

The PMEL MAPR

(Miniature Autonomous Plume Recorder)



*NOAA/Pacific Marine Environmental Laboratory/VENTS Program
Seattle, WA*

Introduction



The PMEL MAPR is a durable, self-contained instrument that records data from temperature, pressure, optical backscatter (LBSS, or “nephelometer”) and oxidation-reduction potential (ORP) sensors located at one end of the instrument. Data is recorded internally, and cannot be accessed or viewed during deployment. Clamp inserts are available for a variety of different cable sizes, or alternatively, MAPRs can be secured (ie, with hose clamps) to the frame of other packages being deployed.

Getting Started

MAPR shipments include:

- MAPR instruments
- Tool box with necessary tools and supplies
- MAPR→computer serial communication cables (in tool box)
(Impulse subminiature 3-pin connector for MAPR COM port on one end, 9-pin RS232 serial connector on the other end)
- Instruction manual and software CD
- Spare batteries

User must supply:

- A computer with Windows operating system (English language)
- Microsoft Office (Excel is required)
- Media for backing up/archiving data

NOTE: MAPR programs and macros have been tested with Win95/98/Me or NT/Win2000 operating systems and Excel 2003. Issues related to use of these programs and files in Windows 7 and Excel 2007, where known, are noted throughout this manual

Upon receipt of a MAPR shipment, please inspect the contents of the box to become familiar with the items included and check for any signs of damage that may have occurred during shipping. Notify Sharon Walker (Sharon.L.Walker@noaa.gov) or Dr. Ed Baker (Edward.Baker@noaa.gov) of any missing or damaged items.

MAPR software installation

To install the program and required files:

- Create a new folder named **MAPR WorkSpace**
- Install the **MAPR-Terminal** program:
 - open the **MAPR-Terminal SetupDisk** folder on the MAPR software CD
 - run **Setup.exe** to start the Setup program.
- Follow the steps in the Setup utility:
 - Click **Change Directory** and browse to select the **MAPR WorkSpace** folder as the destination for the program installation.

HINT: Click on the large square button with the computer icon (upper left area of window) once the **MAPR WorkSpace** folder has been selected to continue with the program setup.

→ You will get a “completed successfully” message box when the installation is complete.

- Copy all the files in the “**MAPR Files Disk**” folder to the **MAPR WorkSpace** folder.

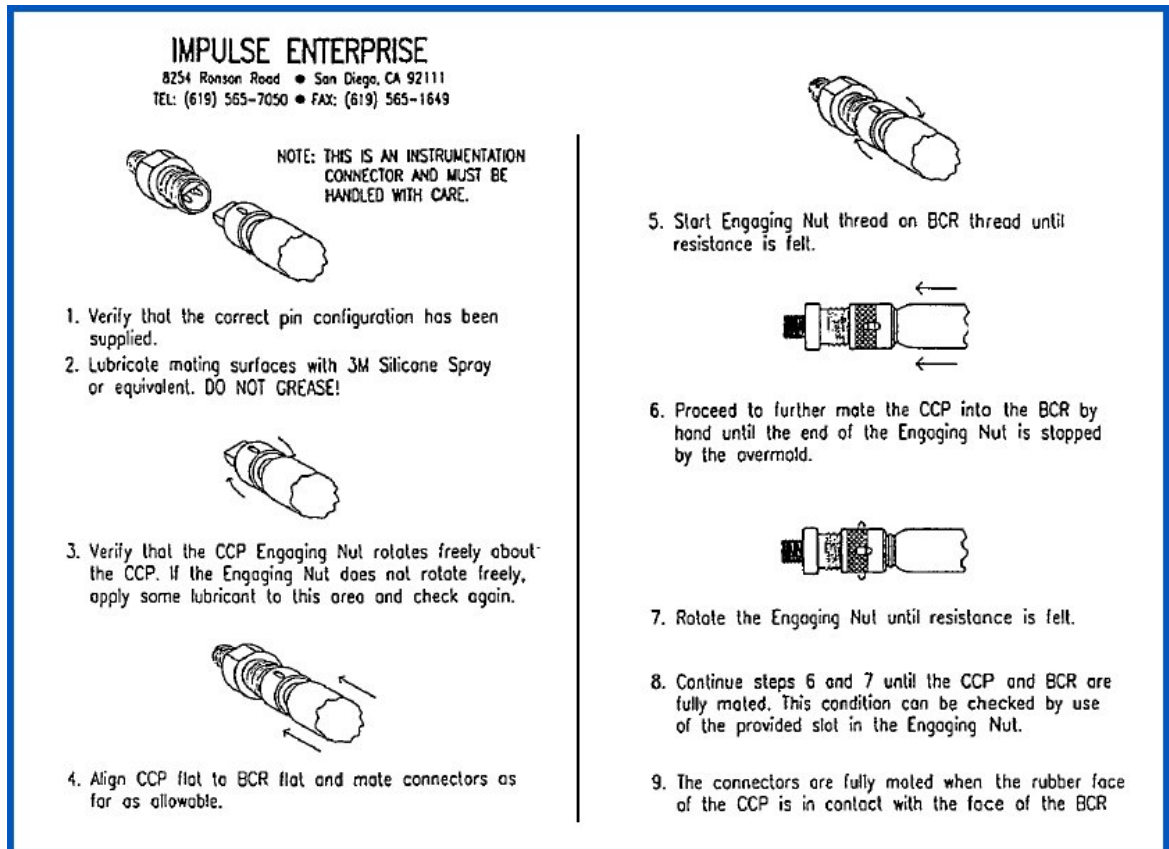
This folder includes the most current version of the Excel workbook **MAPRWorkbook.xls** (the date of the most recent version is included in the file name), test data files, the MAPR manual, supplemental files with more recently updated information, and information about the Ultralife U9VL-J lithium batteries that are supplied with the MAPRs (including the MSDS).

- Create a **Shortcut for the MAPR WorkSpace** folder and place it on the desktop for easy access. You may want to also create a shortcut for the **MAPRTerminal** program on the desktop for easy access.

Connect to the MAPR

- Remove the dummy plug from the COM port on the MAPR and attach the special communications cable that has been provided.

HINT: Be careful to fully seat the Impulse micro-connector when attaching either the communications cable or the dummy plug. Follow manufacturer's instructions shown below:



- Connect to a serial port on your PC.

NOTE: USB to Serial adapters must be RS-232 communications compliant. When using a USB to Serial adapter, determine and note which COM port number is assigned to this connection. [The COM port assigned to the USB to Serial adapter can be found in the Device Manager: (Windows XP) **Start → Control Panel → System → Hardware → Device Manager**]

CAUTION: The USB to Serial adapters sent with the MAPR shipments are known to be RS-232 communications compatible, however updated drivers may be required for use with Windows 7.

Communicate with the MAPR

MAPR communication is via standard RS232 serial protocols. The **MAPRTerminal** program is a serial communication (RS232) program designed specifically for use with MAPRs and provides access to the most often used MAPR functions and commands in a point-and-click environment. Use the **MAPRTerminal** program to communicate with the MAPR, configure MAPRs for deployment and download data.

NOTE: Any standard RS232 serial communication program (i.e., the HyperTerminal accessory program included with Windows) may be used to communicate with the MAPR, however, the user will need information beyond the scope of this manual to do so. The MAPR command set and other pertinent information is available if required.

To communicate with the MAPR:

- Connect the MAPR to the computer using the cable provided (see **Connect to the MAPR** section of this manual)

Make sure the computer system date/time is set and synchronized to the same time used standard for other ship-board data (i.e., UTC time for GPS navigation).

[Start → Control Panel → Date and Time]

- Run the **MAPRTerminal** program (Figure 1)
- Click the **Set Communication Port Properties** button to change port settings if necessary.

HINT: The default settings are as required by the MAPR. It should only be necessary to change the COM port number if using a USB to Serial adapter (i.e., the COM port number is automatically assigned by Windows when the USB to Serial adapter is installed).

Default settings are:

- Port = COM1
- Maximum Speed = 57600
- Echo = off
- Data bits = 8
- Parity = none
- Stop bits = 1
- Flow control = Xon/Xoff

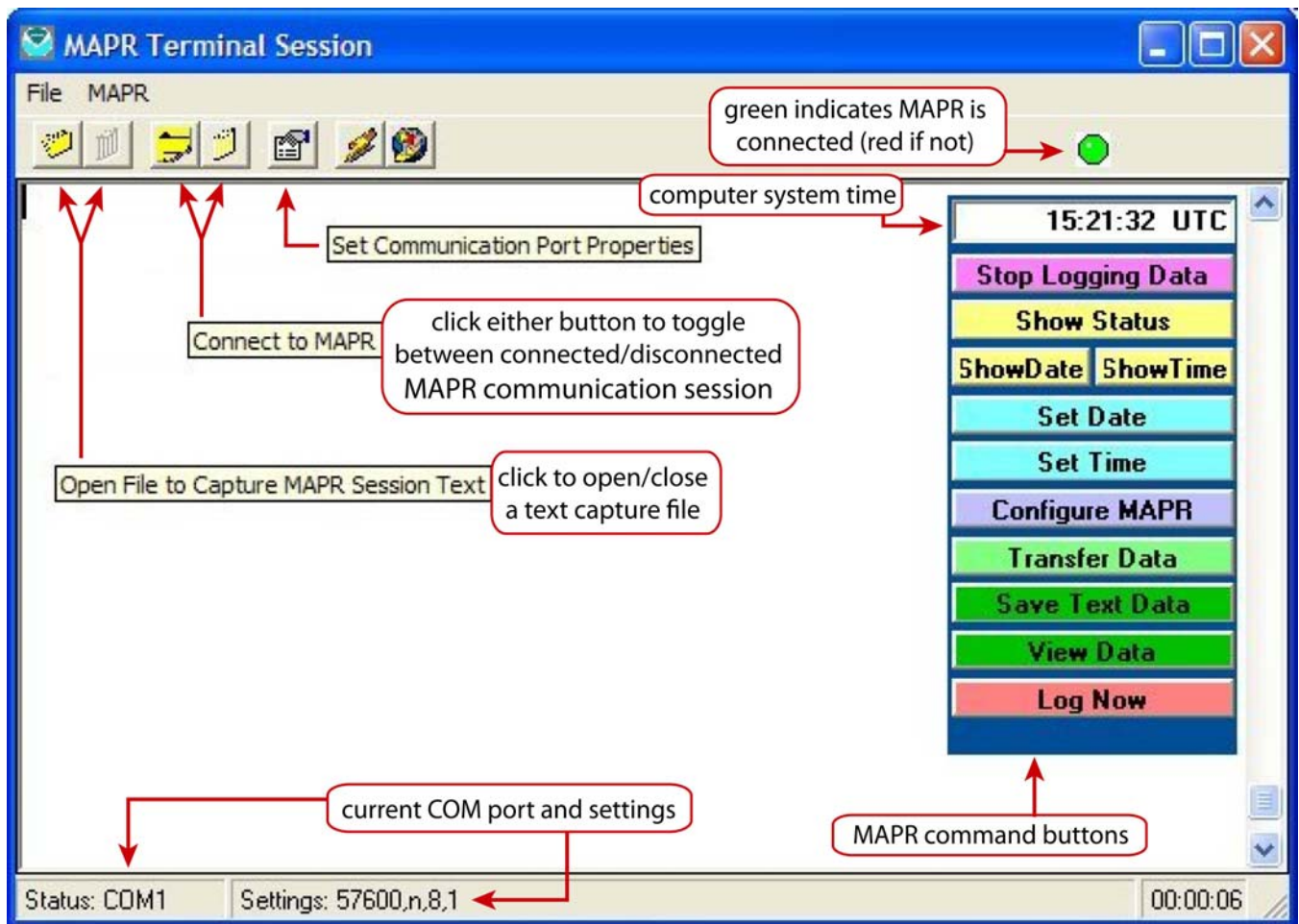


Figure 1. The buttons above the upper left corner of the terminal window control various program functions (hold the cursor over the button to display the help message). The colored buttons on the right side of the terminal window (below the computer system time display) send commands to the MAPR when clicked.

- Click the **Connect to MAPR** button (upper left line of icons) – the symbol above the system time display will turn green to indicate the connection with the MAPR has been opened.
- The MAPR will respond immediately with either “OK” or a window may appear asking if you want to “Wake the sleeping MAPR” (click the firecracker icon to wake the sleeping MAPR).

Other ways to check for MAPR response are to:

- Hit **[Enter]** a few times
- Hit **[CNTRL]-C** or the **Stop Logging Data** button at few times

- The main reasons a MAPR fails to respond are:
 - The cables are not secured properly
 - The logic battery has died
(see **Changing Batteries** section)
 - The COM port has experienced a problem
(see **Troubleshooting** section)
 - The MAPR has two modes:
 - Command mode where you can interact with the MAPR:
 - Check MAPR status (see the number of data records recorded, check battery voltage, etc.)
 - Set MAPR date/time
 - Configure MAPR for sampling
 - Download data
 - Logging mode where:
 - The MAPR will be in a power-conserving state while waiting for the delayed start time to begin sampling
- OR**
- The MAPR will be sampling at the specified sample interval. When the MAPR is sampling and connected to **MAPRTerminal**, data is echoed to the **MAPRTerminal** window.

NOTE: Data echoed to the **MAPRTerminal** window while the MAPR is sampling are in units of raw data sample counts. Data must be downloaded from the MAPR and the saved file must be imported to Excel using the macros provided to be converted to meaningful units of temperature, pressure, light scattering voltage and oxidation-reduction potential (see **Importing Data to Excel** section of this manual).

When the MAPR is in Logging mode, return to command mode by clicking the **Stop Logging Data** button a few times or entering [**CNTRL-C**] a few times from the keyboard.

Configure the MAPR for deployment:

- Make sure your computer system date/time is set to the same time standard that other data acquisition systems throughout the ship are using (ie, GPS time from the ship's navigation system). [**Start**→**Control Panel**→**Date and Time**]
- Connect to the MAPR using the **MAPRTerminal** program.
- Click the MAPR command **STATUS** button to verify the voltage of the MAPR batteries.

HINT: If the MAPR has been unused for a while, the battery voltages may show 20.00 volts in the **STATUS** report lines. Click the **Set Date** button and then try **STATUS** again to update the voltage reading of the batteries. There is more detailed information about battery use and longevity in the **Changing Batteries** section of this manual.

- Use the MAPR command buttons (right side of terminal window) to:
 - **Set Date** (uses computer system date to automatically set MAPR date)
 - **Set Time** (uses computer system time to automatically set MAPR time)
 - **Configure MAPR** (displays form to set MAPR sampling parameters)
Enter Start Date, Start Time and sample interval and click **OK**.

DO NOT the sample interval to anything shorter than 5 seconds.

Configure MAPR for Deployment

The MAPR will begin sampling on the Date and Time set here, using the sampling interval entered:

Enter Start Date: 07/15/09

Enter Start Time: 13:00:00

Enter Sampling Interval: 00:00:05

Nephelometer Serial Number: 11545

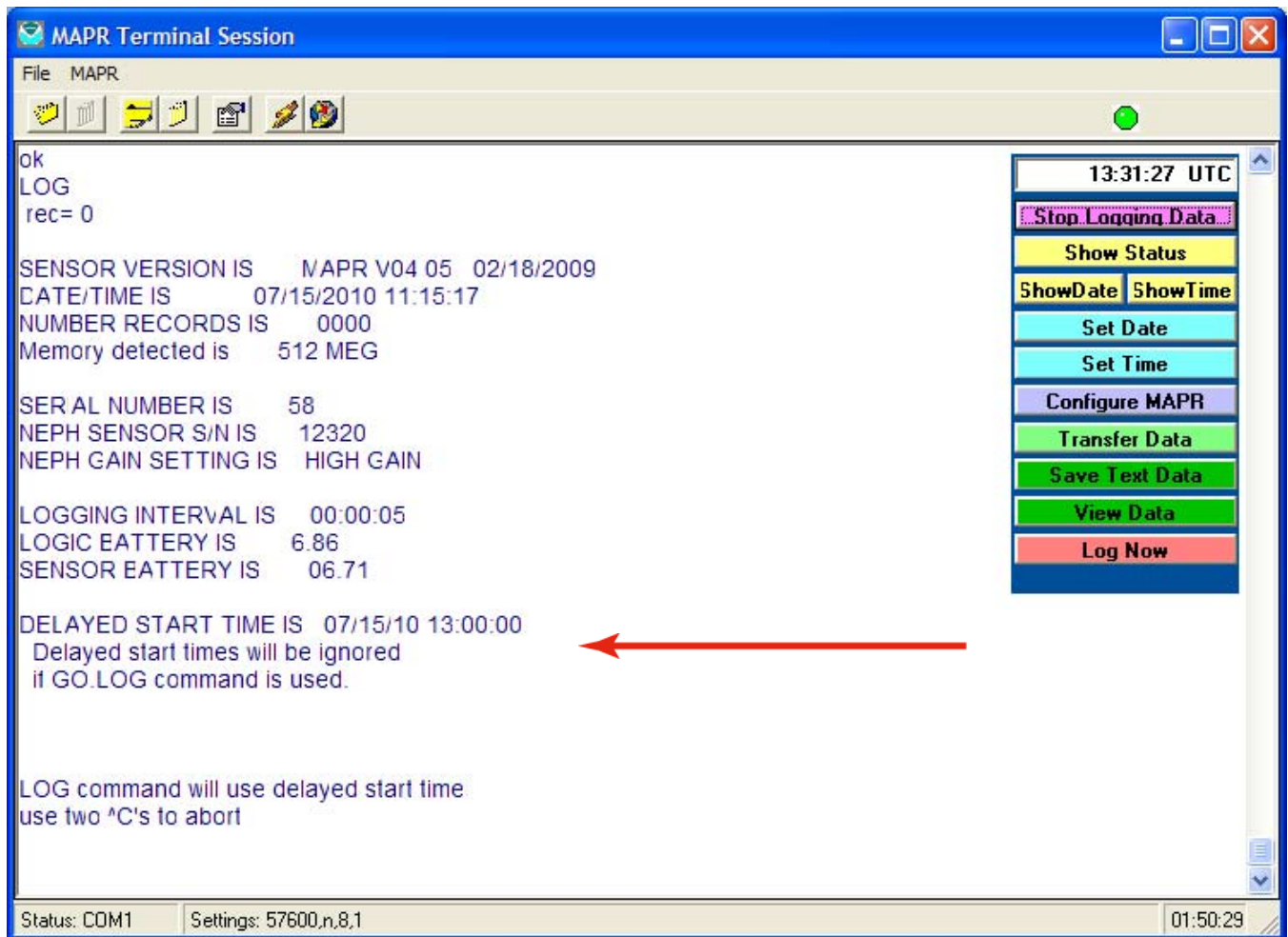
Cancel OK

Start Date (mm/dd/yy)

Start Time (24-hr format)

Sample Interval (5-sec)

- The MAPR will respond by showing the STATUS lines, will enter LOG mode automatically, and will begin sampling at the designated delayed start time:



Check the “**DATE/TIME IS**” line and the “**DELAYED START TIME IS**” lines to be sure the delayed start time is in the future relative to the current MAPR date/time.

CAUTION: If the delayed start time is not in the future relative to the current MAPR data/time, the MAPR will sit around forever waiting for the past to re-occur and will not start sampling. If you need to reset the delayed start time, click the **Stop Logging Data** button a few times (or hit [CNTRL-C] on the keyboard) to return the MAPR to Command mode, click the **Configure MAPR** button and re-enter data into the form.

- Data entered into the Configure MAPR form is retained while **MAPRTerminal** is open to simplify configuring multiple MAPRs with the same start date/time.

REPLACE THE DUMMY PLUG BEFORE DEPLOYMENT

Stop Logging and Recover Data:

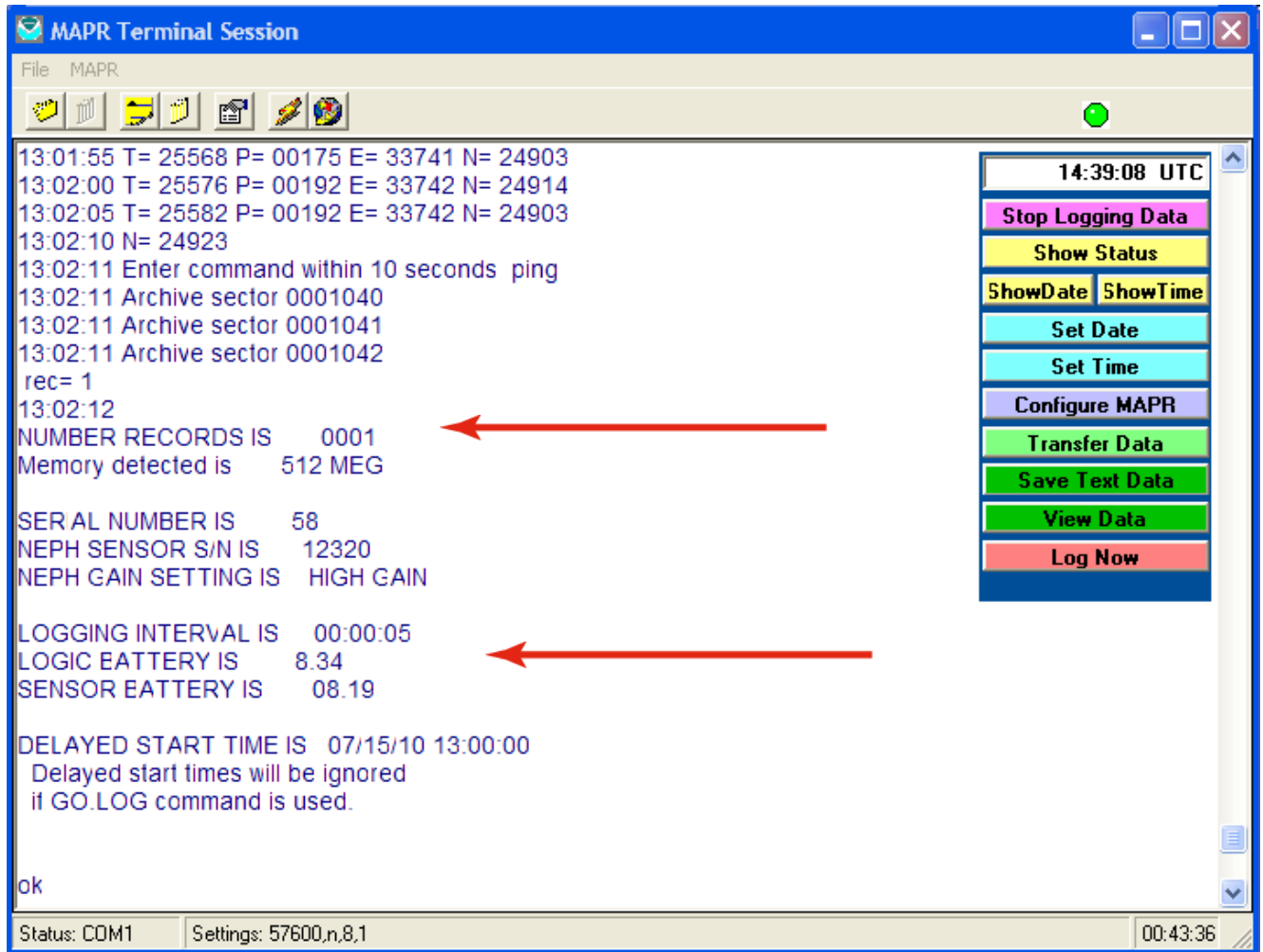
- After a deployment, rinse and dry the MAPR thoroughly before removing the dummy plug and connecting the communication cable.
- Connect the MAPR to **MAPRTerminal**
- Check to see that the MAPR is still sampling

Data sample values will be echoed to the **MAPRTerminal** window at the sample interval specified during configuration prior to deployment.

- Stop logging and enter command mode by either clicking the **Stop Logging Data** button or hitting [**CNTRL-C**] from the keyboard a few times.
- STATUS lines will be displayed when the MAPR stops logging and finishes saving data to the internal storage.

Note the following information from the STATUS lines:

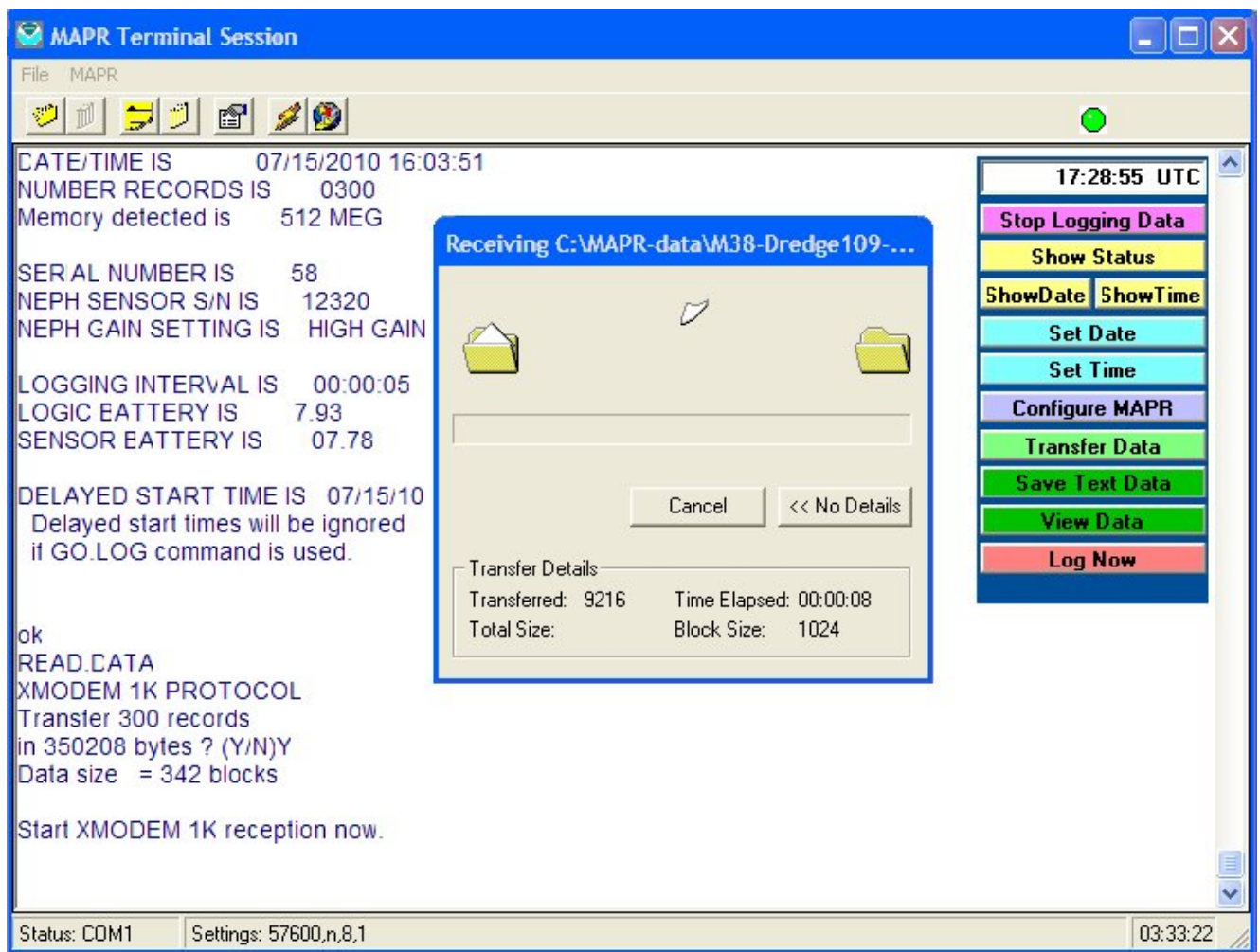
- Number of records
- Logic and Sensor battery voltages



It is recommended that this information be noted for each deployment so that battery use can be tracked during the course of a cruise and problems can be more easily analyzed if anything unusual occurs.

- Click the **Transfer Data** command button to begin downloading data
- Use the window that opens to browse to an appropriate folder and enter a file name for the data file.

Having a file naming convention can be useful for data management and archival purposes. File names should have the extension “.DATX”.
(ex: M58-Dredge109-15Jul2010.DATX includes MAPR serial number, operation designation, and date when data was downloaded from the MAPR.)

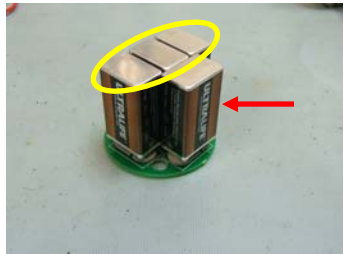


The MAPR transfers data to a binary file using the XMODEM file transfer protocol. The “Receiving...” progress box appears and you can watch the progress of the data transfer by clicking on the **Details>>** button (only the information in the “Transfer Details” box will update as the file transfer progresses).

One known bug is that sometimes the process will hang before data transfer is successfully established. If the “Start XMODEM 1K reception now.” line does not completely echo to the screen or the “Receiving...” window does not appear, hit **[CTRL-X]** on the keyboard as many times as necessary to re-establish control of the MAPR and return to command mode.

Click the **Transfer Data** button and try again. It is sometimes necessary to repeat this a few times before data transfer is successful. DO NOT GIVE UP.

Changing Batteries:

- Change batteries when battery voltages drop below 6.5 v. Open the bottom end cap using the spanner wrench tool.
- 
- Remove the foam spacer and unscrew 4 screws that hold the black battery backer plate in place.
- 
- The battery pack should slide out of the MAPR.
- 
- MAPRs are powered by 4 batteries: 3 batteries power the sensors (yellow circle), one (red arrow) powers the logic functions. Sometimes, it may only be necessary to change the logic battery (e.g., after MAPRs have sat for a while during shipping).
- 
- Exchange batteries, slide battery pack back into the MAPR, replace battery backer plate, foam spacer and bottom end cap. The battery pack fits over the posts only one way to assure proper orientation of the batteries.
- 
- Be sure o-rings and threads are clean and undamaged, and apply a thin coat of silicone grease to lubricate the o-rings before screwing the bottom end cap back onto the MAPR.

NOTE: 4 standard 9v batteries are required. They can be either alkaline or lithium batteries. Lithium batteries (Ultralife U9VL-J) will last approximately 3 times longer than alkaline batteries.

We recommend leaving the MAPR connected to **MAPRTerminal** while changing batteries and replacing the backer plate, foam spacer and end cap to assure the MAPR is operating properly. Hit [**Enter**] on the keyboard to check for MAPR response at various stages of re-assembly (MAPR will echo “OK” to the **MAPRTerminal** window). Occasionally, the batteries can bounce quickly on the contacts and cause a fault that will cause the MAPR logic to lock up. Reset the MAPR by removing the batteries, wait a few seconds, then replace the batteries again.

Battery life depends on deployment conditions, sample rate and the type of battery used. Lithium batteries will last about 3 times longer than alkaline batteries, however they present challenges for shipping (i.e., lithium batteries may not be shipped via passenger aircraft, they are limited to cargo-only flights). If planned deployment operations are on the order of a few hours to a day and the MAPRs will be checked regularly to monitor battery voltage and download data, alkaline batteries will be adequate. For longer duration tows, lithium batteries are recommended.

Reading Data into Excel and Making Data Corrections:

Data files transferred from the MAPR (see **Stop Logging and Recover Data** section) are binary format files. Use the macro included in the **MAPRWorkbook** Excel file (see **MAPR Software Installation**) to read these binary data files into Excel, convert raw data counts to engineering units (pressure, temperature, LSS voltage and ORP millivolts) and write the data to an Excel worksheet.

NOTE: **MAPRWorkbook** files are updated regularly to include the most recent calibration coefficients for each MAPR. A date is included in the file name for instrument history and tracking purposes (ex: 29-MAPRWorkbook-06July2010.xls).

It is assumed that most users are familiar with Excel and will be able to review the data and generate plots within Excel, or move the data from Excel to their preferred application (e.g., Matlab).

CAUTION: Excel 2007 is significantly different from Excel 2000. The notes and instructions included here for Excel 2007 may be incomplete as we have not encountered every possible difference. **The user must know how to enable and run macros in the version they are using:**

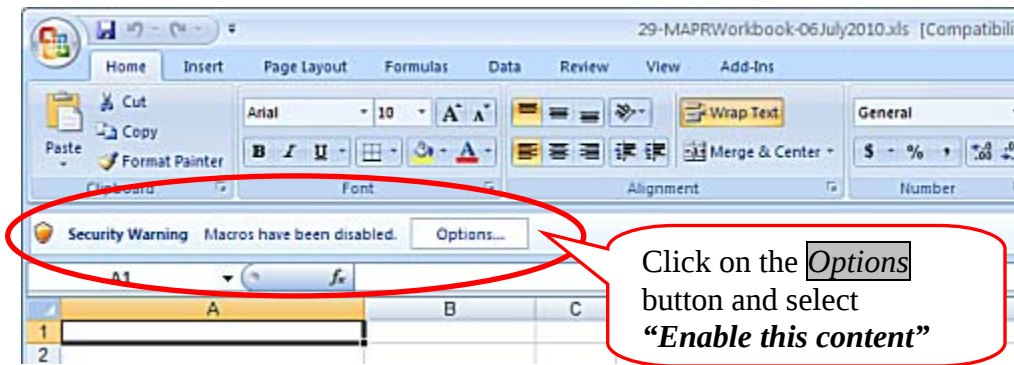
In Excel 2000, macros are accessed either under the “**Tools**” menu, or by adding the “**Visual Basic**” toolbar (**View** → **Toolbars** → **Visual Basic**)

- In Excel 2007, macros (once enabled) can be accessed under the “**View**” menu tab.

We recommend you make a working copy of the **MAPRWorkbook file**. Each MAPR data file needs to be imported to a separate worksheet. It is up to the user how they would like to organize and manage their workbooks and worksheets for their specific cruise(s) and operations.

- Open the **MAPRWorkbook** file – select **Enable Macros** as the file opens.

NOTE: By default, macros are automatically disabled by Excel 2007. Select the **Options** button on the **Security Warning** line when the file opens to enable this content:



Alternatively, go to the **“Trust Center”** – click the Microsoft Office button, find **“Excel Options”** (in lower bar of the menu window that opens), then click **“Trust Center”** (in list on left side of window), then **“Trust Center Settings”** (on right side of window), then select **“Macro Settings”** (list on left), and select **“Enable all macros...”** from the list on the right. **USE CAUTION WHEN USING THE “TRUST CENTER” METHOD AS IT MAY CHANGE THIS SECURITY SETTING TO ENABLE MACROS FOR ALL FILES OPENED WITH EXCEL.**

- Select a blank worksheet as the active worksheet (insert a new worksheet if necessary). Each MAPR data file should have its own worksheet. Existing data in a worksheet will be written over as new data is read in.
- Run the macro **GetBinaryData**
- Enter latitude when prompted

Conversion of Pressure (db) to Depth (m) is a function of latitude. It does not matter if latitude is entered as a positive or negative number. If a tow covers a long distance, use an average latitude value.

- It is helpful to rename the worksheet with the same name as the raw MAPR data file.

- The resulting worksheet has general MAPR information such as calibration coefficients, logging interval and MAPR serial number in column A, rows 1 to 3. Pressure (db), temperature (°C), depth (m), LBSS (nephelometer) voltage, ORP (mv), and the raw data counts are in other columns. The organization of the worksheet is apparent.

Note that the pressure sensor of each MAPR has an arbitrary offset at atmospheric pressure (typically +/- a few to tens of decibars). This offset is deliberately designed into the MAPRs. It is appropriate to adjust pressure values for the entire deployment by correcting for the offset so that on-deck pressures are 0 db.

The pressure sensor is a strain gauge style sensor. Pre-deployment pressure values will be slightly different from values immediately after recovery, though post-recovery values should return to pre-deployment values within 20-45 minutes after the MAPRs return to deck. It is preferable to use pre-deployment values wherever possible to determine the appropriate pressure offset. Pressure values are also sensitive to temperature, so try to avoid using data from periods of time when the MAPRs might be sitting on deck in the hot sun.

NOTE: The depth values that are calculated as data are first read into Excel do not include any adjustment to pressure. Depth is calculated as a function of pressure (db) and latitude (degrees) according to Fofonoff and Millard (1983) [function **Depth** is included in the **MAPRWorkbook** file], and can easily be recalculated to include the adjustment to the pressure record:

- Find the appropriate pressure offset (best to use a period of time when MAPRs are sampling but still on deck prior to a deployment)
- Select an unused column for corrected depth (m)
- Enter the formula “=Depth(press-corr,lat)” in row 5 of that column

Example:

- uncorrected pressure values are in column C starting in row 5
- if average pressure on deck prior to deployment = -5.3 db
- and latitude = 15.5 degrees (sign is not important)
- type “=depth(c5+5.3, 15.5)” into row 5 of the new column
- copy/paste the formula to all the cells in that column
- label new column “Corrected depth (m)”

- The LBSS measurement is a relative rather than absolute measure of the light backscattering coefficient and differs slightly among individual instruments. To convert the raw voltage values into nephelometric turbidity units (NTUs), a standard measure of turbidity as measured by scattering instruments, use the expression:

$$\Delta\text{NTU} = (V_r - V_b) / a_n$$

Where ΔNTU = the plume LBSS anomaly in excess of ambient water, V_r = the raw voltage reading of the LBSS, V_b = the background voltage of local ambient water not affected by hydrothermal plumes (typically the value immediately above the plume horizon is used), and a_n = a factor unique to each LBSS which has been determined from our laboratory calibrations using formazine. The a_n values of the LBSSs supplied are listed on the equipment check sheet packed with the MAPRs.

- Use standard Excel functions to chart the data or otherwise analyze the data as desired.

Operational and Maintenance Considerations:

- **BE SURE THE DUMMY PLUG IS REPLACED AND SECURELY SEATED BEFORE DEPLOYING A MAPR.** Use the provided silicone spray – not silicone grease – to lubricate the micro-connector on the dummy plug and the MAPR COM port connector.
- We make every effort to supply clamp inserts for the size of cables being used. The user may modify clamp inserts if a different size is needed, but we request that any modified clamp inserts be clearly marked (preferably with the new size indicated) and kept separate from other clamp inserts.
- Avoid scratching or damaging the optical (flat) face of the LBSS. An occasional cleaning of the face with soap and water is all that is necessary if it becomes soiled. Do not use organic solvents.
- The cap covering the ORP sensor should be removed prior to deployment and replaced upon recovery (filled with either saturated potassium chloride (KCl) solution or clean, filtered seawater) to keep the porous Teflon junction wet.

Use caution when removing/replacing the ORP sensor cap. The cap needs only to cover the top end of the sensor – do not push it on too far. Pull/push cap straight on/off the end of the sensor – **DO NOT TWIST !** The sensor is secured to the MAPR pressure case with a threaded end and can be worked loose if the sensor gets twisted while removing/replacing the cap. **If the ORP sensor works loose, the MAPR will leak.** If you notice the sensor has worked loose, gently tighten it – DO NOT OVER-TIGHTEN.

Be cautious not to bend or break the platinum wire on the ORP sensor while removing/replacing the cap. The cap is a soft vinyl and can be squeezed out of round to avoid catching the end of the platinum wire while sliding it onto the sensor.

A limited amount of potassium chloride is provided, so it may be best to use clean (preferably filtered) seawater in the cap between operations and use the potassium chloride solution for longer periods between uses (i.e., between cruises or during shipping).

- Rinse MAPRs with fresh water after every deployment. In general, please keep the MAPRs clean for best performance.

- An alternate method to start MAPRs sampling is to click the **Log Now** command button. However, a valid sample interval (i.e., greater than 5-sec) must already have been set (and the easiest way to do that is by using the **Configure MAPR** option). The MAPR will begin sampling approximately 5 seconds after the **Log Now** button is clicked.

The advantage of starting the MAPR sampling using the **Log Now** button is that you know within a few seconds that the MAPR is sampling. The disadvantage is that when deploying multiple MAPRs it is much more difficult to assure that the sampling for each MAPR is time-synched and that the samples are going to be at an even time value (e.g., at the 0, 5, 10... second of each minute). Data processing and merging data sets from multiple MAPRs and other data (i.e., navigation) is much easier when all data sets have a common time basis and/or samples are at an easily-tracked time value (e.g. a multiple of 5 seconds).

- Alkaline batteries are slightly smaller than the Ultralife lithium batteries. When using alkaline batteries, place an additional thin piece of foam (the anti-skid mat material usually covering the tables in the galley works perfectly) between the bottom of the batteries and the battery backer plate to assure connection to power is not lost due to vibrations or jarring of the MAPR.

Troubleshooting:

Please direct any questions regarding MAPR operations or data processing to Sharon Walker at PMEL.

Help is just an e-mail away: Sharon.L.Walker@noaa.gov

Problems with MAPRTerminal :	We have observed some instances of unexpected behavior of the MAPRTerminal program, though most problems have not been consistent or of a nature that affected the overall functioning of the program or of the MAPRs. If something unexpected occurs, we recommend first trying the operation again to see if it is repeatable. In most instances we've run across, the desired action worked properly when tried again. → Please document any recurring or insurmountable problems you might encounter as thoroughly as possible so that they can be addressed during further development of the program or through future modifications to the MAPRs.
MAPR doesn't respond	First check all connectors to be sure connections between the MAPR and computer are securely connected. Be sure you know the COM port number the MAPR is connected to and the COM port properties in MAPRTerminal are set accordingly. If there is still no response, check the batteries. Replace if necessary. If battery voltage is fine, sometimes removing and replacing the batteries is enough to "reset" the MAPR. In some cases, there has been a problem with the computer's COM port and re-booting the computer resolves the problem.

Endless stream of characters to terminal screen	We have encountered, on occasion, an endless stream of characters being written to the terminal screen by the MAPR. Unplugging the batteries and plugging them in again takes care of this problem. The MAPR date/time will need to be reset afterward. You will regain control of the MAPR and will probably not lose any recorded data.
Can't show non-modal form error in MAPRTerminal	The error appears to be caused by trying to do too many things at once. Click OK to get rid of the message and return to the MAPRTerminal session without any other negative effects. It appears this error can safely be ignored. Slow down and make sure the MAPR has completely responded before trying to issue a new command.
MAPR stops responding during attempt to transfer data	See Stop Logging and Recover Data section of this manual. If the "Start XMODEM 1K reception now." line does not completely echo to the screen or the "Receiving..." window does not appear when you try to initiate data transfer, hit [CTRL-X] on the keyboard as many times as necessary to re-establish control of the MAPR and return to command mode. Click the Transfer Data button and try again. It is sometimes necessary to repeat this a few times before data transfer is successful. DO NOT GIVE UP.
Error messages when reading data into Excel with the GetBinaryData macro	A few different conditions can cause errors when reading MAPR data files into Excel. The most common cause is when the MAPR has stopped logging due to dead batteries or power being interrupted for some other reason (i.e., excessive vibrations during deployment or needing to remove the batteries to gain control of the MAPR). If this is the case, the error can be ignored. Verify that the last record in the Excel worksheet is the last record recorded (remember, number of records saved should have been noted from STATUS lines when recovering data from the MAPR). For other circumstances, contact Sharon Walker to assist in trouble-shooting the problem.

Return Shipments:

MAPR shipments are subject to national and international regulations regarding lithium batteries. Users are responsible for disposing of spent batteries appropriately. Since lithium batteries can introduce significant complications to the shipping process, it is OK for the user to remove lithium batteries from the MAPRs and retain unused spare batteries so they do not complicate the return shipment of the MAPRs. We request that you advise us of the number of unused batteries that could be available for future use, and provide us with contact information for who will be responsible for the batteries.

We also request that MAPRs be returned as quickly as possible after the scheduled cruises are completed, and that the user make every effort to clean the MAPRs and return them and the packaging materials in as close a condition as possible to how they were received.

Return MAPRs to:

Sharon L Walker
NOAA/PMEL
7600 Sand Point Way NE, Bldg #3
Seattle, WA 98115

Contact Us:

<u>Contact personnel at PMEL with any questions, comments or news regarding MAPRs</u>	
Sharon L. Walker NOAA/PMEL 7600 Sand Point Way NE, Bldg. #3 Seattle, WA 98115-6349 (206)526-6788 <i>e-mail:</i> Sharon.L.Walker@noaa.gov	MAPR Program Manager