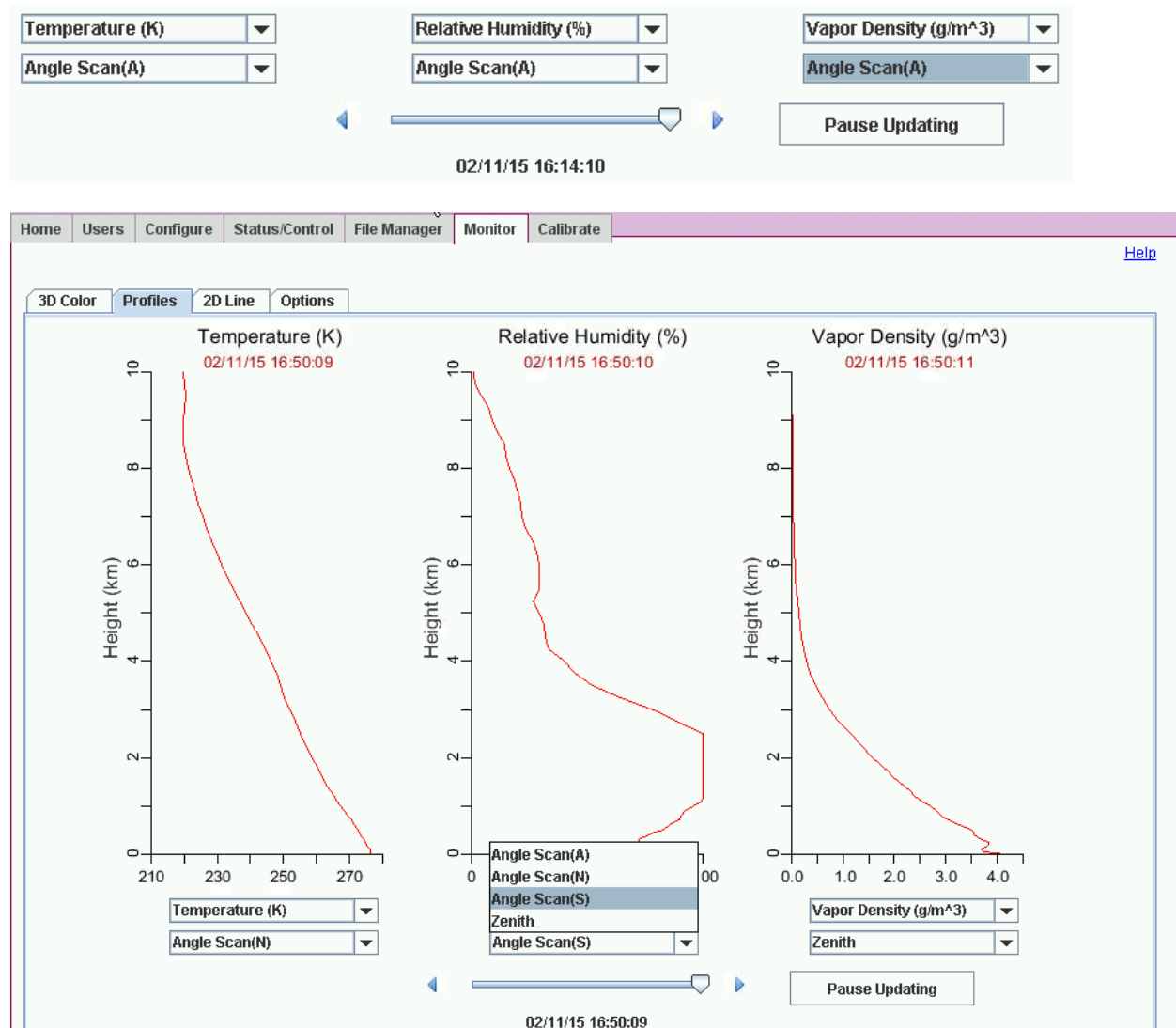
Figure B-8. The Profiles tab

With the exception of Zenith, the Observation Direction shown in the 3D Color Tab, and the Profiles Tab displays does not include the observation angle. For Angle Scans, the letter in parenthesis indicates whether the observation is in the Nominal (N) or Supplemental (S) direction, or the Average (A) of the N and S observations. For example:

> **Angle Scan (N)** indicates that the displayed data is from an off-zenith observation made in the Nominal direction.

> **Zenith** indicates that the displayed data is from a zenith observation.

The standard off-zenith elevation angle is 20 degrees above the horizon. The observation angles are set in the selected procedure file. Note that the Neural Net files

must match the procedure files; that is, if an elevation angle is defined in a procedure file, the same elevation angle must be included in the Neural Net files.
See Chapter 6, *Configuration, Control, and Data Processing*, in the MP-3000A Operators' Manual for more information on procedure files.

2D Line: LV1 data, brightness temps, cloud base, IRT, surface met
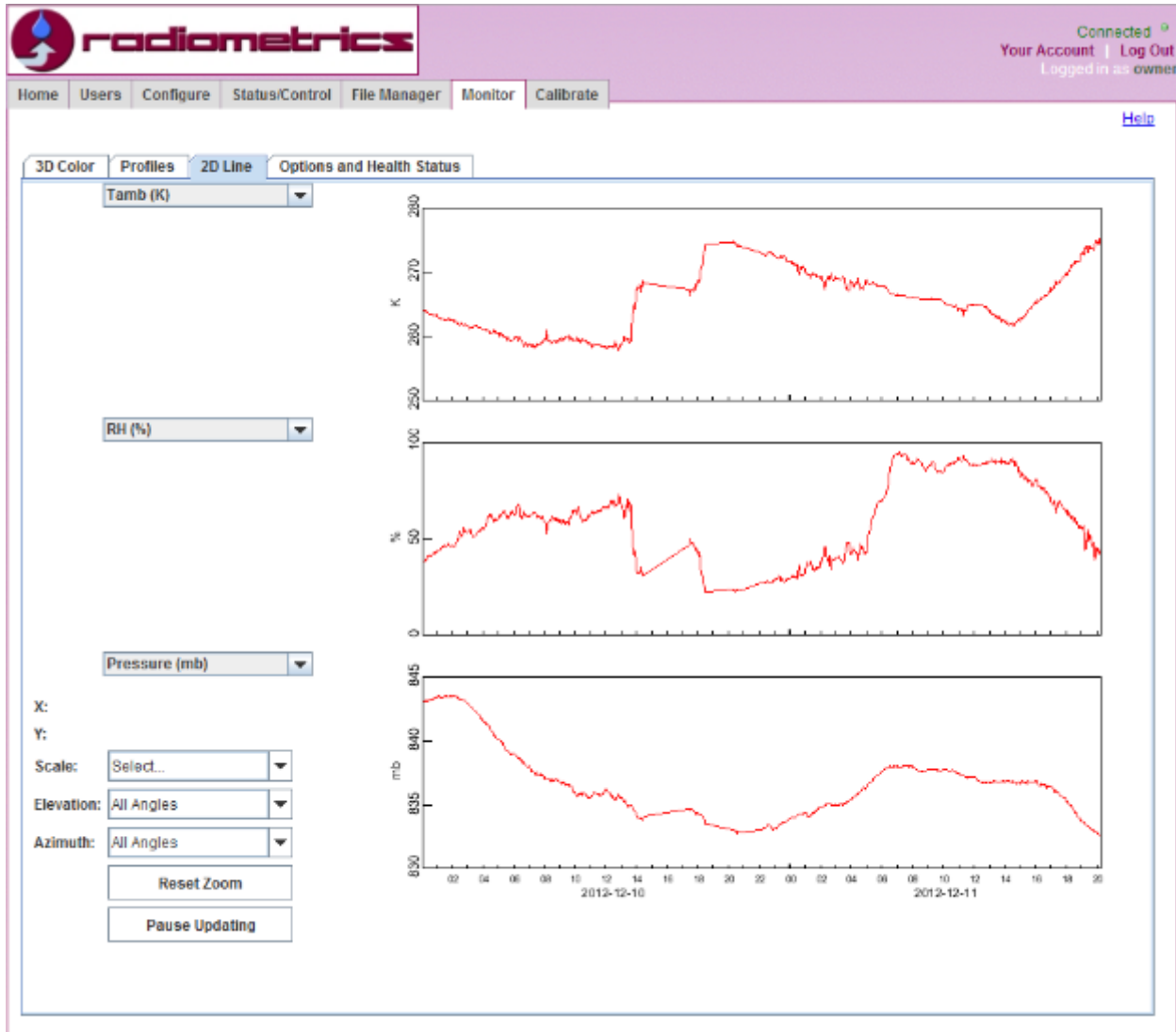
Figure B-9. The 2D Line tab

The **2D Line** sub-tab provides 3 independent, line-graph time series. With click-and-zoom mouse capability, users can select and expand specific time scales and features on the contour plots. Each time series is selectable by a drop-down menu to its left.

Tsky @ 51.248 ▾	The drop-down menus, shown to the left, include the following radiometer parameters and brightness temperatures:
Tamb (K) ▲	
RH (%)	
Pressure (mb)	
TIR (K)	
Rain	
VInt (cm)	
LInt (mm)	
Cloudbase (KM)	
Tsky @ 22.0	
Tsky @ 22.234	

The drop-down menus, shown to the left, include the following radiometer parameters and brightness temperatures:

- surface temperature
- relative humidity
- integrated vapor and integrated liquid
- cloud base temperature
- cloud base height
- observed brightness temperatures from measured microwave channels

If the cursor is located within any of the time series plot boxes, the X and Y values at the cursor location are displayed at lower left. Time scales as well as observations at specific elevation and azimuth angles can be displayed.
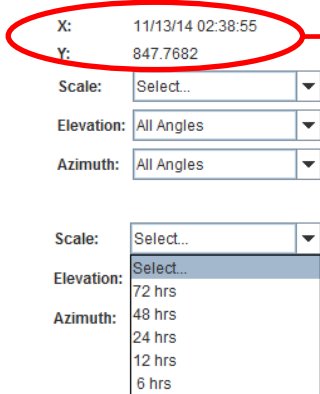
Tsky @ 22.5
Tsky @ 23.0
Tsky @ 23.034
Tsky @ 23.5
Tsky @ 23.834
Tsky @ 24.0
Tsky @ 24.5
Tsky @ 25.0
Tsky @ 25.5
Tsky @ 26.0
Tsky @ 26.234
Tsky @ 26.5
Tsky @ 27.0
Tsky @ 27.5
Tsky @ 28.0
Tsky @ 28.5
Tsky @ 29.0
Tsky @ 29.5
Tsky @ 30.0
Tsky @ 51.248
Tsky @ 51.76
Tsky @ 52.28
Tsky @ 54.4
Tsky @ 54.94
Tsky @ 55.5
Tsky @ 56.02
Tsky @ 56.66
Tsky @ 57.288
Tsky @ 57.964
Tsky @ 58.8

X: 11/13/14 02:38:55
Y: 847.7682

X gives the date and time within the time series.
Y gives the altitude, based on the altitude scale.

Scale: Select... ▾
Elevation: All Angles ▾
Azimuth: All Angles ▾

Scale: Select... ▾
Elevation: [Select... / 72 hrs / 48 hrs / 24 hrs / 12 hrs / 6 hrs]
Azimuth:

These are time periods of 6, 12, 24, 48 and 72 hours.

This drop-down menu displays the elevation angles available to the radiometer. Note that unlike the 3D Color Tab and Profiles Tab, this drop-down menu displays the actual observation angle for the displayed data.

This drop-down menu displays the Azimuth directions available to the radiometer.

Options and Health Status
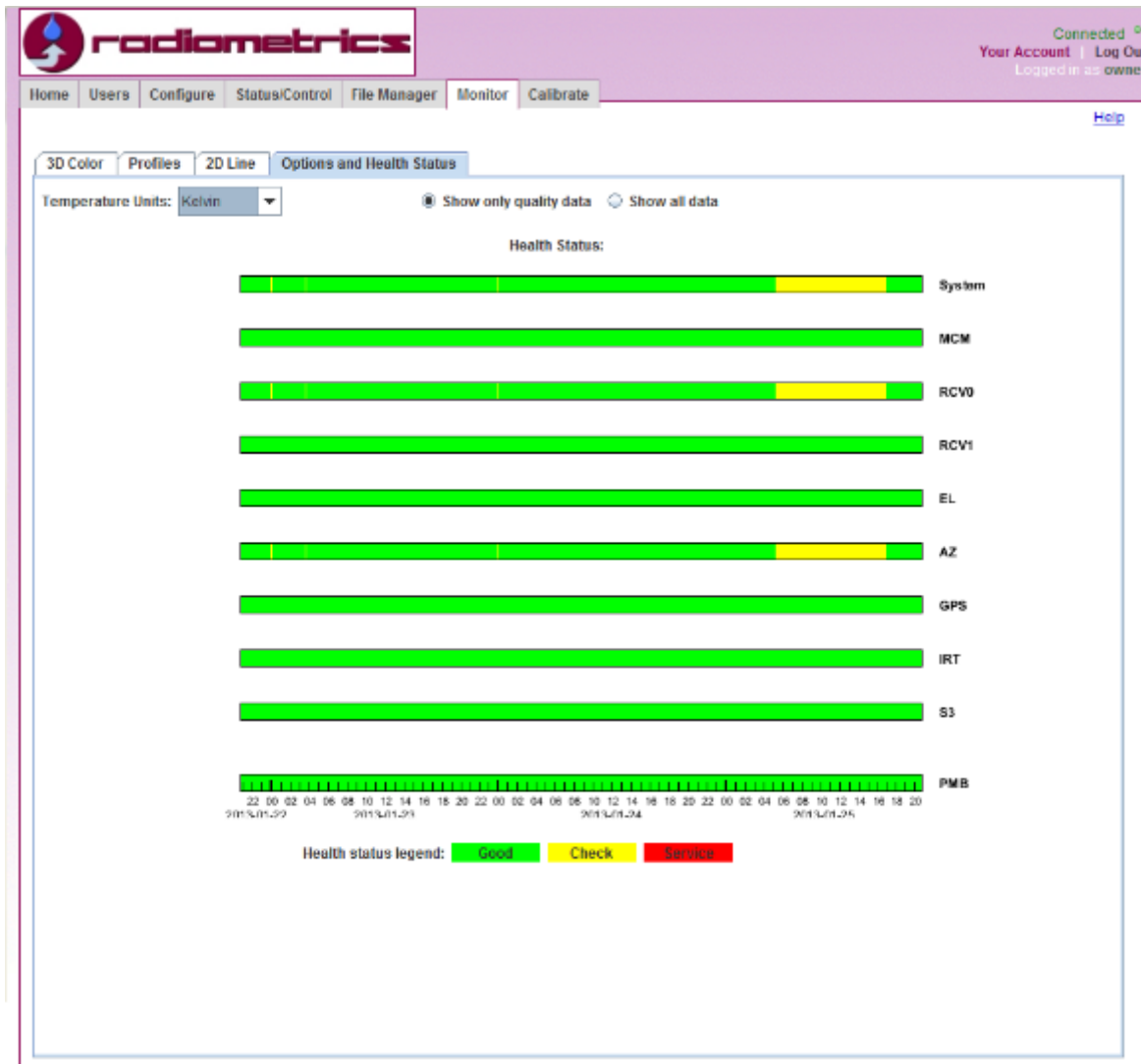
Figure B-10. Options and Health Status tab

In this sub-tab, users see the Health Status of the overall radiometer system, as well as the health status of every subsystem. As indicated by the legend at the bottom of the tab,

- Green indicates good health status
- Yellow indicates that one or more subsystems are within specification but should be checked.
- Red indicates that one or more subsystems are malfunctioning and the profiler requires service.

Above the Health Status display is an option to "Show only quality data" or "Show all data." This option allows the user to either display or hide all lv2 data that is flagged as having "bad" data quality. Data quality is based both on Health Status and on real-time lv2 data analysis. Note that the Data Quality checks are not conclusive; users should perform independent data quality checks when using the profiler data for critical weather forecast and decision applications.

This tab is also where the user can select temperature units: Kelvin, Celsius, or Fahrenheit. Changes here will be updated immediately in the 3D Color, Profiles, and 2D Line tabs.

VII.   Calibrate Tab

This tab simplifies and automates liquid nitrogen (LN2) and TIP calibration procedures described in detail in **Appendix C**. Use the **Calibrate** tab to control LN2 calibration. It also allows TIP and LN2 calibration time series displays and click-and-zoom data selection and transfer. The **Select LN2 Calibration** and **Select TIP Calibration** buttons allow easy access to previous calibration files, if needed. More information on these files is available in the **Operator's Manual**.

VizMet-B LN2 Calibration Instructions

1. Review the LN2 calibration instructions in **Appendix C**.

2. Referring to **Appendix C**, if an Azimuth positioner is installed, disconnect the Azimuth positioner cable.

3. Before starting the calibration procedure, first click on the **Status/Control** tab and click the **Stop** button to stop the current procedure. Wait until the Status value in the Status box indicates **Stopped**.

4. Don't start a new calibration within one hour of midnight UTC, as the Control Computer starts a new set of files at midnight.

   NOTE: The Control Computer clock **MUST** remain in UTC time; if it is on local or other time, the LN2 calibration status on the **Status/Control** tab may not properly display the new calibration date.

5. Click on the **Calibrate** tab.

6. Place the Cryogenic Target on the radiometer, as described in **Appendix C**.

7. Click on the **Start LN2 Calibration** button. Note that if a procedure file is still running, the **Start LN2 Calibration** button will be grayed out and nonresponsive; stop the current procedure to enable the **Start LN2 Calibration** button.

Figure B-11. The Calibrate tab

8. As the calibration progresses, the ND temperatures will populate the **Band 0** (K band) and **Band 1** (V band) plots, as shown in Figure B-11.

   The time series above shows Noise Diode (ND) temperatures in degrees K, as calibrated during a one-hour liquid nitrogen target observation. ***For a successful calibration, the time series should be stable within +/- 2 K, with little to no slope, as shown in Figure B-11 and Figure B-12.*** An imaginary line representing the average ND temperature should be flat with little to no slope (see Figure B-12).

9. After one hour of stable ND calibration data have been collected, click the
    Stop LN2 Calibration button. If necessary, a subset of the time series can be
    selected for transfer from K (**Band 0**) or V (**Band 1**) using click and zoom. VizMet-B
    will then use only the timeframe selected for each band for the calibration
    calculations.

10. Click the **Transfer Band 0** and **Transfer Band 1** buttons to automatically create a
    new mp.cfg file including the new calibration. This also automatically saves the old
    mp.cfg file with a date and time stamp. When transferring **Band 0** and **Band 1**,
    VizMet-B does not provide a visual indication that the transfer is completed;
    however, the transfer is completed immediately. When the new data is transferred,
    VizMet-B creates a new mp.cfg file that has the new calibration data; the original
    mp.cfg is renamed to **yyyy-mm-dd_hh-mm- ss.cfg**, where…

    a. **yyyy-mm-dd** is the date, and
    b. **hh-mm-ss** is the time that the new LN2 calibration was transferred.

More information on the mp.cfg file is included in the **Operator's Manual**.
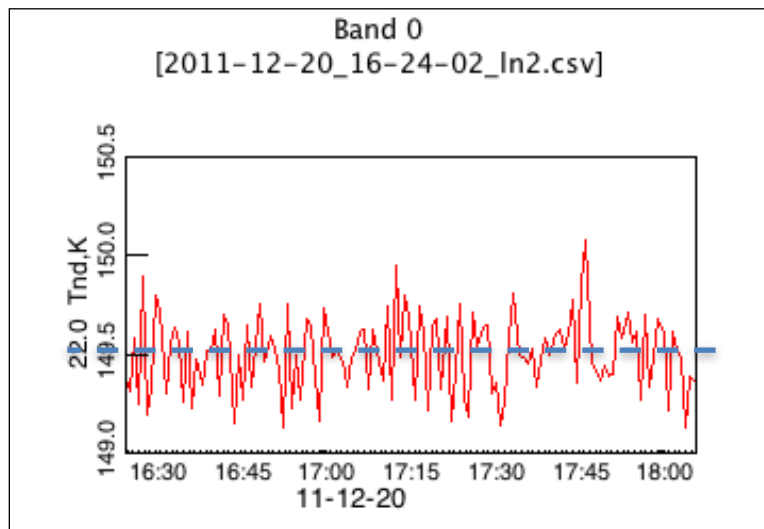
Figure B-12. Imaginary line "averaged" through noise diode temperature

Returning the radiometer to normal operation

1. Referring to **Appendix C**, remove the cryogenic target and Saddle; if an Azimuth
    positioner is installed, reconnect the Azimuth positioner cable.

2. Return to the VizMet-B **Control/Status** tab and restart the desired procedure.
    The new LN2 calibration date will appear in the **Status** box.

3. Perform a quick system health check by opening the current mp.cfg and the newly

created back-up yyyy-mm-dd_hh-mm-ss.cfg and comparing the calibration data in both files. Observe the superimposed mp.cfg files in Figure B-13, below.

a. Use **Notepad** or other ASCII text editor to open the files.

   NOTE: do NOT use Word or WordPad or other word processor program, as these programs will insert additional ASCII characters.

b. The last (right-most) number displayed for every channel in the calibration block is the noise diode (ND) temperature for that channel. The old and new value for most channels should be within +/- 2%; differences greater than 5% should be reported to Radiometrics for analysis.

c. If the old and new calibration data are identical, then the calibration data was not properly transferred. Return to the VizMet-B **Calibration** tab, click the **Select LN2 Calibration** button to select and view the most current calibration data, and follow the instructions above to transfer the calibration data.

Figure B-13. Calibration data: mp.cfg file superimposed over the backup file

4. After calibration is completed, click the **Status/Control** tab, select a procedure and click the **Start** button to resume radiometer observations.

VizMet-B TIP Calibration Instructions

1. Review the TIP calibration instructions in Appendix C.
2. Select the **Calibrate** tab.
3. Click **Select TIP Calibration** button.

    A list of .tip files located in the operational directory appears, with the most recent dates at the bottom of the list, as shown in Figure B-14. If a file containing today's date is listed at the bottom, proceed to **Step 5**. If not, continue to **Step 4**.
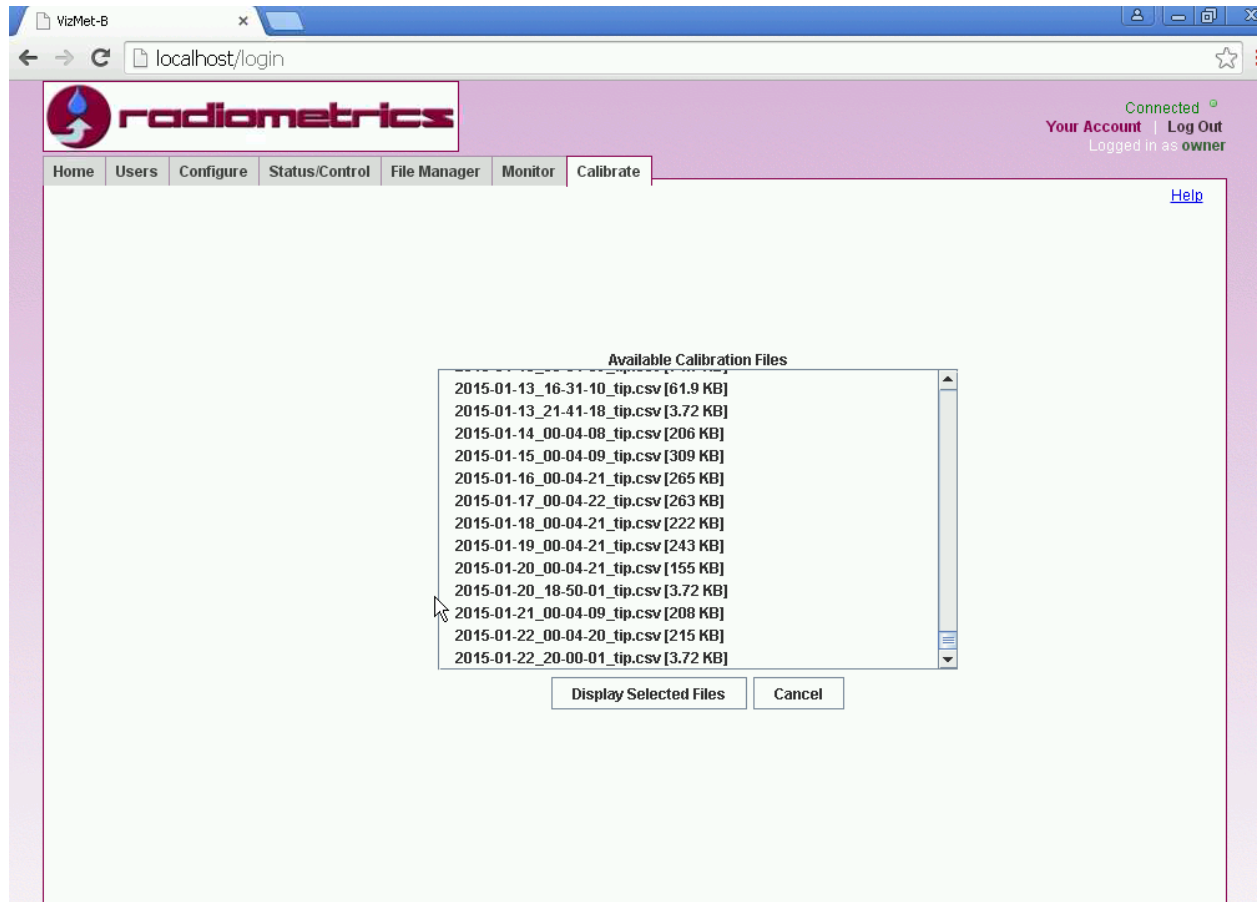
Figure B-14. Calibration file dates

    If the currently running procedure uses either the cal21 command or the tip21.rmc macro (typical), and a tip.csv file for today's date is located in the operational directory but is not listed in the **Available Calibration Files** screen, the Java cache must be cleared, as described below.

4. Clearing the Java cache
    a. Go to the computer's Control Panel and select Java.
    b. Select the **General** tab in the Java control panel.
    c. In the Temporary Internet Files section, click the **Settings** button.
    d. In the Temporary Files Setting screen, click the **Delete Files** button.

> e. In the Delete Files and Applications screen, ensure all 3 boxes are checked, and click **OK**.
> f. Return to VizMet-B.
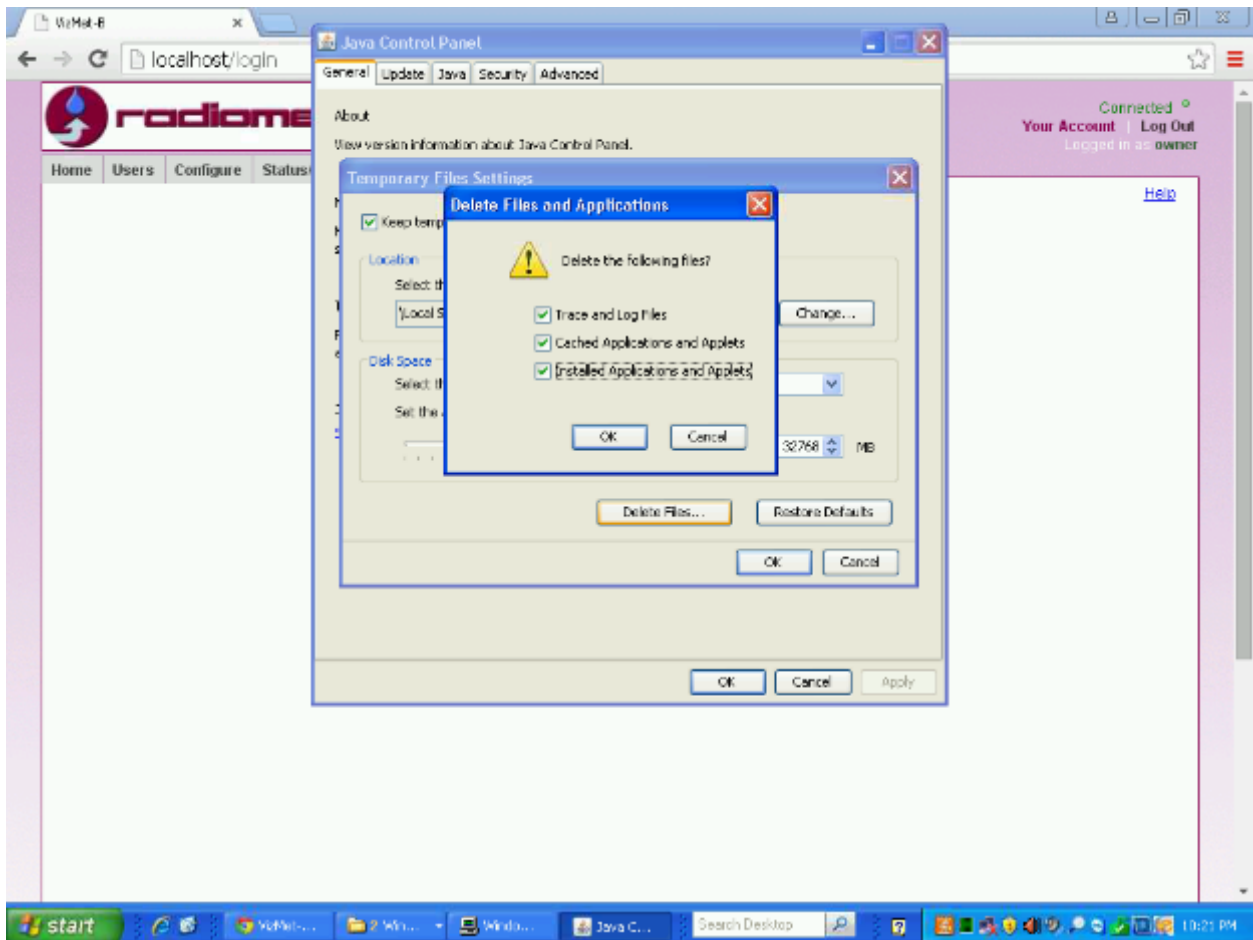
Figure B-15. Clearing the Java cache

> g. Close and restart the Internet browser.
> h. Log back into VizMet-B and return to the **Available Calibration Files** screen (**Steps 1-3**).

Now you should see the most recent .tip files from the operational directory.

5. Select a fairly recent day (up to the last week if possible) with a file that is large (≥100 KB)[1] compared to the file sizes of other days.
6. When you have highlighted your selected day, click the **Display Selected File** button.

---

[1] Files of 3.7 KB indicate files with header and no data. If you find many of files of this size, contact Radiometrics.
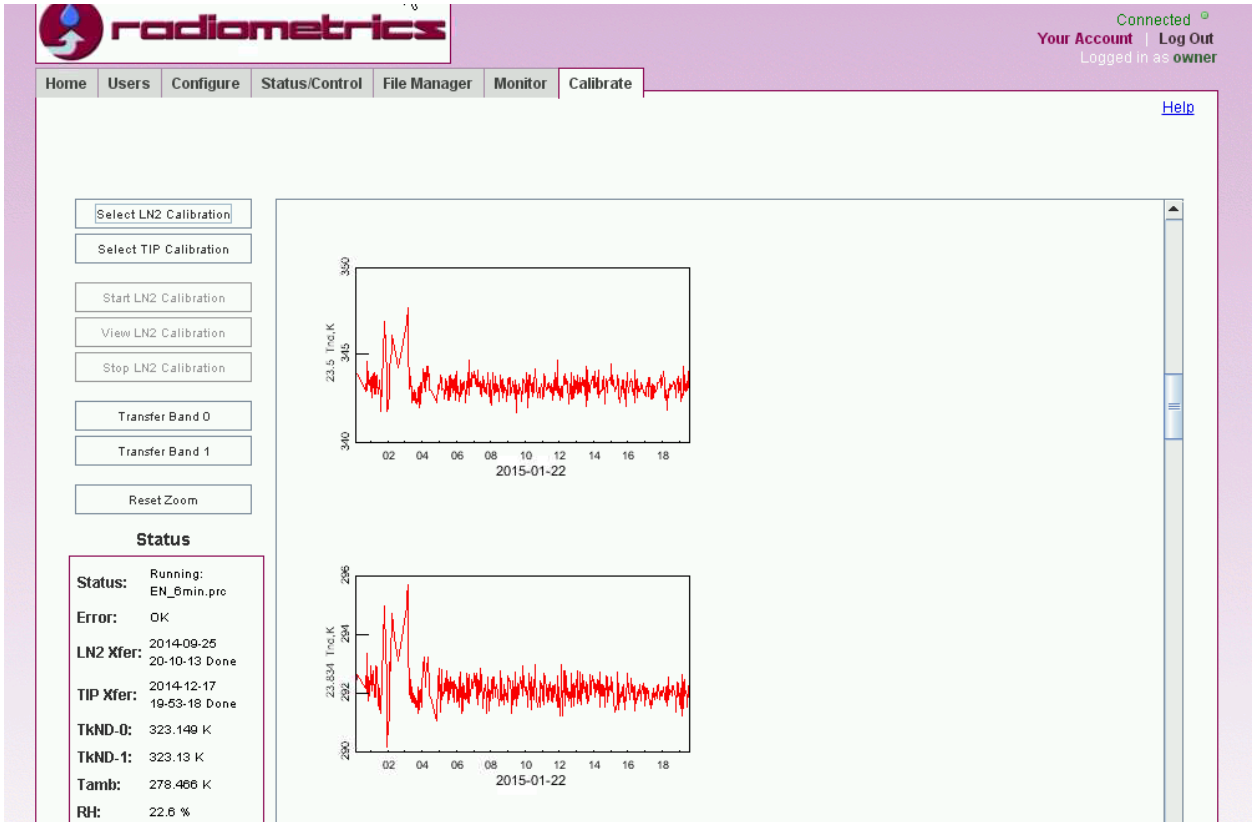
Figure B-16. Example of TIP data

Figure B-16 shows tip data for 2 of the 21 channels in the K-band. Scroll down in the TIP display box to view the rest of the data. Much like the LN2 calibrations, you want to select data that has a range (in the y-axis) of +/- 3K and has a near-zero average slope (Figure B-17).
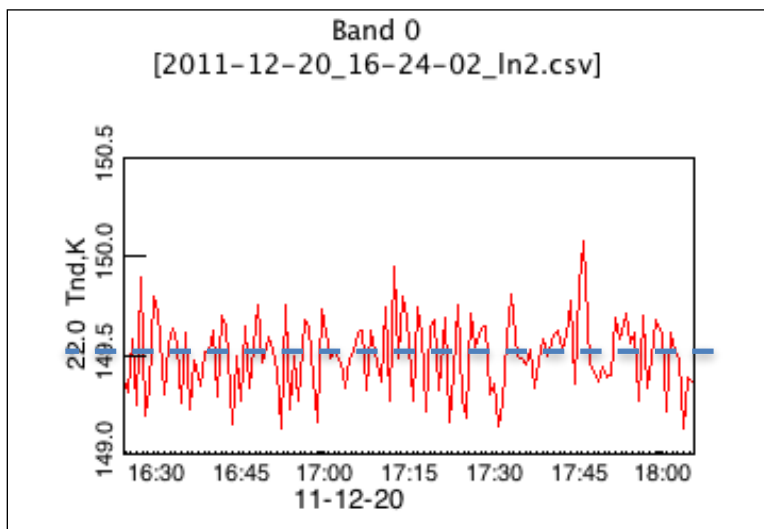
Figure B-17. Imaginary line "averaged" through noise diode temperature

You can select the amount of data that is used for the calibration by clicking and dragging a box around the desired data (Figure B-18).
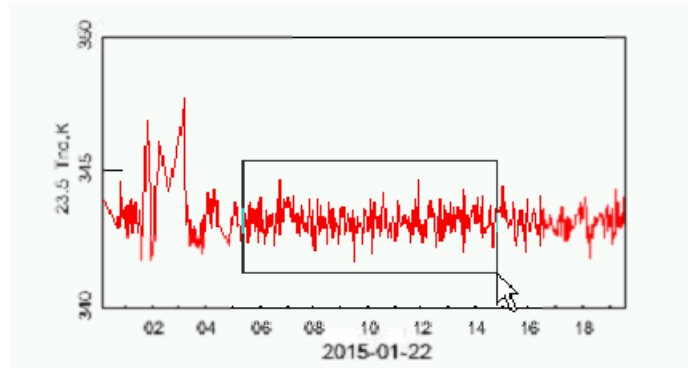
Figure B-18. Selecting desired data

After all channels are viewed and data is selected to specification, click the **Transfer Band 0** button on the left side of the screen (Figure B-19).

Ensure that today's time and date is posted in the TIP Xfer section in the bottom left of the screen as seen in Figure B-19.

Figure B-19. TIP transfer screen

VIII.   Uninstalling VizMet-B from Windows 7

General Information

The VizMet-B software may on rare occasion become corrupted. This problem is often the cause of 'Server Not Ready' errors. Radiometrics Customer Service may direct uninstalling and reinstalling VizMet-B, in such cases.

Overview

The following information describes how to properly uninstall VizMet-B 3.1xx from a Windows 7 ("Win 7") control computer for an MP-xx00A series radiometer. The VizMet-B uninstall will remove several small applications on the destination computer. VizMet-B 3.1xx utilizes Java, Ruby, Ruby on Rails, and SQLite3 to operate the Web server, its maintenance scripts and graphic display. These applications will all be uninstalled, so that they may be configured in the re-install.

Preparation

Backup the operational directory. Navigate:

c:\sites\radiometrics-vizmetb\operational

Copy the operational folder someplace safe, such as another location/drive or the desktop, so you can use the files after the re-install.

<div style="border:2px solid red">

WARNING!
All data will be lost unless you perform a backup!

</div>

Procedure

1. Navigate:

Start > Control Panel > Programs and Features > VizMetB

2. Right-click VizMetB, and select **Uninstall**.
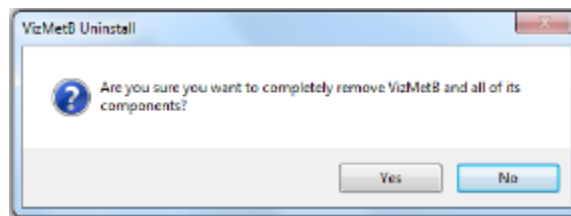
Figure B-20. Uninstalling the VizMet-B program

3. Click **Yes**.

4. Navigate:

Start > Control Panel > Programs and Features > Java 7 Update xx

5. Right-click Java 7 Update xx, and select **Uninstall**.
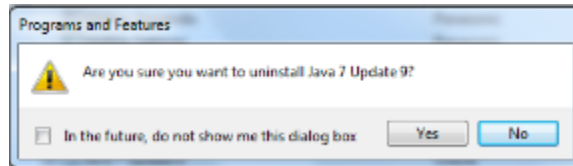
Figure B-21. Uninstalling the Java 7 Updatexx program

6. Click **Yes**.

7. Navigate:

Start > Computer > Local Disk
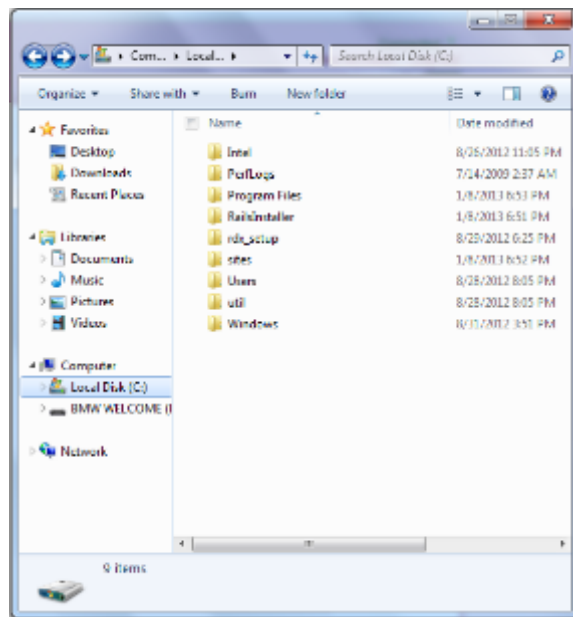
Figure B-22. Navigating to the local disk

8. Right-click the RailsInstaller folder and select **Delete**.
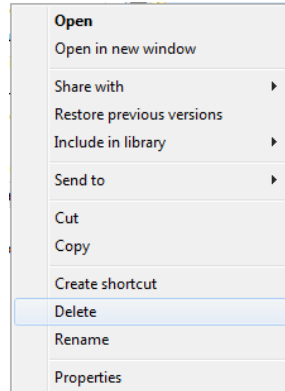
Figure B-23. Selecting the Delete option

A screen checks your decision.
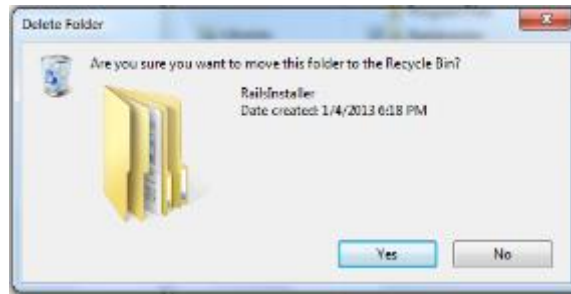
Figure B-24. Deciding to delete the RailsInstaller folder

9. Click **Yes**.

10. Still in the Local Disk, right-click the **sites** folder.
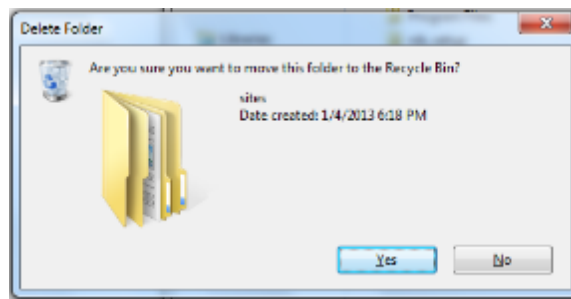
Figure B-25. Deciding to delete the sites folder

11. Click **Yes**.
    If the computer does not allow you to delete the sites folder, delete it after step 12.

12. Restart the computer.

13. Proceed with the following instructions for installing VizMet-B into a Windows 7 environment.

IX.   VizMet-B Installation for Windows 7

General Information

VizMet-B is an optional browser-based control and display software for the Radiometrics MP-Series Microwave Profiling Radiometers (MP-3000A, MP-2500A, and MP-1500A). VizMet-B turns the radiometer Control Computer into a powerful web server, providing interactive access to the instrument from any remote computer connected by LAN or the Internet without installing any special software on the remote computer. VizMet-B uses Ruby and Ruby On Rails technology to enable any modern Windows, Mac, UNIX, or LINUX computer to connect (via LAN or Internet) to the radiometer control computer and display the Graphical User Interface (GUI). Remote computers only require a browser (e.g., Firefox, Opera, or Safari) and Java to display graphics. The VizMet-B color GUI simplifies and automates radiometer configuration, control calibration and monitoring.

Overview

The following information describes how to properly install VizMet-B on a Windows control computer for an MP-xx00A series radiometer. The VizMet-B application installer will install several small applications on the destination computer. These applications are required for the MP-3000A radiometer normal operation.

VizMet-B utilizes Java, Ruby, Ruby on Rails, and SQLite3 to operate the Web server, its maintenance scripts and graphic display. These applications will all be installed and configured to run in the c:\sites directory.

Customers will receive the VizMet-B installers via one of two methods:
- A mailed CD or USB flash drive
- An Internet connection, such as Dropbox

The installer should review the entire instruction set **before** attempting to complete the procedure.

Important Note
User requires Administrator rights (name and password) on the control computer.

Special Requirements:
- Windows System
- 500 Mb of memory

Preparation
1. User requires Administrator rights (name and password) on the control computer.
2. Users must reset their User Account Control settings. Navigate:

   Control Panel > User Accounts > Change User Account Control settings
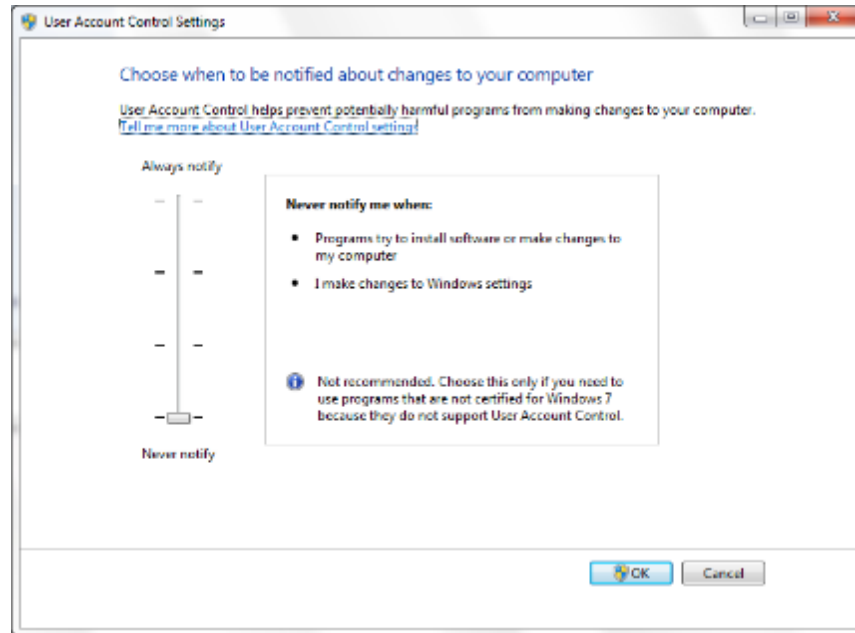
Figure B-26. Resetting UAC notification setting

There, users will change the notification setting to **Never notify**.

3. Users must change their computer's sleep settings to **Never**. Navigate:

Control Panel > Power Options > Change when the computer sleeps

There, users can edit plan settings to **Never**.

Procedure

1. **Run as administrator**. Right-click the VizMet-B icon to select **Run as administrator**.

2. Ensure that the setup wizard specifies version 3.1.1217 (or later) and click **Next**.
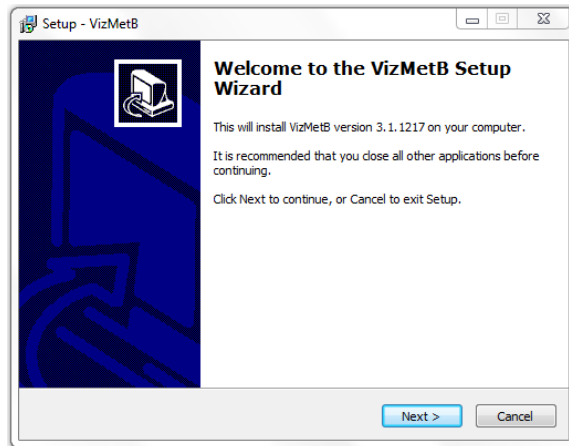
Figure B-27. Setup wizard welcome screen

3. Click **Next** to specify the (default) web server port of 80.
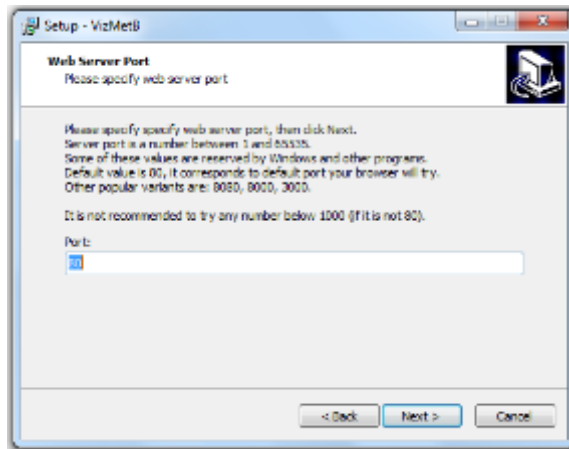
Figure B-28. Web server port

4. Click **Next** to install the program to the default directory.
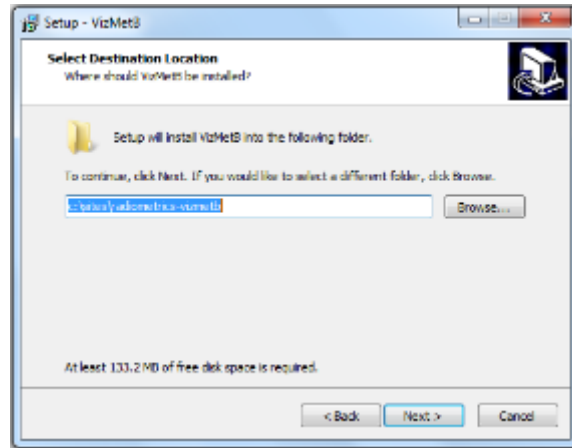
Figure B-29. Setup install location

5. Click **Next** to select *Radiometrics* as the default folder where to install the shortcuts.
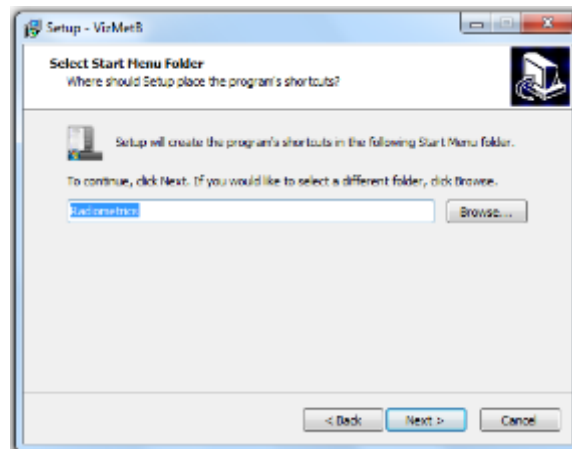
Figure B-30. Setup shortcuts location

6. Review the settings and click **Install**.
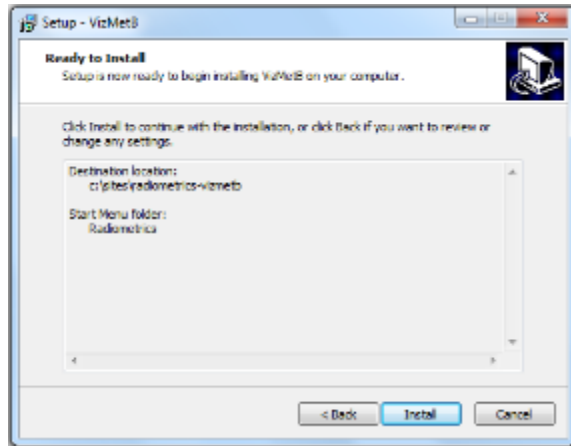
Figure B-31. Setup ready to install

The VizMet-B files install:
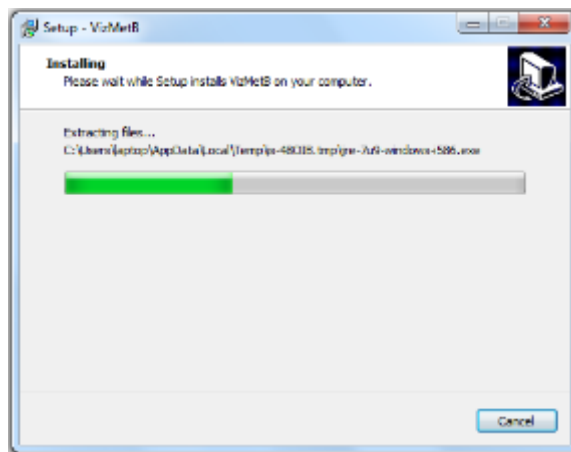
Figure B-32. Installing

Sometimes, this can take a couple minutes. And the setup may continue in the background, even though the setup appears to be finished.
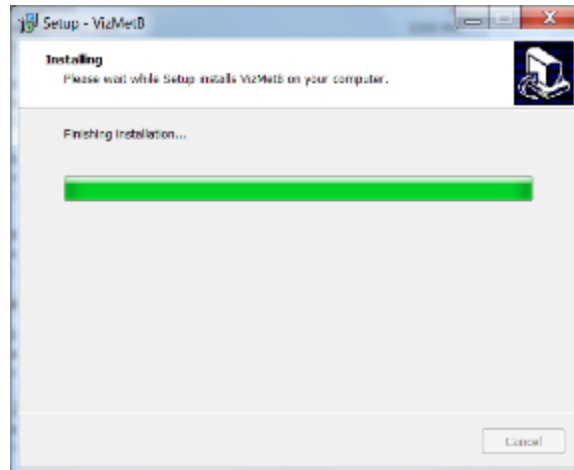
Figure B-33. Setup continuing in background

When complete, the **RailsInstaller** setup starts.

Figure B-34. RailsInstaller setup

7. Click **Next**.
8. Review and accept the license agreement, and click **Next**.
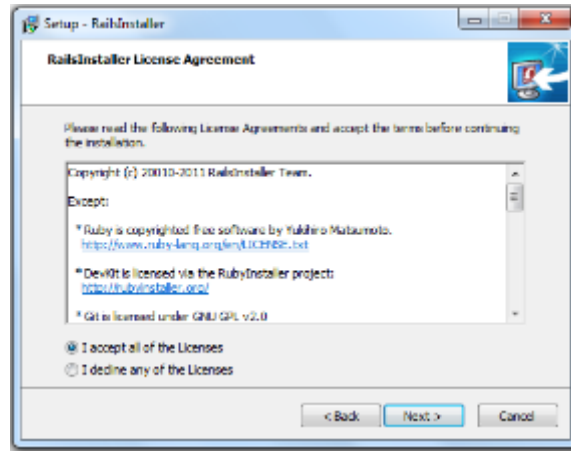
Figure B-35. License agreement

9. Click **Install** to select the default *RailsInstaller* installation destination. (Both check boxes should be checked.)
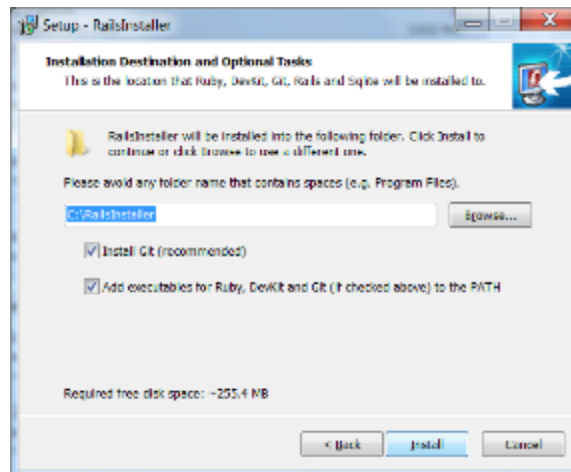
Figure B-36. Installation location

The files will install for a few minutes.
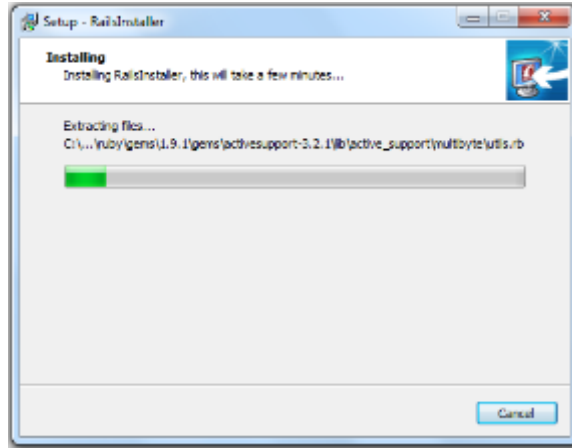
Figure B-37. Files installing

When installation is complete, a RailsInstaller window appears.

10. Leave the configuration box checked, and click **Finish** to complete the setup wizard.

Figure B-38. Completing the setup

A command window appears with a prompt.

Figure B-39. Command prompts (left) and disappearing shell window (right)

11. Click the **Close** button (X), or type **exit** and press **Enter**.

12. Click **Yes** when the prompt window asks if you need Java.
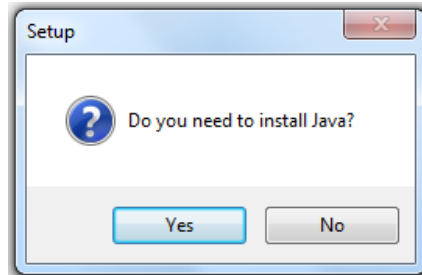
Figure B-40. Starting Java setup

13. Click **OK** when a prompt window tells you what version of Java it will install.
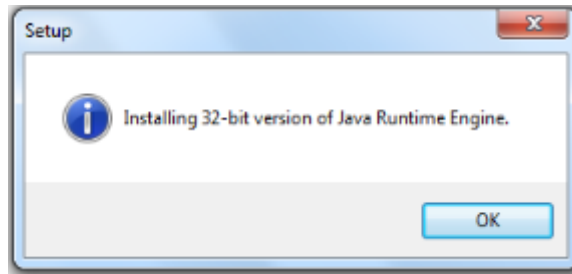
Figure B-41. Notice of Java version

14. Click **Install>** when the Java installer setup appears.

Figure B-42. Java setup

The installation status window appears.

Figure B-43. Java installation status

After Java finishes installing, a success notification appears.

Figure B-44. Success notification

15. Click **Close**.

16. If the computer has an Internet connection, a browser will open to the Java website. Close the browser.

17. When the setup indicates that installation is finished, click **OK**.
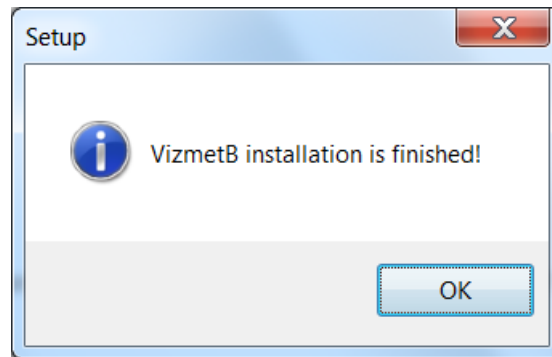
Figure B-45. Setup finished

18. Decide when to restart the computer, and click **Finish**.
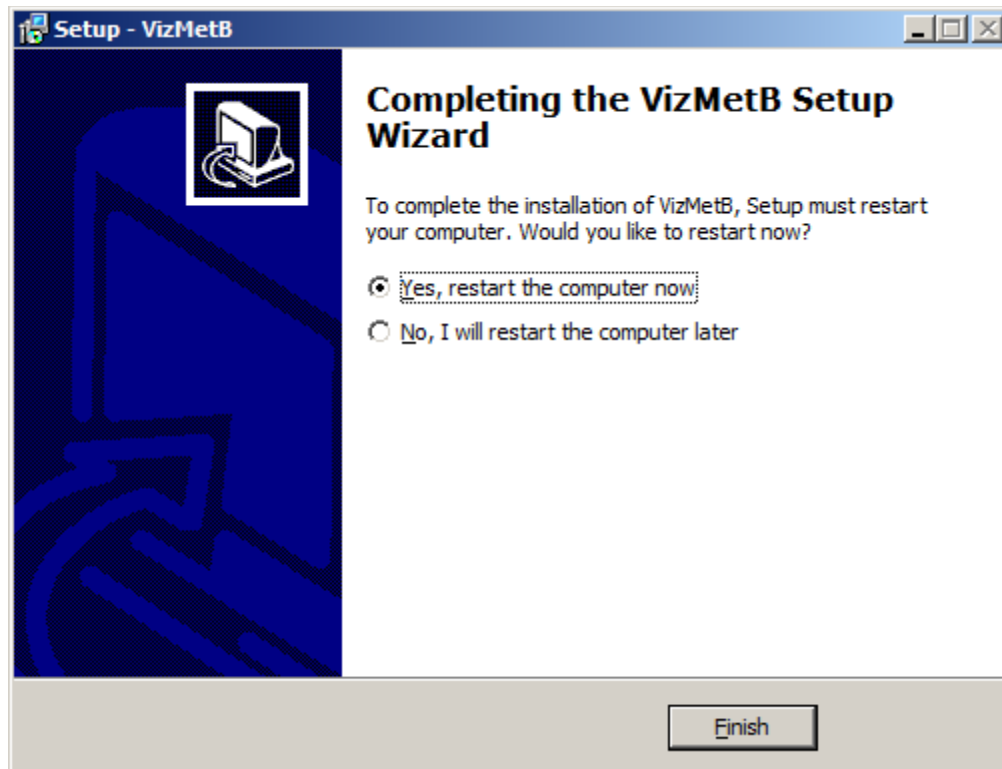
Figure B-46. Notice of completion

19. Restart the computer.

20. Navigate:

c:\sites\radiometrics-vizmetb\operational

21. Select all files in the operational folder and delete them.

Name	Date modified	Type ▲	Size
ln2cal.exe	8/7/2010 2:59 AM	Application	873 KB
mp.exe	4/2/2012 8:42 PM	Application	1,688 KB
tipcal.exe	1/26/2008 1:20 AM	Application	445 KB
mp.cfg	5/11/2012 10:36 PM	CFG File	14 KB
account_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
calibration_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
configuration_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
control_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
filesystem_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
main_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB
monitor_help.html	4/15/2012 10:50 PM	Chrome HTML Docu…	1 KB

Delete Multiple Items

Are you sure you want to move these 11 items to the Recycle Bin?

Yes   No

Figure B-47. Deleting all items from the operational folder

22. Copy the backed up data and configuration files into the operational folder.

Summary

The installation should now be complete. The system should come up, be ready, and be connected to the radiometer. To test this, open a web browser and, if not already showing, direct it to: http://localhost.

Please contact Radiometrics Customer Service for additional information.
Main line: 303-449-9192   Fax: 303-786-9343
supportmwr@radiometrics.com
www.radiometrics.com

X. Confirming VizMet-B Scheduled Tasks in Windows 7

If it seems that scheduled tasks are not functioning properly, it may be necessary to check them. To check Scheduled tasks in Windows 7, open the Windows Control Panel "Task Scheduler." Refer to Figure B-48.

Navigate:

**Start > All Programs > Accessories > System Tools >
Task Scheduler > Task Scheduler Library**
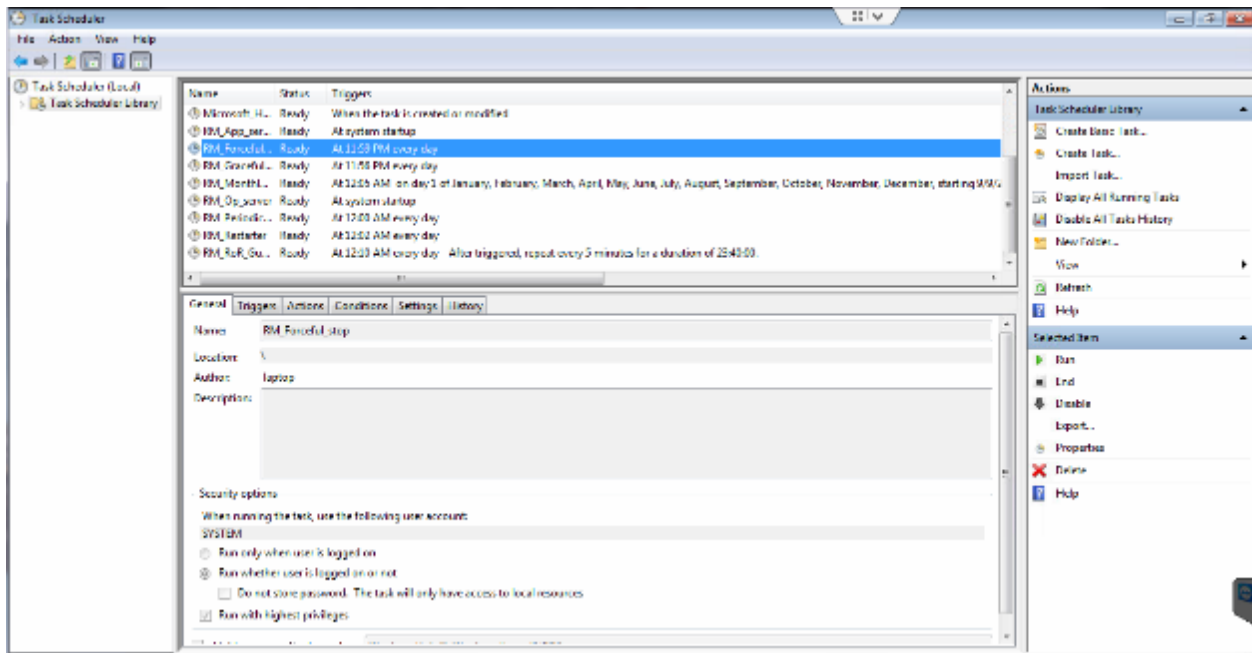
Figure B-48. Navigating to Windows Task Scheduler

The following list of scheduled tasks should appear (Table B-1). If any scheduled tasks are missing, you must uninstall VizMet-B (section VIII) and then re-install VizMet-B (section IX).

Table B-1. Task files

Task	Task operation	Time of Operation
RM_App_server	Runs the appserver Ruby script (.rb) for system startup.	With system startup
RM_Forceful_stop	Runs the forceful_stop Ruby script (.rb) for an immediate stop, even in mid-procedure.	11:59 pm daily
RM_Graceful_stop	Runs the graceful_stop Ruby script (.rb) for normal stopping.	11:56 pm daily
RM_Monthly_archiver	Runs the monthly_archiver Ruby script (.rb) to put the month's data into a zip file for alternative storage.	First day of month, 12:05 am
RM_Op_server	Runs the operational_server Ruby script (.rb) for task system startup.	With system startup
RM_Restarter	Runs the restarter Ruby script (.rb) to control the radiometer restart and resumes whatever task was halted.	Restarts at 12:00 AM (UTC)
RM_Periodic_Cleanup	Runs the periodic_cleanup Ruby scripts (.rb) to clean the CPU.	12:00 AM (UTC)

XI.   Instructions for Configuring Java for VizMet-B

Java frequently requires updates. Beginning with Java *Version 7*, *Update 51*, the VizMet-B **Monitor** and **Calibrate** tabs may not function properly. This bulletin provides instructions for configuring the Java control panel, so that VizMet-B operates normally.

While running VizMet-B, using the **Monitor** and **Calibrate** tabs may bring the following error message.
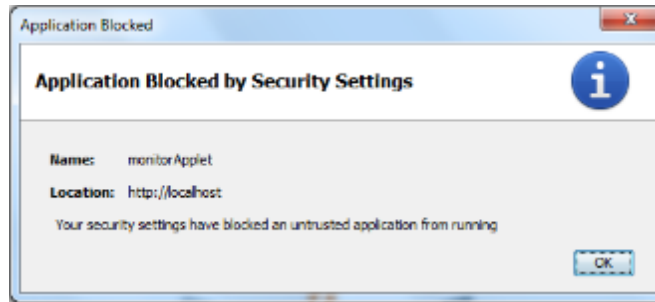
Figure B-49. Security settings message

If this happens, implement the following procedure.

Procedure

1. Navigate to the Windows **Start** button, and type **java** into the **Search programs and files** entry screen (Figure B-50).

    Alternatively, navigate:

Start > Control Panel > Java
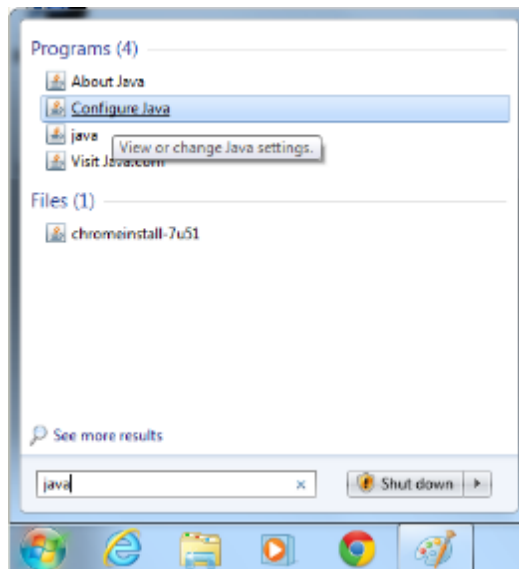
Figure B-50. Searching for Java control panel

2. In the Java Control Panel, click the **Security** tab, and change the Security Level from **High** to **Medium** (Figure B-51).
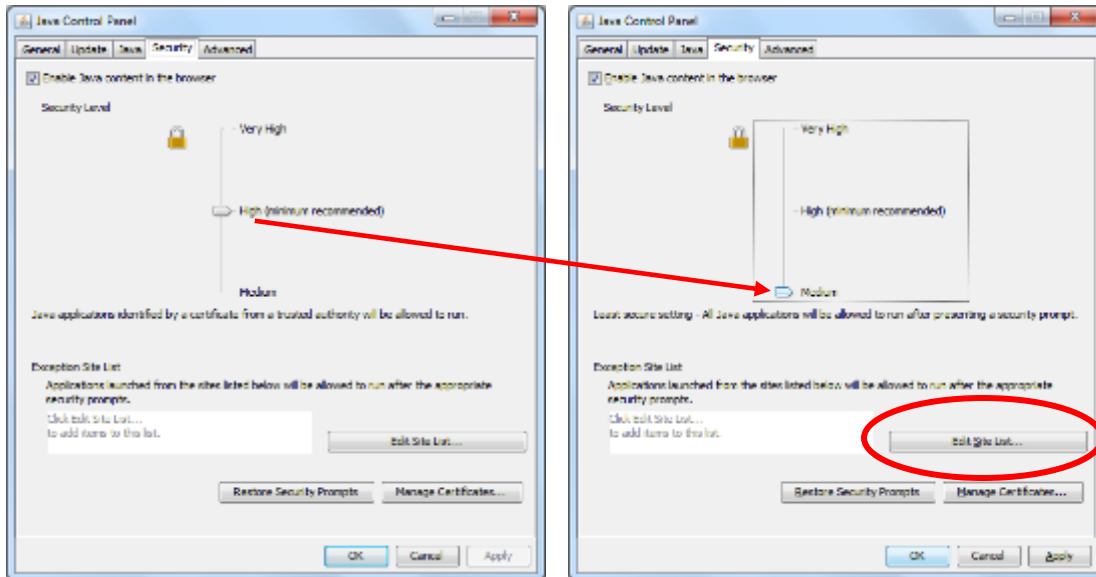
Figure B-51. Changing the security level setting

3. Click the **Edit Site List** button (encircled in red above).
    The **Exception Site List** window appears.

4. Click the **Add** button to add an item to the list. The Location text field appears.

5. Enter `http://localhost` into the text field, and click **OK**.
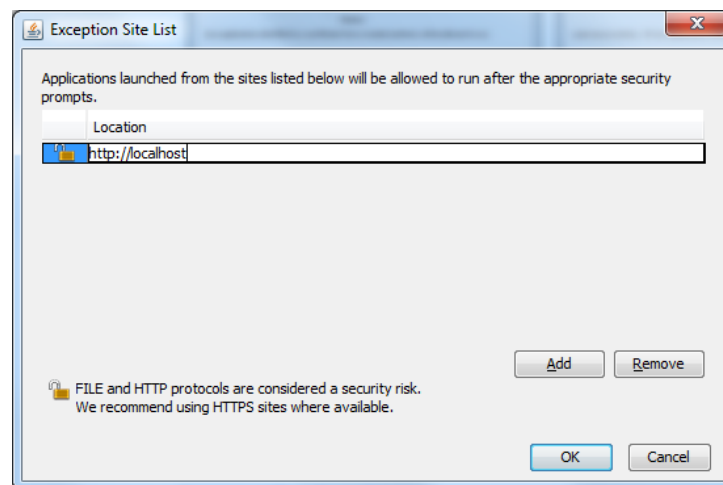
Figure B-52. Exception site list and text field

6. Restart the browser to refresh.
    The application should no longer be blocked.

Appendix C: Radiometer Calibrations

C.1   Calibrating Radiometrics MP-xx00A Radiometers with Liquid Nitrogen (LN2)

<p style="text-align:center; color:red">Safety Considerations</p>

Liquid Nitrogen (LN2) is extremely cold. It can cause severe burns to the human body, particularly to the skin and eyes. To avoid the risk of a cryogenic burn, LN2 should always be handled with care and respect. Handlers should wear appropriate protective clothing, gloves and goggles.

Handlers must also take precautions to ensure adequate ventilation. The gas is not toxic, but at high concentrations, it reduces the available oxygen in the air.

Disconnect the Azimuth drive (if installed) prior to placing the Cryogenic Target on the radiometer to avoid potential LN2 spills resulting from the azimuth drive moving.

To calibrate the profiling radiometer, use two "microwave targets" (microwave loads) of known temperature:

- A built-in ambient-temperature Black Body Target
- An external Cryogenic Target filled with 15 liters of liquid nitrogen (LN2)

C.1.1 Using the Cryogenic Target

When LN2 is placed in a Cryogenic Target containing microwave absorber Figure C-1, the target brightness temperature will be that of boiling LN2 (-195° C).
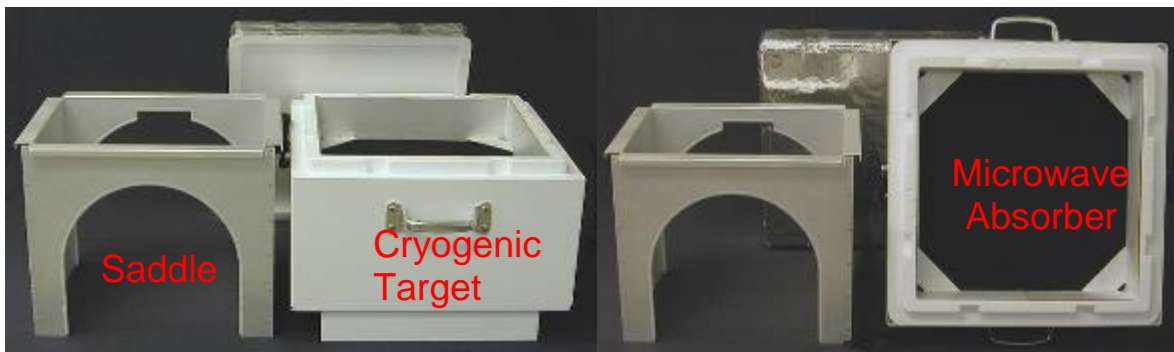
Figure C-1. Cryogenic Target for calibrating microwave-profiling radiometers

The LN2 calibration procedure points the radiometer internal mirror to alternately view the ambient temperature Black Body Target and the Cryogenic Target (refer to Section 2 of the **Operator's Manual** for additional information on the radiometer antenna pointing mechanism).

When a calibration is performed, the Cryogenic Target is placed on top of the radiometer, above the Radome as shown in Figure C-2. Instructions for proper placement of the Saddle and Cryogenic Target are given below.

Figure C-2. Radiometer with Saddle and Cryogenic Target in place

The Saddle is used to position the Cryogenic Target above the radiometer Radome. It also forms a wave guide that serves to minimize extraneous microwave emissions (warm bias) reaching the antenna. The radiometer "views the target" through a Radiometrics-patented microwave transparent window in the bottom of the target.

Note that one end of the Saddle has a notch that fits over the rain sense board on the Superblower, when properly installed. The Saddle is designed so that the front cut out fits over the Superblower and the rear cut out fits against the hood immediately behind the Radome. When properly installed, the Saddle fits securely to the radiometer with no gaps between the Saddle and the hood (except at the bottom of the Saddle) as shown below in Figure C-3.

Figure C-3. Saddle for Cryogenic Target, properly seated

Safety Considerations

Ensure proper LN2 handling safety by filling the Cryogenic Target while it is sitting on the ground, as shown Figure C-4. Use the safety strap to secure the lid to the target before placing the target on the Saddle.

NEVER attempt to pour LN2 into the target when it is on the radiometer.

NOTE:
Do not fill the Cryogenic Target until the operator is ready to start calibration. Load Cryogenic Target onto the Saddle from the front **only**.

Before starting an LN2 calibration:

1. Ensure the radiometer has been powered on for more than one hour to allow the microwave components to reach stable operating temperatures.

2. Stop the current procedure file if one is running.

3. Disconnect the Azimuth Positioner cable (if installed) from the radiometer.

4. Place the Saddle on the radiometer as described above, and place the filled Cryogenic Target on top of the Saddle.

Carefully pour LN2 into the Cryogenic Target until the LN2 level is at least one cm above the microwave absorber. Do not overfill – there should be at least a 2.5 cm (1 inch) gap between the LN2 and the top of the target.

Figure C-4. Proper method for safely pouring LN2 into the Cryogenic Target

Note that when the Cryogenic Target is properly seated on the Saddle, the two handles are oriented as shown in Figure C-2, and the target is level on the Saddle.

Additional information on LN2 availability, transport and storage is provided at the end of this appendix.

C.1.2 MP-Series Calibration Target and Maintenance

Over time, the calibration target can accumulate moisture, especially in humid environments. Such accumulation of water can compromise LN2 calibration. This bulletin provides instructions for inspecting the calibration target and removing moisture from it.

Radiometrics recommends turning the cryogenic target upside down immediately after use to avoid moisture condensation and seepage downward into the Styrofoam-Mylar membrane interface.

Note:
Depending on environmental humidity, consider performing LN2 calibrations indoors or at a time of day when humidity is lowest.

Procedure

1. Remove the Styrofoam from the calibration target body (Figure C-5).
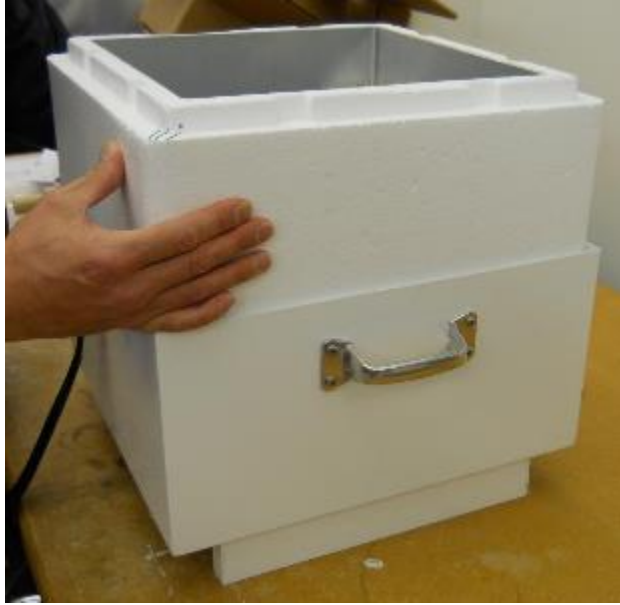
Figure C-5. Lifting Styrofoam box from the target body

2. Inspect the Styrofoam exterior for any cracks or damage, particularly the bottom side (Figure C-6).

Figure C-6. Inspecting Styrofoam

If Styrofoam is cracked or damaged, contact Radiometrics Corporation Customer Service, supportmwr@radiometrics.com or 303-449-9192.

3. Remove the metal frame and microwave-absorbing foam, being careful to not tear the protective liner (Figure C-7).

Protective liner   **Blue foam (top)**

Metal frame   **Black foam (bottom)**
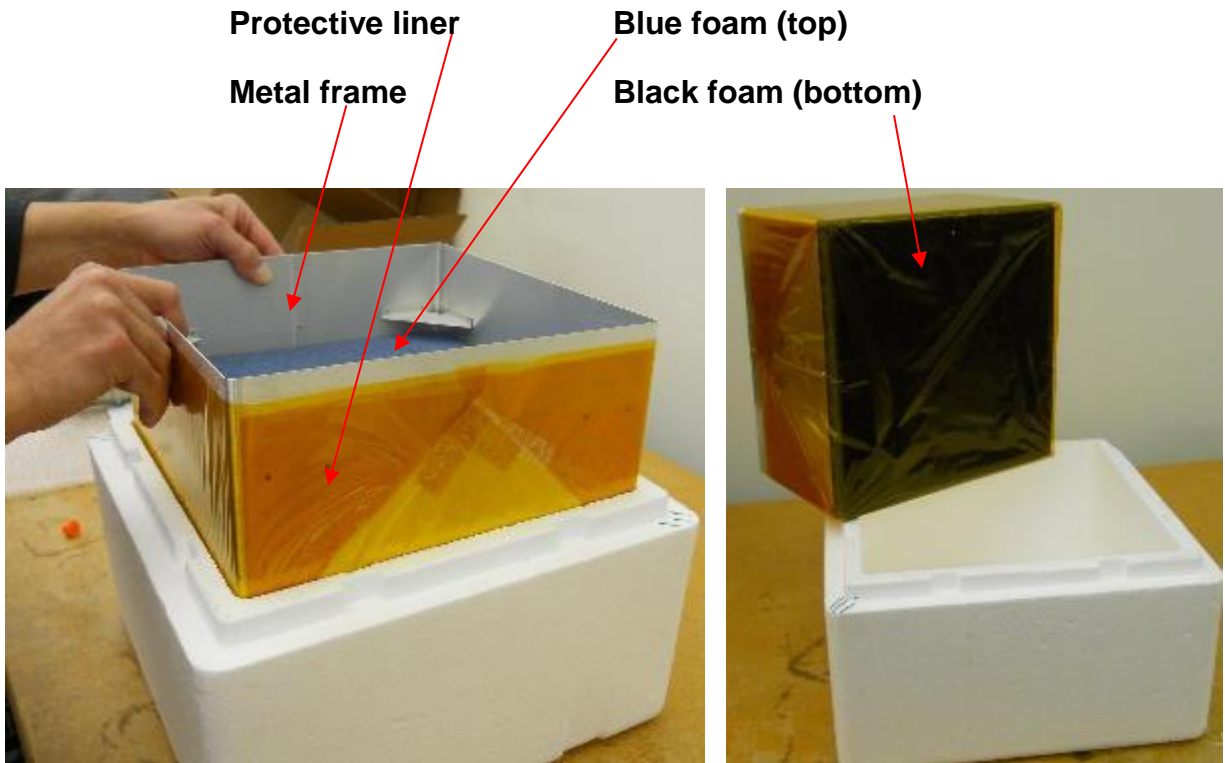
Figure C-7. Removing and inspecting microwave absorbing foam

If the protective liner is torn or damaged, contact Radiometrics Corporation Customer Service, supportmwr@radiometrics.com or 303-449-9192.

4. Inspect the bottom of the target for any moisture or condensation.

5. Carefully remove the protective liner and inspect the foam for moisture (Figure C-8).

Figure C-8. Untaping and removing protective liner

Both sides of the foam should be dry, not even moist. If the foam is not dry, drying may be achieved by the following:

- Placing the target foam in direct sunlight
- Using a hairdryer to dry the foam
- Placing the target foam in a warm, dry environment (not to exceed 45° C)

6. When finished examining or drying the foam, replace the protective liner around the metal frame and insert it back into the Styrofoam (Figure C-9).
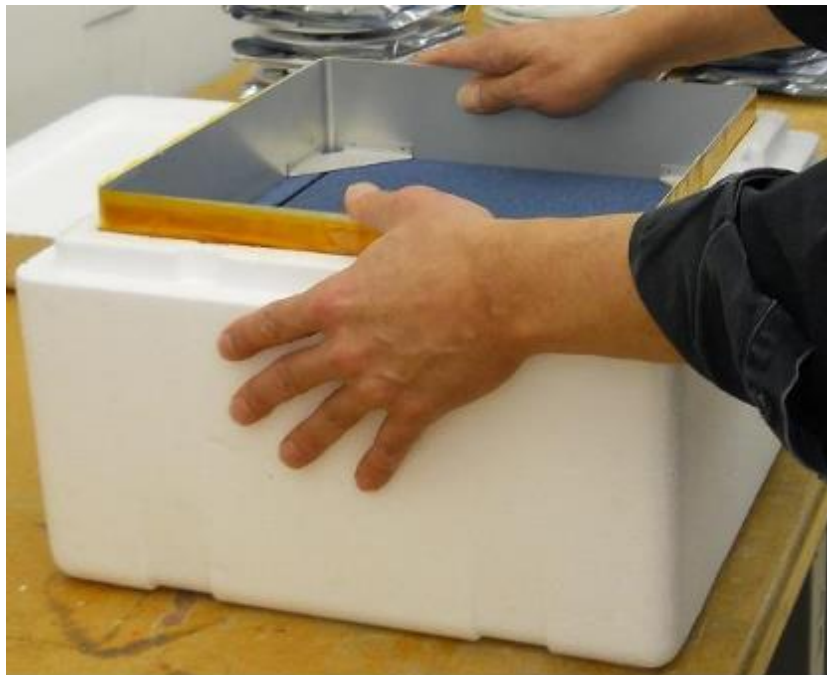
Figure C-9. Replacing the metal frame, target foam, and protective liner

C.1.3 Calibration procedure using the Single-User Interface:

Start the Operating Code in Manual Mode. Check the Tknd0 and Tknd1 temperatures for stability (323.15 K ± 0.1 K typical). When the instrument is ready, press **3** to start the LN2 Calibration. The calibration will begin automatically and continue until the user terminates it with a "**Q**" command (Quit).

Allow the calibration to continue for 1-2 hours, provided that dry conditions prevail, and condensation on the target is not observed or expected. If condensation on the bottom of the target is likely to form, due to high humidity (RH > 70%), then shorten the calibration to ~30 minutes.

During the calibration, the Operating Code will display the calibration elapsed time, and a graph of Tnd for each channel as shown in Figure C-10. LN2 calibration observations are logged in a file named **yyyy-mm-dd_hh-mm-ss_ln2.csv** where yyyy-mm-dd_hh-mm-ss is the start time of the calibration.
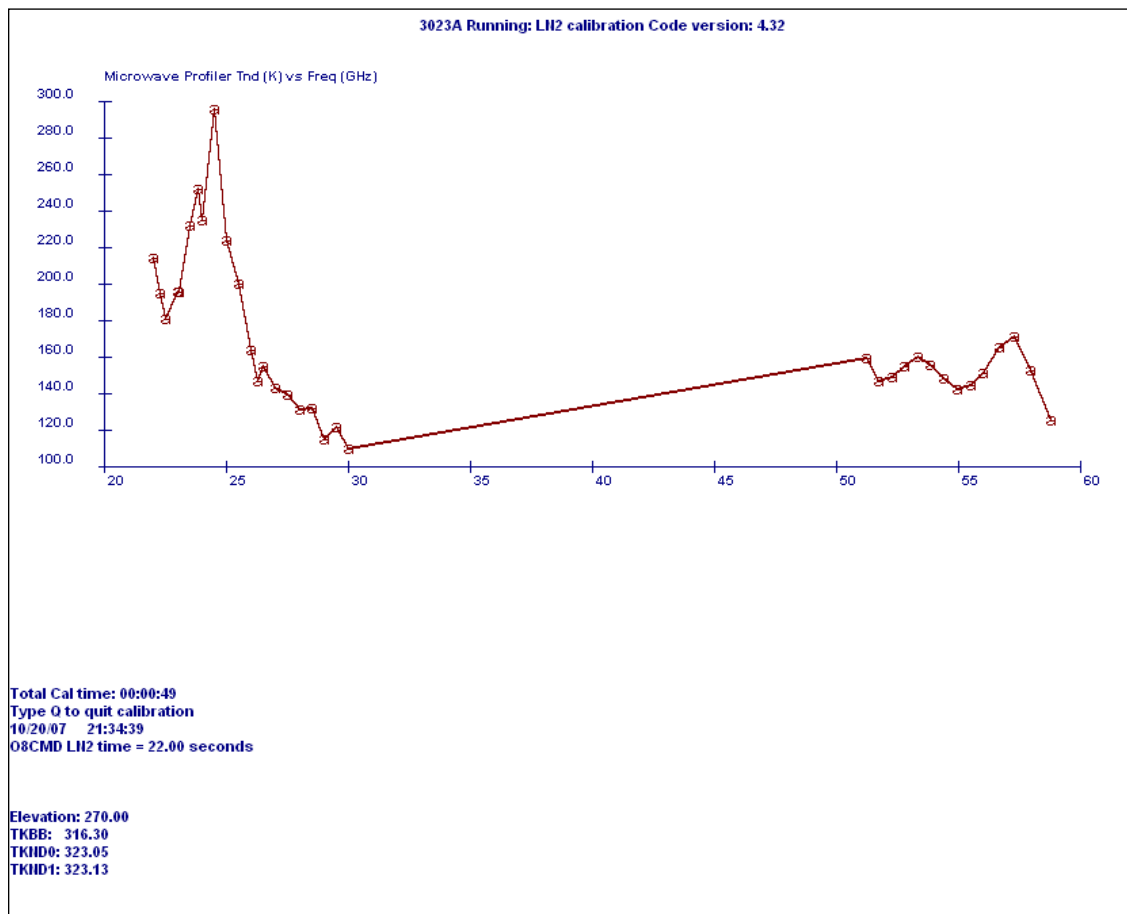
Figure C-10. LN2 calibration display

When the user presses the **Q** key to end the calibration, the Operating Code automatically computes new Tnd calibration values for all channels, and then terminates execution. The Operating Code writes these values to the operational configuration file

(mp.cfg) and archives the previous configuration file with a file name indicating the date/time corresponding to the time of the calibration (i.e., 2007-01-10_18-29-16.cfg). The Operating Code logs the date of the user LN2 calibration in the new configuration file in the Channel Calibration Block.

There are two methods to verify that the calibration completed correctly. First, the new and previous configuration files can be opened and inspected using the text editor **Notepad**. When closing these files, be sure **not** to "save changes." Unless the calibration follows repairs or changes to the hardware, the new values of alpha, dTdG and Tnd should be close to the previous values. Typically, alpha will be in the range of 0.9 to 1.1, dTdG will be in the range of -100,000 to -5,000,000, and Tnd will be within 1-2% of the value computed in the previous known good calibration. Departure from these guidelines may indicate a poor calibration.

Second, to verify that moisture did not corrupt the calibration, open and plot the values of Tnd in the LN2 calibration file (**yyyy-mm-dd_hh-mm-ss_ln2.csv).** If the values of Tnd are reasonably constant over time (only a small amount of random noise, but no long-term drift up or down), then the calibration is good. Figure C-11 shows a plot of the data in a typical MP-3000A LN2 calibration file. Notice that all channels remain constant over the duration of the calibration and the noise level is very low. These checks provide high confidence that a successful, accurate calibration has been achieved.
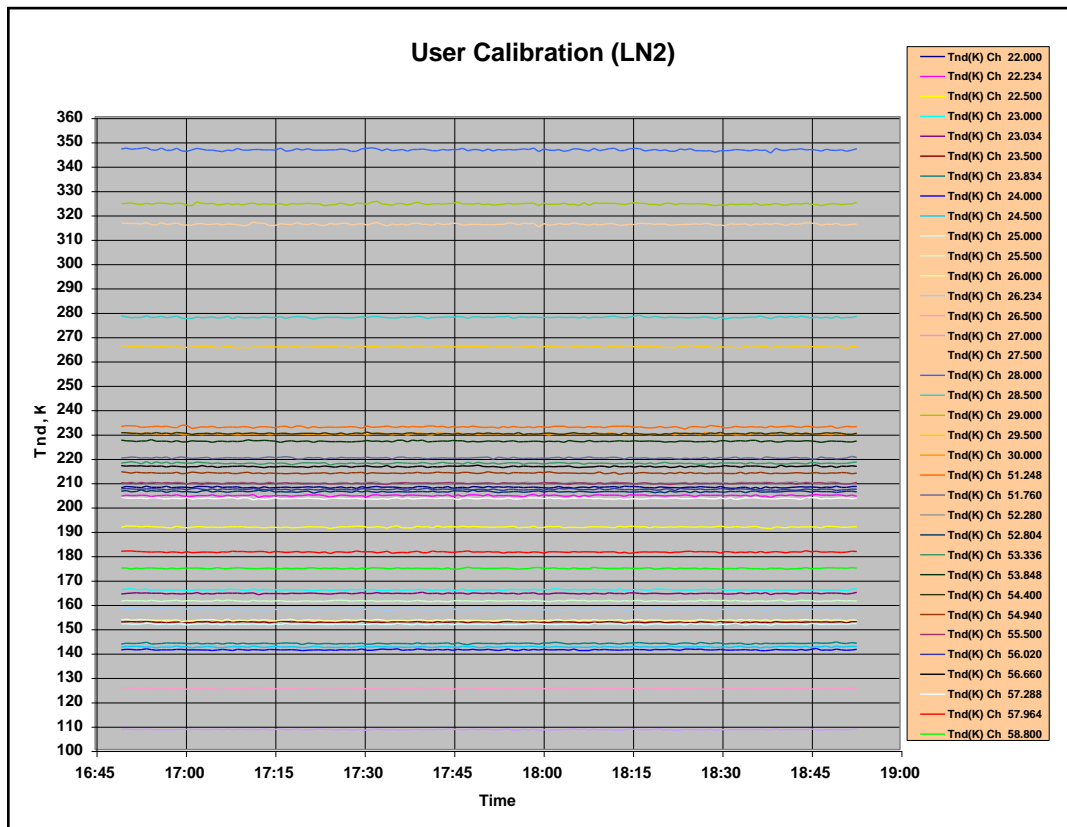
Figure C-11. Tnd values from user LN2 calibration (Excel plot)

C.1.4 LN2 Calibration Verification Test

While the target is still on the Saddle, the new calibration can be further verified by running a special procedure that alternates between views of the internal Black Body Target (elevation angle = 270 degrees) and the external cryogenic target (elevation angle = 90 degrees). It is best to start this verification immediately after the calibration completes, while the target still has sufficient LN2, and moisture has not started to build up on the bottom surface. A test Procedure File is included in the standard procedure list to do this. To run this procedure, restart the Operating Code (double click on the radiometer icon on the desk top), then select option **1** (Standard Procedure), then scroll to the Procedure File named B&L35.prc. Press **Return** to begin the verification procedure. Press **1** to select the Brightness Temperature Display. After a few observation cycles have completed, the display will begin showing the sky brightness temperature for all channels, switching back and forth between the internal ambient and external Cryogenic Targets.

If the calibration was successful, then the brightness temperatures for all channels should closely match the calculated values of the effective target temperature (typically, 77-80 K, depending on barometric pressure). If the target has not been moved on the Saddle, and the LN2 level has not dropped below the black absorbing foam in the target, then the average of the cryogenic target observation errors (observations minus effective target temperature) should be < 0.5 K. The average of the ambient target observation errors (target observation minus TkBB) should be < 0.5 K.

It is sufficient to observe the Brightness Temperature Display for a few cycles of the procedure to verify that all channels were calibrated reasonably well. However, to calculate the errors more precisely, allow the B&L35.prc procedure to run for approximately 1-2 hours, and then press **Q** to Quit. Open the new *level1* file in a spreadsheet or data analysis application to calculate the brightness temperature error (T_observed – T_target) for each record, and the average of the errors for each channel. Figure C-12, Figure C-13 and Figure C-14 show examples of the data from a post user cal B&L test. See Section 5 of the **Operator's Manual** for additional information on data files and data processing techniques.
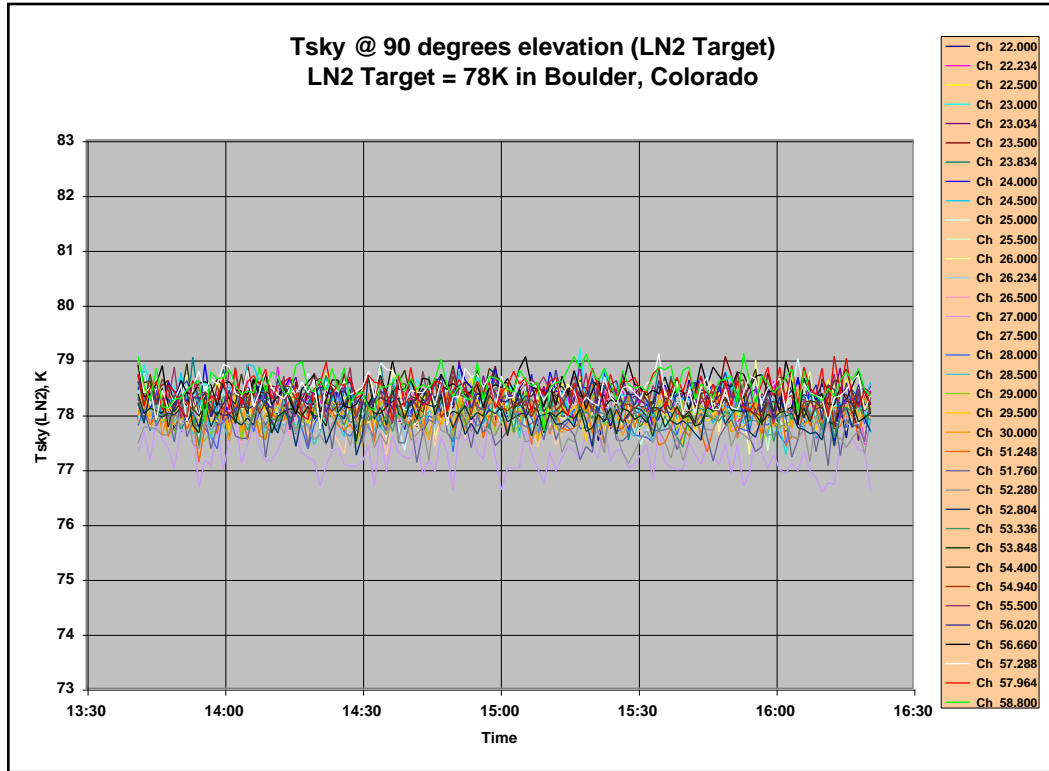
Figure C-12. Example of B&L Cryogenic Target for MP-3000A (Excel plot)
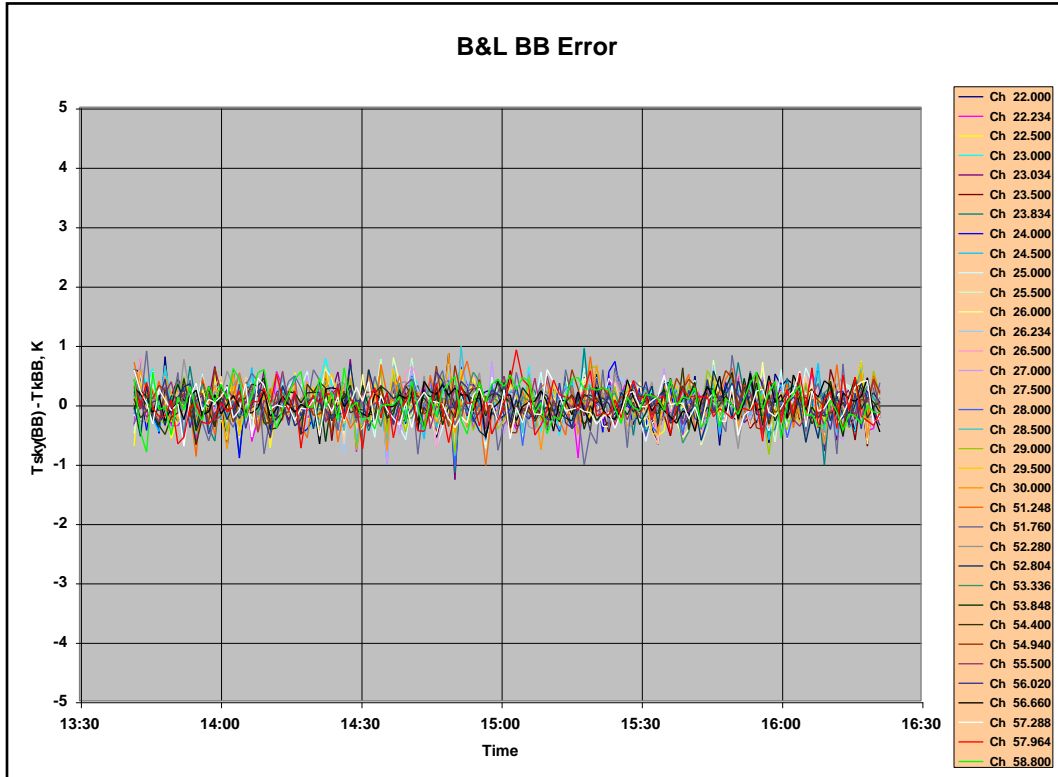
Figure C-13. Example of B&L temperature error for MP-3000A (Excel plot)
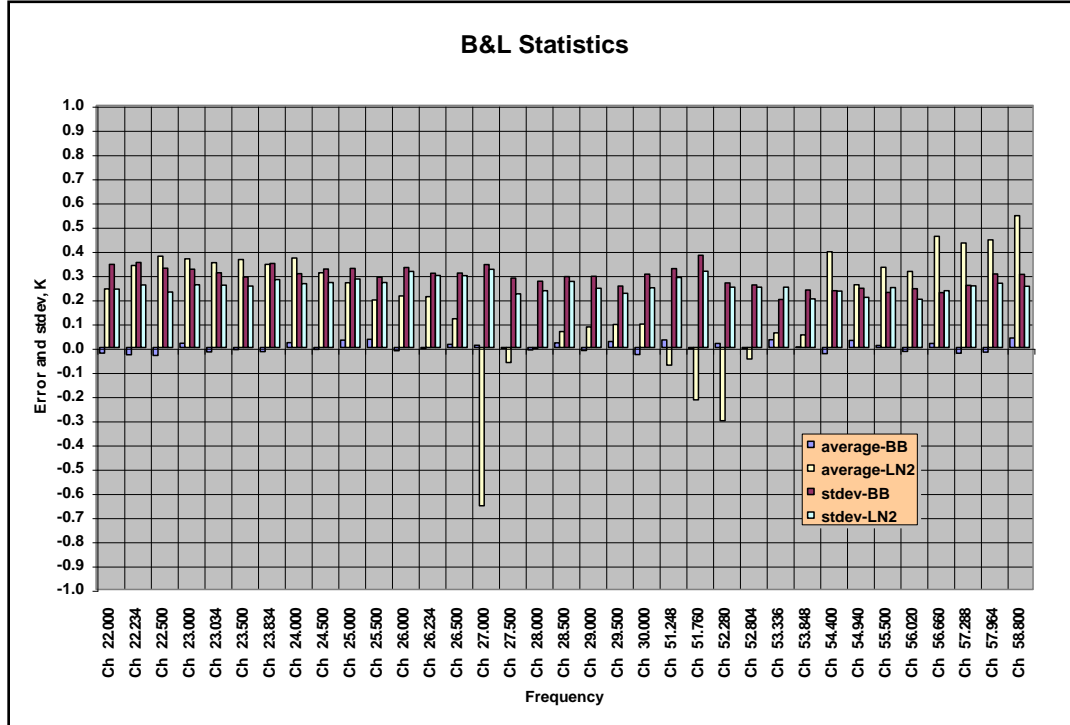
Figure C-14. Example of B&L statistics for MP-3000A (Excel plot)

C.1.5 LN2 availability, transport and storage

Nitrogen is the most abundant naturally occurring gas in the earth's atmosphere (78%). When we breathe, we breathe mostly nitrogen into our lungs. It is not toxic in normal concentrations. LN2 is used for many industrial and medical purposes. Because it is so abundant and nontoxic, it is relatively easy to manufacture and use. It is readily available from any industrial gas supplier. It is often available in limited quantities from local hospitals if there is no industrial gas supplier nearby.

LN2 is typically delivered from suppliers in large (160 liter) Dewars, as shown in Figure C-15. It can also be purchased in smaller quantities.

Figure C-15. Dewars used for storing and handling LN2

For short-term use, Dewars can be rented from many industrial gas suppliers. Dewars are also available for purchase from Radiometrics. Dewars can be used to transport LN2 and for short-term storage (typically less than 24 hours).

Figure C-16. Handling LN2: Filling Cryogenic Target (left)
Pouring residual LN2 into Dewar after calibration is finished (right)

Contact Radiometrics Customer Support for additional information on radiometer LN2 calibration.

C.2   Radiometer Calibration

There are seven parameters associated with every microwave channel that are individually calibrated to provide the highest level of accuracy over all operating conditions. The surface met sensors also contribute to the accuracy of level2 data

products. Most of the Profiling Radiometer parameters that require calibration remain stable for many years. All these parameters are calibrated at the factory, *over the full operating temperature range*, and normally require no user adjustment. The seven factory-calibrated parameters associated with each microwave channel are:

- alpha   linearity correction exponent
- dTdG   1/f noise suppression coefficient
- K1   zero order coefficient of Tnd temperature dependent correction
- K2   1st order coefficient of Tnd temperature dependent correction
- K3   2nd order coefficient of Tnd temperature dependent correction
- K4   3rd order coefficient of Tnd temperature dependent correction
- Tnd@290   effective Noise Diode Temperature at TkBB = 290K

These seven parameters are used to compute brightness temperature in accordance with the transfer function described in the Brightness Temperature Transfer Function section of **Appendix B**:.

The *effective* Noise Diode Temperature (Tnd) is very stable, but it should be recalibrated after transport of the instrument, and once every 3-6 months to ensure the highest accuracy. Two methods are available to calibrate the Noise Diode "secondary gain standards" using "primary standards." The "LN2 calibration method" is applicable to just the V-Band in all models. The "TIP calibration method" is only applicable to the relatively transparent K band channels MP-3000A model. Each method has strengths and weaknesses described below.

The instrument configuration file (mp.cfg) contains all the settings and parameters associated with the operation of an instrument. The Channel Calibration Block in the configuration file contains the factory calibration data unique to each instrument RF subsystem. It contains data for each V-Band channel in the receiver (51-59 GHz as applicable). Figure C-17 shows an example of a typical Channel Calibration Block for the 14-channel MP-3000A.

CALIBRATION BLOCK:
2006/08/11 22:22:39   Date of last factory LN2 calibration
2007/03/02 18:03:04   Date of last user LN2 calibration
.90   :target tolerance for ln2 cal
35   :number of frequencies

Frequency	MRT	Window Coef	ND drive	IF Atten	alpha	dtdg	k1	k2	k3	k4	Tnd
22.000	275.0	0.000140	22000	18.5	1.0564	-8.89E+05	-7.51E+00	3.85E-02	-6.53E-05	7.53E-08	173.250
22.234	275.0	0.000140	22000	18.5	1.0437	-7.98E+05	-7.01E+00	1.01E-01	-5.24E-04	8.98E-07	155.140
22.500	275.0	0.000140	22000	18.5	1.0360	-7.91E+05	-2.16E+02	2.24E+00	-7.80E-03	9.12E-06	151.090
23.000	275.7	0.000140	22000	18.5	1.0218	-6.50E+05	-5.21E+01	4.92E-01	-1.61E-03	1.84E-06	144.360
23.034	275.7	0.000140	22000	18.5	1.0238	-6.53E+05	3.69E+01	-4.37E-01	1.61E-03	-1.87E-06	143.920
23.500	275.7	0.000140	22000	18.5	1.0181	-6.02E+05	-5.47E+01	5.40E-01	-1.85E-03	2.19E-06	159.320
23.834	276.0	0.000150	22000	18.5	1.0154	-6.53E+05	6.07E+00	-6.93E-02	1.81E-04	-4.79E-08	151.430
24.000	275.7	0.000140	22000	18.5	1.0184	-6.73E+05	-2.47E+01	2.18E-01	-6.54E-04	6.73E-07	145.060
24.500	275.7	0.000140	22000	18.5	1.0394	-7.63E+05	-3.68E+01	3.33E-01	-1.03E-03	1.11E-06	184.940
25.000	275.4	0.000164	22000	18.5	1.0519	-9.40E+05	1.33E+01	-1.59E-01	5.32E-04	-4.93E-07	141.490
25.500	275.4	0.000164	22000	18.5	1.0592	-9.36E+05	-1.28E+01	9.46E-02	-3.20E-04	5.06E-07	158.860
26.000	275.4	0.000164	22000	18.5	1.0712	-8.00E+05	3.20E+01	-3.60E-01	1.27E-03	-1.43E-06	137.290
26.234	275.4	0.000164	22000	18.5	1.0723	-7.10E+05	5.81E+01	-6.20E-01	2.13E-03	-2.34E-06	143.860
26.500	275.4	0.000164	22000	18.5	1.0685	-6.58E+05	-2.13E+01	2.44E-01	-1.02E-03	1.47E-06	168.390
27.000	275.4	0.000164	22000	18.5	1.0629	-5.87E+05	3.20E+01	-3.88E-01	1.46E-03	-1.72E-06	160.490
27.500	275.4	0.000164	22000	18.5	1.0537	-5.80E+05	-8.01E+01	8.46E-01	-3.08E-03	3.85E-06	187.580
28.000	275.4	0.000164	22000	18.5	1.0444	-6.39E+05	-3.38E+01	2.80E-01	-7.93E-04	7.88E-07	210.880
28.500	274.1	0.000200	22000	18.5	1.0407	-7.84E+05	-1.29E+02	1.32E+00	-4.64E-03	5.55E-06	213.600
29.000	274.1	0.000200	22000	18.5	1.0397	-1.11E+06	-1.22E+02	1.28E+00	-4.54E-03	5.45E-06	234.990
29.500	274.1	0.000200	22000	18.5	1.0347	-9.59E+05	-1.94E+02	2.03E+00	-7.11E-03	8.37E-06	189.640
30.000	274.1	0.000200	22000	18.5	1.0315	-1.21E+06	-8.08E+01	8.77E-01	-3.26E-03	4.11E-06	184.890
51.248	274.1	0.000200	45000	20.5	1.0500	-8.56E+05	2.01E+01	-1.14E-01	-2.95E-05	6.37E-07	181.500
51.760	274.1	0.000200	45000	20.5	1.0570	-1.28E+06	-4.52E+01	4.90E-01	-1.86E-03	2.46E-06	192.020
52.280	274.1	0.000200	45000	20.5	1.0590	-7.56E+05	-1.90E+01	2.16E-01	-9.93E-04	1.64E-06	226.450
52.804	274.1	0.000200	45000	20.5	1.0566	-7.62E+05	-4.76E+01	4.01E-01	-1.25E-03	1.50E-06	218.580
53.336	274.1	0.000200	45000	20.5	1.0512	-7.13E+05	-8.90E+01	9.01E-01	-3.22E-03	4.04E-06	165.690
53.848	274.1	0.000200	45000	20.5	1.0507	-7.36E+05	-1.06E+02	1.07E+00	-3.63E-03	4.20E-06	136.590
54.400	274.1	0.000200	45000	20.5	1.0547	-7.46E+05	-6.54E+00	3.19E-02	-8.58E-05	1.84E-07	138.260
54.940	274.1	0.000200	45000	20.5	1.0634	-9.87E+05	7.78E+01	-7.68E-01	2.40E-03	-2.32E-06	158.610
55.500	274.1	0.000200	45000	20.5	1.0600	-9.65E+05	-2.63E+01	2.35E-01	-8.44E-04	1.20E-06	168.490
56.020	274.1	0.000200	45000	20.5	1.0504	-7.68E+05	1.76E+01	-2.27E-01	8.05E-04	-8.00E-07	143.740
56.660	274.1	0.000200	45000	20.5	1.0603	-8.32E+05	-2.10E+01	2.05E-01	-7.54E-04	1.02E-06	118.280
57.288	274.1	0.000200	45000	20.5	1.0680	-1.06E+06	-4.07E+01	4.01E-01	-1.39E-03	1.70E-06	124.880
57.964	274.1	0.000200	45000	20.5	1.0545	-8.97E+05	9.25E+00	-8.72E-02	1.71E-04	6.80E-08	146.690
58.800	274.1	0.000200	45000	20.5	1.0574	-1.28E+06	-3.17E+01	2.92E-01	-9.91E-04	1.25E-06	138.380

Figure C-17. Example of Channel Block Configuration File

C.3   LN2 Calibration

The Noise Diodes in Profiling Radiometers are used as the "secondary standard" to measure *system gain* in each channel for each observation. When enabled, they add a calibrated increase to the brightness temperature. When the value of Tnd is not known, it can be determined by observing two targets of known temperature. In the fully automated method used by Radiometrics, the built in ambient Black Body target provides one target of known temperature for the calibration, and an external Cryogenic Target, filled with LN2, provides the second. The ambient target physical temperature (TkBB) is measured by the instrument each time a **Trcvcal** command is executed. The

effective target temperature of the Cryogenic Target is calculated automatically by the Operating Code.

Contributions to Cold Target Temperature

Temperature contributions to the patented cryogenic calibration target developed by Radiometrics include:

- insertion loss of the polystyrene insulation that contains the target and absorbing foam (the insertion loss contributes to temperature by re-radiating to the same extent as the absorption)

- reflection from the polystyrene-LN2 interface

- reflection from the surface of the absorbing foam that is immersed in LN2

- elevation in boiling point of the LN2 due to the hydrostatic pressure associated with the depth

These contributions are automatically taken into account by the automated calibration through coefficients held in the configuration file (mp.cfg).

The boiling point of LN2 (TLN2) is a weak function of ambient barometric pressure P:

TLN2(K) = 68.23+0.009037*P(mb)

The physical temperature of the LN2 target is determined by the local LN2 temperature. The hydrostatic load must therefore be added to the atmospheric pressure at the surface of the LN2. This hydrostatic pressure enhancement is about 1.2 mb/cm of depth. At a 20 cm depth of LN2, the temperature increase is about 0.22° K. The various components contributing to the effective Black Body temperature are summarized in Table C-1. An ambient temperature of 300° K and a target temperature of 77° K are assumed.

Table C-1. Typical contributions to Cryogenic Target Black Body temperature

Contribution	Amount
Insertion loss at 55 GHz of polystyrene containing LN2	0.26° K
Air-polystyrene interface reflection	0.002° K
Polystyrene-LN2 interface reflection	1.74° K
LN2-absorbing foam interface reflection	0.00° K
Increase in boiling point due to 20 cm hydrostatic column of LN2	0.22° K
Total contribution at 300° K ambient temperature	2.22° K

LN2 Calibration Precautions

When performing the LN2 calibration, a number of precautions must be observed:

- To achieve the best possible calibration accuracy, the bottom of the target must be clean and dry. The Profiling Radiometer "looks" through the target bottom. Any dirt, debris, or moisture on the bottom of the target will contribute an error to the effective target temperature. If necessary, the target should be cleaned with mild soap and water, and allowed to thoroughly dry before use.

- The Profiling Radiometer must be at its stable operating temperature. Thus, the Profiling Radiometer should be turned on for a period of at least 30 minutes before the calibration begins. It is always best if the instrument has been on for several hours. (It is not necessary for the software to be running.)

- When LN2 is in the target, the outside will eventually cool, and may reach the atmospheric dew point temperature. This may cause condensation on the outside bottom surface of the target, which causes error. Therefore, the target should not be filled until shortly before calibration begins. The Superblower will help to minimize condensation, as will performing the calibration on days when the humidity is low (dew point is depressed). The user LN2 calibration may not produce accurate results if the ambient RH > 70%.

- The calibration procedure should be allowed to continue for 1-2 hours to obtain a large number of observations, thereby reducing measurement noise.

WARNING!
Contact with LN2 can cause burns and skin damage — handle with care!

LN2 User Calibration Procedure

NOTE:
Be sure to disconnect the Azimuth drive prior to calibrating the radiometer with LN2. LN2's cold temperature could damage components of the Azimuth drive, if spillage were to occur.

TIP Calibrations

The use of an external Cryogenic Target is required to calibrate the Noise Diodes in 51-59 GHz receivers. However, because the zenith brightness temperature in the 22-30 GHz band are typically less than 50 K under clear skies, the 22-30 GHz receiver Noise Diode should be calibrated using a "TIP derived calibration." In this method, the Profiling Radiometer uses the atmosphere itself as a "cold target." By observing the brightness temperature of the sky at several elevation angles in rapid succession, the Profiling Radiometer can calculate an estimate of the 22-30 GHz Noise Diode temperatures. The 51-59 GHz Noise Diodes cannot be reliably calibrated using the TIP method due to the relatively small temperature difference observed between the built-in ambient Black Body target and some of the more opaque channels.

LN2 vs. TIP Calibrations: Strengths and Weaknesses

The LN2 and TIP calibration methods each have their own strengths and weaknesses. The following example will illustrate why the LN2 calibration method works best for the 51-59 GHz band, while the TIP method has certain advantages and is recommended for the 22-30 GHz band.

Assume for the purpose of this cryogenic calibration example that the ambient Black Body target is at 278 K, and there is no ambient target error. Then assume a cryogenic LN2 target at 78 K, but with a 2 K error. This effective LN2 target temperature error will produce a sky brightness temperature with a 1% gain error [2/(278-78)]. This manifests as a 2 K error for Tsky = 78 K, a 1 K error for Tsky = 178 K, but only 0.2 K error for Tsky = 258 K. Since most 51-59 GHz channels produce sky brightness temperatures much closer to ambient than the Cryogenic Target (78 K), a relatively large target error does not impact the 51-59 GHz channels as much as it would a 22-30 GHz channel, where the sky brightness temperature is sometimes less than 10 K. Thus, for a given effective LN2 target temperature error, the impact is generally much less in the 51-59 GHz channels than it is in the 22-30 GHz channels. Fortuitously, the TIP calibration method works best on the coldest radiometer channels, where the Cryogenic Target is weakest, and the Cryogenic Target works best for the warmest channels, where the TIP method breaks down.

Of course, the TIP calibration method also has error sources, but for 22-30 GHz, these errors can be managed to a level lower than the typical Cryogenic Target induced error. To obtain a high quality TIP calibration, make sure the Profiling Radiometer is level, and use a spreadsheet to select only data from observation periods when the atmosphere is very stable. This process will be described in the following procedure.

TIP Calibration Procedure

To calibrate the 22-30 GHz channels with the TIP method, use the following procedure:

1. Specify the elevation angles to be used in the TIP Configuration section of the configuration file (mp.cfg), if necessary. The default values (30, 45, 90, 135, 150 degrees) usually provide excellent results. In most cases, the use of complementary angles (i.e., 30 and 150) will provide the best results since they tend to compensate for instrument leveling error and atmospheric gradients.

2. Collect TIP data for at least a few hours during a time when the atmosphere is generally stable. A full day or more may be necessary at times and in areas where the atmosphere is rarely stable. If necessary, collect TIP data for several days to make sure a stable period is included. Select a Procedure File that includes frequent periodic **cal21** commands. The **cal21** command collects TIP calibrations on all 21 K band channels. The standard Procedure File xxx_zen_ret_tip.prc (where xxx is the site code) will produce alternating TIP calibrations, zenith observations and 26 input zenith NN retrievals. New TIP data

and the current operational values of Tnd can be viewed graphically in real-time by pressing the T key to check for differences.

3. Use VizMet-B to select and transfer TIP calibrations.

Surface Met Sensor Calibration

The Surface Met Sensors include ambient air temperature, relative humidity, barometric pressure, IRT, and rain. All Profiling Radiometers are delivered with the Met Sensors pre-calibrated at the factory, ready to use. This Section provides general information about the Met Sensors. For detailed information on the maintenance and calibration of these sensors, refer to **Section 6** of the **Operator's Manual**.

Temperature and Relative Humidity Sensor

Radiometrics Profiling Radiometers are fitted with a Rain Mitigation System consisting of the Superblower and the hydrophobic radome. The Superblower uses increased airflow, but no heater (as used in previous models) to keep the radome dry.[2] The Superblower incorporates an ambient air temperature and RH sensor in the air-inlet where unbiased ambient air is constantly flowing over the sensor. The Superblower assembly also shades the sensor from direct sun. The sunshade and continuous airflow ensure negligible bias due to solar radiation.

Figure C-18. Superblower with End Cover removed; sensor and filter

The sensor is factory calibrated to a high standard, and normally requires no field calibration. If the user has access to very high accuracy field standards for Tamb and RH, and wishes to adjust the sensor calibrations in the field, linear offset values may be entered in the configuration file (mp.cfg) in place of the default values (0.0) as follows:

+0.00   :Tamb correction

+0.00   :Rh correction

Offset values for Tamb and RH are *added* to the measured values. For example, if the temperature observed with a high quality standard (placed close to the inlet of the

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[2] Elimination of the heater eliminates one source of locally generated error in ambient temperature and RH measurements.

blower) is 0.2K higher than the air temperature recorded by the Profiling Radiometer, then an offset of +0.2 should be entered in the field provided for the Tamb offset in the mp.cfg file. Because the expected difference is normally very small, it may be necessary to average the data for 1-2 hours to obtain a meaningful estimate of the bias.

Barometric Pressure

Barometric pressure is measured with a solid-state transducer located inside the radiometer cabinet. The standard sensor is rated from 10 to 1300 mb. It is a factory replaceable unit module that is located on the frame.

There are no user-adjustable controls on the sensor.

Rain Sensor

The Rain Sensor is an analog device that measures conductivity across a grid of inter-digital, gold plated conductors etched on a conventional fiberglass circuit board. The analog output from the device varies approximately as shown in Figure C-19.

Rain Sensor Transfer Function
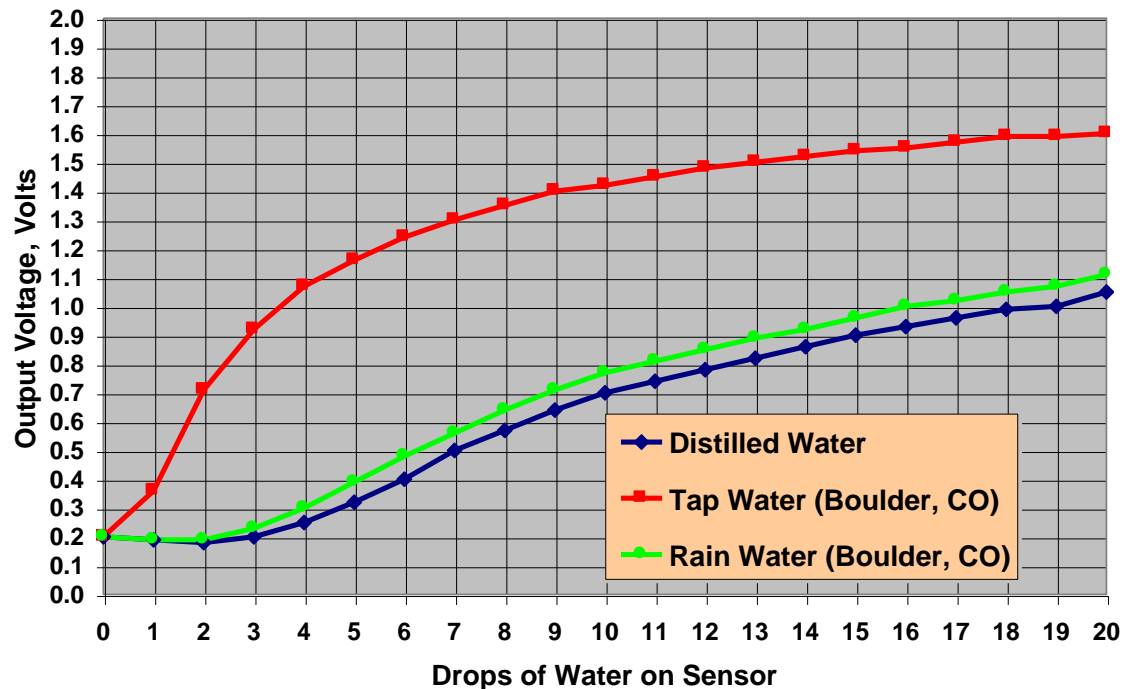
Figure C-19. Typical Rain Sensor transfer function

This sensor is used to provide a "Flag" for data that is potentially contaminated by some liquid water on the radome. It is not intended to provide rain rate or total rainfall information. A typical threshold setting of 0.8 volts, specified in the configuration file, is

used to "turn on" the Rain Flag (1 or 0) in the *level1* and *level2* data files. The Flag is also displayed on the Profile Graphs. The Flag can also be used to suppress TIP calibrations during rain (specified in mp.cfg). To observe the Rain Flag in *level1* data, the Profiling Radiometer must be executing a Procedure File containing **obs** commands.

Precise calibration of the rain sensor is not necessary. The basic function can be verified by dripping a few drops of water on the sensor. When Vrain > Rain Threshold (set in the configuration file), the *level1* Rain Flag = "1." Wiping the sensor dry should once again set the Rain Flag to "0." The threshold may be adjusted by opening the configuration file in Notepad and editing the threshold value in the TIP Configuration section. Depending on the sensitivity desired and mineral content of the rain, values between ~0.6 and 1.2 volts can be used. In Figure C-19, the difference between distilled water and domestic "tap water" illustrates how mineral content affects the sensitivity.

The Rain Sensor should be wiped clean with a non-abrasive cloth or paper towel as required to keep dirt and mineral deposits from accumulating.
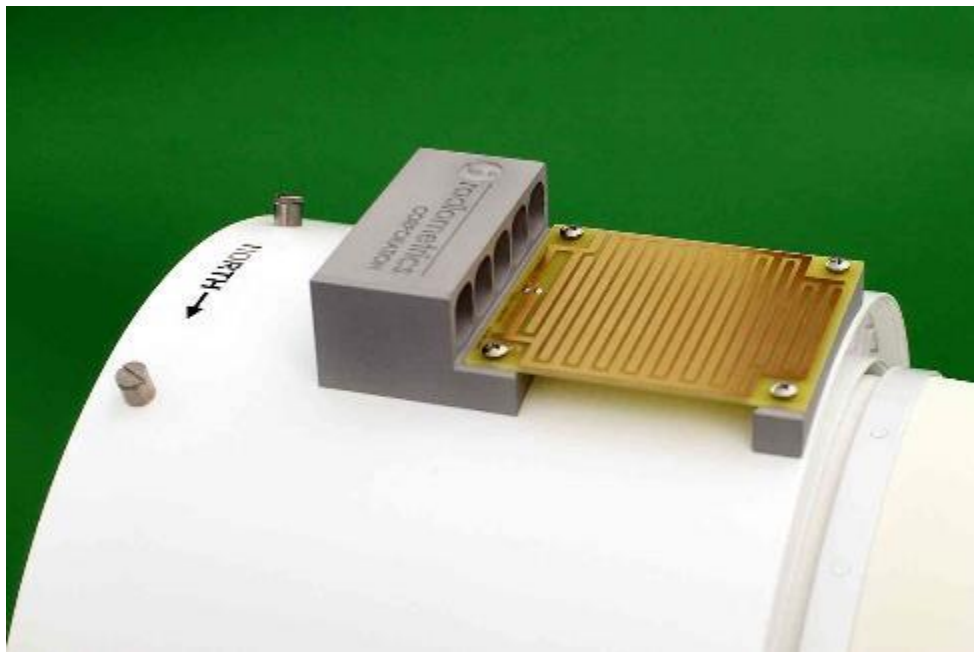
Figure C-20. Rain Sensor

Infrared Thermometer

When the KT-15 IRT is installed, it is mounted inside the cabinet, positioned to view the sky through a low-loss window in the Cabinet Hood. The IRT is connected to the MCM via the Interconnect PCB. Communication with the MCM is digital (RS232). The IRT is factory calibrated and normally requires no user calibration.
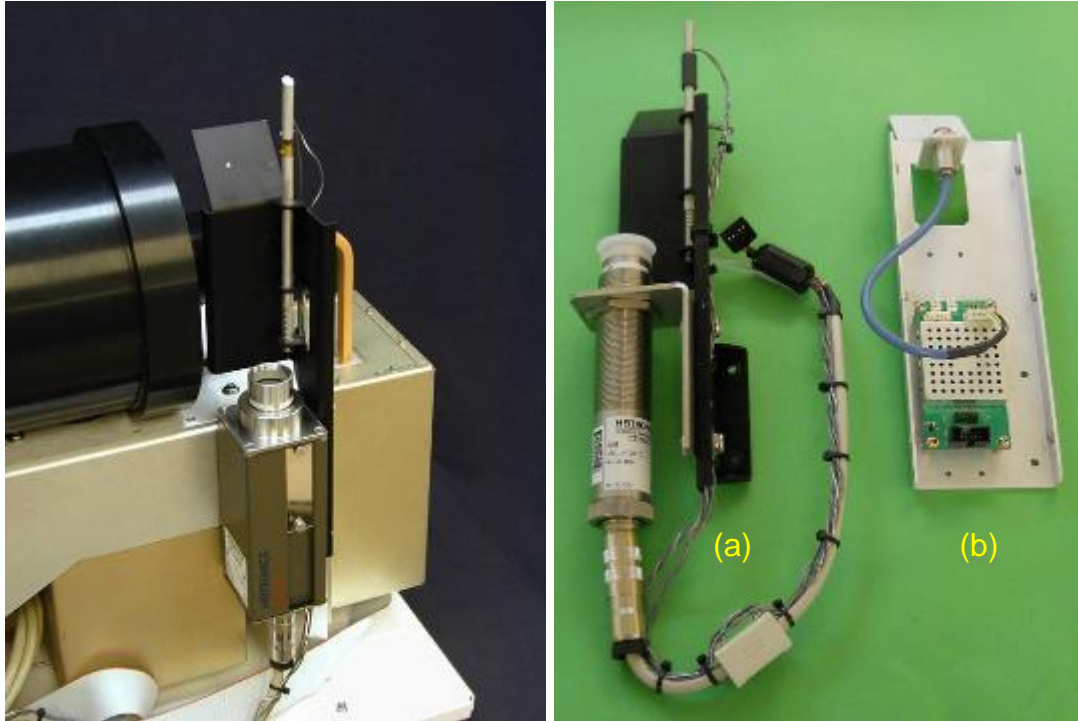
**Figure C-21. Left: KT-15 IRT Assembly; Right: Optional CT09 (a) and
MI-3 IRT (b) Assemblies**

Moving the IRT inside the radiometer cabinet has several major advantages over
externally mounted IRTs. Mounted inside, the KT-15 instrument is maintained in a
moisture free environment, thus eliminating corrosion damage to the lens and mirror
sometimes experienced on earlier radiometer models. In addition, the minimum
operating temperature is extended to –40C without the need for supplementary heaters.
The new digital interface provides a wider dynamic range and lower noise. The carbon-
coated window has a longer life than gold plated mirrors, and is easily field-replaceable
by simply unscrewing the old window and screwing on a new one.

To correct for the window loss and reflection errors, the IRT assembly includes two
temperature sensors. One measures the window physical temperature, and the other is
used to measure the temperature of a black body radiator positioned in the reflection
path. The IRT computes the true cloud base temperature using these physical
temperatures and factory-calibrated coefficients stored in the mp.cfg file.

Appendix D: Error Messages for A-Series Radiometers

Errors are reported in the level0 (lv0.csv) file, on the VizMet-B Status/Control tab. The most recent error also appears on-screen in the lower-left corner; the error will remain for the entire day.

In the lv0.csv files, all errors have a record type of 0 so that they sort to the top when the file is sorted by record type. There are two basic types of errors:

- Radiometer operating program errors produced by the operating code, usually due to configuration problems or Control Computer problems)
- Radiometer subsystem errors – these errors will often cause operating code errors as well.

Radiometer operating program errors

These errors do not have an error code and are descriptive of the problem that occurred. They include problems with the computer, operating system and file system. An example of these operating program errors is an inability to open the serial port connection to the instrument because it is in use by another program or because the serial port specified in mp.cfg does not exist. File system errors include attempts to open files that do not exist (for example, specifying nonexistent neural network files or macro files in a procedure file) and errors related to an inability to access a file (because it is locked by another program, read-only, or on a network drive that is not accessible for some reason).

There are also errors related to incorrect procedure files. These include specifying frequencies in TRCVCAL and OBS commands that are not present in the mp.cfg file. This results in a "Factory Calibration Not Available" error. Specifying a frequency in an OBS command that has not previously appeared in a TRCVCAL command will result in an

- **ERROR – Trcv not available at f = xxxxx** and/or
- **ERROR – Gbb not available at f = xxxxx**

    …where **xxxxx** if the frequency in MHz.

Errors related to problems communicating with the instrument include RS-232 timeout errors (the instrument did not respond in the expected time) and command retry errors. If this happens only once, there is probably no problem, but repeated timeouts and retries indicate a more serious problem. The operating code should be stopped, the instrument power turned off for 30 seconds, then back on and the operating code restarted. For a list of Operating Errors, refer to the MP.exe v7.xx error messages later in this Appendix.

Radiometer subsystem errors

There are five subsystems in the instrument that produce numerical errors. These are reported in record **type 0** records in the lv0.csv file with the device name (one of MCM, RCV0, RCV1, EL, or AZ — some devices may not be present in a particular instrument), the number of errors, followed by the numeric error codes. An example of a radiometer subsystem error is shown in Figure D-1. The error message is interpreted as:

    a. record number 143
    b. date (May 15, 2011) time (10:29:00)
    c. record type (0)
    d. device reporting the error (MCM)
    e. number of errors (001)
    f. error code 2

             a.   b.   c. d.   e.   f.

143, 05/17/2011 10:29:00, 0,MCM, 001,002

Figure D-1. Sample level0 error line

A complete list of radiometer subsystem error messages appears on the following pages.

MCM errors

Table D-1. MCM errors

Error Number	Description
1	No reply from IRT
2	No reply from Rain sensor (only if available)
3	No reply from MET
4	No reply from RCV0
5	No reply from RCV1
6	
7	No reply from EL
8	No reply from AZ
9	No reply from GPS

RCV0 and RCV1 errors

Table D-2. RCV0 and RCV1 errors

Error Number	Description
	Note: RCV0 errors refer to the K Band receiver; RCV1 errors refer to the V Band receiver.
1	The real-time clock (RTC) string was not generated because a date value or time value was out of bounds (for example setting the seconds to 70).
2	Creating a string from the RTC year failed.
3	Adding the delimiter to the RTC string failed.
4	Creating a string from the RTC month failed.
5	Creating a string from the RTC day failed.
6	Creating a string from the RTC hour failed.
7	Creating a string from the RTC minute failed.
8	Creating a string from the RTC second failed.
9	Not used.
10	Copying a string to the UART buffer failed.
11	Failed to get a byte out of the UART buffer.
12	A string was parsed for a 32 bit number but the value was larger than 32 bits (overflow).
13	A string was parsed as a floating point number and the decimal portion was invalid.
14	A float was being converted to a string but the requested decimal precision was too large.

Error Number	Description
15	A float was being converted to a string but the requested total precision was too large.
16	A float was being converted to a string but the buffer was too small to hold it.
17	A float was being converted to a string but the reversed string buffer was too small to hold it.
18	The function strcat() was called but the destination buffer had no NULL in it (no end of string).
19	The function strcat() did not complete successfully because the buffer size limit was reached.
20	The function PopToTermChar() failed because the output buffer size limit was reached.
21	The record number portion of a text string line of data was invalid.
22	The date/time portion of a text string line of data was invalid.
23	A command was received but the termination character was not found.
24	Invalid record type generated.
25	A configuration parameter was accessed with an invalid data type.
26	An attempt was made to print a configuration parameter with an invalid data type.
27	An attempt was made to lock the SPI bus for an invalid device.
28	A timeout occurred while transferring a byte on the SPI bus.
29	A timeout occurred while waiting for the SPI bus to be not busy.
30	The RTC configuration failed at startup.
31	The semaphore failed for locking the elapsed time variable in the housekeeping task.
32	Not used.
33	The semaphore failed for locking the ADC variables in the housekeeping task.
34	The semaphore failed for locking the ADC variables in the I2C load buffer function in the command I2C task.
35	The semaphore failed for locking the ADC variables in the video task.
36	The semaphore failed for the SPI bus.
37	The semaphore failed for locking the elapsed time variable in the SendMsgFromTaskToComputerA() function.
38	The semaphore failed for locking the SendMsgFromTaskToComputerA() function.
39	The semaphore failed for locking the status variables in the video task.
40	The ADC input was unable to be converted from raw counts to a voltage or temperature.
41	The ADC reading for the ND failed due to a timeout.
42	An invalid channel was specified for the ADC.
43	The control point was invalid.

Error Number	Description
44	A problem occurred with the thermal control such that the control loop was opened and the PWM set to 0 for safety.
45	The H-bridge 5V output is not present.
46	The H-bridge is indicating a short circuit condition.
47	The H-bridge is indicating a temperature fault.
48	The H-bridge is indicating a low voltage on Vpeltier.
49	The H-bridge signals were computed incorrectly.
50	The semaphore failed for locking the status variables in the housekeeping task.
51	The 8051 indicated that data was ready before the trigger was sent.
52	The 8051 did not indicate integration complete within the timeout period.
53	Setting the attenuator for the observation failed.
54	The function call to load the Spinnaker synthesizer failed.
55	Setting the synthesizer to its minimum frequency at the end of an observation failed.
56	The 8V supply was outside of the range of 7.4V to 8.6V.
57	An observation was performed and a video voltage was outside of the range of 0.5V to 2.4V.
58	The temperature sensor T1 was outside of the range of -50C to +70C.
59	The temperature sensor T2 was outside of the range of -50C to +70C.
60	The temperature sensor T3 was outside of the range of -50C to +70C.
61	The temperature sensor T4 was outside of the range of -50C to +70C.
62	The 8051 responded with an unexpected value of "prime data."
63	The 8051 responded with an unexpected value of "reset."
64	The 8051 responded with an unexpected value of "no command."
65	The 8051 responded with an unexpected value of "2."
66	The 8051 responded with an unexpected value of "3."
67	The 8051 responded with an unexpected value of "4."
68	The 8051 reported an error indicating an invalid integration configuration.
69	The 8051 reported an error indicating data was read but no trigger was received.
70	The 8051 reported an error indicating data was read before integration completed.
71	The 8051 reported an error indicating the video voltage is railed low.
72	The 8051 bus is stuck high or the device is in reset.
73	The 8051 bus is stuck low.
74	The 8051 data on the SPI bus is all the same but not high or low.
75	The 8051 related error is unknown.
76	Priming the 8051 for integration after a reset failed.
77	Priming the 8051 for integration failed.

Error Number	Description
78	The frequency sent to the synthesizer was invalid. Valid frequencies are in the ranges of 11000-MHz to 15300-MHz or 22000-MHz to 30600-MHz or 50800-MHz to 61200-MHz inclusive.
79	Not used.
80	Not used.
81	Not used.
82	The BBP failed to generate a response for the MCM.
83	Message on I2C was larger than the transfer buffer.
84	Not used.
85	Not used.
86	Not used.
87	Not used.
88	The total size of the configuration parameters is too large for one page of Flash.
89	The total size of the configuration parameters is not divisible by 4.
90	The configuration parameters were read from flash but were determined to be invalid (based on the CRC). This is typical for a newly programmed board.
91	The configuration parameters in Flash are for a different version than what the present firmware supports.
92	The FLASH_ErasePage() function failed.
93	The FLASH_ProgramWord() function failed.
94	Readback of the programmed word failed.
95	The FLASH_ProgramWord() function failed for writing the version.
96	Readback of the programmed version failed.
97	The FLASH_ProgramWord() function failed for writing the CRC.
98	Readback of the programmed CRC failed.
99	The 8051 reported an error indicating the command byte was not in the right byte location.
100	The PR-series tried to divide by zero when computing brightness temperatures.
101	The PR-series had alpha set to zero when computing brightness temperatures.
102	The 8051 data is incorrectly being parsed for error codes.
103	The video state sequence had an undefined state other than the normal antenna, load, ND off/on combinations.
104	The housekeeping task was called by the ADC data had not been updated.

Elevation and Azimuth Controller Errors

These errors are bit fields. The number reported is hexadecimal.

Table D-3. Elevation error codes

Elevation	
Sum	**Error Condition**
1	RAM ERROR
2	TILT ERROR
3	RAM ERROR and TILT ERROR
4	HOME NOT FOUND
5	RAM ERROR and HOME NOT FOUND
6	TILT ERROR and HOME NOT FOUND
7	RAM ERROR, TILT ERROR and HOME NOT FOUND

Table D-4. Azimuth error codes

Azimuth	
Sum	**Error Condition**
01	RAM ERROR
04	HOME NOT FOUND
05	RAM ERROR and HOME NOT FOUND
08	CW LIMIT HIT
09	RAM ERROR and CW LIMIT HIT
0C	HOME NOT FOUND and CW LIMIT HIT
0D	RAM ERROR, HOME NOT FOUND and CW LIMIT HIT
10	CCW LIMIT HIT
11	RAM ERROR and CCW LIMIT HIT
14	HOME NOT FOUND and CCW LIMIT HIT
15	RAM ERROR, HOME NOT FOUND and CCW LIMIT HIT
18	CW LIMIT HIT and CCW LIMIT HIT
19	RAM ERROR, CW LIMIT HIT and CCW LIMIT HIT
1C	HOME NOT FOUND, CW LIMIT HIT and CCW LIMIT HIT
1D	RAM ERROR, HOME NOT FOUND, CW LIMIT HIT and CCW LIMIT HIT

MP.exe v7.xx error messages

Table D-5. MP.exe v7.xx error messages

Error Message	Notes
GPS data missing in new_gps	These gps errors are only for version > 6.08
Serial timeout in new_gps	
Error reading GPS data	
V7.xx requires MCM >=1.35!	
Serial timeout in getserial	
5 serial timeouts in getserial - resetting MCM	
MCM did not respond to interfaceclear	interface clear command was added in v6.07
Serial timeout in interfaceclear	
5 serial timeouts in interfaceclear - Hard reset	
MCM in i2c - wait 30 seconds	MCM returned '&' in response to interface clear
Spontaneous MCM re-boot detected	added in v6.09
hcmd retry	H command gets housekeeping data from MCM
hcmd retry, bad value	
ptcmd retry	Pn is pass-through command to device n
rcmd retry	R command reads a single channel (not used much anymore)
rcmd retry, bad value	
icmd retry	I command is initialize (MCM)
ccmd retry	C command is configure timing parameters
qcmd retry	Q command is surface met
fcmd retry	F command gets errors from MCM
fcmd fail	
tcmd retry	T command sets synth type
jcmd retry	J command resets i2c bus
dcmd retry	D command controls blower speed
ecmd retry	E command is elevation move
acmd retry	A command is azimuth move
acmd fail	
Az Drive hit limit switch	
Unable to recover from az limit switch hit	
RS-422 time out in readbuf	
RS-422 time out in receive	
RS-422 time out in receive	
RS-422 time out in readbuf	
o8cmd error	o8 errors - from obs,trcvcal,tip21 commands
synth lock error	synth reported un-locked on 1 or more frequencies
Read error in o8cmd	

Error Message	Notes
Serial timeout in o8cmd	
error in newplot	Legacy graphics errors
error in addtrace	
error in autoscale	
error in autoscale	
error in autoscale	
error in graphics mode: fonts not found	
error in graphics mode: could not set font	
error in graphics mode: could not set font	
error in display plot: could not set font	
error in graphics mode: could not set font	
error in symbol: could not set font	
error in symbol: could not set font	
error in disptime: could not set font	
error in disptime: could not set font	
error in disptime: could not set font	
error in menu: could not set font	
error in menu: could not set font	
menu: could not set font in put_text	
error in menu: could not set font	
menu: could not set font in put_text	
ERROR, cannot open the MP.CFG file	errors in reading mp.cfg file
Could not find the MP TYPE: line	
in the MP.CFG file. ShutDown.	
Could not find the TIP CONFIGURATION: line	
in the MP.CFG file. ShutDown.	
ERROR reading TIP data from MP.CFG	
Could not find BLOWER SETTINGS: line	
in the MP.CFG file. ShutDown.	
ERROR reading BLOWER data from MP.CFG	
Could not find the CHANNEL CALIBRATION BLOCK: line	
in the MP.CFG file. ShutDown.	
Too many frequencies for microwave profiler	
Could not find the COEF: line	
in the MP.CFG file. ShutDown.	
End of MP.CFG file!	
ERROR, cannot open the MP.CFG file	
Could not find the MP TYPE: line	
in the MP.CFG file. ShutDown.	
could not open the .prc file	prc file errors

Error Message	Notes
runproc: error, non digit, non delim at end	
Hard-reset!	Hard reset errors - for non-responsiveness of MCM
HR retry	
Could not open serial port for mp. Aborting	serial port does not exist or is locked by another program
DlySec called with too big delay - STOP	
DlySec called with minus value - STOP	

Appendix E: RAOB for Radiometrics

Table of Contents

Disclaimer

1. RAOB is licensed software, developed by Environmental Research Services (ERS).

2. This document does not supersede or modify RAOB documentation provided by ERS.

3. The Customer is responsible for any modifications or use of the RAOB program that are not in accordance with documentation or directions provided by ERS.

4. Radiometrics Corporation is not liable for any flaws, errors, or data produced in RAOB, based on the information provided herein.

5. Please direct all questions regarding the RAOB software to ERS.

List of Figures

About RAOB with Radiometrics data

RAOB is designed by John Shewchuk.
RAOB works with Radiometrics' lv2.csv data files.

The purpose of this manual is to guide Radiometrics customers more specifically in performing radiometer tasks with RAOB. Such tasks include:
- Opening and viewing sounding files
- Using **Compare** menus
- Creating cross sections
- Saving images to file
- Merging soundings

RAOB version 5.9 was the first to process RDX data. It was released in 2008.

RAOB Technical Support and Upgrades

Each RAOB program comes with free technical support and a free upgrade to the next RAOB program release. This is accomplished via monthly newsletters for customers who choose to directly contact RAOB.com.

Updating RAOB

1. In a browser, open the RAOB.com website to see find the latest RAOB version number.
2. Running RAOB, navigate:

Help > About RAOB…

The **About RAOB** screen appears.

3. Compare your RAOB version number with what is listed at the raob.com site.
4. If you have an earlier version, contact wxx@raob.com to become a BETA user.
5. To get program update to the latest version, navigate:

Help > RAOB Program Updates

Radiometrics Tasks Performed with RAOB

Opening and Viewing Sounding Files

1. To open files, navigate:

File > Open Sounding (Ctrl+O)
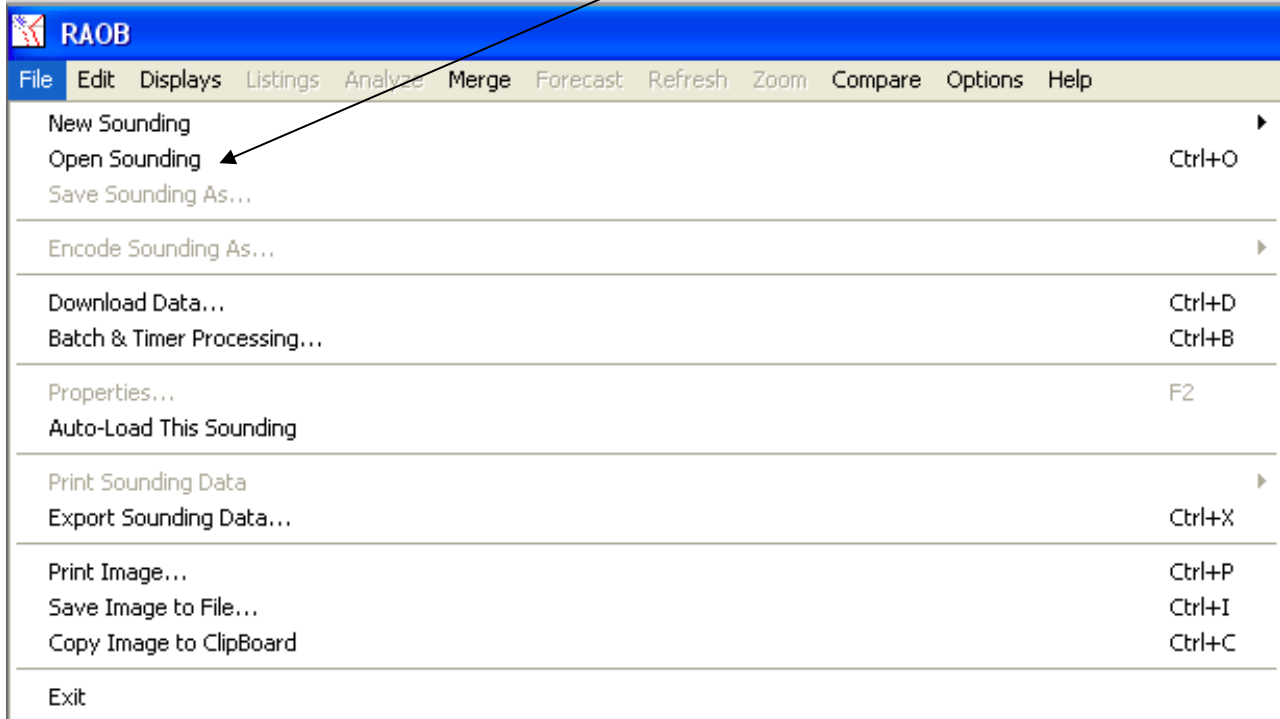
Figure E-1. File menu

2. Direct your search path to find Level 2 data in the operational folder.

   The **Available data scans** menu appears (Figure E-2).
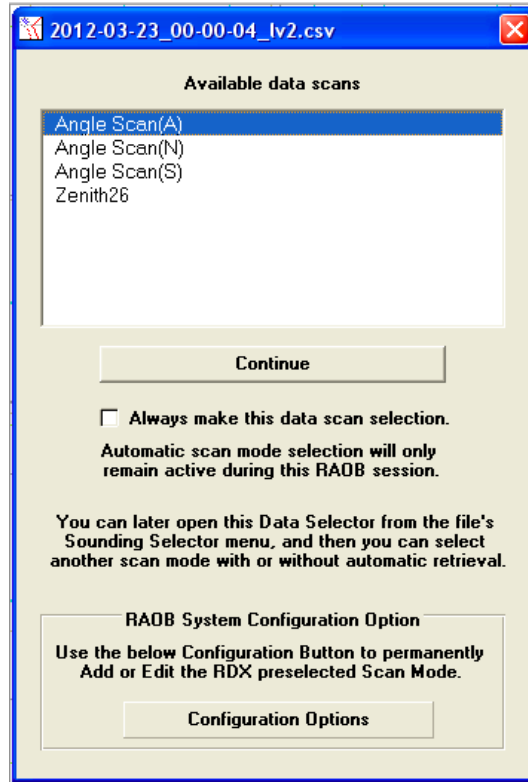
Figure E-2. Available data scans

3. Select the Scan type you want.
4. Click **Continue**.

   The list of radiometric soundings appears (Figure E-3).

5. Select required radiometric Sounding files by time (Figure E-3).
6. Click **Plot** (lower left on Figure E-3).

NOTE:
Users can also use the arrow keys to toggle between soundings.
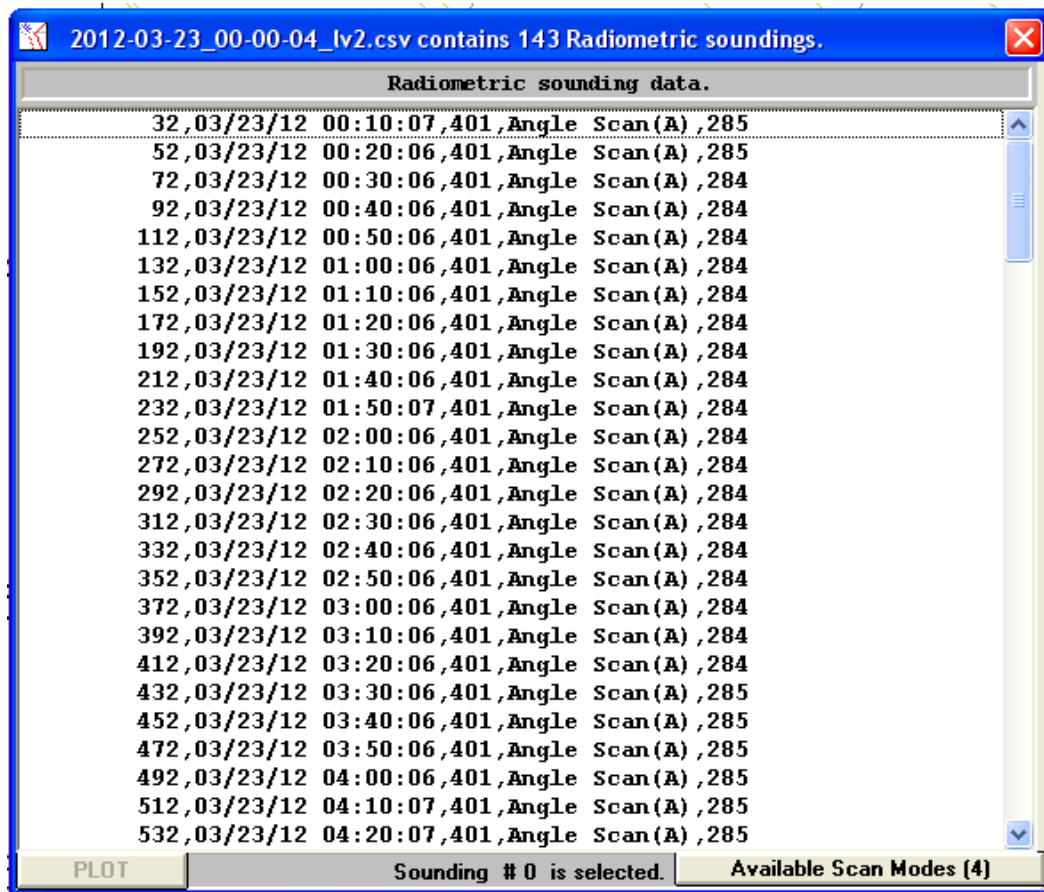
Figure E-3. Selecting radiometric sounding files by time and click Plot.

The radiometer sounding appears (Figure E-4).
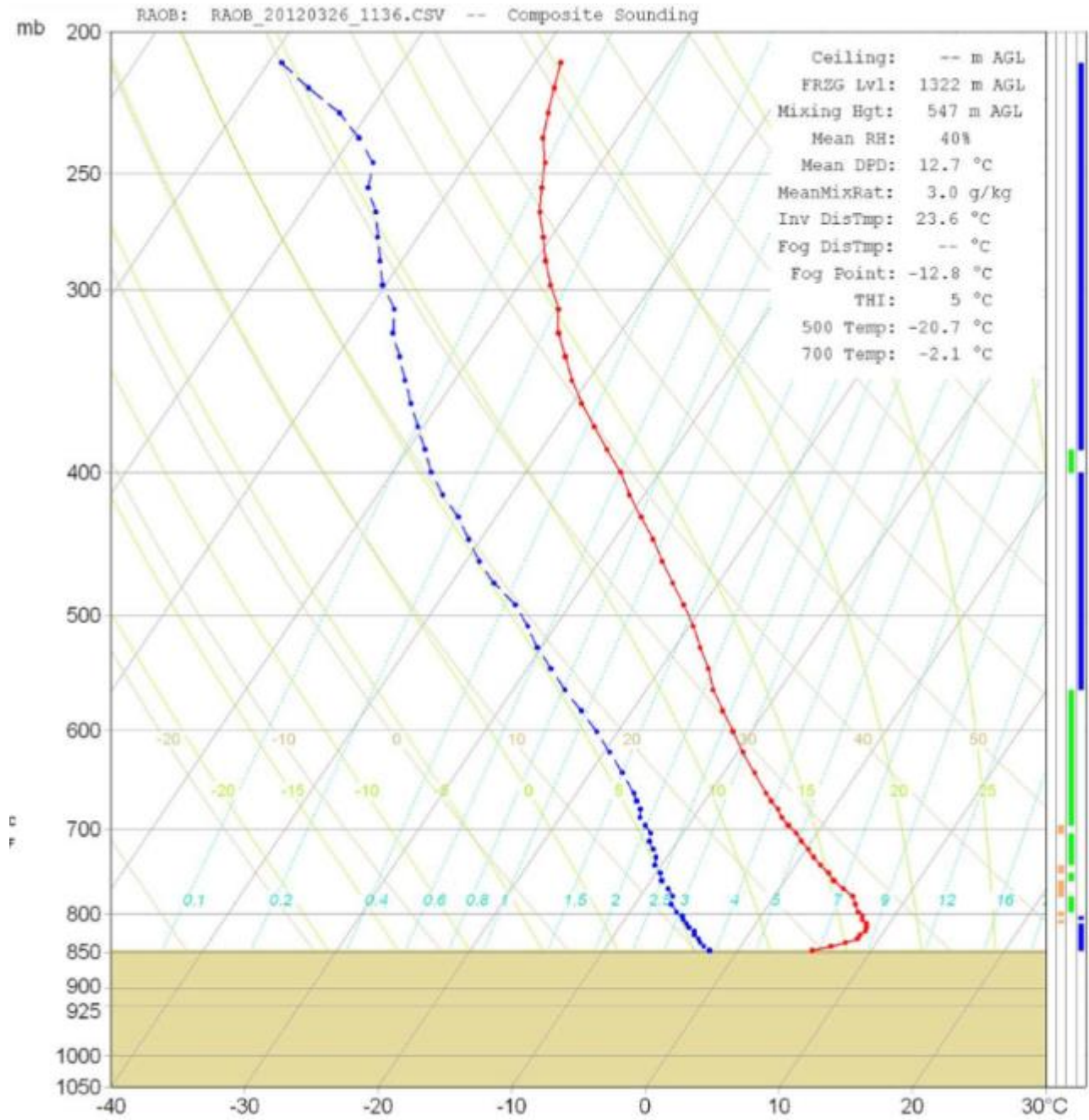
Figure E-4. Radiometer sounding

Using Compare Menus

Users can use the **Compare** menu to overlay sounding files. In this way, sounding files may be seen as they evolve across time.

Two useful **Compare** options are:
- **Compare Another Sounding**—permits analytical comparison of two soundings
- **Compare Multiple Soundings**—permits comparisons of up to five soundings
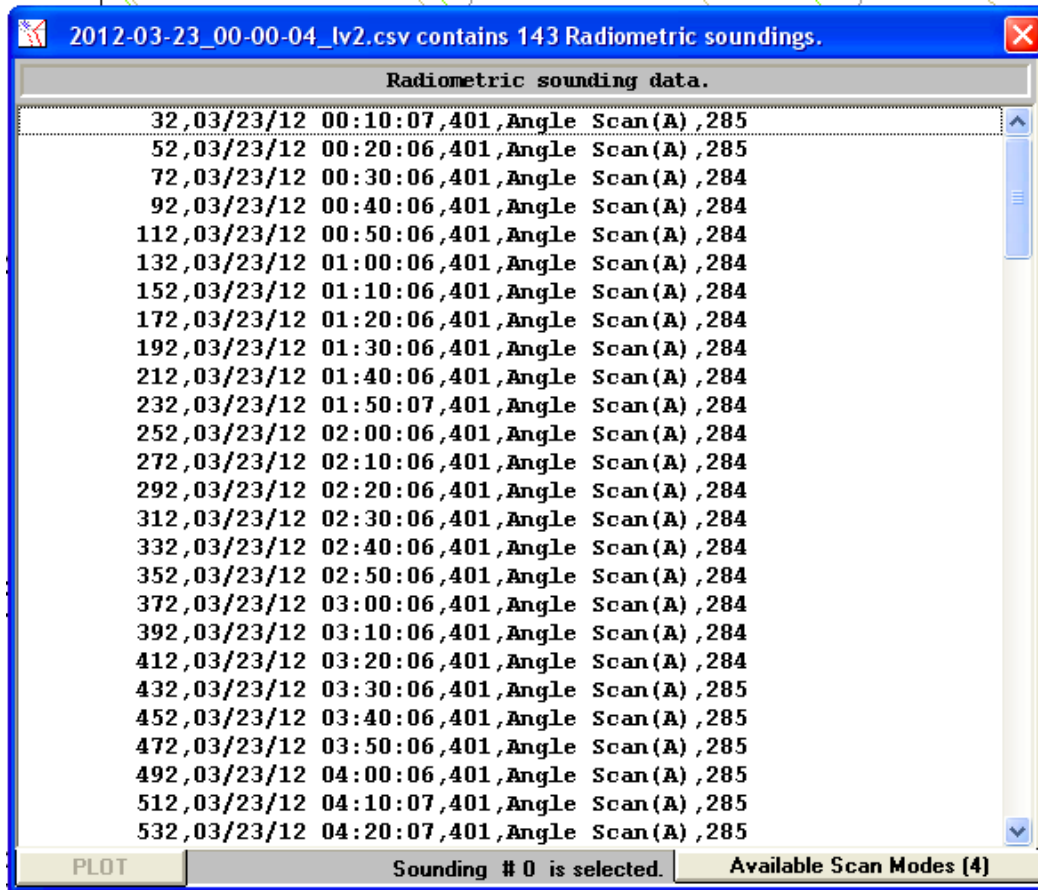
1. To compare files, navigate:

   Compare > Compare Multiple Soundings (for this example)

   The list of radiometric soundings appears (Figure E-5).

2. Select required radiometric Sounding files by time, one at a time (Figure E-5). To choose and compare files from a different folder, simply close the selection box.

3. Click **Plot** (lower left on Figure E-5).

Figure E-5. Radiometric sounding files

The static compared radiometer sounding appears (Figure E-6).
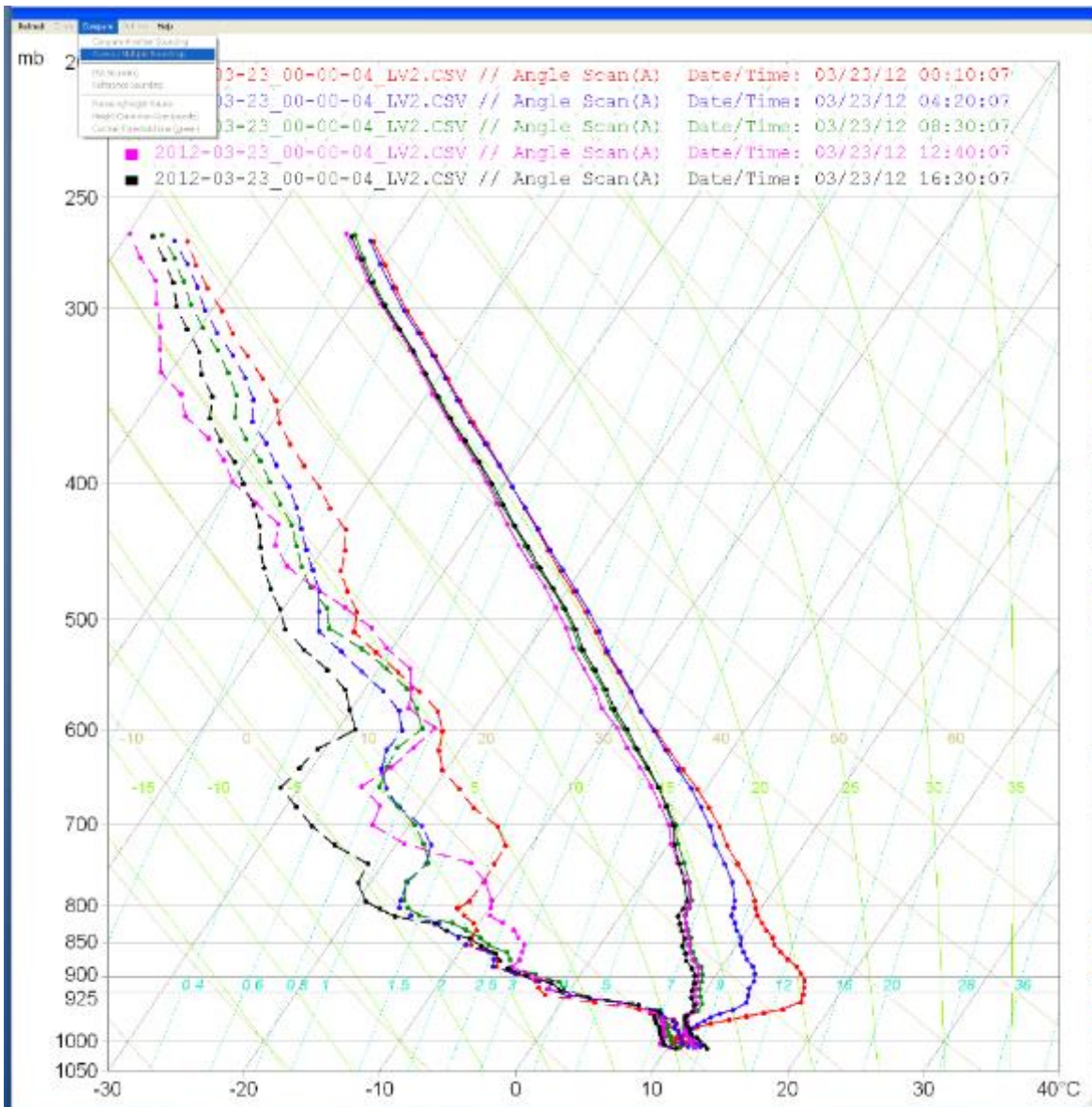
Figure E-6. A static set of five radiometer soundings

Table E-1. Sounding color chart (defaults)

Compare Another Sounding	Overlay Multiple Soundings
Sounding plot colors: • 1st in red • 2nd in blue	Sounding plot colors: • 1st in red • 2nd in blue • 3rd in green • 4th in magenta • 5th in black

4. Use the arrow keys (**<** and **>**) on your keyboard to return to **Normal** view and to control sequential looping of the data files (not available when comparing soundings).

Creating Cross Sections

Users can use the **RAOB Cross-Section** mode to access the cross-section menus. With the RAOB Cross-Section mode, users can see two views of the data:

- time-based

- distance-based (with two or more radiometers)

1. To work with cross-sections, navigate:

Displays > Cross-Section (F6)

A blank cross sectional field appears.

2. Right-click the cross sectional field and the **Cross-Sections Options** menu appears (Figure E-7).
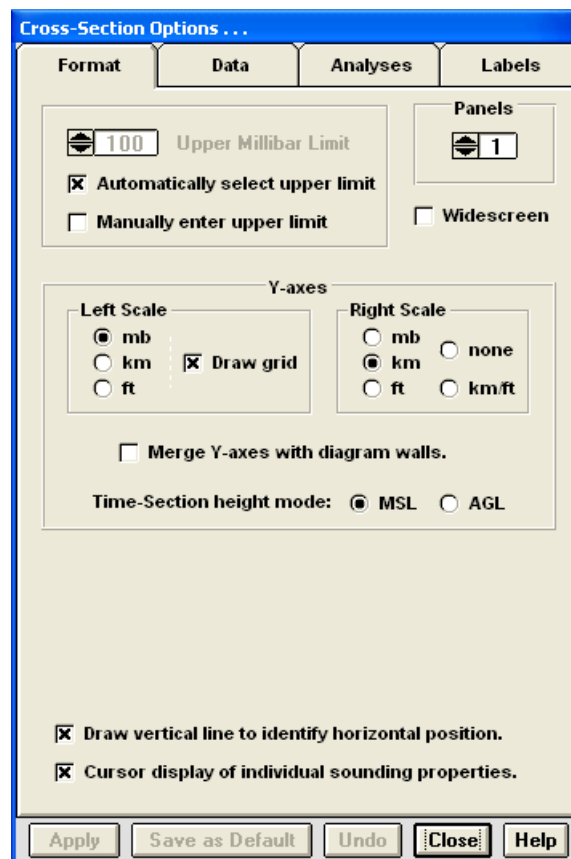
Figure E-7. Cross-Sections Options menu

3. Choose two Y-axis options by which to view the diagram.

4. Refer to the RAOB manual concerning questions about the other three tabs on the **Cross-Section Options** window.

5. To create a new cross section, navigate:

File > Create a New Cross-Section

The cross-section diagram type selector screen appears (Figure E-8).
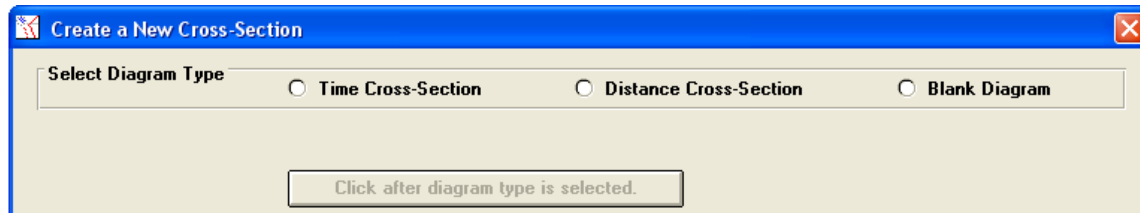
Figure E-8. Diagram type selection

6. Choose between **Time Cross-Section** or a **Distance Cross-Section**, and click the **Click here to continue** button.

    The **Create a New Cross-Section** window appears (Figure E-9).

7. Click the **Add a Sounding** button to choose from the Radiometrics lv2 sounding data (Figure E-9).
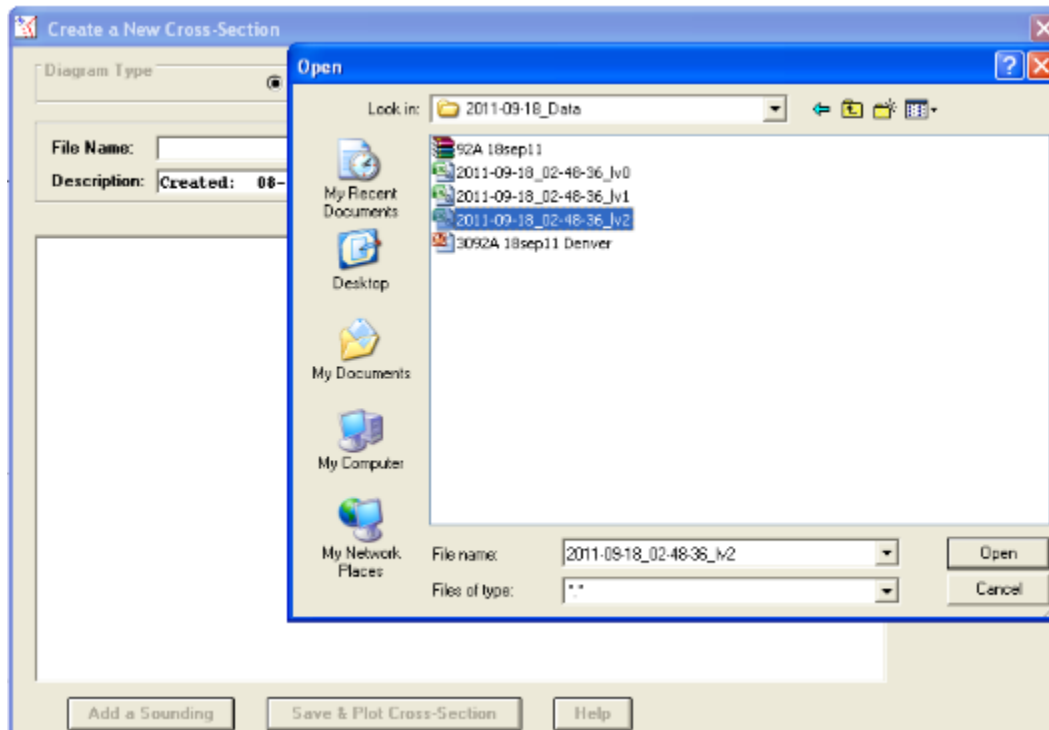
Figure E-9. New cross-section window

The **Available data scans** menu appears (Figure E-10).
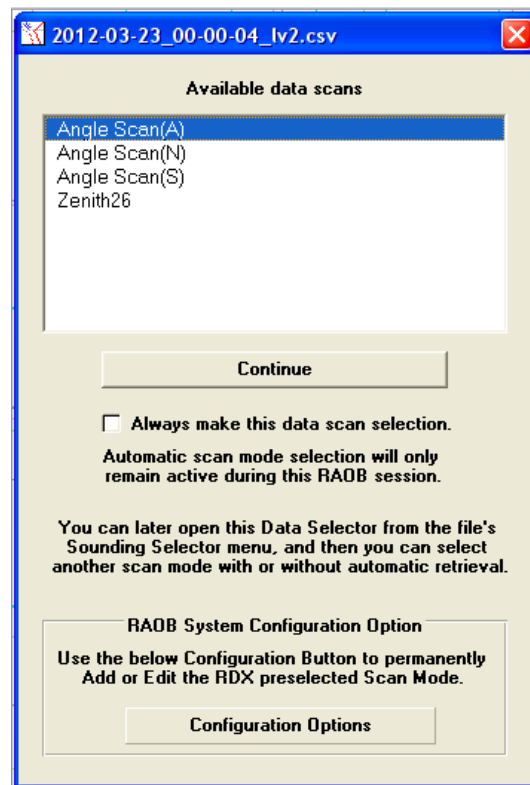
Figure E-10. Available data scans

8. Select the Scan type you want.
9. Click **Continue**.
10. In the Radiometric soundings window (Figure E-11), select one of the two options:
    - **Select All**
    - **Select every i'th**
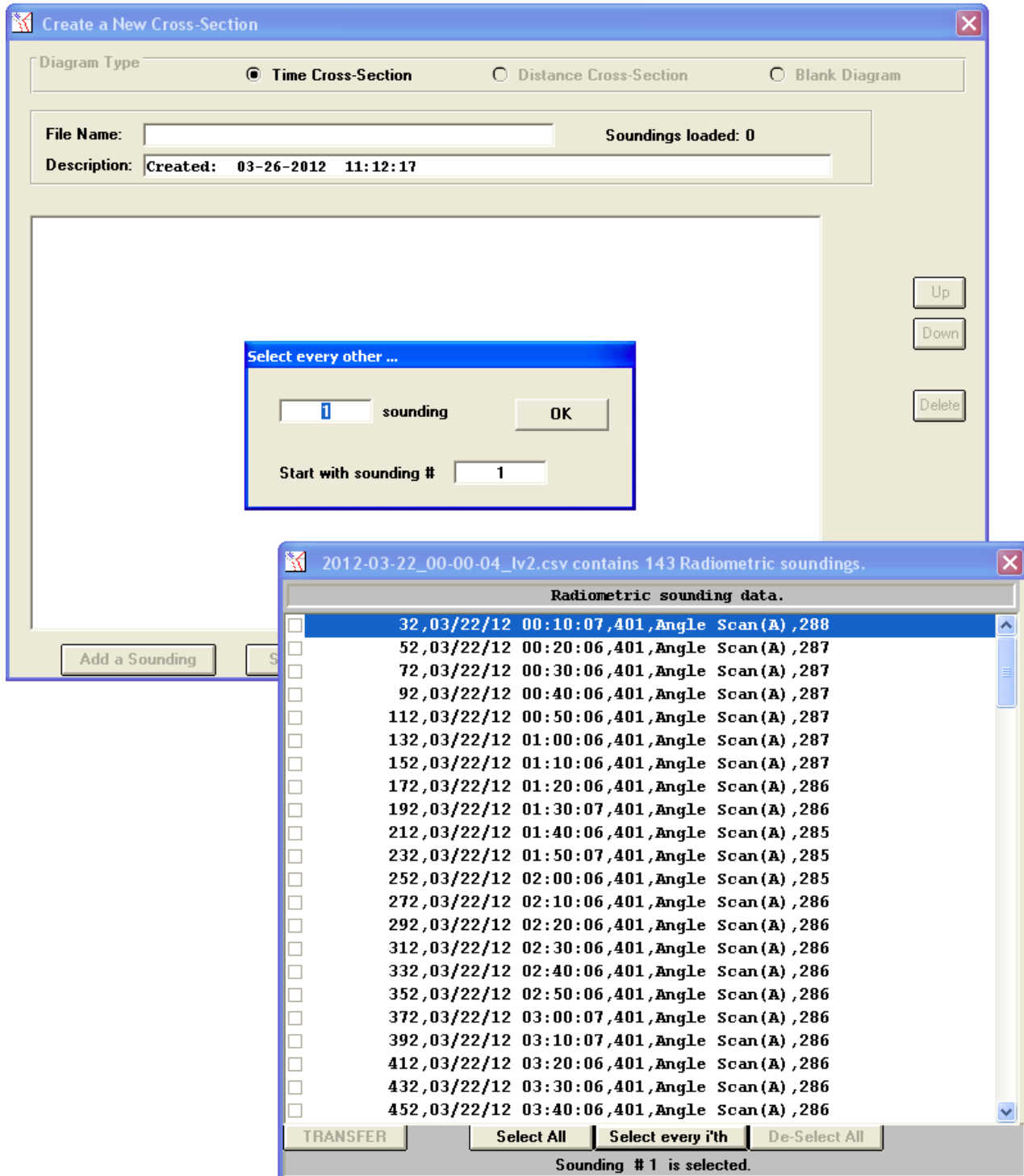
Figure E-11. Select every i'th sounding

11. Click the **Transfer** button and check that all the data in the field looks uniform (Figure E-12).
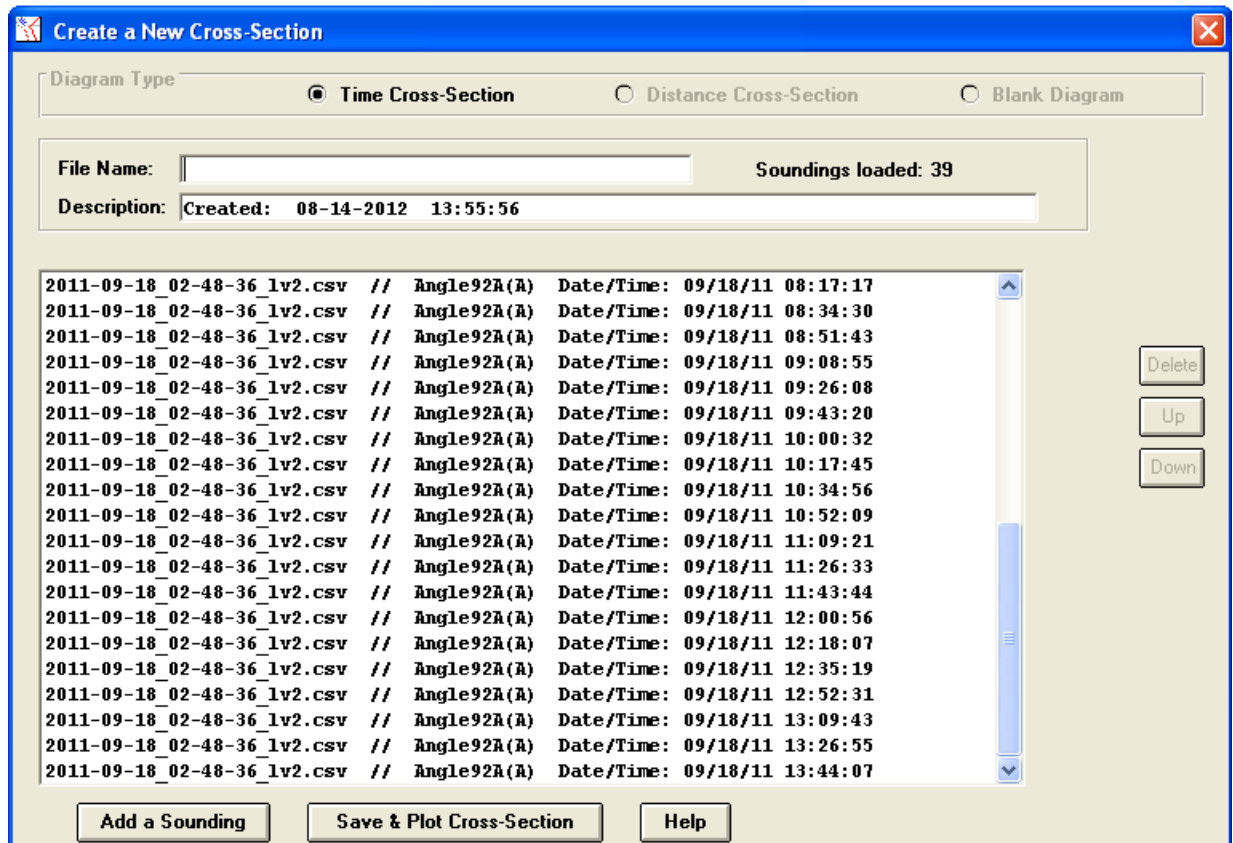
Figure E-12. Transferred data

12. When you have collected all the required data, click the **Save & Plot Cross-Section** button (Figure E-12).

    The plot appears, without data.

13. From the **Analyze** tab of the Cross Section window, select the analysis you want to observe (Figure E-13, for example).
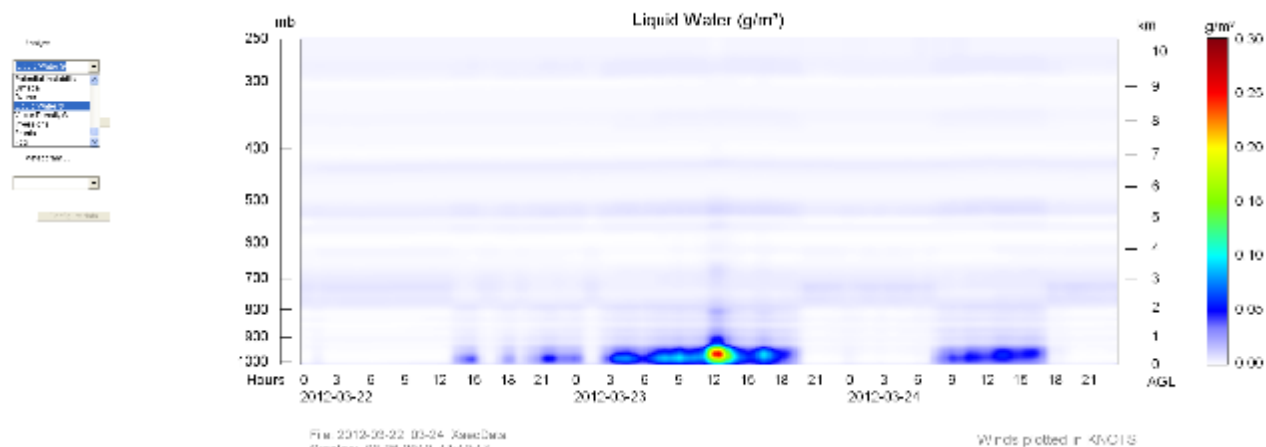
Figure E-13. Radiometer scan, showing Liquid Water analysis

NOTE:
It's important to use a consistent and systematic naming and storage convention when you save files. Figure E-14 shows an example of saving to a dedicated folder (**X-Sections**) with a name that uses a date range and hints about the data (Temperature and Liquid Water at 600 mb).
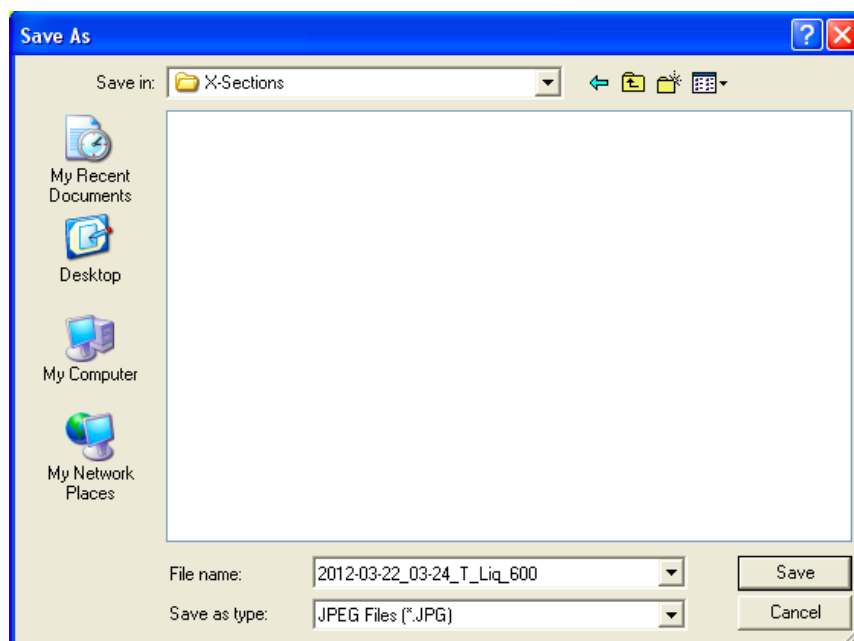
Figure E-14. Saving with a naming convention

14. Save the image. Navigate:

File > Save Image to File (Ctrl+I)

Merging Sounding Files

Users can merge sounding files to create composite sounding data. For example, users can combine Temperature and Humidity data with Wind data. Merging only utilizes the last available file, so it is important to know the correct data collection date. Users will create two paths (Path #1 / Path #2[3]):

- Path #1 is thermal data
- Path #2 is wind data

1. To begin merging sounding file data, navigate:

File > Batch & Timer Processing (**Ctrl+B**)

The **Batch and Timer Processing Options** window appears (Figure E-15).
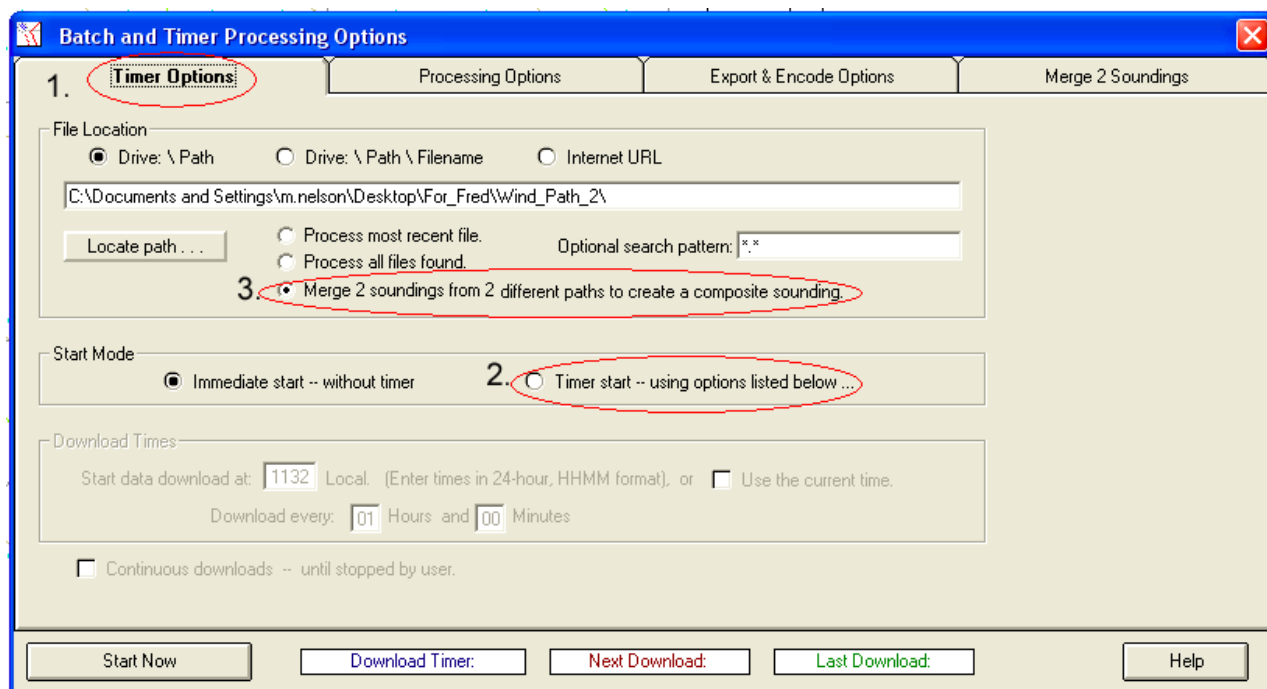
Figure E-15. Batch and Timer Processing

2. Navigate:

Timer Options tab > Timer start > Merge 2 soundings from 2 different …

RAOB automatically navigates the user to the **Merge 2 Soundings** tab (Figure E-16).

---

[3] Path #2 is always wind data only.
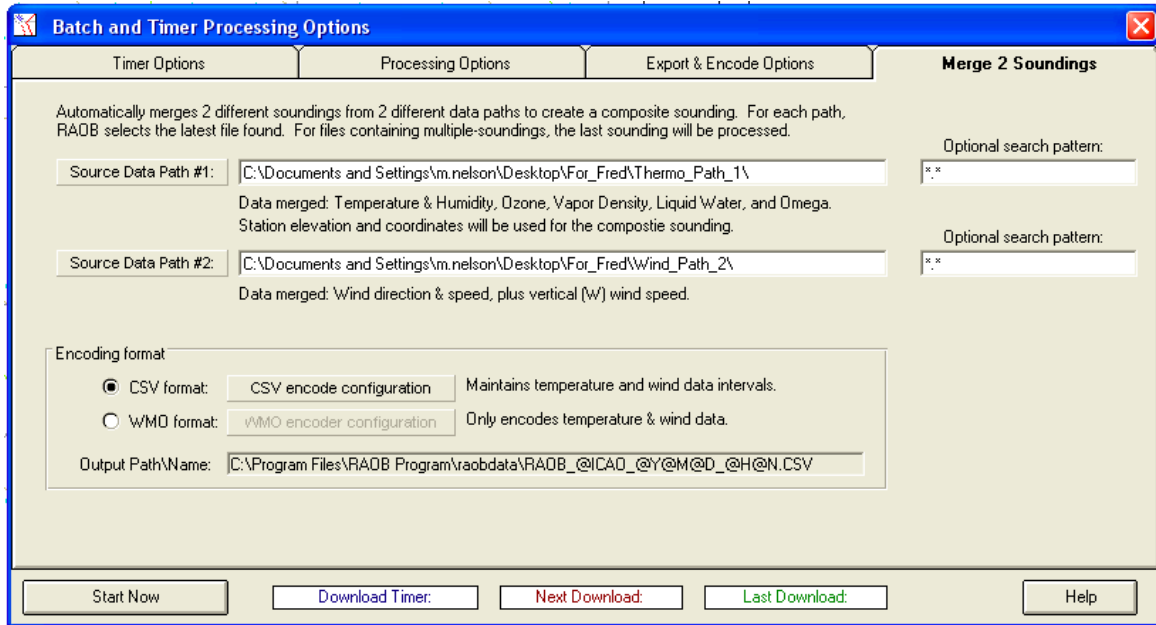
Figure E-16. Merge 2 Soundings tab

3. Point the **Source Data Path 1** to the Radiometer files (thermal data).
4. Point the **Source Data Path 2** to the wind data files.
5. Click the **Start Now** button.

   The merged sounding graph appears (Figure E-17).
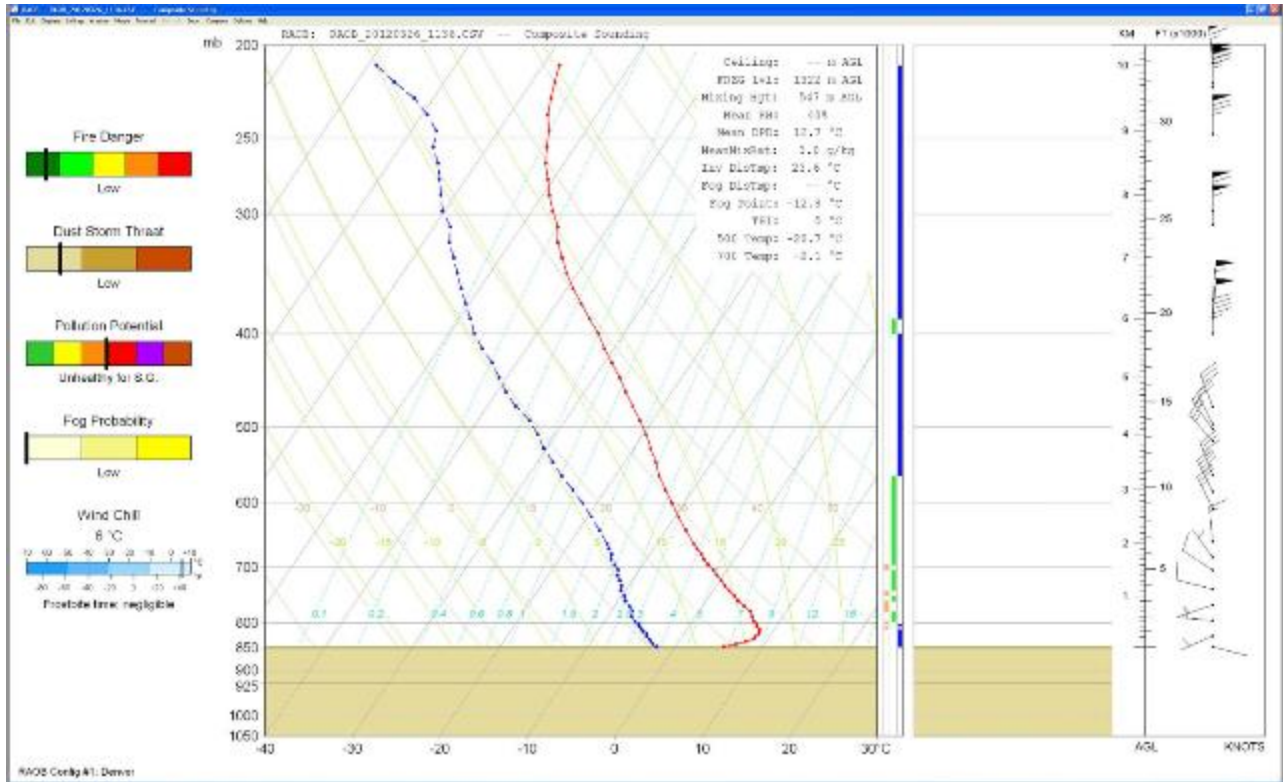
Figure E-17. Merged sounding

Appendix F: Removal and Replacement of Common FRUs

Overview:
This appendix describes the process of removing and installing the Field Replaceable Units (FRUs) associated with the MP-xx00A radiometer. A list of FRUs with part numbers is also provided.

While the radiometer hood is not considered an FRU, the removal/replacement process is included in this Appendix because it is a required step for replacing and installing many FRUs. Returning the radiometer to normal operation after replacing any FRU is covered in the last section of this appendix.

Table of Contents for Appendix F:

NOTE: Installers should review the entire instruction set **before** attempting the procedures described herein. Contact Radiometrics Customer Support with any questions regarding this procedure at:

• email: supportmwr@radiometrics.com
• Phone: +1-303-449-9192

F.1 Removing and Reinstalling the Radiometer Hood

SAFETY NOTICE:
Disconnect power to the radiometer system as described below, before removing the radiometer hood.

NOTE:

Two persons are required to lift the radiometer hood, by using the handles at both ends of the hood. The hood must be lifted straight up until the bottom edge of the hood clears the IRT window temperature probe sensor.

CAUTION! The IRT window temperature probe is at the height of the IRT window, and it can be damaged if the hood is not lifted until the bottom edge of the hood clears the sensor.

⚠ **WARNING**
Hazardous voltage enclosed.
Voltage or current hazard sufficient to cause shock, burn or death. Disconnect and lock out power before servicing.

Replacing any FRU, except for the Superblower, HC2-S3 probe, GPS receiver, and Rain Sense board, requires removing the radiometer hood. The process is described below and should be referenced whenever replacing an FRU that is inside the hood.

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Disconnect the Power Cable, RS-422 Cable, GPS Cable, and Superblower Cable from the radiometer Front Connector Panel.

4. Open all six latches (three per side) securing the hood to the radiometer frame. Note that once open, the latches can be reseated as shown in Figure F-1, so that the bail doesn't catch on the strike when removing the hood.
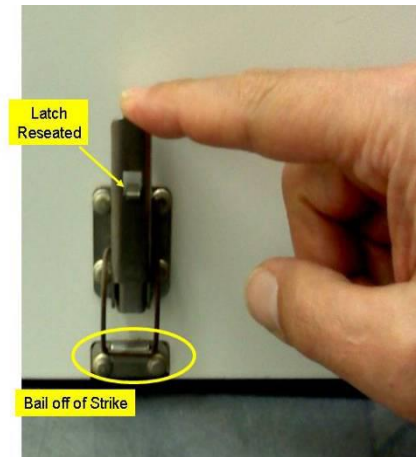
Figure F-1. Reset the latch with the bail off of the strike

Using the handles at both ends of the hood, lift the hood straight up, until the bottom of the hood clears the IRT window temperature probe sensor (see Figure F-2). The IRT window temperature probe sensor is at the height of the IRT window, and can be damaged if the hood is not lifted straight up until it is clear of the probe sensor.

Figure F-2. One person, lifting the radiometer hood straight up
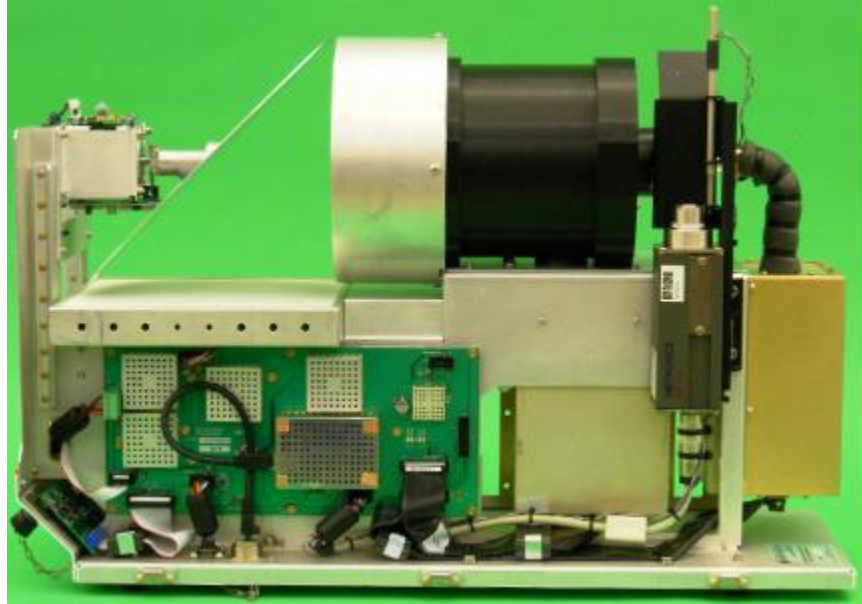
Figure F-3. Side view of MP-3000A radiometer with hood removed

Reinstall the Hood & Cables

When all maintenance tasks are complete, the radiometer hood should be reinstalled. The same cautions for hood removal described above apply to hood installation.

1. Center the hood directly over the frame, being careful to avoid damage to the IRT window temperature probe sensor shown in Figure F-3.

2. Align the hood so that the latches are directly above the strikes on the frame.

   As the hood is lowered to the frame, note that there are guides inside the hood that receive the mirror motor support struts, as shown in Figure F-3.

3. Once the hood is fully seated, lock all six latches.

4. Reconnect the cables to the radiometer Front Connector Panel. The order of connection is not important. Ensure that:

   a. The Front Connector Panel power switch is set to OFF before connecting the power cable.

   b. The serial data cable (RS-422) connects to the **COMPUTER RS422** connector, not the **AUX RS422** connector. Note that the cable will connect to either port, but only the **COMPUTER RS422** connection is active.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.2 Replacing the Infrared Thermometer (IRT) Unit

Overview
This section provides instructions for replacing the IRT unit in an MP-xx00A series radiometer. For instructions on replacing just the IRT assembly, refer to the next FRU.

Preparation
Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
There are only two tools required to replace the MP-3000 IRT:
- Wire cutters
- 10 mm wrench or 10 mm socket driver

Procedure

1. After removing the radiometer hood, locate the IRT on the right side of the radiometer, as highlighted in Figure F-4.
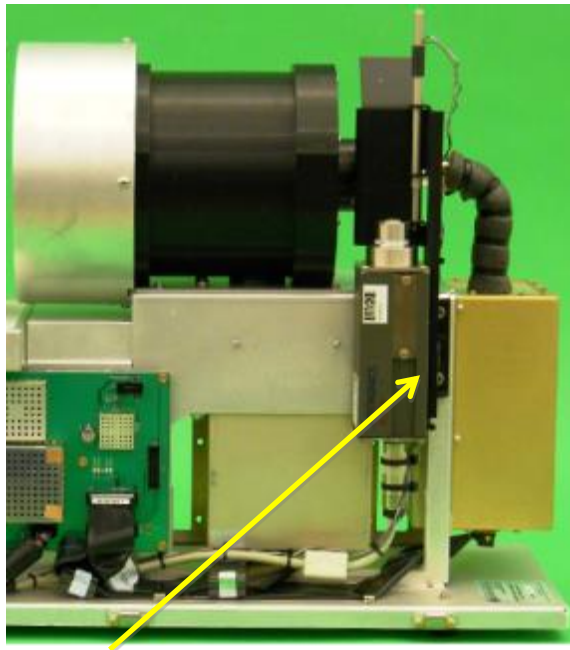
Figure F-4. IRT on right side of radiometer

2. Two cable-tie retainers hold fast two thermal sensor data cable pairs. Use the wire cutters to cut the two cable-tie retainers on the IRT (Figure F-5).
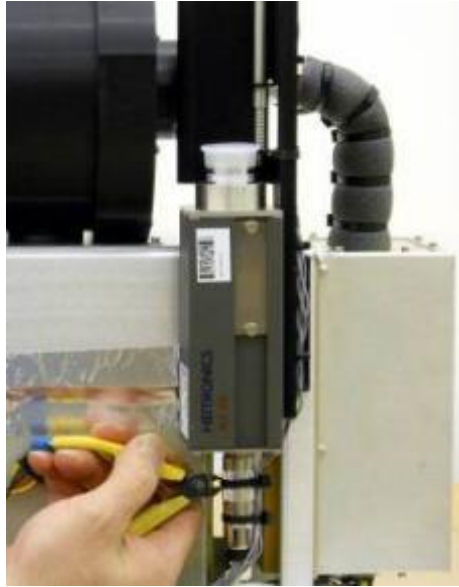
Figure F-5. Using wire cutters to remove cable-tie retainers

3. Disconnect (unscrew) the IRT from its data cable.
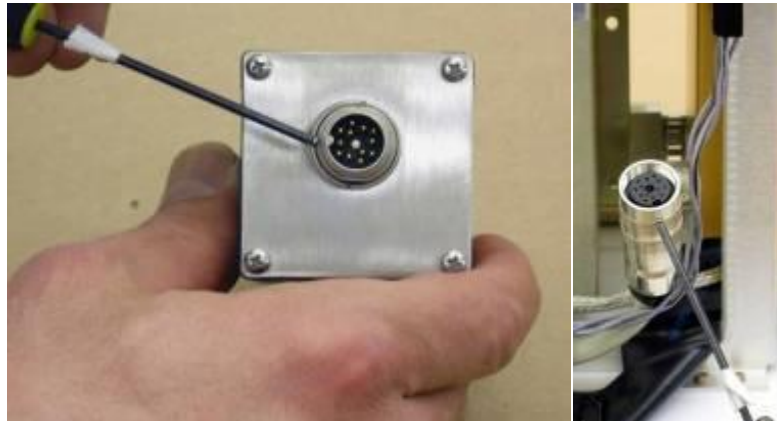
**Figure F-6. Underside of IRT, with pins (left) and
IRT data/power cable harness (right)**

4. Use the 10mm wrench or socket head to remove the two hex head bolts that hold the IRT to its bracket (Figure F-7), while supporting the IRT.
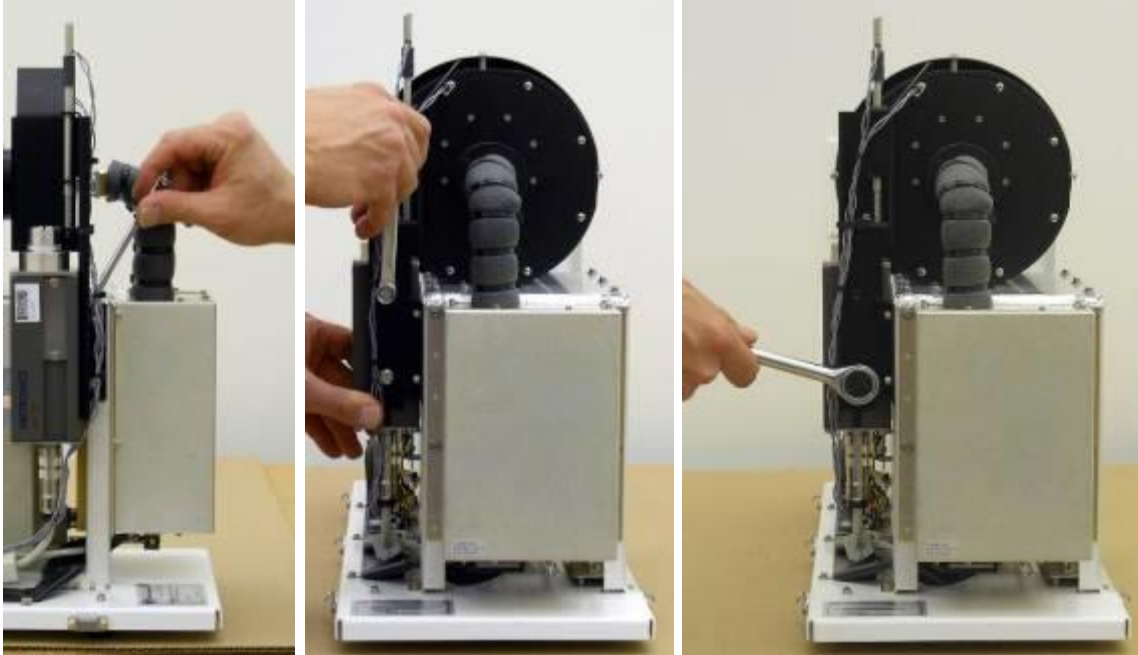
**Figure F-7. 10mm wrench (left and middle) or socket head (right) to
disconnect IRT from its bracket**

5. Install replacement IRT, reversing steps 1 through 4 and remembering to use two
   cable-ties to retain the two pairs of thermal sensor data cable sets to the IRT's
   data/power cable harness (Figure F-8).

Figure F-8. Fastening thermal sensor cable pairs with cable-tie retainers

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.3 Replacing the Infrared Thermometer (IRT) Assembly

Overview
This section provides instructions for replacing the IRT assembly in an MP-xx00A series radiometer. For instructions on replacing just the IRT unit, refer to the previous FRU.

Preparation
Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
Only one tool is required to replace the MP-3000 IRT assembly: 9/64 hex driver

Procedure

1. After removing the radiometer hood, locate the IRT on the right side of the radiometer, as highlighted in Figure F-9.
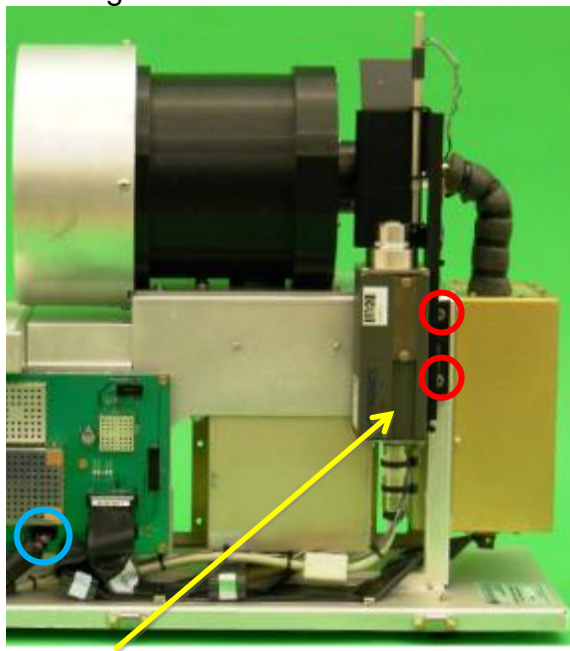
Figure F-9. IRT on right side of radiometer

2. Use the 9/64 hex driver to disconnect the two socket-head cap screws that hold the IRT assembly to the radiometer frame (circled in red in Figure F-9).

3. Disconnect the IRT assembly cable (circled in blue in Figure F-9) from the MCM board.

4. Replace the old IRT assembly with the new IRT assembly.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.4 Replacing the IRT Window Mount Cap

Overview
This section provides instructions for replacing the IRT Window Mount Cap for the MP-xx00A Radiometer.

NOTE:
Radiometrics recommends removing the hood for this procedure to avoid potential damage to the IRT probe. Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
- No tools are required to perform this task, as it should only be hand tight.

Procedure

1. Stop any current procedures running on the Control Computer.
2. Turn off power to the radiometer.
3. Remove the radiometer hood.
4. Unscrew the IRT Window Mount cap from the IRT Window Mount Base.
5. Remove the old O-ring from the IRT Window Mount Base.
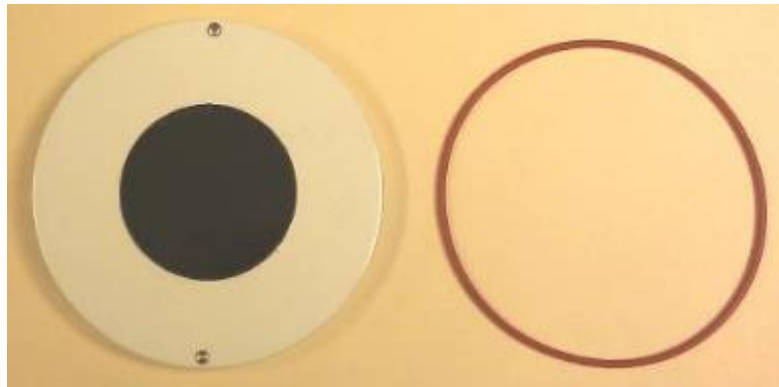
Figure F-10. IRT window mount cap and replacement O-ring

6. Replace the old O-ring with the new O-ring.
7. Seat the O-ring in the groove of the IRT Window Mount base.
8. Fasten the new IRT Window Mount Cap to the base, tightening it snugly by hand.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.5 Replacing the Main Control Module (MCM)

Overview
This section provides instructions for replacing the MCM PCBA in an MP-xx00A series radiometer.

Preparation
Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
- 7/64" socket driver
- Digital camera

Procedure

1. Locate the MCM PCBA, and as shown in Figure F-11.
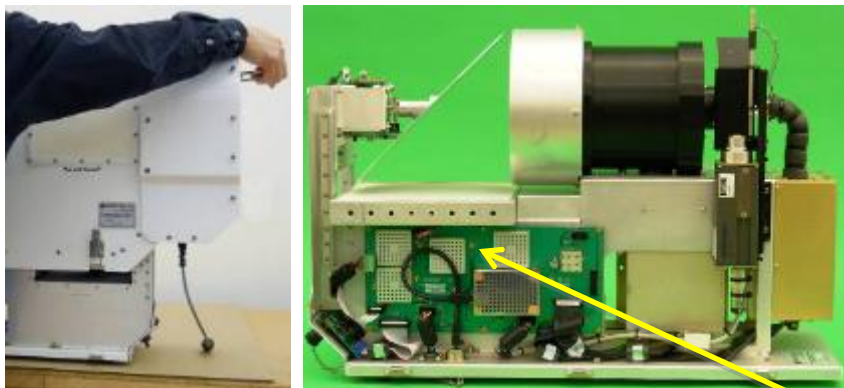
Figure F-11. Removing radiometer hood and revealed MCM PCBA

NOTE:
Perform the following procedure under static-control conditions. The operator should be grounded with a static-control wrist strap.

2. Carefully note the connection for each cable. Consider creating a digital image of the MCM setup to be able to correctly replace the cables.

   For reference, a close-up of the MCM PCBA without cables attached is shown in Figure F-12.
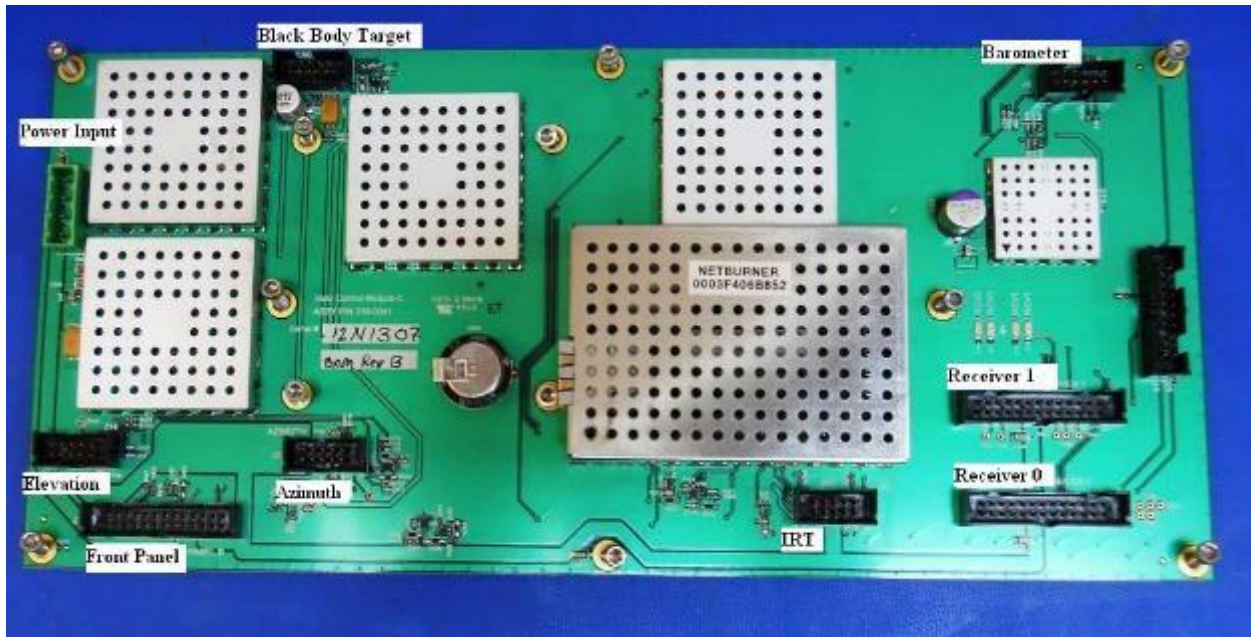
Figure F-12. MCM PCBA with no cables attached

3. Disconnect the following cables from the MCM:
   - Azimuth drive
   - Barometer
   - Black body target
   - Elevation
   - Front panel
   - IRT
   - Power input
   - Receiver 0
   - Receiver 1

   Be very careful to not confuse the Receiver cables when reconnecting.

4. Use the 7/64" socket head driver to remove the 12 screws that hold the MCM PCBA to the frame.

5. Carefully remove the MCM PCBA and place on a clean, dry surface, on an anti-static mat or in an anti-static bag.

6. Place the new MCM PCBA onto the card standoffs on the frame and fasten with the 7/64" socket head driver.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.6 Replacing the Front Connector Panel

Overview
This section provides instructions for replacing the Front Connector Panel for the MP-xx00A Radiometer.

Preparation
Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
- Torque driver
- 3/8" wrench
- 5/32" hex driver
- 3/32" hex driver
- #1 Phillips head screwdriver
- #2 Phillips head screwdriver

Procedure

WARNING!
Only trained personnel should perform this task!

1. Remove the radiometer from the Tripod, and place the instrument on a sturdy workbench or other clean work surface.

2. Remove the radiometer hood.

3. Use the 3/32" hex driver to remove the four screws that hold the Front Panel Voltage Guard (Figure F-13). *The guard will remain in place until after the Front Connector Panel is loosened.*

4. To release the AC Line Filter, carefully turn the radiometer on its side, as shown in Figure F-14. (Ensure the IRT assembly faces upward.)
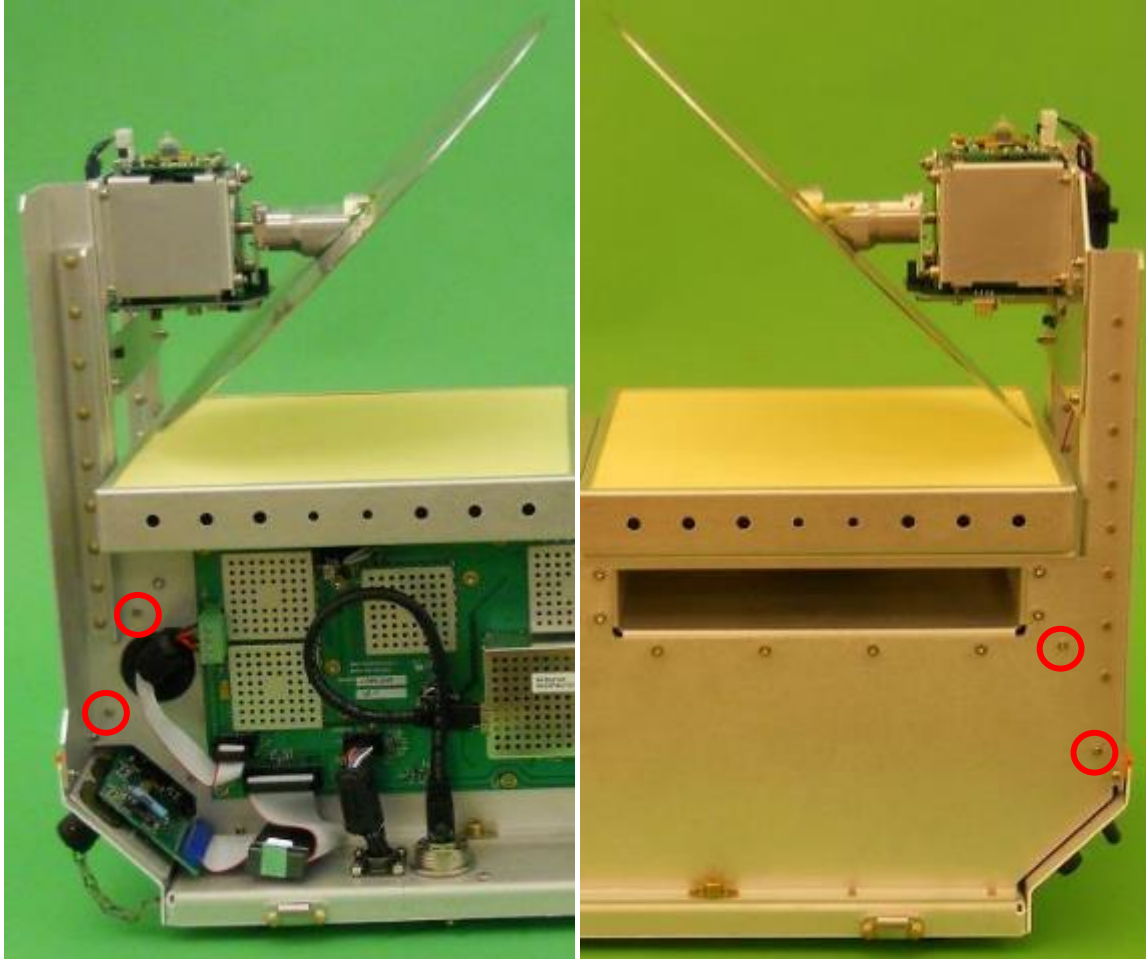
Figure F-13. Showing the four screws that hold the front panel voltage guard

5. Use the #2 Phillips to remove the two screws holding the AC Line Filter to the underside of the radiometer (Figure F-14).

Figure F-14. Underside of radiometer, AC Line Filter retaining screws circled

6. Use the #1 Phillips screwdriver to remove the top three screws circled in Figure F-15 below. Do not remove the remaining top screws.

Figure F-15. Front Connector Panel

7. Use the #2 Phillips screwdriver to remove the bottom three screws from the bottom of the Front Connector Panel, circled in Figure F-15.

8. Carefully pull the Front Connector Panel and the Front Panel Voltage Guard away from the frame (Figure F-16).

9. Use the 3/32" hex driver to remove the two screws that hold the Power Supply Terminal Guard (Figure F-16), and then remove the lower plastic connection shield.
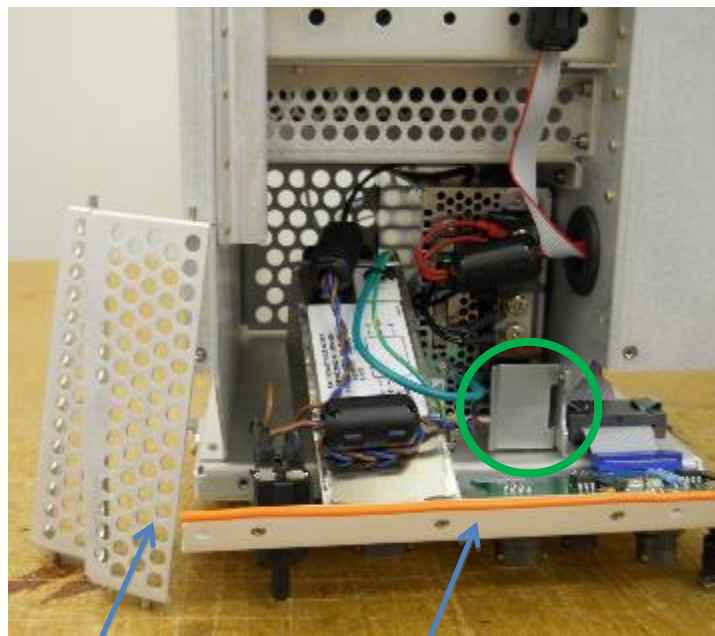
Figure F-16. Voltage Guard and Front Connector Panel removed, Power Supply Terminal Guard circled

10. Unplug the Front Panel ribbon connector from the MCM board (Figure F-17).

Figure F-17. Ribbon connector unplugged from the MCM board

You can now access the connections to the power supply.
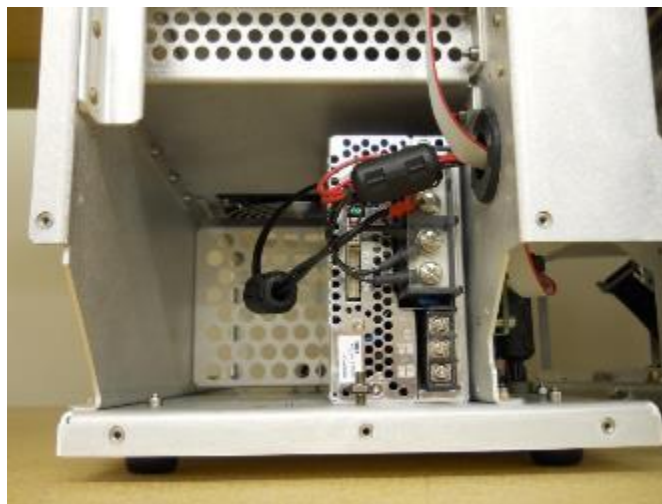
Figure F-18. Front of Power Supply

11. Make note of how the Power Supply's lower wires connect. Refer to Table F-1.

Table F-1. Front Panel wiring table

Power supply marking	Wire terminal	Wire color	Torque screws to	Position
FG (⏚)	Ground	Green	14.1 lb·in	Top
AC (N)	Neutral	Blue	14.1 lb·in	Middle
AC (L)	Power	Brown	14.1 lb·in	Bottom

12. Use the #2 Philips screwdriver to loosen the screws and disconnect the wires.

Use the 3/8" wrench to disconnect the chassis ground wire (Green/Yellow) from the radiometer frame.

13. Reverse the procedure to install the new Front Connector Panel. When reconnecting the Front Panel, use the torque driver to torque the wire terminals to 14.1 lb·in.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.7 Replacing the Power Supply

Overview

This section provides instructions for replacing the Power Supply for the MP-xx00A Radiometer.

Special Tool Requirements:

- Torque driver
- 5/32" hex driver
- 3/32" hex driver
- #1 Phillips head screwdriver
- #2 Phillips head screwdriver

Procedure

WARNING

Hazardous voltage enclosed.

Voltage or current hazard sufficient to cause shock, burn or death. Disconnect and lock out power before servicing.

WARNING!
Only trained personnel should perform this task!

Procedure

1. Remove the radiometer from the Tripod, and place the instrument on a sturdy workbench or other clean work surface.

2. Remove the radiometer hood as described in Section I of this Appendix.

3. Remove the radiometer Front Connector Panel as described in Section V of this Appendix.

4. Make note of how the Power Supply's upper wires connect, as shown in Figure F-19. Refer to Table F-2.

Table F-2. Power supply wiring table

Power supply marking	Wire terminal	Wire color	Torque screws to
+	From fan	Red	22.1 lb·in
+	MCM PCBA J8 Pin 1	Red	22.1 lb·in
+	MCM PCBA J8 Pin 3	Red	22.1 lb·in
−	From fan	Black	22.1 lb·in
−	MCM PCBA J8 Pin 2	Black	22.1 lb·in
−	MCM PCBA J8 Pin 4	Black	22.1 lb·in

Figure F-19. Front of Power Supply, showing two connection shields

5. Use the #2 Philips screwdriver to disconnect the wires. Note that these are a screw/lock washer/flat washer combination.

Figure F-20. Screw – lock washer–flat washer combination

6. To remove the power supply, carefully turn the radiometer on its side, as shown in Figure F-21. (Ensure the IRT assembly faces upward.)
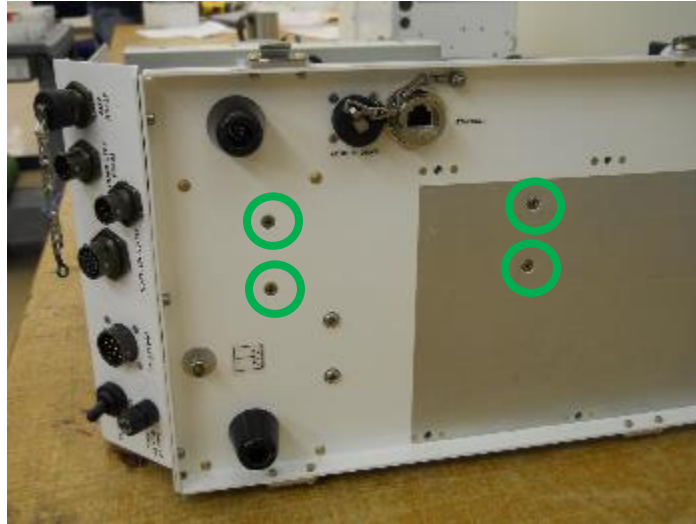
Figure F-21. Underside of radiometer, Power Supply mounting screws circled

7. Use the 5/32" hex driver to remove the radiometer Mounting Plate, and then detach the power supply from the frame by removing the four screws highlighted in Figure F-21. Note that one hand should be used to hold the power supply in place when removing these screws.

8. Remove the Power Supply from the radiometer.

9. Install the replacement Power Supply, reversing steps 1 thru 7. When reconnecting the Front Panel, use the torque driver to torque the wire terminals to 22.1 lb·in.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.8 Replacing the HC2-S3 Ambient Air Probe

Overview

This section provides instructions for replacing the HC2-S3 Ambient Air Probe for the MP-xx00A Radiometer. Prior to replacing the HC2-S3 sensor, test the radiometer's existing sensor, using the instructions listed in section 6.1.4.1 of the **Radiometrics Profiler Operator's Manual**. For maintenance information on sensor screen removal and cleaning, refer to section 6.1.4 of the **Radiometrics Profiler Operator's Manual**.

NOTE:

It is not required that the radiometer hood be removed for this procedure.

Special Tool Requirements:

- A straight-bladed screwdriver might be required to loosen the thumbscrews.

Procedure

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Remove the Superblower front panel.
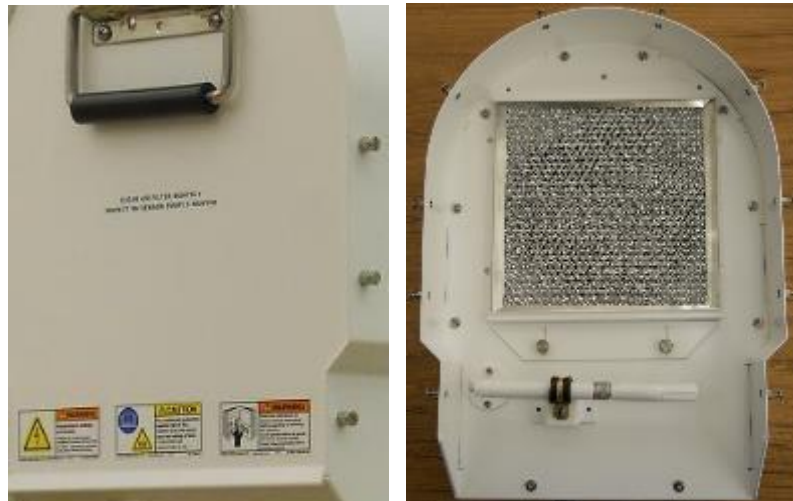
**Figure F-22. Loosened thumbscrews on Superblower cover;
cover removed (right)**

4. Loosen the locking metal collar that holds the air probe to the probe arm, and pull probe to the right to remove.
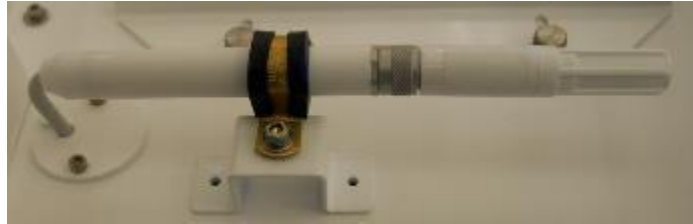
Figure F-23. HC2-S3 probe removal

5. Make note of how the probe pins align with the receptors, as shown below in Figure F-24.

Figure F-24. HC2-S3 Ambient Air Probe, showing receptors

6. Replace the HC2-S3 Ambient Air Probe, reversing the steps 1 thru 4.

The Superblower End Cover must be properly replaced to its original location prior to restarting the radiometer.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.9 Replacing the Superblower

Overview
This section provides instructions for replacing the Superblower for the MP-xx00A Radiometer.

NOTE:
It is recommended that the radiometer hood be removed for this procedure. It is easier to put just the radiometer hood on its end, instead of the entire radiometer.

Preparation

Remove the radiometer hood, as described in Section I of this Appendix.

Special Tool Requirements:
- Hex driver

Procedure
1. Place the radiometer hood on a workbench, with the Superblower facing upward, as in Figure F-25.

Figure F-25. Radiometer hood on workbench

If necessary, the Superblower can be removed with the instrument on the Tripod. The procedure requires two people:
- one person holds the Superblower in place, while
- the second person removes/reinstalls screws

2. Disconnect the Superblower cable from the Front Connector Panel.
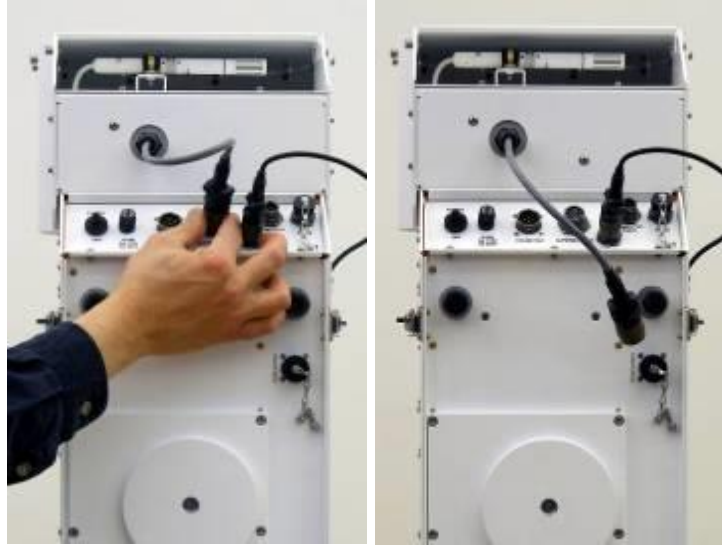
Figure F-26. Disconnecting Superblower cable / cable disconnected

3. Use the hex driver to remove the four screws and flat washers from the Superblower. Note the access holes in the side of the Superblower in Figure F-27.

Figure F-27. Removing Superblower screws (two on each side)

4. Use the handle and front face to lift the Superblower upward and separate it from the radiometer.

Figure F-28. Lifting Superblower away from the radiometer hood

5. Install replacement Superblower, reversing steps 1 thru 4.

The Superblower End Cover must be properly replaced to its original location prior to restarting the radiometer.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.10 Replacing the Front Connector Panel Fuse

Overview
This section provides instructions for replacing the Front Connector Panel for the MP-xx00A Radiometer.

NOTE:
It is not required that the radiometer hood be removed for this procedure.

NOTE:
No special tools are required for this procedure.

Procedure

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer, and disconnect the power cable from the Front Panel.

3. Locate the fuse cap in the Front Connector Panel (Figure F-29 below).

Figure F-29. Front Connector Panel

4. Turn the fuse cap counterclockwise and pull it away from the Front Connector Panel.

5. Discard the old fuse and replace with a new fuse.

NOTE:
Before installing a new fuse, confirm the mains supply voltage. Replacement fuses must be rated as shown in the table below, and they must be properly approved, based on the country of use (*e.g.,* UL and/or CE approved).

Table F-3. Replacement fuse ratings

Voltage Range	Fuse Rating	Fuse P/N
100VAC to 127V (50 or 60 Hz)	Medium acting, 250V, 6A, 5 x 20 mm	419-0015
220VAC to 240V (50 or 60 Hz)	Time lag, 250V, 3.15A, 5 x 20 mm	419-0012

6. Place the fuse within the fuse cap, so its markings are visible (Figure F-30).

Figure F-30. Fuse in fuse cap, markings visible

7. Insert the fuse cap back into the Front Connector Panel and turn it clockwise.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.11 Replacing the Hydrophobic Radome

Overview
This section provides instructions for replacing the Hydrophobic Radome for the MP-xx00A Radiometer. For maintenance information on radome cleaning, refer to section 6.1.3 of the **Operator's Manual**.

NOTE:
It is not required that the radiometer hood be removed for this procedure.

Special Tool Requirements:
* A #1 Phillips head screwdriver might be required to loosen the thumbscrews.

Procedure

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Remove the 32 external Phillips head screws and washers to unfasten the radome retainer from the radiometer.

4. Slide the radome retainer off of the radiometer.

5. Remove the old radome.

Radome Window
Retainer, with
external screws

Figure F-31. External screws, washers and radome retainer

To install the new radome:

1. Fit the radome within the radome retainer, and insert the top (center) screws and washers into the retainer to act as positioning guides

2. Slide the radome and retainer (together) onto the radiometer; align the two screws with the mating threaded holes and tighten the screws.

NOTE:
Do not over tighten the screws; doing so will deform the radome retainer.

3. Install the remaining screws starting from the top and working down the sides; the screws along the bottom of the retainer should be installed last.

4. Tighten screws evenly in pairs, while going down the retainer.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.12 Replacing the GPS Receiver

Overview
This section provides instructions for replacing the GPS Receiver for the MP-xx00A Radiometer.

NOTE:
Do not remove the radiometer hood for this procedure.

Special Tool Requirements:
- #2 Phillips head screwdriver

Procedure

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Disconnect the GPS Receiver cable from the radiometer Front Connector Panel.

   The GPS Receiver cable is fastened to the radiometer hood with two P-clips.

4. Use the #2 Philips screwdriver to disconnect the two P-clips from the radiometer hood (two 8-32 x 3/8" pan head screws with flat washers,).

   The GPS Receiver is attached to a GPS Mounting Plate (shown in Figure F-32) that is attached to a bracket on the radiometer hood.

5. Use the #2 Phillips screwdriver to disconnect the GPS Mounting Plate from the bracket on the radiometer hood (four Phillips 6-32 x3/8" round head screws with flat washers).

   The bottom side of the GPS receiver is attached to the GPS Mounting Plate, as shown in Figure F-32
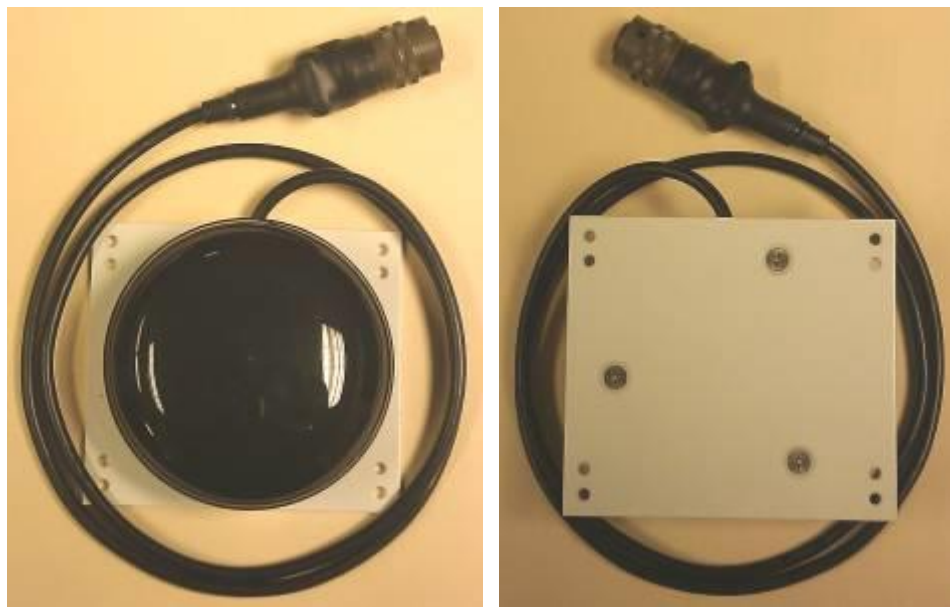
**Figure F-32. GPS receiver attached to Mounting Plate with
three screws (right)**

6. Use the #2 Phillips screwdriver to remove the GPS Mounting Plate from the GPS
   receiver (three metric M4 x 6mm flathead screws).

7. Install replacement GPS receiver, reversing steps 1 thru 4.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix.

F.13 Replacing the Rain Sense PCBA

Overview
This section provides instructions for replacing the Rain Sense PCBA for the MP-xx00A Radiometer.

NOTE:
Do not remove the radiometer hood for this procedure.

Special Tool Requirements:
- #2 Phillips head screwdriver

Procedure

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Use the #2 Philips screwdriver to disconnect the Rain Sense PCBA from the radiometer hood (four 6-32 x 3/8" pan head screws with flat washers).

4. Disconnect the cable to the radiometer from Rain Sense PCBA (Figure F-33).
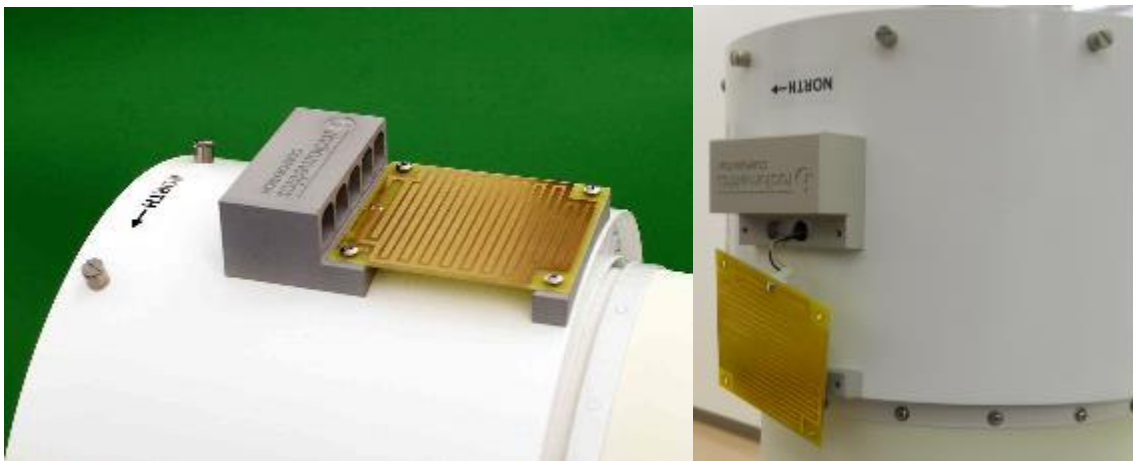
Figure F-33. Rain Sense PCBA, detached and showing cable on the right

5. Connect cable to the replacement Rain Sense PCBA (part number 316-0005).

6. Install the replacement Rain Sense PCBA, reversing steps 1 thru 4.

Return the Radiometer to Normal Operation

Refer to **Returning the Radiometer to Normal Operation** at the end of this Appendix

F.14 Returning the Radiometer to Normal Operation

1. Turn on the radiometer power switch. The blower fan should start, and the mirror motor movement should be audible during its self-test.

2. Power on the Control Computer.

3. Open VizMet-B and on the **Status/Control** tab, start the desired procedure. Monitor the tab for several minutes to ensure the desired procedure starts normally.

4. If the procedure does not start up normally, perform the following troubleshooting steps:

   a. Ensure the radiometer is powered on.

   b. Verify that the RS-422 data cable is connected to the **COMPUTER RS422** port on the radiometer Front Connector Panel, and not the **AUX RS422** port.

   c. If the radiometer Superblower is not running (blowing air over the Radome), turn off power and check the Front Connector Panel fuse.

   d. Repeat the process described above to remove the hood and ensure the connections to the power supply are correct and secure.

5. If none of these steps correct the problem, contact Radiometrics Customer Support for additional support.

F.15 Lists of FRUs and Consumables, with Part Numbers

Part No.	Description
317-0007	24V Power Supply
327-0004	IRT Window Assembly
319-0007	Front Connector Panel Assembly (MCM-C)
217-0001	GPS Receiver Assembly
119-0003	RS-422 Data Cable Assembly, 30 m
119-0008	RS-422 Data Cable Assembly, 60 m
119-0049	RS-422 Data Cable Assembly, 90 m
229-0012	Superblower Assembly (MCM-C)
316-0005	Rain Sense PCBA
316-0041B	Main Control Module Assembly (MCM-C)
119-0001	Power Cable Assembly, 30 m
119-0007	Power Cable Assembly, 60 m
417-0044	RS-422 to USB Adapter
229-0002	IRT Assembly
317-0005	IRT only (no bracket or temp probe)
419-0030	Setra Barometer, ext. range, 500-1100 mb (optional)
419-0031	Setra Barometer, 600-1100 mb (optional)
417-0119	HC2-S3
417-0065	HygroClip replacement filter cap
417-0066	HygroClip long-life Teflon filter cap
423-0100	Aluminum Mesh Filter
129-0004	Coated Hydrophobic Radome, 1-pack[4]
129-0003	Coated Hydrophobic Radome, 2-pack[3]
129-0006	Coated Hydrophobic Radome, 4-pack[3]
129-0009	Azimuth Positioner Assembly
419-0015	Fuse, 6 Amp, 100-127V[5]
419-0012	Fuse, 3 Amp, 220-240V[4]
119-0006	Ethernet Cable, 30 m
119-0030	Ethernet Cable, 60 m
119-0048	Ethernet Cable, 90 m
792-0001	Insulated Gloves
792-0002	Safety Goggles

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[4] See Section 6.1.3 of the Profiler Operator's Manual for information on cleaning the Radome.
[5] Located on the Front Connector Panel, refer to the Figure 3-10 in Section 3.8 of Profiler Operator's Manual for fuse location. Use appropriate fuse for commercial voltage.

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Appendix G: Azimuth Positioner Installation and Removal

Definitions

Azimuth Positioner
The Azimuth Positioner is used to point the radiometer to a specific azimuth defined by the user. The Azimuth Positioner is mounted on the bottom of the radiometer and connects to the Tripod with a T-Bolt.

Radiometer Mounting Plate
The radiometer Mounting Plate is attached to the bottom of the radiometer and provides the means to secure the radiometer to the Tripod with a T-Bolt. The radiometer Mounting Plate is not used when the Azimuth Positioner accessory is installed.

Introduction

All radiometers are supplied with a radiometer Mounting Plate as part of the standard equipment. The radiometer Mounting Plate provides the means of securing the radiometer to a Tripod or other mounting platform. Users who have purchased an Azimuth Positioner must first remove the radiometer Mounting Plate (if installed) before installing the Azimuth Positioner. Users who have purchased the Azimuth Positioner should not discard the radiometer Mounting Plate, but they should instead store it in the Reusable Shipping Container.

Note: Customers who require additional assistance should contact **Radiometrics Corporation:** supportmwr@radiometrics.com

Azimuth Positioner Installation Kit Contents

The following items are supplied for installation of the Azimuth Positioner on all A-Series radiometers**:**

- Azimuth Positioner, part number 129-0009
- Qty. six 10-32 x 3/4" socket head cap screw, part number 421-3034

NOTE:
Radiometers are typically shipped with the radiometer Mounting Plate (part number 423-3005) pre-installed to the bottom of the radiometer. When a radiometer is purchased with the Azimuth Positioner, the radiometer Mounting Plate will **not** typically be attached to the bottom of the radiometer. In these instances, the mounting hardware for the radiometer Mounting Plate will be located inside a plastic bag secured to the radiometer Mounting Plate. **The mounting hardware to secure the radiometer Mounting Plate to the radiometer is the same as the hardware used to secure the Azimuth Positioner**.

To install a radiometer Mounting Plate, the following are required:
a. Radiometer Mounting Plate, part number 423-3005.
b. Qty. six 10-32 x 3/4" Socket head cap screws, part number 421-3034.

Installation Tool and Parts Requirements

To install or remove either the radiometer Mounting Plate or an Azimuth Positioner, the installer performing the installation (or removal) will need the following tools and parts:

      Qty. one, 5/32" hex L-key or ball driver (supplied in the radiometer Tool Kit)

      Qty. six,10-32 x 3/4" Socket head cap screws, part number 421-3034

Installing the Azimuth Positioner

1. If the Mounting Plate is already installed on the radiometer, it must be removed before the azimuth positioner can be installed:

    a. If the radiometer is in operation:
       i.   Stop any current procedures running on the Control Computer
       ii.   Turn off power to the radiometer
       iii.   Disconnect power and data cable
       iv.   Remove the radiometer from the Tripod

    b. Place the radiometer on a workbench, with the Superblower facing upward, as shown in Figure G-1.

    c. Locate the six mounting holes used to secure the radiometer Mounting Plate.

    d. Remove the six 10-32 x 3/4" socket head cap screws (part number 421-3034).

Figure G-1. Underside view of radiometer with Mounting Plate

2. If the Mounting Plate is not installed, place the radiometer on a workbench, with the Superblower facing upward.

3. Locate the six mounting holes on the underside of the radiometer (these are the same mounting holes used with Mounting Plate). For reference, see Figure G-1.

4. Use six 10-32 x 3/4" socket head cap screws to secure the Azimuth to the bottom of the radiometer, as shown in Figure G-2.

5. On the bottom of the radiometer, connect the Azimuth Positioner Interface Cable to the connector receptacle labeled **AZIMUTH DRIVE**, as shown in Figure G-2.

Figure G-2. Underside of radiometer with Azimuth Drive installed

NOTE:
If the Azimuth Positioner Interface Cable is removed from the radiometer, attach the Cap to the **AZIMUTH DRIVE** connector receptacle on the bottom of the radiometer to prevent debris from entering the connector receptacle.

6. Refer to the **Radiometrics Profiler Operator's Manual** (supplied with the radiometer) for additional information on the operation of the Azimuth Positioner.

7. Mount the radiometer to the Tripod or other mounting platform using the T-Bolt supplied with the radiometer. **Make certain the T-Bolt is tight**.

8. Reconnect all power and communication cables and turn the radiometer power switch "On." The radiometer will move on the Tripod upon recognition of the Azimuth Positioner.

9. After all motions have stopped, slightly loosen the T-Bolt and rotate the radiometer so that the Superblower faces East (see **Radiometrics Profiler Operator's Manual**).

10. Retighten the T-Bolt.

Removing the Azimuth Positioner and Installing the Mounting Plate

NOTE:
After the Azimuth Positioner is removed, install the Mounting Plate onto the radiometer to be able to mount it to the Tripod.

1. Stop any current procedures running on the Control Computer.

2. Turn off power to the radiometer.

3. Disconnect power and data cables.

4. Loosen the T-Bolt and remove the radiometer from the Tripod.

5. Place the radiometer on a workbench, with the Superblower facing upward, as shown in Figure G-2.

6. Disconnect the Azimuth Drive positioner cable.

7. Locate the six mounting holes used to secure the Azimuth Positioner.

8. Remove the six 10-32 x 3/4" socket head cap screws (part number 421-3034).

9. Use the same six mounting holes and six 10-32 x 3/4" socket head cap screws(as those used to mount the Azimuth Positioner) to secure the Mounting Plate (part number 423-3005) to the bottom of the radiometer, as shown in Figure G-1.

10. If the Azimuth Positioner Interface Cable is removed from the radiometer, attach the Cap to the **AZIMUTH DRIVE** connector receptacle on the bottom of the radiometer to prevent debris from entering the connector receptacle.

11. Refer to the **Radiometrics Profiler Operator's Manual** (supplied with the radiometer) for additional information on the operation of the Azimuth Positioner.

12. Mount the radiometer to the Tripod or Quadpod using the T-Bolt supplied with the radiometer. **Make certain the T-Bolt is tight**.

13. Reconnect all power and communication cables and turn the radiometer power switch to **ON**.

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Appendix H: Cable Data
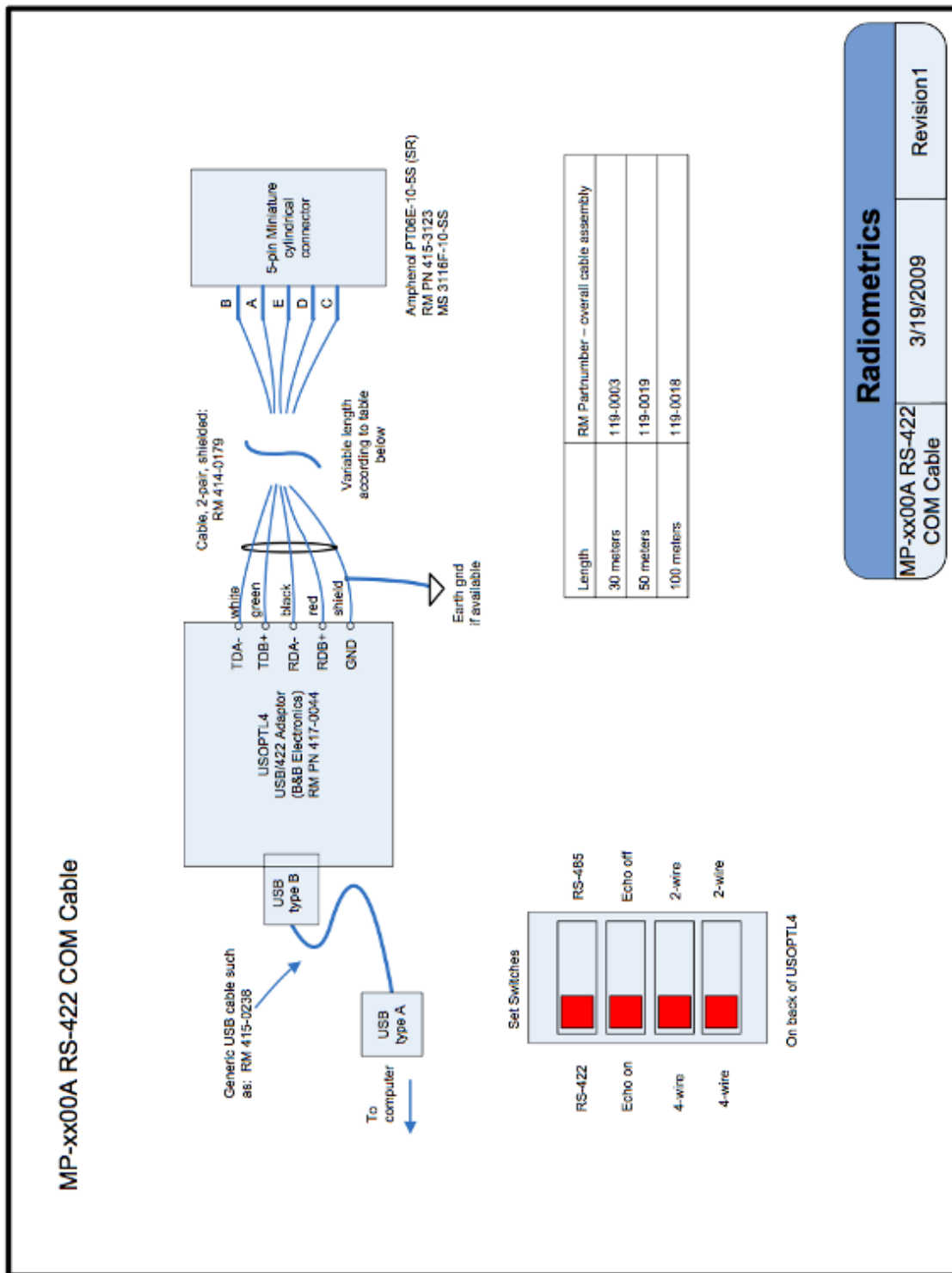
Figure H-1. RS-422 Com cable pin-out

MP-3000A Power Interface

Radiometer Power Cable (115VAC or 230VAC)
Cable connector: MS3116F–14–12S (also known as PT06E–14–12S(SR))
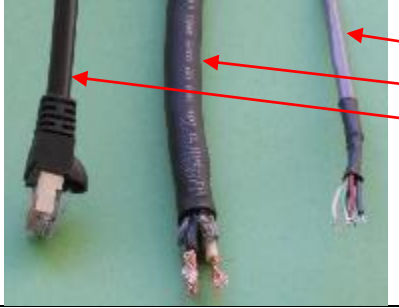
Table H-1. Radiometer power cable

Pin Connection	Mains Name	230VAC color	115VAC color
K	Hot	Black	Black
M	Neutral	White	White
L	Ground	Green	Green

Ethernet Cable
The Ethernet cable is a heavy-duty cable, rated for outdoor use. The supplied Ethernet cable is for connection to the Control Computer through a network, router, or switch. A crossover cable is required for direct connection to the Control Computer.

Table H-2. Cable and connector diameters

	Cable diameters • 0.25 inches for the RS-422 cable • 0.4 inches for the Power cable • 0.75 inches for the Ethernet cable
	Connector diameters • 1.12 inches for the Power cable • 1.30 inches for the Ethernet cable • 0.83 inches for the RS-422 cable
	Plug the USB connector into any available USB port on the Control Computer. Drivers for the USB adaptor are preinstalled. Refer to Figure H-1.

Appendix I: Radiometer Theory of Operation

This section describes the theory of operation for the MP-3000A. Ground-based microwave profiling methods make use of atmospheric radiation measurements in the 20 to 200 GHz region. The atmospheric absorption spectrum at several altitudes for a typical mid latitude atmosphere is shown in Figure I-1. Two altitudes and two water vapor densities are shown. The features near 22 GHz are water vapor resonances that are pressure broadened according to the pressure altitude of the water vapor distribution. The feature near 60 GHz is an assemblage of atmospheric oxygen resonances. The cloud liquid water emission spectrum has no resonances in this frequency range, and increases approximately with the second power of frequency in this region.
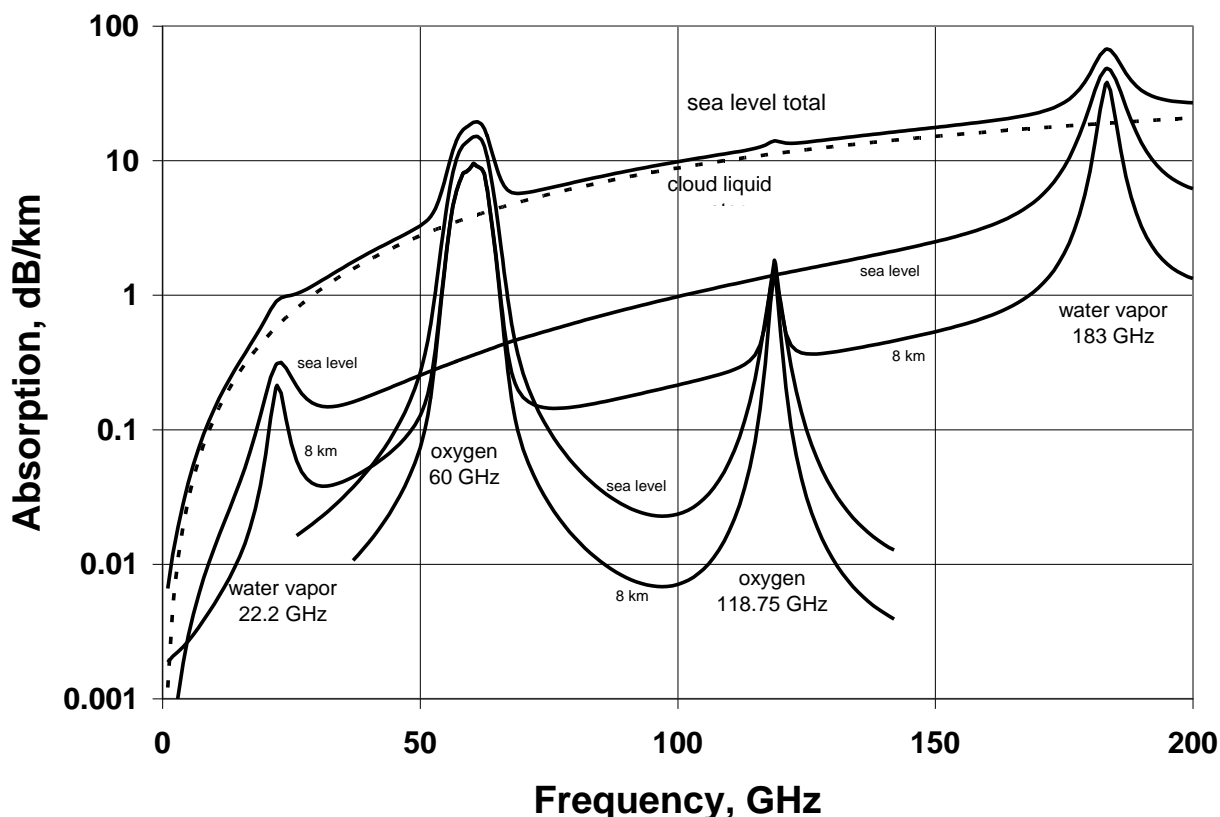
Figure I-1. Absorption spectrum of a typical mid-latitude atmosphere for two altitudes and two water vapor densities

Temperature profiles can be obtained by measuring the radiation intensity, or brightness temperature, at points along the side of the oxygen feature at 60 GHz. By sampling the brightness temperatures outward from line center, where the opacity is so great that all signal originates from the atmosphere close to the antenna, on to the "wing of the line", where the radiometer "sees" further into the atmosphere, the instrument can obtain

altitude information. Emission at any altitude is proportional to local temperature and density of oxygen; thus the temperature profile can be retrieved.

Water vapor profiles can be obtained by observing the intensity and shape of emission from pressure broadened water vapor lines. The line near 22 GHz is suitable for ground based profiling in relatively moist areas. The emission from water vapor is in a narrow line at high altitudes and is pressure broadened at low altitudes. The intensity of emission is proportional to vapor density and temperature. Scanning the spectral profile and mathematically inverting the observed data can therefore provide water vapor profiles.

Limited resolution cloud liquid water profiles can be obtained by measuring the contribution of cloud liquid water to atmospheric spectral features of varying opacity. Cloud liquid information in the 22 to 30 GHz and 51 to 59 GHz bands is used by the MP-3000A radiometer to produce a liquid profile. Cloud base altitude information derived from the IRT improves the water vapor and liquid water profile retrievals.

The absorption of the atmosphere in the vicinity of the assemblage of oxygen lines centered at 60 GHz at sea level and at 4 km is shown in Figure I-2. Pressure broadening smears the numerous oxygen lines into one broad feature. The 22 GHz water vapor line exhibits similar pressure broadening.
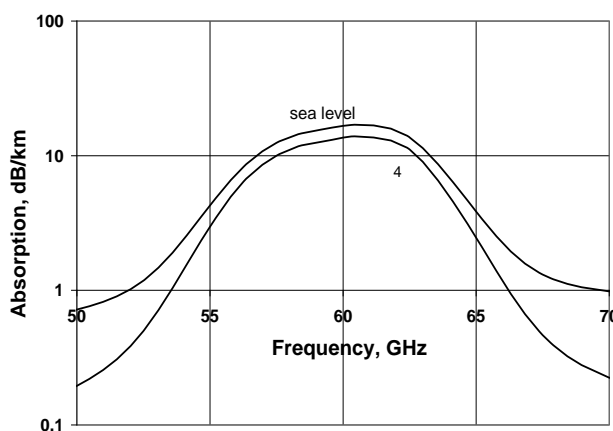
Figure I-2. Atmospheric absorption spectra near 60 GHz

Surface relative humidity, temperature, and barometric pressure are measured by the Profiling Radiometer and used in the determination of profiles. Additionally, a vertically pointed IRT indicates the presence of cloud, and measures cloud base temperature if clouds are present. Knowing cloud base temperature yields the vapor density at cloud base (at saturation), and combined with the retrieved temperature profile, yields cloud base altitude. These physical measurements are important constraints for profile retrieval.

Brightness Temperature Transfer Function

The Profiling Radiometer uses a state-of-the-art algorithm and calibration system to derive sky brightness temperature from the *level0* observations (receiver detector output voltage). This algorithm makes use of factory measured calibration coefficients to compensate for the small but finite effects of ambient temperature and system nonlinearity. The algorithm and calibration system also include proprietary methods for the elimination of most "1/f" noise in observations, thereby significantly reducing the overall noise compared to competing technologies. The transfer function is as follows:

$$\text{Tsky} = (\text{Vsky/gain\_sky})^{\wedge}(1/\alpha) - \text{Trcv\_sky}$$

Where measured values are:

Vsky	**=**	**integrated receiver output from a sky observation with Noise Diode off**
Vsky_nd	**=**	**integrated receiver output from a sky observation with Noise Diode on**
Vbb	**=**	**integrated receiver output from an ambient Black Body target observation with Noise Diode off**
Vbb_nd	**=**	**integrated receiver output from an ambient Black Body target observation with Noise Diode on**
TkBB	**=**	**Black Body target effective radiation temperature[6]**

Where calibrated parameters are:

α	**=**	**non-linearity correction exponent**
Tnd290	**=**	**Noise Diode temperature @ TkBB = 290K**
K1 - K4	**=**	**factory calibrated temperature coefficients**
dTdG	**=**	**receiver hardware specific parameter**

Where calculated values are:

gain_sky =		**gain during sky observation =** $[(\text{Vsky\_nd}^{\wedge}(1/\alpha) - \text{Vsky}^{\wedge}(1/\alpha))/(\text{Tnd290} + \text{TC})]^{\wedge}\alpha$
Trcv_sky =		**Receiver temperature during sky observation =** **Trcv_bb + dTdG*(gain_sky – gain_bb)**
gain_bb =		**gain during ambient Black Body Target observation =** $[(\text{Vbb\_nd}^{\wedge}(1/\alpha) - \text{Vbb}^{\wedge}(1/\alpha))/(\text{Tnd290} + \text{TC})]^{\wedge}\alpha$
Trcv_bb =		**Receiver temperature during ambient Black Body Target observation =** $(\text{Vbb/gain\_bb})^{\wedge}(1/\alpha) - \text{TkBB}$
TC =		**K1 + K2*TkBB + K3*TkBB^2 + K4*TkBB^3**

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[6] TkBB is the measured physical temperature of the ambient Black Body target adjusted for implementation bias.

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Appendix J: MP-3000A Service Schedule

Item	Interval
Check system Health Status in VizMet-B (or manually review lv0 files)	daily
Verify that profiler is generating new daily files	daily
Ensure profiles are realistic for current weather conditions	daily
Transfer recent TIP Calibration	monthly
Clean hydrophobic radome	monthly
Replace hydrophobic radome	6 mo
Clean aluminum mesh filter; replace if needed	monthly
Clean rain sense board, replace if needed	6 mo
Clean IRT window; replace if needed	6 mo
Field LN2 Calibration and B&L	6 mo
Post-LN2 calibration, send B&L and set of daily files to Radiometrics for review	6 mo

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Appendix K: MP-3000A Troubleshooting Procedures

Problem	Possible Cause	What to Do
Unable to connect to Radiometer.	(1) Ethernet cable disconnected. (2) Radiometer not powered on. (3) Ethernet connection not configured. (4) Front Panel damaged.	(1) Ensure Ethernet cable is securely connected to Radiometer Front Panel. (2) Ensure radiometer is powered on (verify that superblower is running). (3) Configure Ethernet connection as described in the MP-3000A Operators Manual, Chapter 4. (4) Replace Front Panel.
"Server Not Ready" error in VizMet-B.	(1) VizMet-B software crash. (2) VizMet-B corrupted.	(1) Stop then restart VizMet-B Server. (2) Uninstall and Reinstall VizMet-B (see Service Bulletin "Uninstalling and Reinstalling VizMet-B Windows-7").
System generating large number of daily files that show no data.	MCM-C needs reboot.	Stop current procedure, using Remote Desktop, shut down the ICC, then cycle power to radiometer; the ICC should restart normally. If problem persists, contact Radiometrics.
System not creating new daily file set; data from multiple days in the same data file.	Windows Scheduled Tasks were changed.	Restore Windows Scheduled Tasks (see Service Bulletin "Recreating Scheduled Tasks Windows-7").

Problem	Possible Cause	What to Do
Humidity profile shows continuous saturation at mid-levels, or saturation under clear skies.	(1) K-band out of calibration. (2) K-band attenuator needs adjustment. (3) IRT sensor problem.	(1) Transfer TIP Calibration. (2) Send lv0 file to Radiometrics for Diagnostics. (3) See IRT problems below.
Surface temperature or RH measurements are unrealistic (too high or too low).	Wrong sensor offset in the mp.cfg file.	If a HC2-S3 sensor is replaced, the sensor offsets in the mp.cfg file need to be updated to match the new sensor. Contact Radiometrics to get new offsets.
Surface temperature or RH measurements are "0" or "999" or constant (value never changes).	Defective HC2-S3 sensor.	Verify problem by checking data in the lv0, lv1 or lv2 data files. Replace sensor.

Problem	Possible Cause	What to Do
Unrealistic Temperature, vapor, and/or RH profiles.	(1) Defective HC2-S3 sensor. (2) Radiometer Out of Calibration. (3) Wrong Neural Net files. (4) Defective barometer. (5) Defective K-band or V-band Receiver.	(1) Verify problem by checking surface temperature and RH data in the lv0, lv1, or lv2 data files. Replace HC2-S3 Sensor. (2) Perform LN2 calibration and/or Transfer Tip calibration. (3) Verify that the procedure file being used calls the correct NNs for the site. (4) Verify problem by barometric pressure in the lv0 or lv1 data files. Replace the Setra barometer if needed. If the problem persists, send set of recent data files to Radiometrics for analysis.
System not generating profiles.	Procedure file being used does not generate profiles.	Check procedure file in the VizMet-B Status/Control tab. The procedure should be the site-specific procedure.
Health Status of a subsystems continuously yellow or red.	Subsystem failure or communications error.	Send set of files (lv0, lv1, lv2, ser, and healthstatus) files to Radiometrics for diagnosis.

Problem	Possible Cause	What to Do
Rain Flag on continuously.	(1) Rain sense threshold voltage at incorrect setting. (2) Contamination or conducting material on rain sense board.	(1) Verify rain sense setting in the mp.cfg file is correct; increase voltage threshold if needed. (2) Clean rain sense board; replace if damaged or heavily corroded.
Error displayed continuously on VizMet-B Status/Control tab.	(1) The most recent error message will display until the next daily files are created. (2) An ongoing problem.	Review the lv0 file to determine the frequency of the error; refer to the error messages chart in Appendix C of the Operators' Manual. If the error is only occurring once daily when a new set of files starts; it can be ignored. If the error occurs frequently, contact Radiometrics for support; if uncertain, send a recent lv0.csv file to Radiometrics for analysis.

Problem	Possible Cause	What to Do
Azimuth Drive not moving correctly.	(1) Azimuth Drive not connected to radiometer. (2) Procedure running does not use Azimuth Drive. (3) Cords/objects obstructing movement. (4) Azimuth Drive is inoperative.	(1) Ensure connection from the Azimuth Drive to the radiometer is correct and secured. (2) Some procedures do not call for the Azimuth Drive to turn to specific directions. Ensure the procedure running includes Azimuth positions. (3) Ensure power and data cables are not wrapped around radiometer; cables should be dressed properly to ensure the radiometer can turn freely. Ensure no foreign objects are obstructing radiometer movement. (4) If the Azimuth Drive makes a grinding or a humming sound but does not turn, the drive gears may have stripped. Contact Radiometrics for Repair.

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Appendix L: Radiometer Error Sources

The operator should be aware of the following error sources:

- The Sun is a 6,000 K Black Body radiator. Therefore, K and V band Observations (3-6 degree beam width) should be avoided in directions within ~15 degrees of the Sun position, where error up to 60 K can result.

- Neural network retrieval algorithms are somewhat site dependent, especially for retrieval of water vapor and liquid water. The operator should ensure that the retrieval coefficients are representative for the observation site. Such retrieval coefficients are generated from a history of radiosonde (RAOB) data from a representative site.

- Liquid water on the Profiling Radiometer radome can result in artificially high radiometer brightness temperature measurements. However, Radiometrics' patented Rain Effect Mitigation (REM) system, which includes the hydrophobic radome and Superblower, minimizes the accumulation of liquid water on the radome and provides measurement capability during most precipitation events.

- Radio frequency interference (RFI) can cause "spikes" in the data. Although Radiometrics has implemented RFI protection throughout the systems, transmitters in the 22 to 30 GHz and 51 to 59 GHz regions can interfere with the Profiling Radiometer receivers. Observations are averaged to minimize this effect. However, spikes with a magnitude greater than several degrees Kelvin can affect the accuracy of the retrieved profiles. The Profiling Radiometer should be installed in a location that is isolated or shielded from all strong radio transmitters.[7]

- Calibration error will degrade the inherent instrument accuracy. Noise Diodes provide an accurate, high stability operational gain reference, but they are only as accurate as the accuracy of the primary standards used to calibrate them. Care should be taken when calibrating the Noise Diodes using either of the methods described herein. The internal ambient Black Body target provides a means to calibrate the system temperature, from which the receiver temperature (Trcv) is derived. The receiver temperature is very stable, so observations of the Black Body target can be relatively infrequent. To minimize Trcv error during periods of rapidly changing ambient temperature, receiver temperature calibrations should be performed every 5 minutes or more often.

- In all radiometers, the system gain fluctuates with "1/f noise", resulting in added random noise in the observations. For typical integration times (~1 sec), 1/f noise can be dominant. All Profiling Radiometers use Radiometrics' proprietary calibration methods and transfer function to virtually eliminate 1/f noise contributions.

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[7] Note that Radiometrics' patented frequency-agile architecture uniquely provides the means to select RFI-free channels within each band to mitigate RFI problems, should they develop. If the user suspects RFI problems, contact Radiometrics for assistance in programming alternative frequencies.

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Appendix M:Single User Graphical User Interface (GUI)

To start the Operating Code (Single User GUI), double click the Operating Code shortcut icon on the Windows Desktop. This will load the profiling radiometer program (mp.exe). Diagnostic tests will be automatically performed immediately. Then the Control Computer will display an array of small housekeeping data graphs (sometimes referred to as "engineering data") that indicate the state of the instrument.

Figure M-1 shows the display following a successful power on test of the MP-3000A. When the graphs of Tknd0 (K band noise diode physical temperature) and Tknd1 (V band noise diode physical temperature) stabilize at 323.15 ± 0.1 K (+50.0C), the receivers have reached thermal stability, and observations can be started.[8] (Note: The MP-1500A and MP-2500A single band profiling radiometers only display information for one receiver, rcvr0).
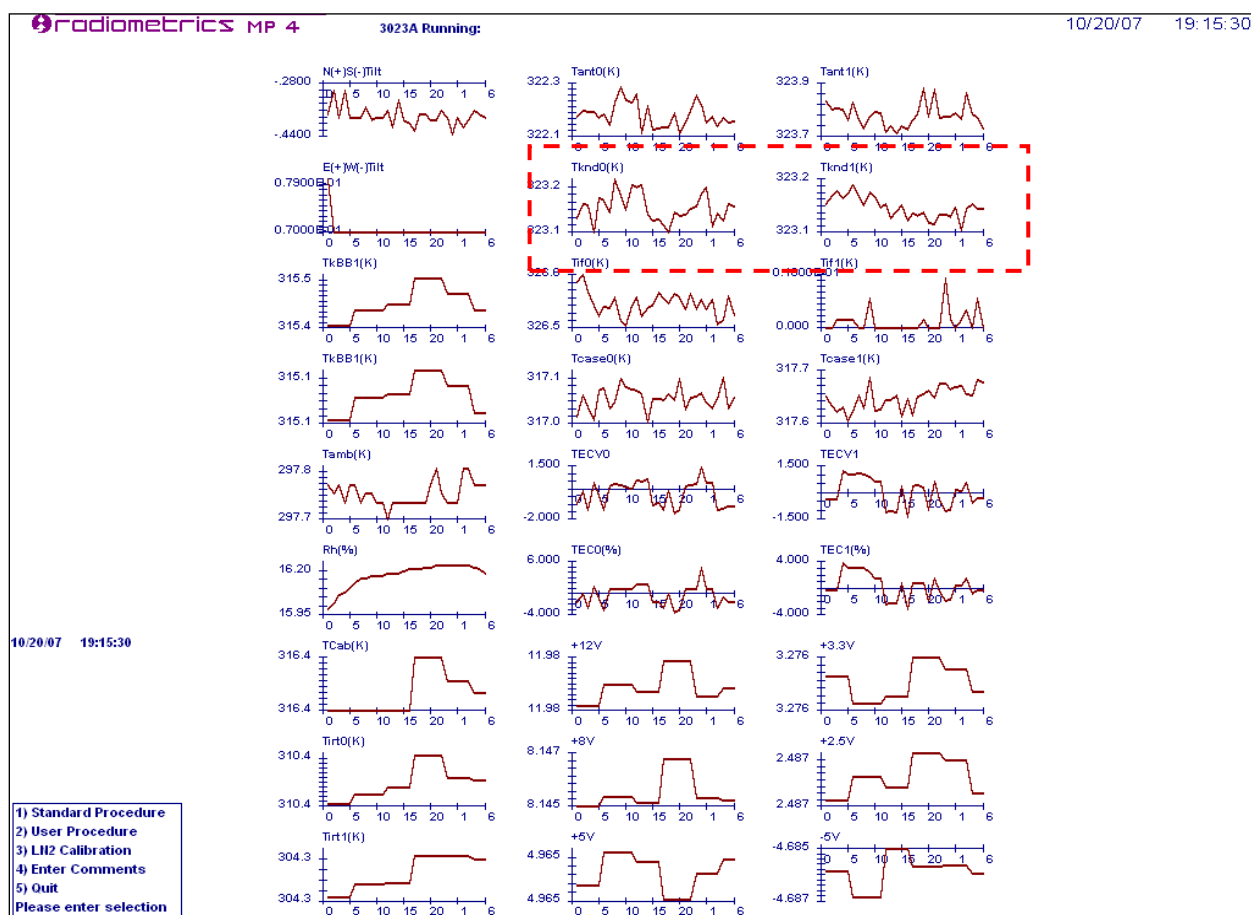

Figure M-1. Operating Code display after power-on tests have completed

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[8] The normal receiver operating temperature is factory set to +50C but may be changed at the factory for special cases.

NOTE:
If the cursor is moved to the lower edge of the screen while in Windows, the full-screen display will change to a windowed display with scroll bars at the side and bottom of the screen. Other programs can then be selected from the bottom tool bar. To return to full screen, press **Alt-Enter**.

The main menu is displayed in the lower left corner of Figure M-1, and enlarged in Figure M-2 below.

```
1) Standard Procedure
2) User Procedure
3) LN2 Calibration
4) Enter Comments
5) Quit
Please enter selection
```
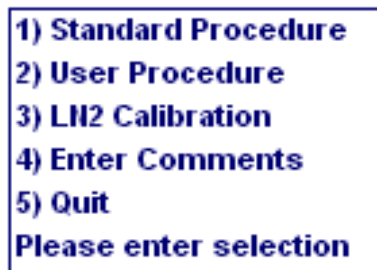
Figure M-2. Main menu screen

From the main menu, the user may select from the following five options:

Table M-1. Main menu options

1. Standard Procedure	Select from a list of standard factory-supplied procedures.
2. User Procedure	Select from a list of previously written user-defined procedures.
3. LN2 calibration	Perform an LN2 user calibration with the external Cryogenic Target.
4. Enter Comments	Enter a brief note (free-form text) that will be appended to the next level0 data file.
5. Quit	Make the Operating Code terminate execution after an orderly shutdown.

NOTE:
The radiometer may be operated immediately after installation, but it should be recalibrated before "official" data collection begins, and after any transport.

To begin observations immediately using the Manual Mode and a factory-preconfigured procedure, choose option 1 (press the "**1**" key). The next screen will display the available standard procedures one at a time by scrolling through the list using the "**<**" and "**>**" keys.

Scroll to the procedure named "Zen_35_tb.prc" and press "Enter" to begin. Zen_35_tb.prc is a procedure that will exercise most of the instrument observation functions. For the MP-3000A, Zen_35_tb.prc does the following:

- logs 48 housekeeping data values, including the GPS time, date and position
- performs a 35-channel receiver temperature calibration and a 21-channel TIP calibration
- observes all 35 zenith brightness temperatures

To generate Lv2 retrievals, start a procedure fill that calls neural nets.

After a few observation cycles, the screen will display a set of real-time graphics similar to those in Figure M-3. The user may toggle between the three screens illustrated in Figure M-3, Figure M-4 and Figure M-5 below to see views of level1 data and TIP calibration data. Toggle the screens by pressing the **1**, **2** and **T** keys:

- **1**   View brightness temperatures for all channels
- **2**   View profiles of temperature, RH, vapor and liquid, and time series of integrated vapor and liquid
- **T**   View TIP calibration derived values of Tnd
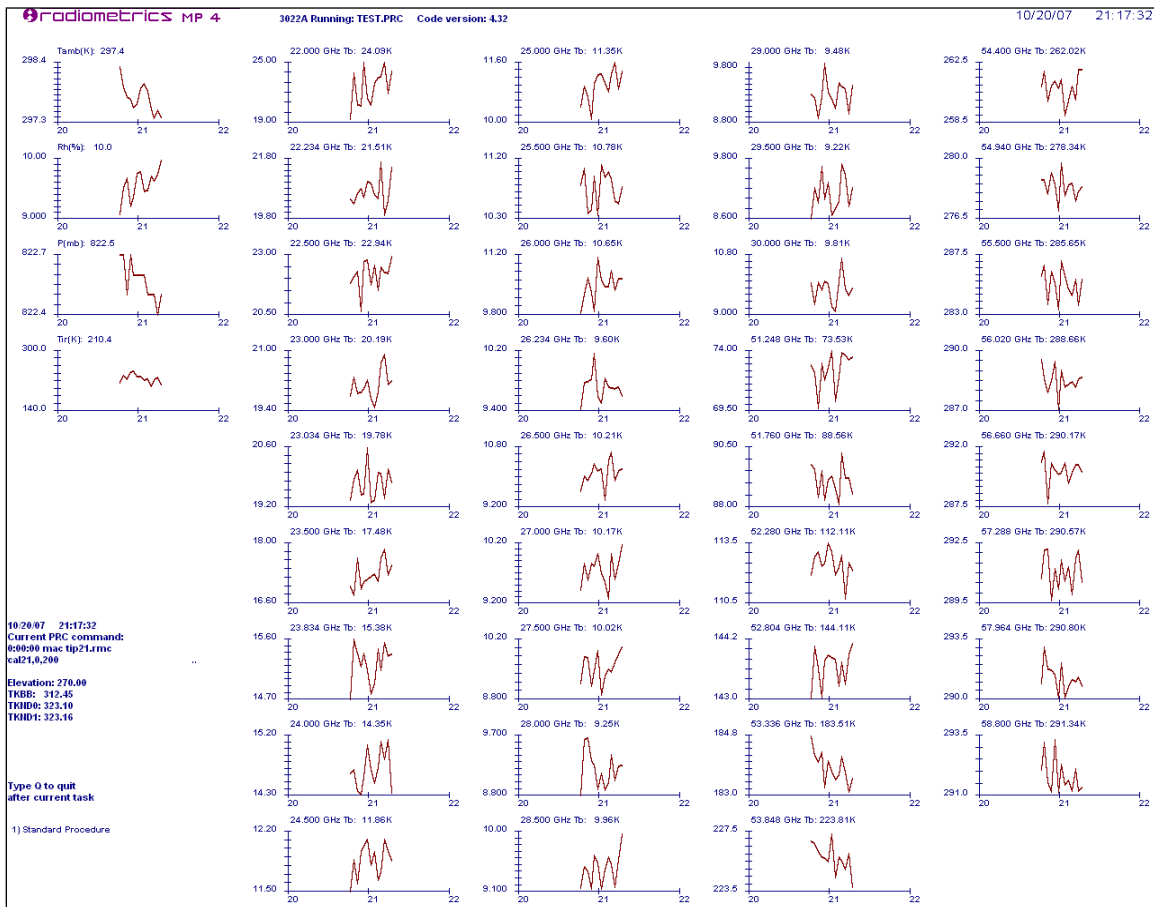
Figure M-3. Key 1 for level1 data (brightness temperature)
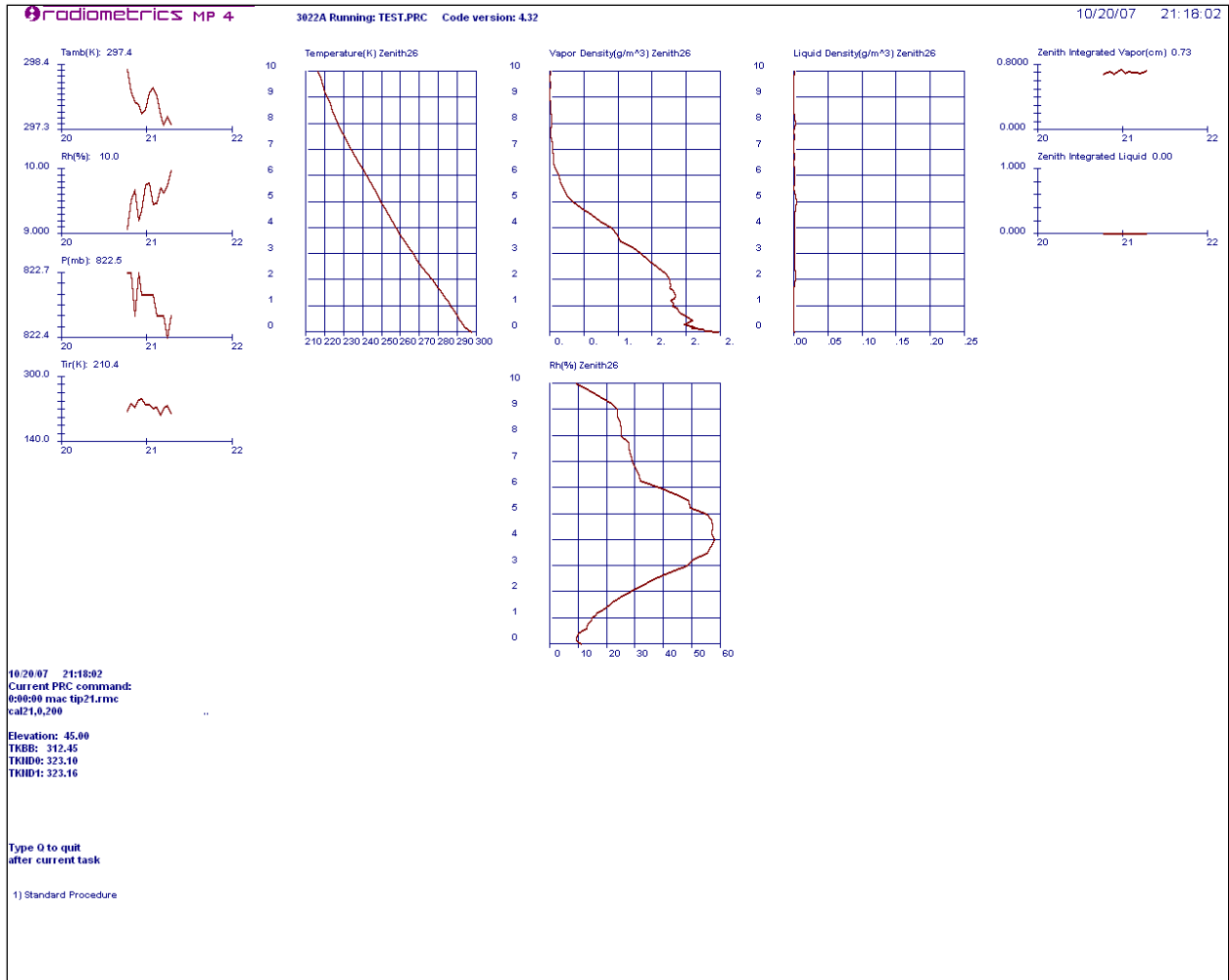
Figure M-4. Key 2 for level2 data (profiles and integrated values)
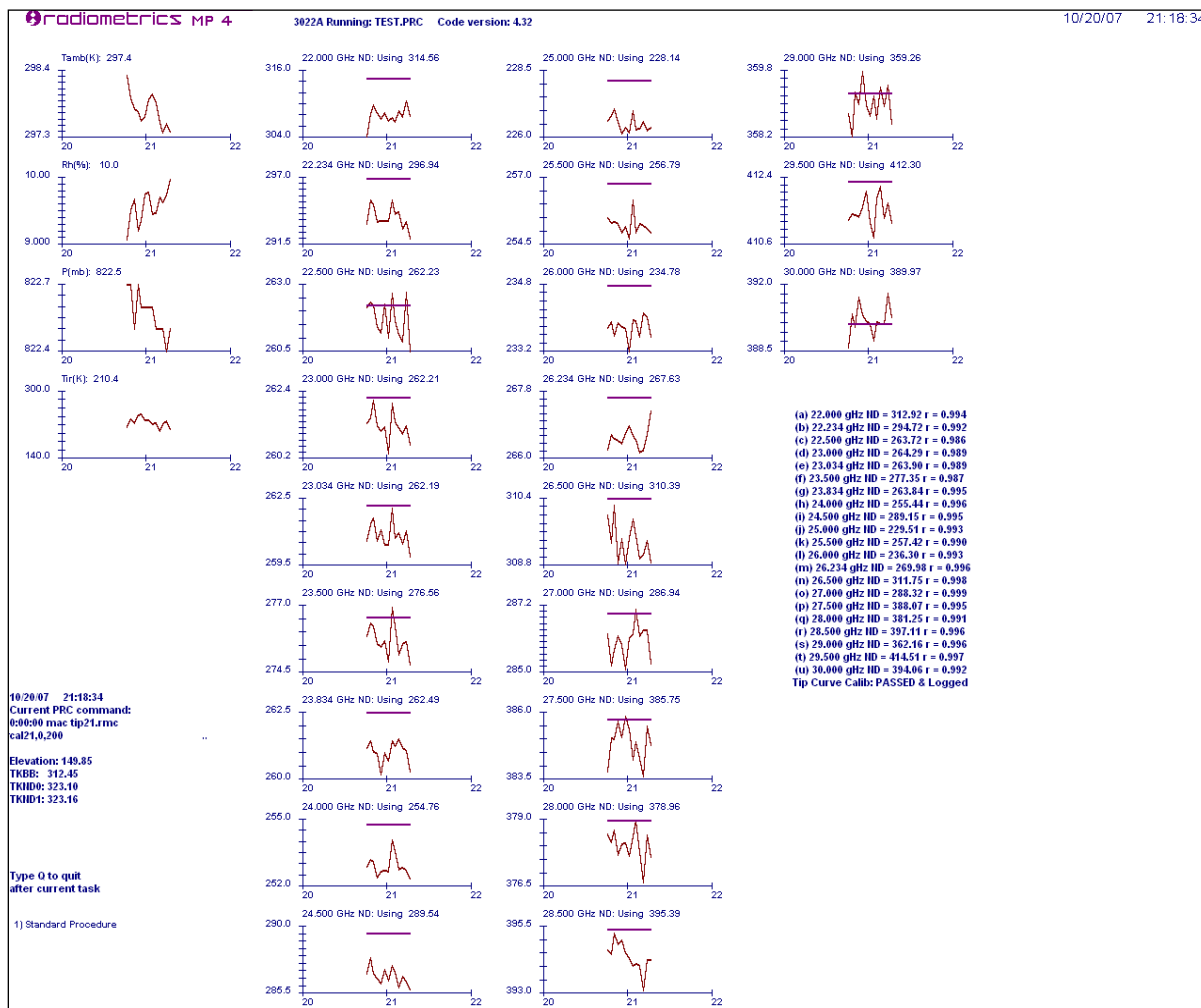
Figure M-5. Key T for TIP calibration display: K band noise diode calibrations

NOTE:
The availability of **1**, **2** and **T** displays will depend on the procedure file used.

For the limited purpose of this initial test, it is sufficient to verify that the instrument and software produce displays similar to those viewed above. To terminate the test, press the "**Q**" key. This causes the Operating Code to stop in an orderly manner after completing the current observation. Section 6 provides a more detailed description of the operation of the instrument.

CAUTION

Ending the program by closing the window may corrupt data files.

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Appendix N: Specifications, Weights and Dimensions

Function or Parameter	Specification
Calibrated Brightness Temperature Accuracy[9]	0.2 + 0.002*|TkBB-Tsky| [10]
Long Term Stability	<1.0 K / yr typical
Resolution (depends on integration time)[11]	.01 to 1 K
Brightness Temperature Range[12]	0-400 K

Antenna System Optical Resolution and Side Lobes
    22-30 GHz
    51-59 GHz
	
	4.9 - 6.3° -24 dB
	2.4 - 2.5° -27 dB

Integration Time (user selectable in 10 msec increments)	0.01 to 2.5 seconds

Frequency Agile Tuning Range (Accuracy = $\pm$ 2*10^{-6})
    Low Water Vapor Band (MP-3000A)
    Oxygen Band (MP-3000A)
Minimum Frequency step size (K band; V band)
	
	22.0 – 30.0 GHz (K band)
	 51.0 – 59.0 GHz (V band)
	10; 20 MHz

Standard calibrated channels MP-3000A	 35
Pre-detection channel bandwidth (effective double-sided RF bandwidth)	300 MHz

Surface Sensor Accuracy
    Temperature (-50° to +60° C)
    Relative Humidity (0-100%)
    Barometric pressure (10 – 1300 mb)[13]
    IRT[14] (Note: ΔT = Tambient - Tcloud)
	
	0.5° C @ 25°C
	2 %
	$\pm$1.5 mb
	(0.5 + .007*ΔT)°C

Brightness Temperature algorithm for *level1* products	4 point nonlinear model
Retrieval algorithms for *level2* products	Neural Networks

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[9] Specified accuracy for instrument calibrated with an external target with no error.

[10] Absolute accuracy is best for sky brightness temperatures close to ambient, such as for the highest V band channels, and degrades as the absolute difference between the black body reference and sky temperatures increases.

[11] Typical resolution for 250 msec integration time is 0.25 K.

[12] Wider ranges are available. 0-400K is optimum for meteorological applications.

[13] A high-accuracy barometer (600 – 1100 mb $\pm$ 0.5 mb) is optional.

[14] The IRT is on all Profilers. The standard Field of View (FOV) = 5°. Other lenses are available.

Function or Parameter	Specification

Calibration Systems
      Primary standards
      Operational standards
	
	LN2 and TIP methods
	Noise Diodes + ambient Black Body Target

Environmental Operating Range
     Temperature
     Relative Humidity [ambient air]
     Altitude
     Wind (operational/survival)
	
	-40° to +45°C[15]
	0-100 % non-condensing
	-300 to 3000 m
	30 m/s / 60 m/s

Physical Properties
     Size (H x W x L)
     Mass
	
	86 x 53 x 31 cm
	27 kg (with IRT)

Electrical Ratings
    Voltage   115VAC / 60Hz / 3A
               230VAC / 50Hz / 1.5A
    Phase/Wire   1ϕ / 2C + Ground
	200 watts typical (Tamb = +25C)
	400 watts max at "cold start"

Data Interface
     Primary computer port
     Auxiliary port
     Standard cable length[16]
	
	RS422 57600 kb/s 8N1
	RS422 1.2 - 57600 kb/s 8N1
	30 m

Data File Formats	ASCII CSV (comma separated variables)

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[15] A high operating temperature option is available to extend operational temperature to +50C. Contact Radiometrics for details.

[16] The 30 m length is standard. RS422 communications cable lengths up to 1000 m are available by special order.

Weights and Dimensions

MP-3000A	26 kg	Instrument weight w/o IRT
	27 kg	Instrument weight w/IRT
	87x53x31 cm	Instrument dimensions
	76 kg	**Instrument/IRT/Ship Container**
	85 kg	**Instrument/Az Drive/IRT/Ship Container**
Case Dimensions (2x)		**Dimensions of shipping containers**
34" x 24" x 12.5"		See Figure N-1 for standard palletized
(86.4 x 61 x 31.8 cm)		shipping configuration
• Radiometer case:	**86 lbs (39 kg)**	
• Accessories case:	**102 lbs (46 kg)**	

CALIBRATION TARGET	4 kg	Weight with housing
	48x53x31 cm	Dimensions
	14 kg	Weight with LN2
	7 kg	**Weight in ship container w/saddle**
	66x58x41 cm	**Ship container dimensions**

TRIPOD	12 kg	Instrument weight
	63x168 cm	Height x diameter, minimum leg extension
	13 kg	**Packed in shipping container**
	94x28x15 cm	**Dimension of shipping container**

AZIMUTH DRIVE	9 kg	Instrument weight
	30x18x15 cm	Instrument dimensions (not including cable)

DEWAR, 25 L	15 kg	Boxed weight
	43x43x69 cm	Boxed dimensions

RADOME 2 or 4 PK	1 kg	Boxed weight
	63.5x25x5 cm	Boxed dimensions

Figure N-1. Typical MP-3000A Shipping Configuration, on 40 x 40 in Pallet