This file is typically located at:
Program Files (x86)\L and M Instruments\Land M Software Suite\RTG OM Readme.pdf

RTGOM Quick Install Guide

Thank you for purchasing your RTGOM, Ready-to-Go Optical Monitor. The RTGOM is a series of industrial hardened, precision optical monitoring device that operates via simple USB connection. Features include:

- Simple, cost-effective, fully integrated USB 2.0 design for all your scientific and industrial applications
- Automatic Gain Control to produce optical density measurements from 0.00 to 4.00 Optical Density (RTGOM-01) or 0.00 to 7.00 (RTGOM-02) with +/- 2.5% accuracy and +/- 1.0% precision throughout the entire range.
- Industrial strength, dust-proof housing for your toughest environments
- Low-power operation at 150mA per RTGOM, allowing simple development of multi-channel (multi RTGOM) monitoring solutions
- Factory and User-Programmable "Dark Current" functions stored in FLASH memory
- Multiple diode options providing monitoring capability from the ultraviolet, through the visible, and into the infrared spectral region.
- Dust-proof, user-accessible optical filter enclosure to provide a wide range of wavelength monitoring across the ultraviolet, visible, and infrared spectrums
- "Headless" data-logging capability
- "Headless" system design, with the RTGOM-02, allowing panel meter feedback in the absence of a computer.
- Multiple FREE applications provided to cover a range of applications.
- Fit for several scientific and industrial applications including:
    o Scientific monitoring and recording of current, irradiance, percent transmission, reflectance, and optical density
    o Thin film deposition monitoring of fixed and continuous web processing
    o Ribbon clarity monitoring during glass production
    o Windows pane testing for visible light transmission and reflectance
    o Liquid turbidity measurement via light transmission or optical density
    o UV curing light-level monitoring

Installation Requirements

- 50MB free disk space
- Free USB port on Windows7/8/10 or MAC OS X machines
    o FREE application software is available for Windows 7/8/10
- Additional RTGOM's can be installed in additional free USB ports, or via a USB hub

Usage Notes - USB Power

- The RTGOM is powered by the USB port. As a result, when continuous operation is desired over long periods, *disable any Hibernate or Standby modes* that would remove power from the USB port. In some older OS instances and servers, and particularly in Windows multi-user configurations, returning from Hibernate or Standby may require a reboot to reset the USB driver stack.

RTGOM Software Installation

Installing within Windows 7/8/10 environments

1. Run the RTGOM **L-and-M-Software-Suite v#.#.#.msi** installation package.
   a. This will install the RTGOM applications (CLI, Trend, Bar, FW-Update, and Datalog)
   b. If connected to the internet, this will also automatically install the Visual Studio 2012 libraries.
2. Plug the first RTGOM into any available USB port.
3. The device drivers should be auto-installed. If not see *Installing FTDI Drivers* section below. You are now ready to run one of the four free RTGOM applications (described further below) to validate proper installation.
4. Install additional RTGOM's. These additional devices will automatically load the proper driver based on the installation of the first RTGOM.

Installing within MAC OS X environments

The RTGOM is based on a standard FTDI interface that provides a USB-to-Serial connection to a MAC OS X system. To interact with the RTGOM on a MAC, perform the following steps:

1. Plug the RTGOM into an available USB slot
2. Install the FTDI drivers found at http://www.ftdichip.com/Drivers/VCP.htm
   a. See *Installing FTDI Drivers* section below.
3. Open a Terminal window on the MAC
   a. The Terminal program is found at: Applications -> Utilities -> Terminal
4. From within Terminal, type **ls /dev**
   a. This will list all the devices found on the system
5. Locate *tty.usbserial[…..]A* and *tty.usbserial[…..]B*
   a. Note that, due to the large amount of tty devices typically available, the tty.usbserial[…] device may scroll off the screen. If it is not seen, simply scroll up to find it.
   b. The device with the 'B' is the correct tty device.
   c. The [….] will be a device specific string that needs to be inserted in the next line
6. From within Terminal, type **screen /dev/tty.usbserial[…..]B 115200**
   a. Example: **screen /dev/tty.usbserial-TIWNK5JQB 115200**
   b. 115200 is the baud rate to be used
   c. NOTE: this value is 9600 for firmware versions earlier than 1.1.0.0.
7. Type **echoon** followed by pressing Enter
   a. Note: the screen will not display the characters while typing the above command
   b. Once entered, this command will instruct the RTGOM to echo all characters to the Terminal program
8. Type **help** to display the RTGOM commands
   a. These commands can now be executed within the Terminal program

Installing FTDI Drivers

The RTGOM utilizes an industry-standard "FTDI" chip set for all communications. As a result, the drivers are typically already installed within your Windows or MAC operation system. If the device is not being recognized, please install the drivers found at http://www.ftdichip.com/Drivers/VCP.htm.

In Windows environments it is best to use the "setup executable" shown in the Comments section of the diagram below.

Operating System	Release Date	Processor Architecture							Comments
		x86 (32-bit)	x64 (64-bit)	PPC	ARM	MIPSII	MIPSIV	SH4	
Windows*	2012-04-26	2.08.24	2.08.24	-	-	-	-	-	2.08.24 WHQL Certified Available as setup executable Release Notes
Linux	2009-05-14	1.5.0	1.5.0	-	-	-	-	-	All FTDI devices now supported in Ubuntu 11.10, kernel 3.0.0-19 Refer to TN-101 if you need a custom VCP VID/PID in Linux
Mac OS X	2012-08-10	2.2.18	2.2.18	2.2.18	-	-	-	-	Refer to TN-105 if you need a custom VCP VID/PID in MAC OS
Windows CE 4.2-5.2**	2012-01-06	1.1.0.10	-	-	1.1.0.14	1.1.0.10	1.1.0.10	1.1.0.10	
Windows CE 6.0	2012-01-06	1.1.0.10	-	-	1.1.0.14	1.1.0.10	1.1.0.10	1.1.0.10	

In Windows 8.x environments, note the following:
1. In the initial release of Windows 8, and this may be true in subsequent releases, some customers have found they had to load FTDI drivers as documented above. Windows 8, however, is considerably more stringent when it comes to drivers. Its default behavior is to only allow "signed" drivers to be loaded. While FTDI indicates their drivers are signed for Windows 8, sometimes the operating system is requiring configuration to allow unsigned drivers. This is well documented on the Internet, and summarized as follows (exact sequence and wording may differ depending on the version of Windows 8):
   a. Enter the Settings screen. This can be accomplished with Win+I or right-to-left swipe from the right side of a touch screen and selecting "Settings"
   b. At the very bottom of the Settings screen, select the link for "Change PC Settings"
   c. Select "General"
   d. Select "Advanced Startup"
   e. Select "Restart"
   f. Select "Troubleshoot"
   g. Select "Advanced Options"
   h. Select "Startup Settings"
   i. Select "Restart"
   j. Select "Disable driver signature enforcement". Note that this is only active for this power cycle, but this will allow the new drivers to be used for all subsequent power cycles, including plugging in new RTGOM devices.

In MAC environments, note the following:
1. Once the file is downloaded, typically to the desktop, the downloaded file has to be run to install the drivers.
2. Upon attempting to install the drivers, the system may report an error related to only allowing the execution of applications from the "Mac App Store" or the "Mac App Store and Identified developers". To resolve this, modify the setting within System Preferences -> Security & Privacy dialog. Note the lock in the lower left-hand corner of this dialog box. This will need to be unlocked, by an admin, to change this setting. After installation of the drivers, this setting can be reverted.

RTGOM Free Applications (for Windows 7/8/10)

Below are descriptions of three FREE programs delivered as part of the RTGOM.

CLI

CLI is a simple command line program to interface with the device. When run, CLI will automatically detect the first available device and present a CLI interface. If you wish to control additional devices, running another instance of CLI will open up another CLI to control the next device found. Typing **exit** exits the CLI program.

Below is a representative **help** output of CLI (this can change with new firmware releases, typically adding new features/commands). CLI opens the RTGOM device in "echooff" mode, where all responses are numerical. This mode is used for interactive programs like Trend and Bar below. This help output also serves as the documented API for the device.
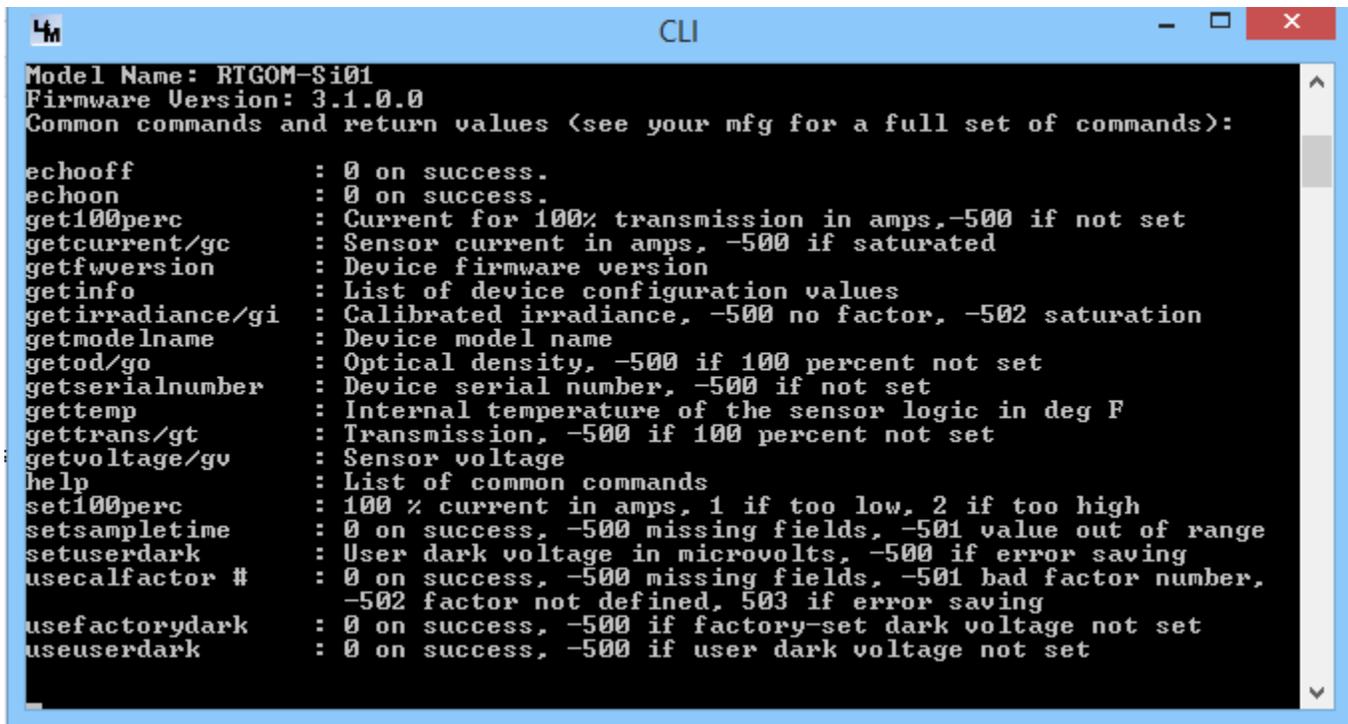
```
                                            CLI                              _  □  ×
Model Name: RTGOM-Si01
Firmware Version: 3.1.0.0
Common commands and return values (see your mfg for a full set of commands):

echooff          : 0 on success.
echoon           : 0 on success.
get100perc       : Current for 100% transmission in amps,-500 if not set
getcurrent/gc    : Sensor current in amps, -500 if saturated
getfwversion     : Device firmware version
getinfo          : List of device configuration values
getirradiance/gi : Calibrated irradiance, -500 no factor, -502 saturation
getmodelname     : Device model name
getod/go         : Optical density, -500 if 100 percent not set
getserialnumber  : Device serial number, -500 if not set
gettemp          : Internal temperature of the sensor logic in deg F
gettrans/gt      : Transmission, -500 if 100 percent not set
getvoltage/gv    : Sensor voltage
help             : List of common commands
set100perc       : 100 % current in amps, 1 if too low, 2 if too high
setsampletime    : 0 on success, -500 missing fields, -501 value out of range
setuserdark      : User dark voltage in microvolts, -500 if error saving
usecalfactor #   : 0 on success, -500 missing fields, -501 bad factor number,
                   -502 factor not defined, 503 if error saving
usefactorydark   : 0 on success, -500 if factory-set dark voltage not set
useuserdark      : 0 on success, -500 if user dark voltage not set
```

Trend

Trend is a graphical user interface program for interfacing with a single device. Like the CLI application above, Trend detects and monitors the first device found. If you wish to simultaneously monitor more than one device, running Trend.exe a second time will detect the second device and control/monitor it. Opening a third, forth, fifth, etc., will do the same. Note, however, that each RTGOM can only be accessed by one application (CLI, Trend, Bar) at a time.

Below is a representative screen shot of Trend (*features may have been added or removed*). The application usage is designed to be self-explanatory for basic operation, but includes some features that may require some instruction as indicated below.
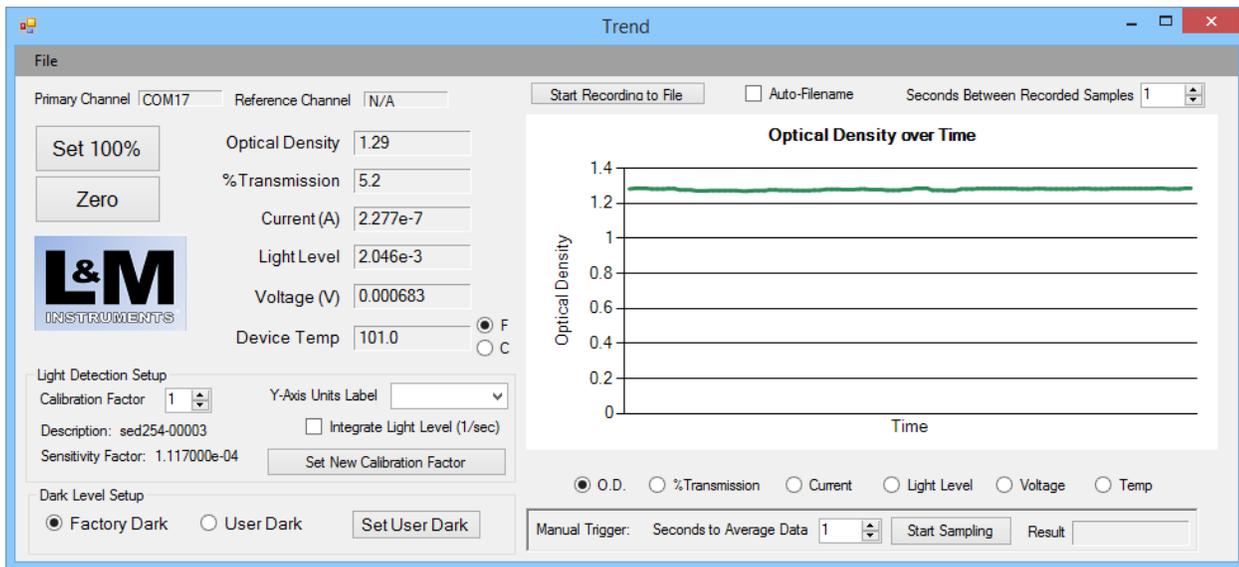
Recording to File

The "Start Recording to File" will open up a file, in My Douments\L and M Instruments\Reports, based on the date/time stamp at the button is pressed. The file output is .CSV (comma separated values) and can be opened in most spreadsheet files.

<u>Light Detection Setup</u>

The RTGOM device, through L&M Instruments OEM's, can be configured at the factory with a particular "Calibration Factor". The device can store up to 20 of these, based on the filter combination in place, providing a very accurate measure of irradiance for the specific RTGOM device and its optical filters.

<u>Manual Trigger</u>

For low-light measurements, or measurements where the incident light is fluctuating, the Manual Trigger provides a way to take an average, over a number of user-defined seconds, of the signal. The average is started with the "Start Trigger" button. The variable measured depends on what is currently being displayed on the graph.

<u>Advanced File-Menu Functions</u>

There are a few advanced functions found under the File menu.
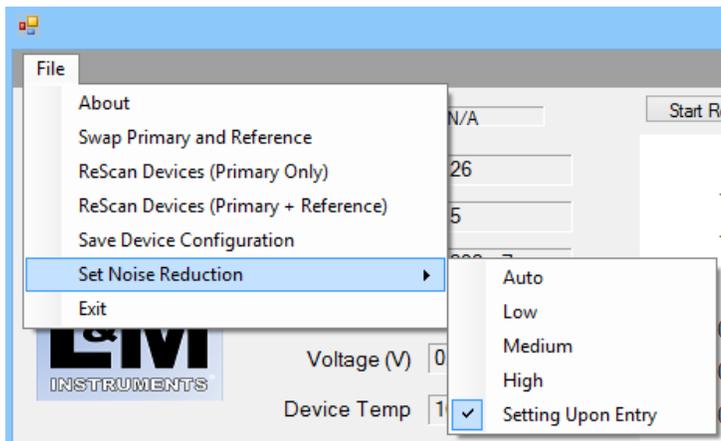
Swap Primary and Reference:

The Trend program will automatically detect if there are two RTGOM devices present, and automatically assign one as a Primary and one as a Reference signal. If the Trend program guessed wrong, selecting this option will reverse the two: The Primary will become the Reference, and the Reference will become the Primary.

ReScan Devices (Primary Only):

When the Trend program runs, it either uses a saved configuration (see below) or it assigns the RTGOM devices in the order it finds them. With this option, Trend will only scan for one device (the "Primary") and not automatically detect a "Reference" device. This will allow subsequent devices to be discovered by subsequent/additional runs of the Trend program.

ReScan Devices (Primary + Reference):

This is similar to the option above, but will look for two RTGOM's, the first to serve as a "Primary" and the second to serve as the "Reference". This can be reveresed with the Swap Primary and Reference function above.

Save Device Configuration:

This option saves the current RTGOM configuration (Primary device and, if available, Reference device). The next time Trend is run, this configuration will be restored.

Set Noise Reduction:

This option allows the user to trade-off signal stability and response time, as follows:

Auto: Sample time varies with light level (more sampling for lower levels)
Low: Approximately 6 samples/sec
Med: Approximately 3 samples/sec
High: Approximately 1 sample/sec
Setting Upon Entry: This, the default, allows the CLI program to be used to set a custom sampling time to be used with Trend.

Trend creates the following directories under My Documents\L and M Instruments:

\Logs   This diretory contains warning and error logs for each COM port
                    associated with an RTGOM device. These files are helpful in the case of
                    USB cabling and noise issues.

\Reports   This directory contains all reports as initiated by the "Start Recording
                    File" button.

\Inventory   This directory contains one file as follows:

                    rtgomtrendorder.txt: this file contains the COM port ordering, Primary
                    channel followed by Reference channel

Bar

This application automatically detects all RTGOM devices and presents a bar chart display of the values. The application also allows control of the Y-axis scaling and color-coded level detection. This application can be used out-of-the-box for process control systems within a manufacturing environment.

Below is a representative screen shot of Bar (*features may have been added or removed*). The application usage is designed to be self-explanatory for basic operation, but includes some features that may require some instruction as indicated below.
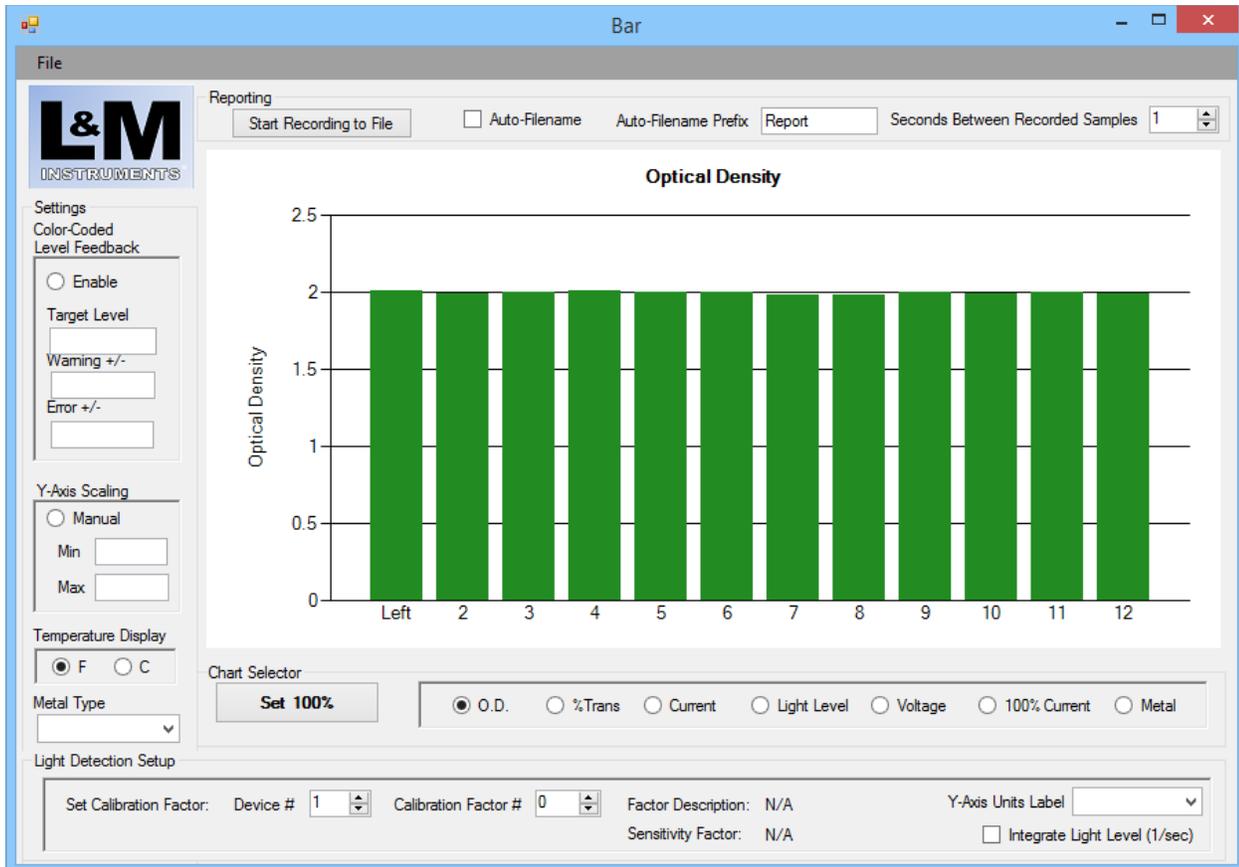
Recording to File

The "Start Recording to File" will open up a file, in My Douments\L and M Instruments\Reports, based on the date/time stamp at the button is pressed, and an optional filename prefix. The file output is .CSV (comma separated values) and can be opened in most spreadsheet files.

Light Detection Setup

The RTGOM device, through L&M Instruments OEM's, can be configured at the factory with a particular "Calibration Factor". The device can store up to 20 of these, based on the filter combination in place, providing a very accurate measure of irradiance for the specific RTGOM device and its optical filters.

Advanced File-Menu Functions

There are a few advanced functions found under the File menu.
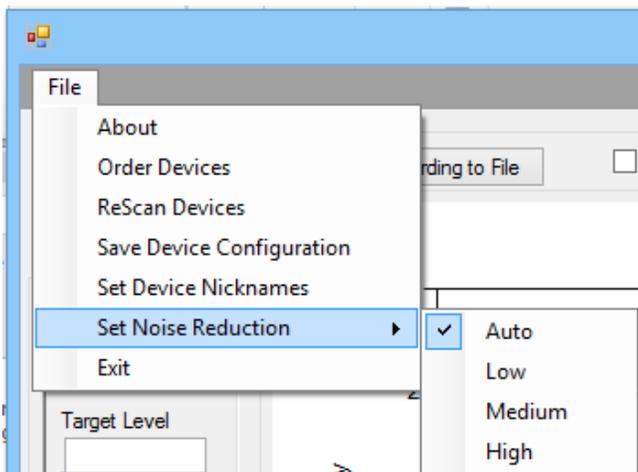
Order Devices:

The Bar program will automatically detect multiple RTGOM devices, and automatically assign them to the bar chart in the order discovered. This is often not the order desired by the user. This function allows the user to easily "teach" the Bar program the correct order. The program will pace the user through the follow steps:

1. Ensure that all devices have a 100% transmission / 0.00 optical density level set.
2. Ask the user to darken each device, in the order desired. This is usually accomplished by passing a hand over the detectors in order (the Bar program is looking for an optical density of greater than 1.00 to detect the next device).
3. An audible "beep", from the host computer, signaling the end of the exercise.

After the procedure, the bar chart is re-ordered accordingly.

ReScan Devices:

If the user wishes to abandon the current device ordering, or has added devices since Bar was run, this option is selected. This function will cause Bar to scan the devices as if it were discovering them for the first time.

Save Device Configuration:

This option saves the current RTGOM configuration, i.e. the ordering of the devices. A common practice is to run Bar, select Order Devices to teach Bar the correct order, and then using this option to save the order for subsequent runs.

Set Device Nicknames:

The Bar program automatically labels the bars in the graph as 1, 2, 3, etc. This function allows setting custom X-axis labels for each bar. These nicknames are automatically stored for subsequent runs of the Bar program.

Set Noise Reduction:

This option allows the user to trade-off signal stability and response time, as follows:

Auto: Sample time varies with light level (more sampling for lower levels)
Low: Approximately 6 samples/sec
Med: Approximately 3 samples/sec
High: Approximately 1 sample/sec

Bar creates the following directories under My Documents\L and M Instruments:

\Logs   This diretory contains warning and error logs for each COM port associated with an RTGOM device. These files are helpful in the case of USB cabling and noise issues.

\Reports   This directory contains all reports as initiated by the "Start Recording File" button.

\Inventory   This directory contains two files as follows:

                         rtgomscannedportinfo.txt: this file contains a list of all RTGOM devices discovered, along with each one's FW level.

                         rtgombarorder.txt: this file contains the COM port ordering of the bar chart display and is output as a result of selecting File -> Order RTGOMs.

Datalog

Below is a representative sample screen shot of Datalog (*features may have been added or removed*). The application is used to program individual devices to log data on their own, typically when disconnected from the host computer (data logging when connected to the host computer is achieved with the Trend or Bar applications).


Basic Usage

This application automatically detects the first RTGOM device present and allows it to be programmed, as well as accessed, for log data. Datalog allows logging of various pieces of information while the RTGOM device is not connected to a host computer. A typical scenario is as follows:

1. Connect an RTGOM to the host computer.
2. Run Datalog.

3. Add an optional 'Nickname' that will appear in data files later. This is to help quickly identify the device when multiple devices are logging data offline.
   a. Note that the Nickname is store on the host computer and not the device.
4. Select the monitoring parameters ("Data Logging Period" and "What to Log").
5. Select "Start" to start logging.
   a. At this point the device's red LED will start blinking to indicate that logging is active.
6. Disconnect the device from the host computer.
7. Connect the device to battery power for monitoring away from the computer. Power can be supplied by a USB hub, a USB power plug adapter (as used with common smart phones), or a USB battery pack.
   a. For RTGOM-01 devices without a battery-back real-time clock, quickly reconnect power to the device to restart logging and maintain logging timestamp accuracy.
8. Reconnect the device when data is to be downloaded.
9. Select "Stop" to discontinue data logging.
   a. This is optional as data can be downloaded without stopping data collection.
10. Select "Download", which presents a Save dialog to download the time-stamped data.
11. Select "Erase Data From Device"
   a. This is optional, but required before starting a new data logging session.

Advanced File-Menu Functions

There are a few advanced functions found under the File menu.
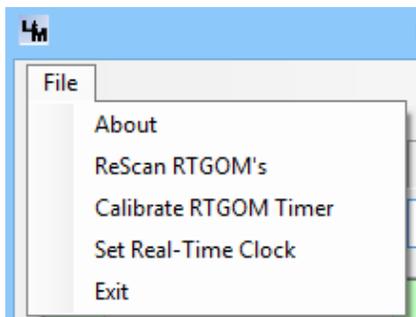
ReScan RTGOM's:

If multiple devices are being used to log data, they can be sequentially connected and disconnected from the host computer. When this is done, the File->ReScan RTGOM's function is required to discover the new device. A typical programming sequence is as follows (the data download sequence is similar):

1. Connect a device
2. Program the device as described above
3. Disconnect the device
4. Connect the next device
5. Select File->ReScanRTGOM's
6. Goto Step #2

Calibratre RTGOM Timer:

This does not apply to RTGOM-02 devices which have a built in real-time clock.

For RTGOM-01 devices, the time-stamping function for Datalog is a relative one. When "Start" is selected, the host computer's time is sent to the device. The device then records data based on the Data Logging Period interval. As a result, the accuracy of the time-stamps is dependent on how well the device measures the data logging interval. This routine calibrates the devices timer to ensure time stamp accuracy. It is important, as the routine will prompt the user, to ensure that all programs are shut-down while the calibration routine is running.

The calibration routine takes exactly 1 minute, and a progress bar is displayed in the upper right of the Datalog application window.

Set Real-Time Clock:

For RTGOM-02 devices, which have an on-board real-time clock, this function sets that clock to the computer's time.

RTGOM Application Source Code

Please contact L and M Instruments regarding interest in source code for the FREE applications above. L and M has flexible source code licensing terms, often free-of-charge given some minimum level of RTGOM purchase.

In addition, L and M typically posts C# code example on its download page. These code examples are provided with an MIT license to facilitate legal review and use within custom products.

RTGOM "USB Serial Port" Programming / Theory of Operation

Below is the Theory of Operation for interfacing with the RTGOM over a serial port.

- The device responds to a number of commands (together known as the command-line API) delivered via the USB port.
    o Contact your L&M representative for a complete API guide.
- The USB port is configured on the device as a USB Serial Port. As a result, interfacing can be done with any standard terminal programs (hyperterminal, putty, MAC terminal window, etc), or direct programming via LabView, .NET, etc.
    o Serial port settings are:
        ▪ Baud Rate: 115200
        ▪ Data Bits: 8
        ▪ Parity bits = None
        ▪ Stop bits = 1
        ▪ Flow Control = None
- The device behaves as follows and in sequence:
    a. Perform analog/digital conversion and mathematical functions as part of optical level detection
        i. Buffer up to 4 characters of any incoming commands while performing the processing above
    b. Check for any characters in the buffer referenced above to indicate an incoming command and process any commands as required. Important programming notes:
        i. It can take up to 50ms for the system to complete complex analog/digital tasks and process the remainder of the command that was not buffered.
        ii. The device determines the completion of the command by detecting a "\r" character, i.e. ASCII code 13 decimal.
    c. Start all over from the top at (a)….
- As a result of the above device behavior, the recommended method to program each device is to:
    o The device operated at 115200 baud, 8 bits, 1 stop bit, no parity bits, no flow control.
    o Always append commands with \r to indicate the command completion.
    o Send the first character of the command, for example the "g" in "getcurrent\r".
    o Pause 50ms (this can be lowered for high speed access, but start with 50ms)
    o Send the remainder of the command, i.e. "etcurrent\r". While there are no pauses required between characters as the device is rapidly draining the incoming serial port at this point, some customers have found more success by inserting a 1ms pause between each character sent.
    o Immediately start sensing the response from the device.
        ▪ The device will always send a response to acknowledge the status of the command completion as well as to return values for "get" commands.
        ▪ The response will always be terminated with a "\r\n" (13 decimal, 10 decimal) sequence. This can be used to sense the end of the response and start sending the next command.
            - Regarding time-outs for command responses, "get" commands will typically respond within 100ms. "set" commands that store their

configuration in flash memory can take up to 5 seconds to respond. Other special commands like "setfactorydark", "setuserdark", and "captureflash" can take longer to respond.

- Be careful not to expect an immediate response from the device. For instance, after sending the remainder of the command, i.e. "etcurrent\r", do not immediately check the receive buffer and give-up if data is not sensed. It can take over 1 ms for even the fastest commands to return. It is better (more robust) to (a) send the remainder of the command, (b) continue looking for and processing a response until "\r\n" is sensed, and (c) use a timeout to detect when a response has not returned within some time period.

- Each RTGOM device is single threaded, meaning that commands and responses need to be processed in sequence. A 2nd command cannot, for example, be initiated before the 1st command's response is fully processed. As a result, if a multi-threaded application is accessing the device, a programmatic lock must be placed around device command/response sequences to make sure multiple threads do not attempt to access the device at the same time.
  - o If multiple devices are being monitored, a single lock can be used for access to all devices. This is simpler from a coding perspective, but not as efficient as it does not allow multiple devices to operate in parallel. For the best performance it is recommended that a per-device lock be established. This allows all devices to be accessed in parallel.
  - o As a further performance benefit when monitoring multiple devices, the delay after the first character can be performed in parallel across all devices. For example, if sending "getcurrent\r" to 5 devices, one would:
    - Send "g" to all 5 devices
    - Wait 50ms
    - Send "etcurrent\r" to all devices
    - Process the reply from all devices

- The most common commands have short-hand, 2 character versions of the command, to avoid the 50ms delay altogether. These are as follows:
  - o getvoltage = gv
  - o getod = go
  - o getcurrent = gc
  - o getirradiance = gi
  - o gettrans = gt

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L & M Instruments RTGOM Application Software

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L & M Instruments Device Firmware

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