

**OPERATING INSTRUCTIONS
FOR**

FIBEROPTIC

DISPLACEMENT MEASUREMENT SYSTEM

10DMS Multi-Channel Rack

Model 10DMS

Serial Nos.



PHILTEC, INC.

www.philtec.com

Precision Dynamic Measurements

Description

The model **10DMS** Displacement Measurement System is a 19" table top/rack mountable instrument equipped with up to ten removable sensors. Communication with the sensors is conducted through one RS232 port. Additional racks can be daisy-chained together to create a larger complement of sensor channels.



- Any combination of Philtec D or RC type displacement sensors can be used
- Any sensor can be installed at any position in any rack. The sensors are not installed sequentially, although they are installed that way as delivered from the factory.
- The sensors are addressed by their unique serial number.
- DMS Operating Software is provided with each 10DMS system.



SENSORS

The sensors are removed from the racks by loosening and then pulling on the two captive fasteners. The sensors can be operated externally from the racks using an optional AC/DC power supply and Y cable shown here.



Calibrations

Two factory calibrations are provided with each sensor channel: a mirrored (specular) target and a dull (diffuse) target. The calibration data is stored on board each sensor in separate calibration tables. Hard copies of each calibration chart are provided under separate enclosure.

Additional calibrations (up to 25) can be stored per channel.

COMMUNICATION

Each rack is equipped with two RS232 serial ports: one male and one female. Communication with all sensors is conducted thru one RS232 port and daisy-chain connections to additional racks. The sensors are addressed with their serial number.

The RS232 pins are standard:

From a PC:

Pins 1, 7 & 9 = not connected

Pin 2 = Receiver

Pin 3 = Transmitter

Pins 4, 6 & 8 = connected all together

Pin 5 = Ground

(From the DMS: pin 2 = transmit; pin 3 = receive)

POWER REQUIREMENTS

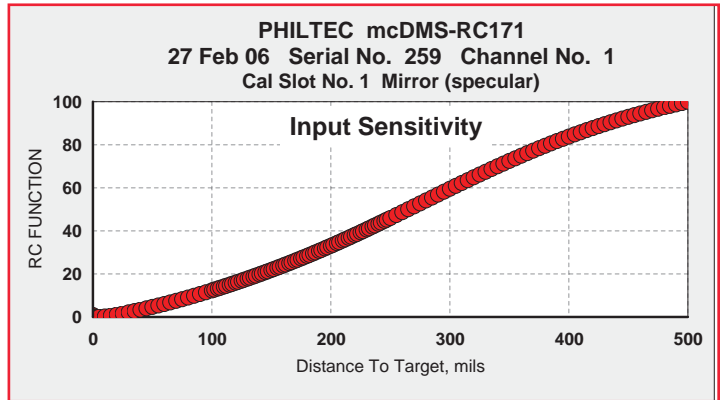
Input Voltage: 100 to 260 VAC at 50 or 60 Hz

Input Current Usage: 40 mv/channel at 120 VAC; 20 mv/channel at 240 VAC

OPERATING RANGES AND GAPS

Calibration data is stored on-board each sensor. This means the sensor can be gapped for measurements anywhere within the sensor's total operating range.

As with all type RC fiberoptics, optimum performance is achieved where signal-to-noise is greatest; i.e., where the RC function has the steepest slope (greatest sensitivity). A sensitivity chart is included with every sensor channel showing its RC function vs. Distance. When optimum performance is desired, refer to that chart to determine the optimum gap settings.

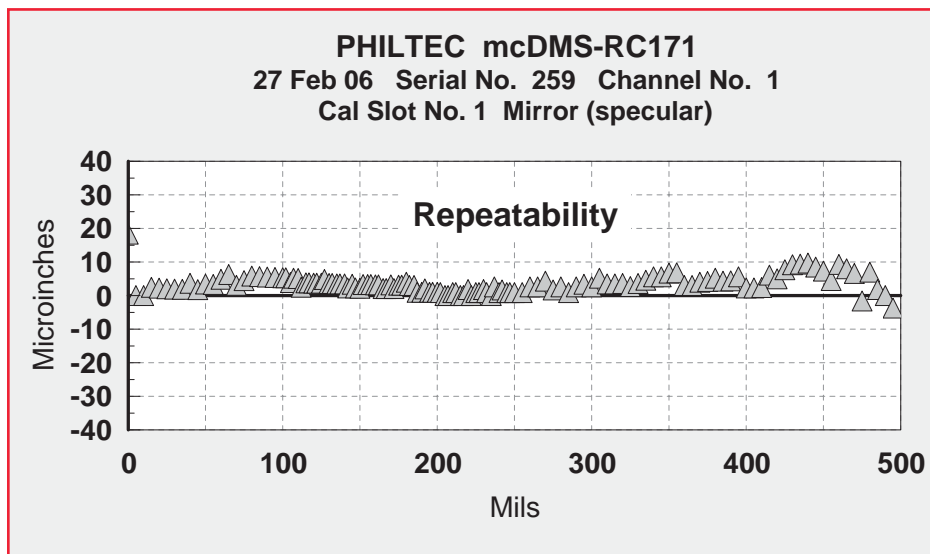


FACTORY CALIBRATIONS AND ACCURACY

Each sensor has been calibrated using a 0.2 micron accuracy linear air bearing stage.

Procedure

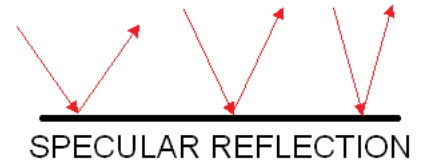
1. Mount the target on the stage table.
2. Mount the sensor off the stage table. The target moves during calibration. The sensor is stationary.
3. Begin with the sensor making light contact with the target.
4. Move the stage with target away from the sensor in small steps covering the total operating range.
5. After each step move, a) the stage position is read from the stage encoder and b) the sensor outputs are read. These two data are stored in the designated calibration slot.
6. Then, without disturbing the setup, the stage is moved back to its original position using the same steps. This time, the stage position is read from the sensor at each calibration step.
7. Repeatability is a measure of the accuracy of the sensor. A chart is prepared for each sensor calibration, where the repeatability data is graphed over the sensor's operating range. These charts graph the difference between the stored calibration (data moving away from the sensor) and the read data on the return moves.



REFLECTIVE NATURE OF THE TARGET SURFACE

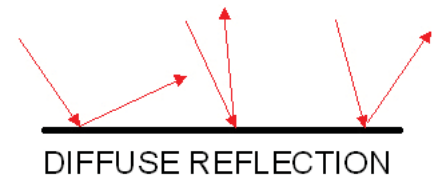
1. Specular Targets...*A mirror surface calibration should be used when making measurements to mirrored surfaces.*

A factory supplied calibration to a specular target is stored in cal slot #1, where the target is a front surface mirror. This calibration should be used if the target surface is any highly polished, mirrored, glossy or very shiny (specular) target. Thin transparent materials require their own calibration, which should be stored in a separate slot.



2. Diffuse Targets... The surface looks dull rather than shiny. *A diffuse surface calibration should be used when making measurements to diffuse surfaces.*

A factory supplied calibration to a diffuse reflector is stored in cal slot #2, where the target surface is anodized aluminum. With diffuse surfaces, reflected light rays travel randomly varying path lengths back into the sensor tip. Reflectance compensation does not correct for random scattering of light rays, which can lead to measurement errors.



So, for diffuse target surfaces, which include anything with a dull, flat or matte finish, as well as those with machined, honed or ground finishes:

- Use the diffuse calibration or
- Calibrate the system to the target material and store in a separate cal slot.

MATERIAL	% REFLECTANCE
Gold Mirror	100
Mirror Polished Aluminum	85 - 90
Mirror Polished Stls Stl	60 - 70
Brushed Aluminum	40 - 50
Copper Clad PC Board	45
Finely Ground Steel	30 - 35
Anodized Aluminum	20 - 25
Silver Paint, Glossy	15 - 20
Photo Paper, High Gloss	15
inkjet Paper, Bright White	7 - 8
Fiberglass, Glossy	7
Black Plastic, Glossy	6
Black Matte Finish	3
Column of Water	2
Flat Black Rubber	1

The table here shows the relative reflectance of some common materials.

Operation

1. **Install sensors** into rack channels by engaging the D-sub floating connector inside the rack and then by tightening the two captive fasteners.
2. **Apply power** to the rack and turn on the front panel power switch.
2. **Load into PC & Execute** the DMS Operating Software provided. The sensors will first go thru an initialization routine. During this process, in addition to many other checks, the software reads and copies all of the calibration tables from the sensors into the PC.
3. **Allow the sensors time to reach thermal equilibrium**, app. 20 minutes. For example, in a factory environment, where the air temperature has been around 24 C, the sensor temperatures rise to about 32 C. Therefore, the heater controls should be set to 2-3° C higher in each sensor. They are very stable at this set point.

NOTE: The temperature set point may require higher or lower set temperatures depending upon the factory temperatures in winter and summer months.

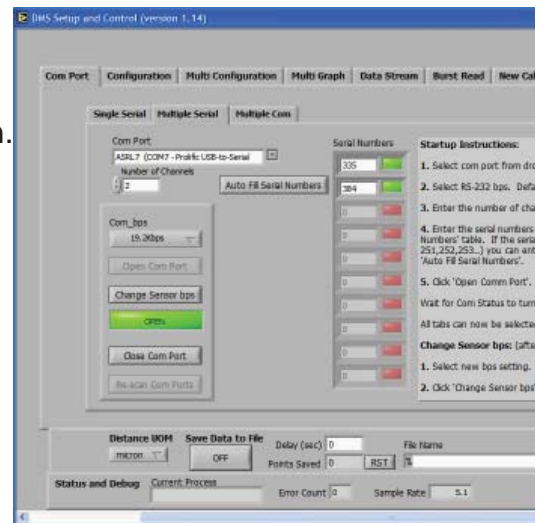
The Set Temperature should be 2 - 3 degrees above the equilibrium temperature. The amplifier temperature will be maintained at the set temperature ± 0.1 °C. If the amplifier temperature creeps above or below the set temperature by more than 0.1 degree, change the set temperature to reach a stable temperature set point.

4. The sensors are now ready to make measurements.

DMS Control Software

The DMS Setup and Control software opens at the **Com Port tab**.

1. At the **“Multiple Serial”** tab select a com port from the drop down list.
2. At “Number of Channels, enter the number of sensors to open.
3. Enter the sensor serial numbers
4. Click Open Com Port



SETUP & CONFIGURATION - RC Models

RC models can be setup for measurements using the **Multi Configuration Tab**. The sensors should be fixtured in place and perpendicular to the targets to be measured.

The **Multi Configuration** tab simultaneously displays data from as many as 10 sensor channels. At this tab you can control or set the following individual sensor variables:

- data average
- amplifier set temperature
- calibration slot

Temperature: Use the slide controls to set the temperature of the electronics. If the heater is not needed it can be turned off (set to 0) to reduce power consumption.

The screenshot shows the 'DMS Setup and Control (version 1.19)' application window. The 'Multi Configuration' tab is active, displaying a grid of 10 sensor channels. Each channel has a 'Serial' field, an 'Average' field with a spin control, 'Transmit%' and 'Receive%' fields with spin controls, 'Set °C' and 'Live °C' fields with spin controls, a 'Calibration' field with a spin control, and 'RC/ D near', 'D Far', and 'Reflect%' fields with spin controls. The bottom section of the window contains several controls: 'Distance UOM' set to 'micron', 'Save Data to File' checked, 'Delay (sec)' set to 60, 'File Name' set to 'C:\grace tests\378_379_521.txt', 'Points Saved' at 1430, 'Error Count' at 60, and 'Sample Rate (readings/second)' at 10.1. There is also a 'Status and Debug' section with a 'Current Process' field.

SETUP & CONFIGURATION - D Models

D model sensors require a reflectance peak setting procedure that can only be accomplished at the **Configuration** Tab. The other parameters that can be controlled, Data Averaging, Calibration Slot, and Temperature can be setup either at the **Config** tab or **Multi-Config** tab. Setup the sensor for measurements. The sensor should be fixtured in place perpendicular to the target to be measured. Click Title Bar of each section for instructions.

Reflectance Peak Set: With the optical peak power maximized at step 3, the sensor must be scaled (calibrated) to the reflectance of the target to be measured. There are two methods:

- Manual - Adjust the sensor gap for maximum 'Reflect Value' and press 'Peak Set'. This will lock in the reflectance value in the 'Reflectance Peak' window.
- AutoPeak - Press 'Peak Hold' and move the sensor tip slowly thru the peak reflectance value. The reflectance peak will be captured and held in the 'Reflectance Peak' window.

After setting the reflectance peak value, reset the operating gap to the desired starting point for measurements.

Temperature: Use the slide control to set the temperature of the electronics. If the heater is not needed it can be turned off (set to 0) to reduce power consumption.

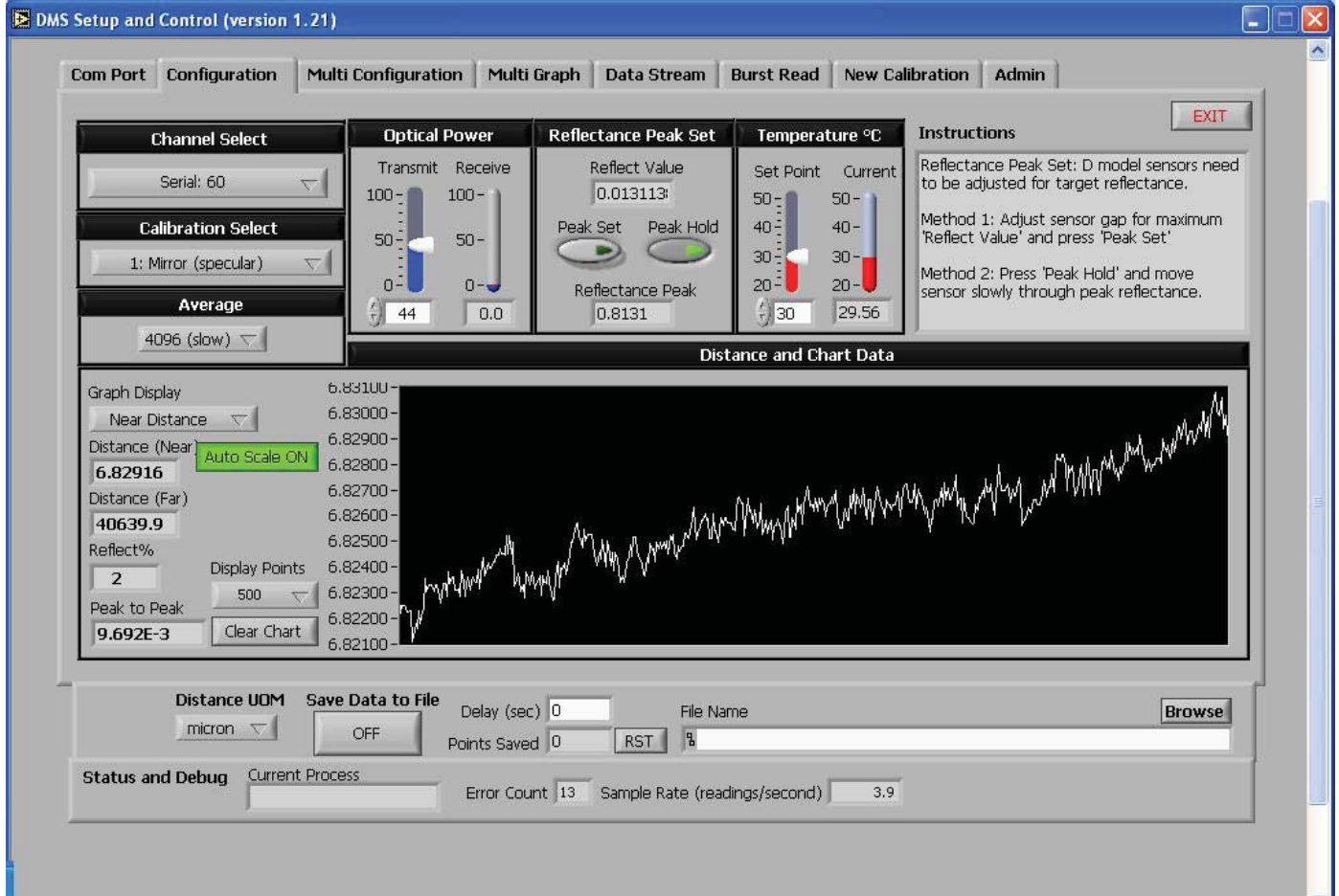
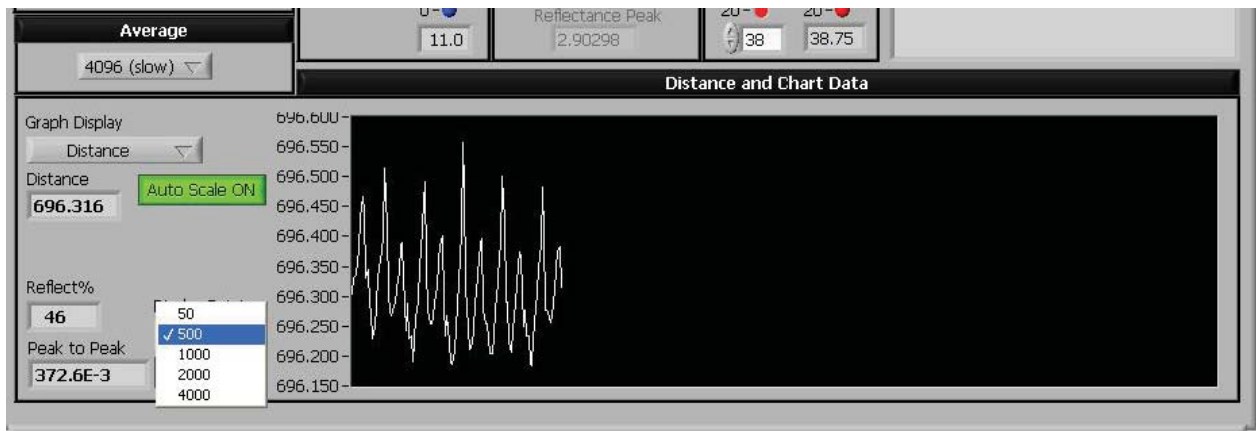


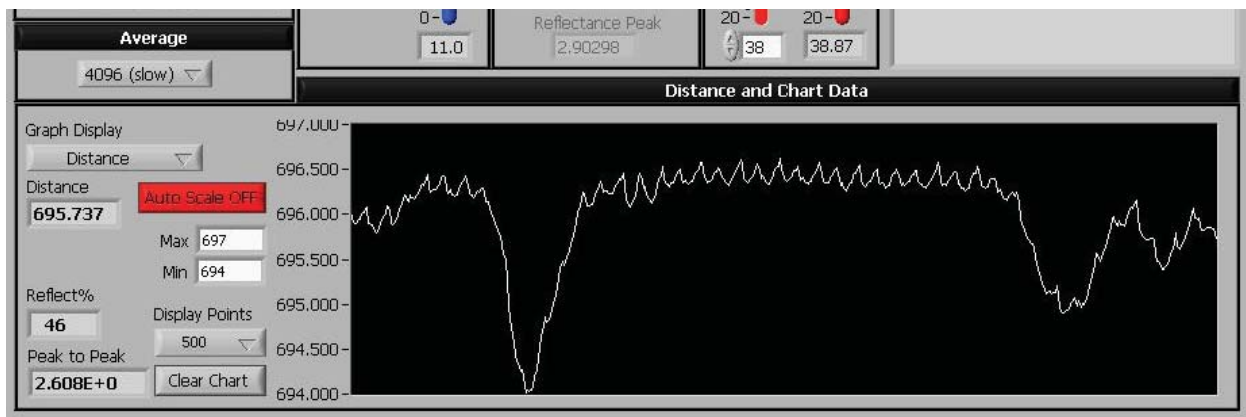
Chart Data



This live graph displays data with selectable point density from 50 - 4000 points on an autoscaling chart.

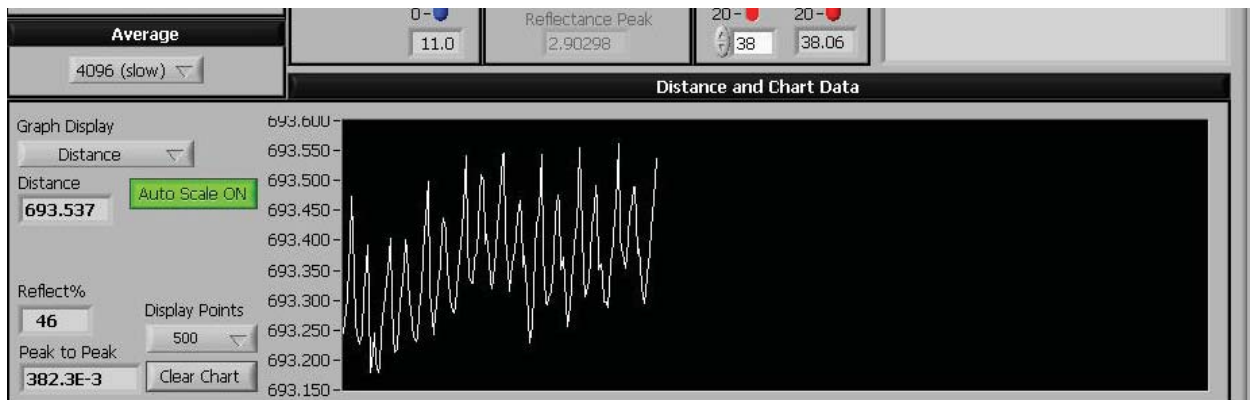
AUTOSCALING

The chart can be cleared at any time and it will restart autoscaling the current input data. Autoscaling can be turned off at any time. When autoscaling is off, the minimum and maximum points are displayed. The user can enter any value in the min-max windows.



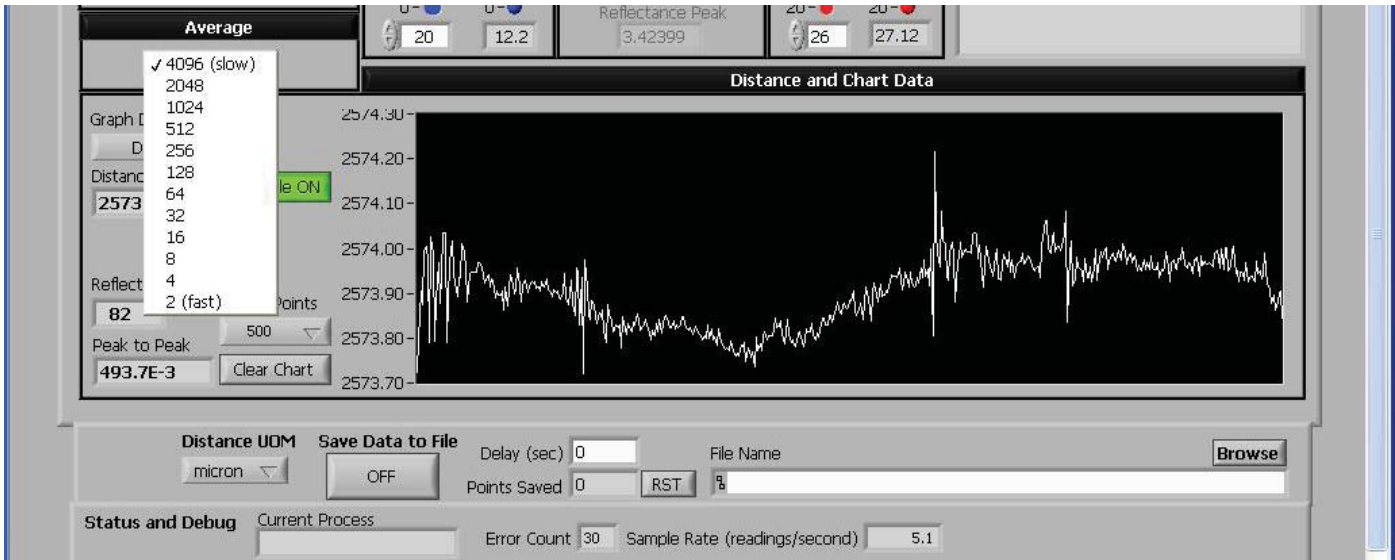
PEAK-TO-PEAK

Peak-to-peak displays the difference between the maximum and the minimum value of the points displayed on the live chart. If 50 points are displayed, this is the pk-pk reading of 50 points. If 4000 points are displayed, it is the pk-pk reading of 4,000 points.



AVERAGE

DMS sensors have an internal sampling rate of 20 KHz; miniDMS sensors have a 40 KHz clock rate. The average filter controls how many readings the sensor will average together before sending the results to the serial port. Higher averages will slow down sensor response and increase resolution. The actual sample rate (readings/second) is displayed below the live chart. The maximum achievable data rate is limited by the serial connection. At the slowest speed (4096), the sample rate is approximately 10 readings per second for mini-DMS sensors and 5 r/s for DMS sensors. For the highest speed, use the Data Stream tab.



GRAPH DISPLAY

At Graph Display, select one parameter to chart from the drop-down list:

- Distance - select units of measure at Distance UOM*
- Reflection % - compares the target material to the reflectivity of the calibration table selected
- Temperature - sensor amplifier temperature, °C
- Sensor Curve - raw sensor curve generally used for factory diagnostics
- Receive Power - the amount of optical power received from a target



* Select Distance UOM (*Units of Measure*):
microns or mm (millimeters), or inch or ml (milliInches)

SAVING DATA TO FILE



There is a common interface at each tab for saving data to a file. Click **Browse** to name a data file.
NOTE: Use the file extension .txt. Use Excel to open the text file.

- **Delay** - dial in the number of seconds desired between data points. Default = 0 seconds
- **ON/OFF** - Click the OFF button to start taking data. The button state will change to ON. The # of points saved is accumulated in the *Points Saved* window. Click the ON button to stop recording data. The button state will change to OFF. Data collection can be restarted by pressing the ON/OFF button again, and the data will be added to the same data file.

The table below shows a sample of the data recorded. Note the column headings give the sensor serial number and channel number.

- Time Stamp - An absolute time stamp: the # days starting 01/01/2000
- Delta T - The amount of time between successive data points, accurate to approx. 1 microsecond
- Raw Sensor Output - A factory diagnostic
- Signal Power - % Optical Power returned from the target
- Temperature - Amplifier temperature, °C
- RC/D Near Distance - Distance for an RC sensor or the Near Side for a D sensor
units of measure = previous set from live graph
- D Far Side Distance - Distance on the Far Side for a D sensor
units of measure = previous set from live graph
- Reflect Percent - reflectivity of the target material compared to the calibration table selected

Note: Time stamping data points enables post processing applications such as fft analysis.

start:1/1/2000	679 / 1	679 / 1	679 / 1	679 / 1	679 / 1	679 / 1	679 / 1
Time Stamp (days)	Delta T (sec)	Raw Sensor Output	Signal Power	Temperature	RC/D near Distance	D far side Distance	Reflect Percent
3092.415247	0.019584	3.630522	10.588235	27.75	3175	0	69.230766
3092.415258	0.017856	3.630842	10.588235	27.75	3175	0	69.230766
3092.415317	0.021408	3.631108	10.588235	27.8125	3175	0	69.230766
3092.415318	0.018912	3.63085	10.588235	27.8125	3175	0	69.230766
3092.41533	0.021936	3.630989	10.588235	27.75	3175	0	69.230766
3092.415341	0.019872	3.631088	10.588235	27.8125	3175	0	69.230766

MULTI-CHANNEL CONFIGURATION

The **Multi Configuration** tab simultaneously displays data from as many as 10 sensor channels. For single channel units, only one column is active. At this tab you can control or set the following individual sensor variables:

- data average
- transmit power
- amplifier set temperature
- calibration slot

The screenshot shows the 'Multi Configuration' tab in the 'DMS Setup and Control (version 1.19)' application. The interface is organized into a grid of 10 columns, each representing a sensor channel. Each column contains several adjustable parameters, each with a numeric input field and a small up/down arrow icon. The parameters and their values for the first three active channels are as follows:

Channel	Serial	Average	Transmit%	Receive%	Set °C	Live °C	Calibration	RC/ D near	D Far	Reflect%
1	521	4096	100	5.9	38	38.0	1	0.0000	3048.0	7.9
2	379	4096	100	5.9	38	37.9	1	0.0000	3048.0	8.6
3	378	4096	100	5.9	38	38.0	1	0.0000	3048.0	8.4
4		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
5		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
6		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
7		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
8		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
9		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0
10		<0>	0	0.0	0	0.0	0	0.0000	0.0000	0.0

Below the grid, there are several control sections:

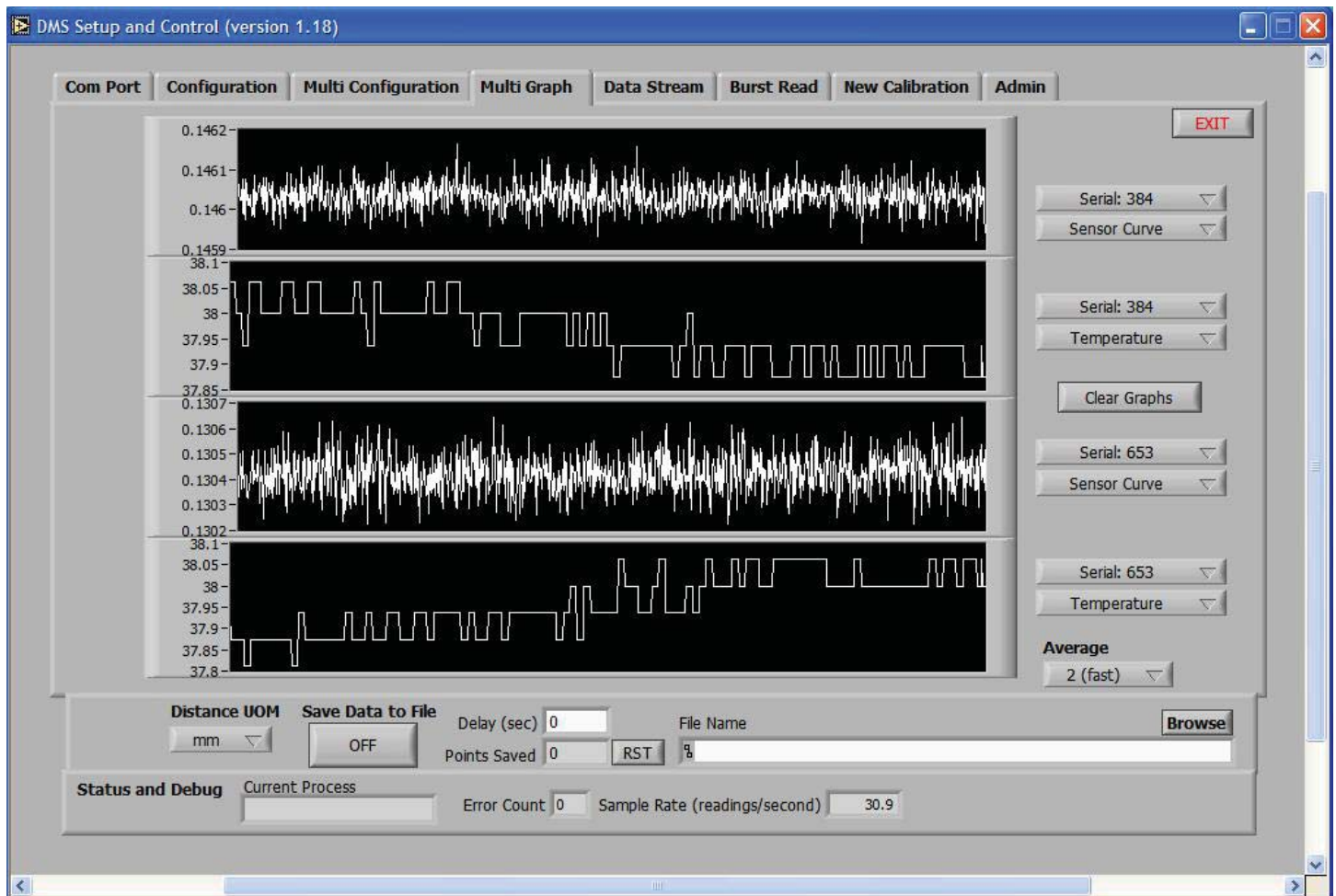
- Distance UOM:** A dropdown menu currently set to 'micron'.
- Save Data to File:** A toggle switch currently set to 'ON'.
- Delay (sec):** A numeric input field set to '60'.
- File Name:** A text input field containing '% C:\grace tests\378_379_521.txt', with a 'Browse' button to its right.
- Points Saved:** A numeric input field set to '1430', with an 'RST' button to its right.
- Status and Debug:** A section containing a 'Current Process' field (empty), an 'Error Count' field set to '60', and a 'Sample Rate (readings/second)' field set to '10.1'.

MULTI-CHANNEL GRAPH

The **Multi Graph** tab simultaneously displays four live autoscaling charts.. The charts display 1000 points when fully loaded. Data averaging can be controlled and units of measure selected.

Each chart has drop down menus for

- » selection of sensor
- » selection of displayed parameter



DATA STREAM

The **Data Stream** mode enables continuous recording of data at high speeds.
Default presets include:

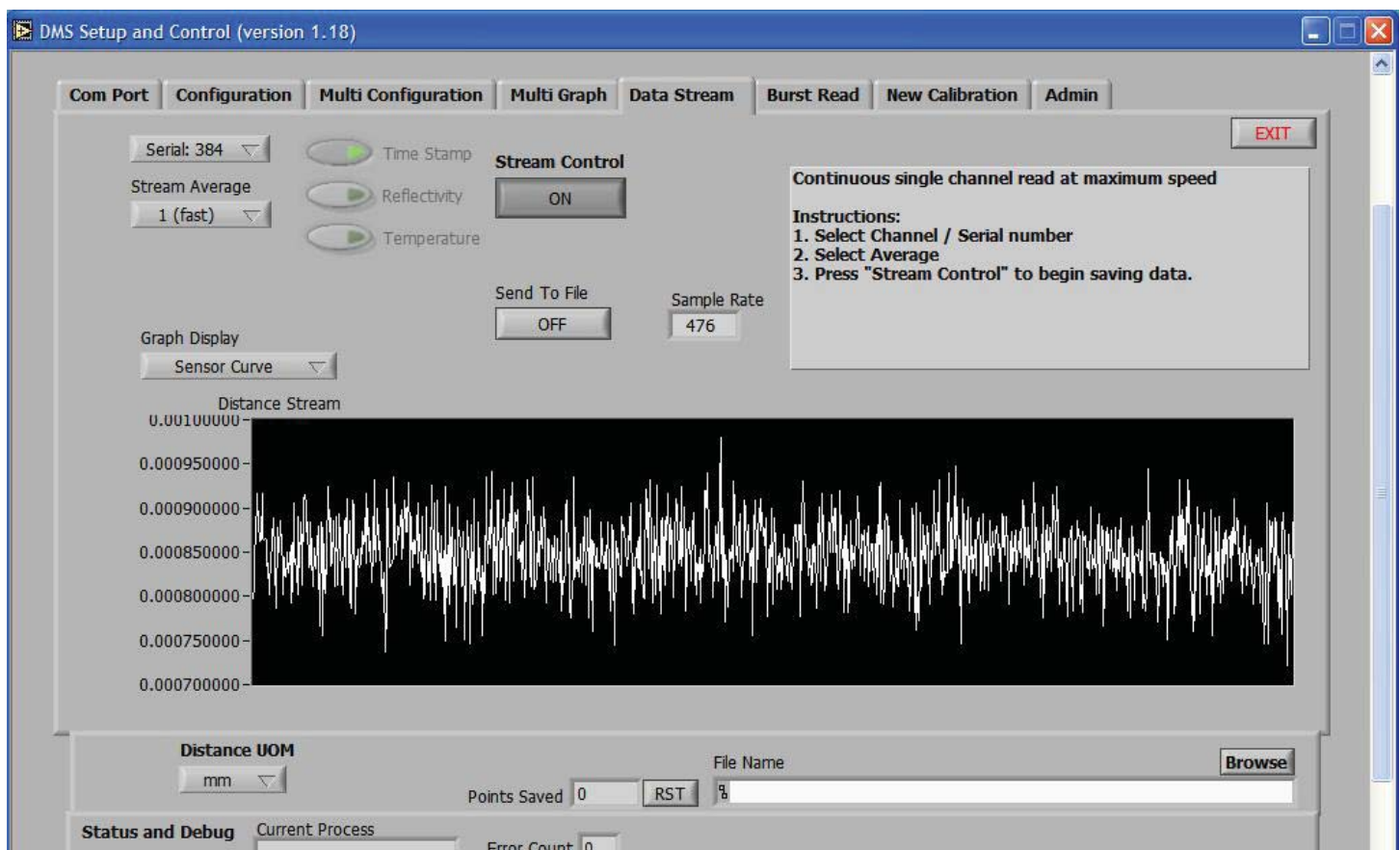
- Time Stamp
- Reflectivity
- Temperature

5000 readings per second will be achieved as follows:

- set the BPS to 115.2 Kbps
 - set stream average to 1 (fast)
 - deselect the Time Stamp, Reflectivity and Temperature presets
- Click the **Stream Control** Button to begin saving data
Note: If you have not preselected a file, you will be instructed to browse to a file for saving the data.
Use the file extension .txt when naming the file.

As data is streaming to the file:

- a) **Points Saved** ... accumulates the total number of readings
- b) **Sample Rate** ... displays the active number of readings per second

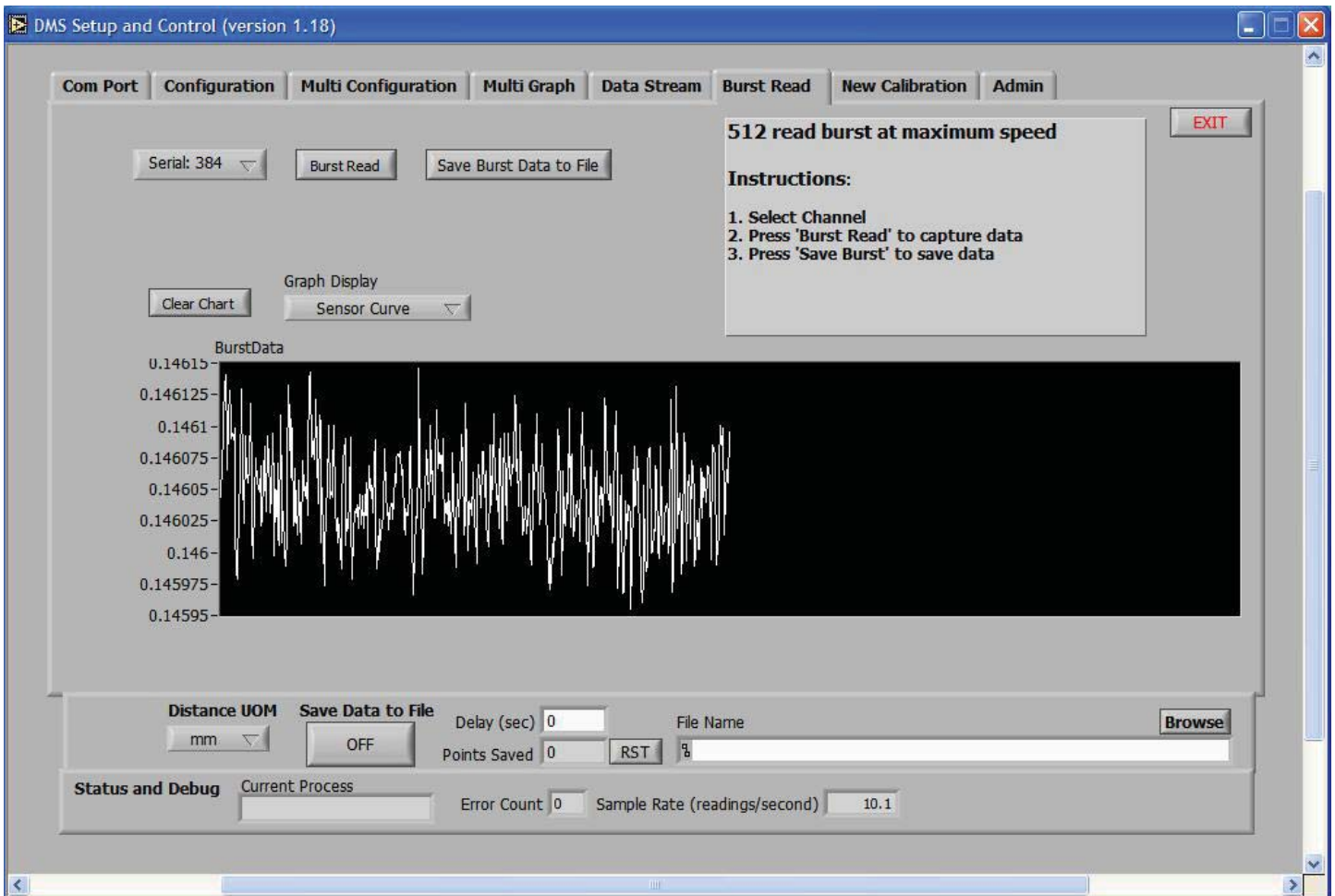


BURST READ

In **Burst Read** mode, 512 readings - equally time-spaced - are recorded at the clock rate of the sensor, which is the highest speed achievable from the sensor:

- DMS = 20.85 KHz
- miniDMS = 41.7 KHz

The data can be saved to a file.



NEW CALIBRATION

The **New Calibration** tab can be used to create a new calibration for the sensor.

- At **New Calibration Slot**, select the calibration slot to be used
- At **Description**, enter a description of the calibration
- At **Distance UOM**, select the units of measure that will be used for the calibration distance
- Click Restart Calibration
- At **Calibration Point Distance**, enter the current distance between the sensor and the target
- Click **Take Sensor Reading**
- Repeat the previous 2 steps until the calibration is completed
- Click “Send New Calibration To Sensor”

The screenshot shows the 'DMS Setup and Control (version 1.21)' application window. The 'New Calibration' tab is active. The interface includes the following elements:

- Menu Bar:** Com Port, Configuration, Multi Configuration, Multi Graph, Data Stream, Burst Read, **New Calibration**, Admin.
- Serial:** 679 (dropdown menu)
- Restart Calibration:** Button
- New Calibration:** Section with a sub-label 'New Calibration based on existing data'.
- New Calibration Slot:** Spin box set to 10.
- Description:** Text input field.
- Calibration Point Distance:** Spin box set to 0, with a **Take Sensor Reading** button below it.
- Calibration Points:** Spin box set to 0, with a **Send New Calibration to Sensor** button below it.
- EXIT:** Button in the top right corner.
- Calibration Instructions:** A scrollable text area containing:
 1. Select Calibration slot. New calibrations will overwrite old data.
 2. Enter a description for this calibration. (24 characters max).
 3. Select UOM for the calibration distance that will be entered.
 4. Click 'Restart Calibration Data' to restart calibration process. (will not change data stored on sensor).
 5. Enter current distance between sensor tip and target.
 6. Click 'Take Sensor Reading' or press 'Enter' key to save this calibration point.
 7. Repeat steps 5 and 6 for each calibration point.
 8. After last calibration point click 'Send New Calibration to Sensor'
- Graph:** A plot with 'Ratio' on the left y-axis (0.82 to 1.02) and 'SNR' on the right y-axis (0 to 100). The x-axis is 'Distance' (3.6 to 4.4). The plot area is currently black.
- Distance UOM:** 'micron' (dropdown menu).
- Save Data to File:** Section with a **Delay (sec)** of 1, **Points Saved** of 5621, **RST** button, **File Name** field with 'C:\Documents and Settings\Jerry\Desktop\test.txt', and a **Browse** button.
- Status and Debug:** Section with **Current Process** field, **Error Count** of 37, and **Sample Rate (readings/second)** of 5.1.

NEW CALIBRATION BASED ON EXISTING DATA

The **New Calibration** tab can also be used to rescale an existing calibration. Only one data point is required for scaling. Digital sensors are normally provided with two calibration tables: mirror and diffuse targets. Select the table which best fits a new target. For best accuracy, pick a scaling distance that is in the middle of the range of operation for the application.

- At **Reference Calibration Table**, select the reference table
- At **New Calibration Slot**, select the calibration slot to be used
- At **Description**, enter a description for the calibration
- At **Distance UOM**, select the units of measure that will be used for the calibration distance
- At **Calibration Point Distance**, enter the scaling distance between the sensor and the target
- Click **Take Sensor Reading**
- Click **“Send New Calibration To Sensor”**

DMS Setup and Control (version 1.21)

Com Port Configuration Multi Configuration Multi Graph Data Stream Burst Read **New Calibration** Admin

Serial: 679
Restart Calibration

New Calibration
New Calibration based on existing data

Reference Calibration table
1: Mirror (specular)
✓ 1: Mirror (specular)
2: Dull (diffuse)
3:
4:
5:
6:
7:
8:
9:
10:
11:
12:
13:
14:
15:
16:
17:
18:
19:
20:
21:
22:

Calibration Instructions

1. Select existing calibration which is similar to new target surface.
2. Select new calibration slot. New calibrations will overwrite old data.
3. Enter a description for this calibration. (24 characters max).
4. Select UOM for the calibration distance that will be entered.
5. Move target to known distance and enter this data in 'Calibration Point Distance'
6. Click 'Take Sensor Reading' or press 'Enter' key to save this calibration point.
note: calibration data will be modified to match the new data point.
note: Reference calibration will not be modified.
7. click 'Send New Calibration to Sensor'.

Ratio
SNR

Distance

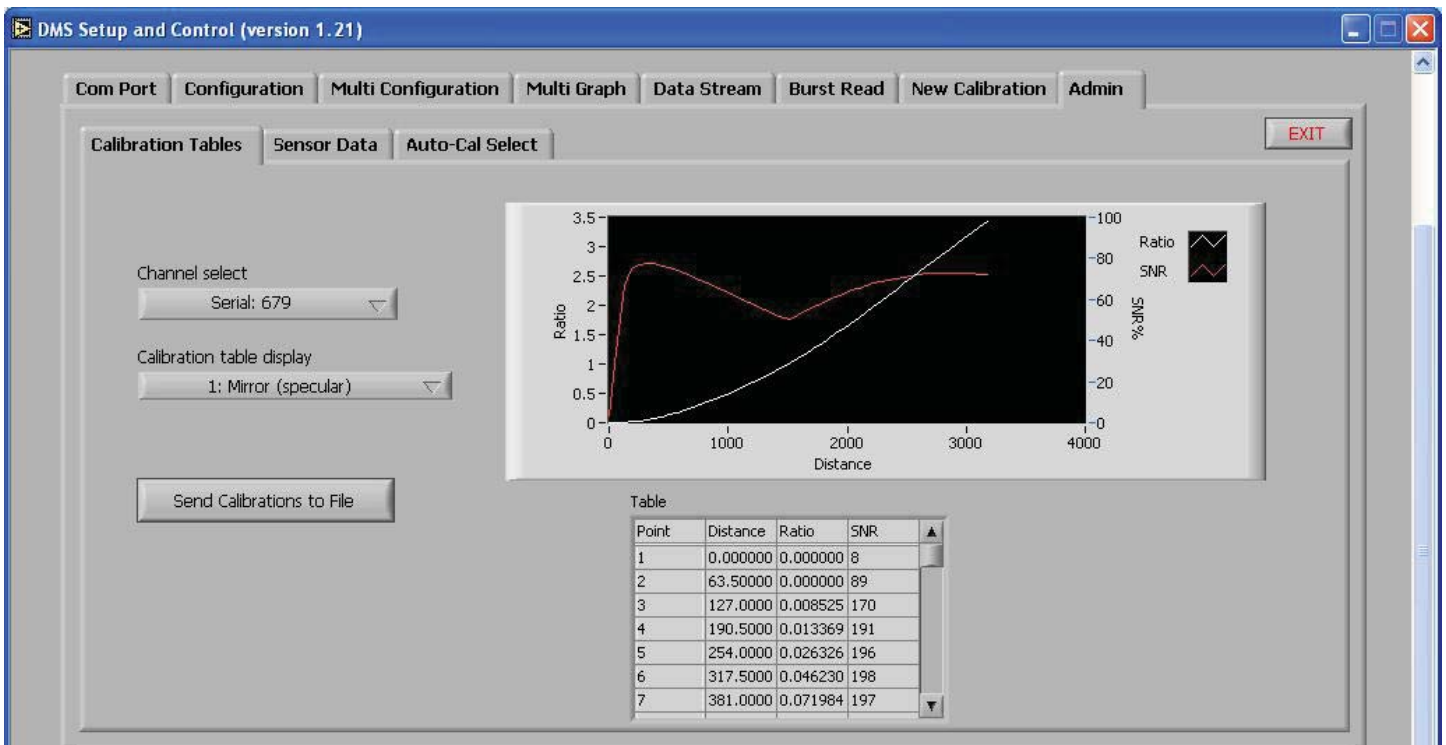
Delay (sec) 1 File Name
Points Saved 5621 RST C:\Documents and Settings\Jerry\Desktop\test.txt

Error Count 37 Sample Rate (readings/second) 5.1

ADMIN - CALIBRATION TABLES

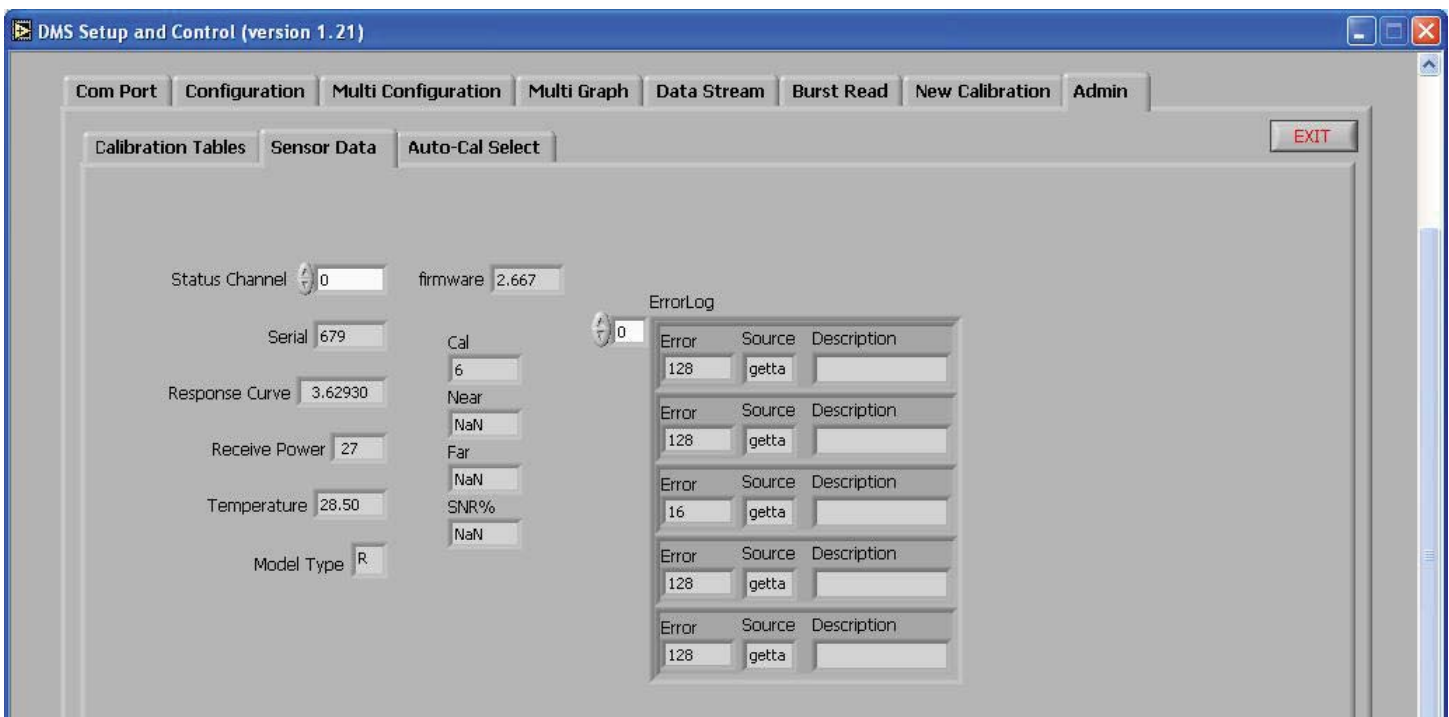
The **Admin-Calibration Tables** tab is used to view the data stored in the sensor's calibration tables.

Click on "**Send Calibrations To File**" to create a text file of all the sensor's calibration tables.



ADMIN - SENSOR DATA

The **Admin-Sensor Data** tab is used to view sensor information for factory diagnostic purposes.

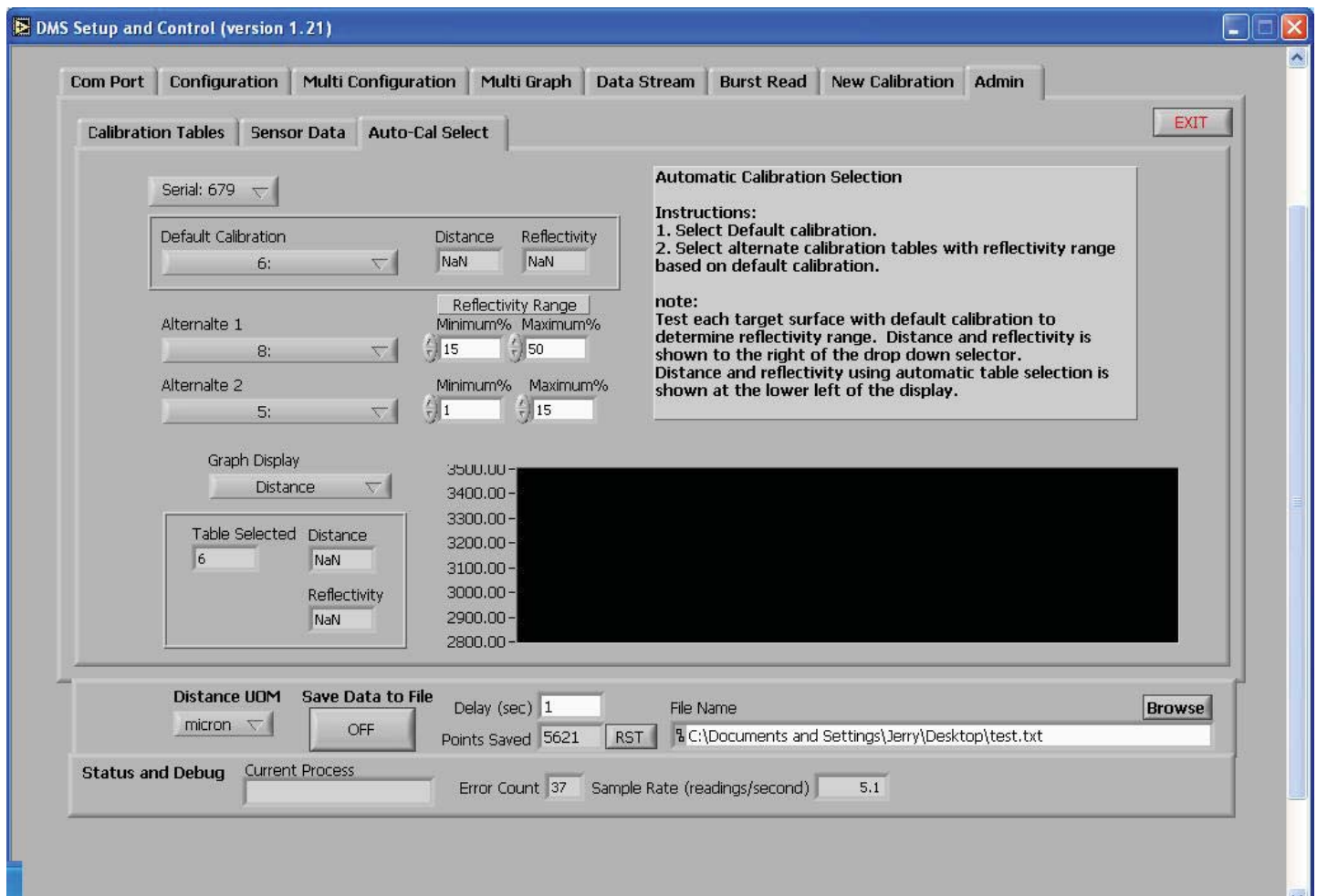


ADMIN - AUTO-CAL SELECT

The **Admin-Auto-Cal Select** tab is intended for use in applications where 2 or 3 distinctly different targets are to pass by the sensor, and the distance measure to each of those targets is required.

When the **Admin-Auto-Cal Select** tab is in view, the sensor will lookup distance information from the stored calibration tables based upon the reflectivity of the target surfaces. For example, targets with a mirror-like finish (specular reflectors) have a different response than dull or diffuse reflectors, and therefore the two calibration tables are stored on board the sensor. The controls at this tab allow the user to select ranges of reflectivities of the targets that will be measured. The sensor will generate accurate distance information based upon the appropriate calibration table, as defined by the reflectance values. This function has no impact on the sensor sample rate.

Auto-Cal Select turns off when this tab is deselected.



SOFTWARE & FIRMWARE UPDATES

mcDMS sensors can be updated remotely at any PC. The most current edition of software and firmware is posted at <http://www.philtec.com/firmware.htm>

PROCEDURE

Download the firmware update program to your local hard drive.

Locate the .exe file and execute the program. Follow the on-screen instructions.

The program will instruct you when to reboot the sensor (turn power off, and turn power on).

HOW TO REPLACE THE 10DMS FUSE

PART MODEL NO.: F400



The fuse is located on the 10DMS rack front panel. It is between the line power cord and the power ON/OFF switch.

TO REPLACE FUSE

1. Remove the AC power cord from the rack.
2. Insert a small screwdriver into the small slot on the side of the fuseholder, and pull out the fuse holder.
3. Remove the fuse and replace with a new fuse.
4. Press the fuseholder back into the power module.



WARRANTY

Displacement Measurement Systems are warranted by Philtec, Inc. against defects and workmanship for 12 months from the date of shipment from the factory. Damage to the fiberoptic cable or sensor tip are not covered under this warranty.