Description	RS232 Real time data connection technical documentation		
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Distribution	BTG Labs and partners.		
Doc. History	**Revision**	**Date**	**Change**
	1	2021-05-28	Initial release

1. Purpose and audience for this document

Describe the RS232 functionality for integrators who wish to export real time data from a Surface Analyst to an external RS232 enabled device.

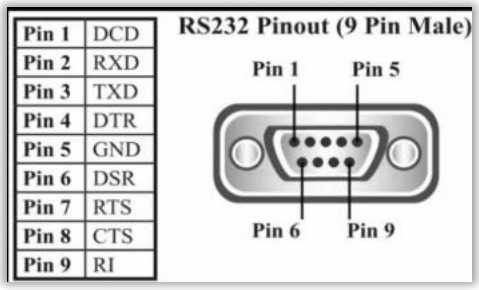
- Wiring information is provided for users to properly prepare their systems to receive real time data from a Surface Analyst.
- Configuration information may require service level login on the Surface Analyst to complete. Individuals who think they need to configure settings (which are available in the service menus) should contact BTG Service to receive a temporary service login.
- Data format is provided for proper programming of the receiving systems to properly parse the desired data from the data stream.

It is expected that the personnel wiring and configuring the system will be familiar with RS232 communication protocol along with wiring and configuration of RS232 systems.

2. Hardware / Wiring

The integration of a Surface Analyst with RS232 requires both the hardware supplied with the purchase of the RS232 connection option as well as customer supplied hardware to connect to the equipment which will receive the RS232 data.

- The RS232 hardware supplied with the Surface Analyst (when the option is purchased) consists of a USB to RS232 adaptor which is based upon PL203 chipset.
  - Along with the USB to RS232 adaptor is a clamp which is screwed to the Surface Analyst case to prevent the adaptor from becoming unplugged.
  - The end of the supplied adaptor is a standard serial DB9 male connector with female screw threads for attaching the mating cable.
  - Only pins 2,3, and 5 are used for communications and are the minimum needed to be wired.



  - Cable length used between the Surface Analyst and the receiving equipment is limited by the baud rate selected and the capacitance of the cable used. Guidelines suggest using a baud rate of 9600 will allow cable lengths up to 500 feet.

- The following can be used for testing the connection (See section 6 for more details):
  - A USB to serial dongle can be used to connect RS232 to the laptop.
  - The USB to serial dongle on the laptop can be connected to the Surface Analyst connector with a 9 pin (female to female) null modem adaptor.
  - A simple Terminal program can be used for testing.
    - Any terminal application can be used for testing, some options are:
      - Putty https://www.putty.org/
      - Terminal https://sites.google.com/site/terminalbpp/

Showing the USB to RS232 adaptor with restraining clamp attached to the Surface Analyst.

The cable ends in a 9 pin male DB9 connector.

3. Output format

There are two different formats available for data export. These formats are configurable through a service menu item (listed under the configuration section). This section uses <CR> to represent the ASII carriage return character (13) and uses <LF> to represent the ASCII line feed character (10).

- The data is output when the results are presented to the user for acknowledgement.
- The Surface Analyst does not receive any data and will not respond to commands sent from the customer equipment.

Standard format is a simple output of only the contact angle. If dyne mode is enabled then the contact angle will be replaced with the dyne measurement. This is the simplest format available and is useful on systems where the user does not have the ability or the need to parse a more complex data stream.

- Description of output:
  - CAngle<CR><LF>
- Sample output when the contact angle reading was 53
  - 53<CR><LF>

Verbose format provides a large amount of configuration and result data for each inspection. Use of this format provides a much richer selection of data but requires more complex parsing than the standard output format. This format also provides fields which will always change between inspections (such as the date and time). These changing fields can be used as triggers to know when new data has been received on systems which do not allow triggering on receipt of data (for example PLC systems where the data just shows up in registers).

- Output format (Color coded to match sample below)
  - Result:username|persistentN|CAngle|profile|minangle|maxangle|droparea|passorfail|acceptedOrRejected|timestamp|dropnumber|opticalcal|dCorrectB|illumination|pressure|numOfDroplets|vSpikeTime|vOpenTime|vPeriod|cartridgeserial|weightcal|UnitSerialNumber|BlurPasses|BlurRadius|DropCenX|DropCenY|Pass2Far|Pass2Near|Pass3Far|Pass3Near|MaxDropRad|MinDropRad|UseAutoCen|Perimeter|Compactness|(UncorrAngle,CorrAngle)(CorrUsed/FactorH/Temp)|dy(Dynesmode/DyneParams)|adder(adder)|stability(stdev)|ProcessOptions|dyne|minDyne|MaxDyne|useDynamic|DynamicWidth|DynamicLength|DynamicLasstPass|DynamicMergeAll|DynamicCenMin|DynamicC

enMax|DynamicCenMergeDist|DynamicEdgeMinDia|DynamicEdgeDefaultDia|DynamicNear1|DynamicNear2|DynamicNear3|DynamicFar1|DynamicFar2|DynamicFar3|DynamicInvert|SurfDelta|SurfDeltaTol|SurfPassFail|PressureResponse<CR><LF>

- Sample output (Color coded to match above description)
  - Result:user1|Lot #234|53|gdeyn|0|180|2100|Pass|accepted|2018-03-05T11:54:43|341|4917.5|1.36|2|4.5|18|8|31|300|test - June 8 2017|1.61|A3212|1|2|49|50|2|0.8|1.6|0.7|33|5|true|185.36|0.77|(53.48/53.47)(1.0002/0.997/0)|dy(false/null)|adder(0)|stability(0)|#U,49,50#|229|20|80|true|15|9|10|true|15|370|10|75|150|0.25|0.5|0.8|2|2|1.72|false|0|0|Pass|0.272475,Pass,0.05,1,0.1575,3.15<CR><LF>

- Detailed list of fields (parsed with the pipe character separator):
  NOTE: The description column below is for reference. More complete explanation of a function or parameter can often be found in the Surface Analyst Administrator Manual.

Field #	Short name shown above	Description
1	Username	Username of the individual logged in.
2	persistentN	Drop note entered by the user on menu page 2.
3	CAngle	Measured contact angle. This field remains reading the contact angle even if the device is configured for dyne. This value will be present for all drops dispensed including rejected drops.
4	profile	Name of the currently selected profile selected by the user on menu page 1.
5	Minangle	Minimum angle for the pass range entered on menu page 6.
6	Maxangle	Maximum angle for the pass range entered on menu page 6.
7	Droparea	Area of the drop measured in pixels.
8	Passorfail	Text indication (Pass/Fail) of the status of the measurement reported to the user on screen. If the drop is rejected then this field will be blank.
9	acceptedOrRejected	Denotes if the drop was accepted or rejected. This status based on either the manual verification from the operator, or automated “SmartDrop” parameters depending on how the instrument is configured.
10	Timestamp	Date and time of the inspection. Changing timestamps can be used to verify that new records have been returned.
11	Dropnumber	Drop number used for this inspection. The drop number is the number of drops left in the current cartridge. This can be used to verify that new records have been returned.
12	Opticalcal	Value stored internally during the optical calibration of the instrument (in pixels). This value will not change unless the instrument is returned for calibration.
13	dcorrectB	Diameter correction applied to this measurement. This is a correction factor which is specific to each profile.
14	Illumination	Value of the illumination setting from menu page 7 which sets the brightness of the lighting in the inspection head.
15	Pressure	Pressure used during the dispense.

Field #	Short name shown above	Description
16	numOfDroplets	Number of microdroplets used to form the drop which was inspected.
17	vSpikeTime	Amount of time a higher voltage is applied to the valve to ensure high speed operation of the valve. This value does not normally change. Units are in 30.52us microcontroller processor ticks.
18	vOpenTime	The amount of time the valve is held open for each microdroplet. Units are in 30.52us microcontroller processor ticks.
19	vPeriod	Time between the start of individual microdroplets. Units are in 30.52us microcontroller processor ticks.
20	cartirdgeSerial	Serial number of the current cartridge. This serial number is entered during the cartridge change process. The date of change is also included in this entry.
21	weightCal	Calibrated weight of the drop dispensed. This is a value set during calibration of the device and does not change during operation.
22	UnitSerialNumber	Serial number of the connected unit. This value will not change for the life of the device.
23	BlurPasses	Number of times a blurring filter is applied to the subtraction image. This item is specific to a profile.
24	BlurRadius	Area impacted by each blur pass. This item is specific to a profile.
25	DropCenX	Expected X location of the drop in the field of view expressed as a percentage of the screen. This is not a measured value and reflects the configuration set through menu page 6.
26	DropCenY	Expected Y location of the drop in the field of view expressed as a percentage of the screen. This is not a measured value and reflects the configuration set through menu page 6.
27	Pass2Far	Value of the pass multipliers set on menu page 7.
28	Pass2Near	Value of the pass multipliers set on menu page 7.
29	Pass3Far	Value of the pass multipliers set on menu page 7.
30	Pass3Near	Value of the pass multipliers set on menu page 7.
31	MaxDropRad	Percentage value representing the largest area to search for a drop.
32	MinDropRad	Percentage value representing the smallest area to search for a drop.
33	UseAutoCen	true/false value representing the state of the Drop Center parameter set on menu page 6.
34	Perimeter	Length of the perimeter of the measured drop represented in pixels. This is a measured value calculated from the found edge points.

Field #	Short name shown above	Description
35	Compactness	Ratio of the measured perimeter to the perimeter of a circle with the same area as the drop. This is a number less than or equal to 1 which represents how smooth and consistently round the drop shape is. Higher numbers indicate the drop is rounder and more consistent.
36	(UncorrAngle,CorrAngle) (CorrUsed/FactorH/Temp)	Values used in the temperature compensation routine.
37	dy(Dynesmode/DyneParams)	Values used during the conversion from contact angle to dyne (if enabled). This also contains if dyne mode is enabled.
38	adder(adder)	Correction factor which can be added to the diameter during contact angle calculations. Not normally used.
39	stability(stdev)	Stability of the pressure before a drop dispense. This value is only available if the instrument is equipped with a pressure transducer in the head of the instrument.
40	ProcessOptions	Packed data field which represents options set in the image processing and other menus. These are specific to a profile and are not measurement results.
41	Dyne	Measured dyne value as converted from the contact angle using the dyne conversion equation entered.
42	MinDyne	Minimum allowed dyne value for a passing result as entered on menu page 6.
43	MaxDyne	Maximum allowed dyne value for a passing result as entered on menu page 6.
44	useDynamic	Dynamic detection mode enabled
45	DynamicWidth	Dynamic detection Edge Width Filter Image processing on menu page 5
46	DynamicLength	Dynamic detection Edge Length Filter Image processing on menu page 5
47	DynamicLastPass	Dynamic detection maximum passes allowed
48	DynamicMergeAll	Dynamic detection Center Merge All Image processing on menu page 5
49	DynamicCenMin	Dynamic detection Center Min Diameter Image processing on menu page 5
50	DynamicCenMax	Dynamic detection Center Max Diameter Image processing on menu page 5
51	DynamicCenMergeDist	Dynamic detection Center Merge Distance Image processing on menu page 5
52	DynamicEdgeMinDia	Dynamic detection Min Diameter for edges
53	DynamicEdgeDefaultDia	Dynamic detection Default Diameter when size invalid
54	DynamicNear1	Dynamic detection Near Pass 1 Pass Multipliers on menu page 7
55	DynamicNear2	Dynamic detection Near Pass 2 Pass Multipliers on menu page 7

Field #	Short name shown above	Description
56	DynamicNear3	Dynamic detection Near Pass 3 Pass Multipliers on menu page 7
57	DynamicFar1	Dynamic detection Far Pass 1 Pass Multipliers on menu page 7
58	DynamicFar2	Dynamic detection Far Pass 2 Pass Multipliers on menu page 7
59	DynamicFar3	Dynamic detection Far Pass 3 Pass Multipliers on menu page 7
60	DynamicInvert	Dynamic detection Invert Finding Image processing on menu page 5
61	SurfDelta	Surfactant Delta angle found between first and last images.
62	SurfDeltaTol	Surfactant Delta Tolerance Surfactant Detection on menu page 5
63	SurfPassFail	Surfactant inspection pass/fail value
64	PressureResponse	Pressure response value returned from the dispense along with the tolerances used. In a comma delimeted format. Pressure response value, Pressure response Pass/Fail,Low Limit set in device, high limit set in device, low limit comparison value, high limit comparison value.

4. Configuration options (need service login to access command entry)

Configuration of the RS232 settings is normally completed by BTG before delivery of the device if the customer has specific settings requests. If the customer does not specifically request specific settings then the default values below will be used.

Setting	Default	Command and Options
Enable or disable serial output	Enable	MC:uest to enable option MC:uesf to disable option
Output format	Standard format	MC:uesvf for standard format MC:uesvt for verbose format
Baud Rate	9600	MC:uesb:x where x is one of the following 2400,4800,9600,14400,19200,38400,57600,115200
Data Bits	8	MC:uesd:x where x is one of the following 5,6,7,8
Stop Bits	1	MC:uess:x where x is one of the following 1,2,3 NOTE: Value of 3 is for 1.5 stop bits
Parity	None	MC:uesp:x where x is one of the following 0,1,2,3,4 NOTE: Values represent the following options 0 = PARITY_NONE 1 = PARITY_ODD 2 = PARITY_EVEN 3 = PARITY_MARK 4 = PARITY_SPACE

5. Limitations

The following limitations and notes apply to the use of the RS232 option.

- The RS232 connection available on the Surface Analyst does not support hardware or software handshaking.
- The USB to RS232 adaptor must stay connected to the Surface Analyst during operations.
- There is no buffering provided on the RS232 output, so if the cable becomes disconnected during operations then data will be lost.
- Cable length and shielding should be appropriate for the selected baud rate and environment to ensure error free communications. The data sent from the Surface Analyst does not include error correction.

6. Testing example under Windows

This section gives step by step instructions for testing the serial connection using a windows laptop running Putty.

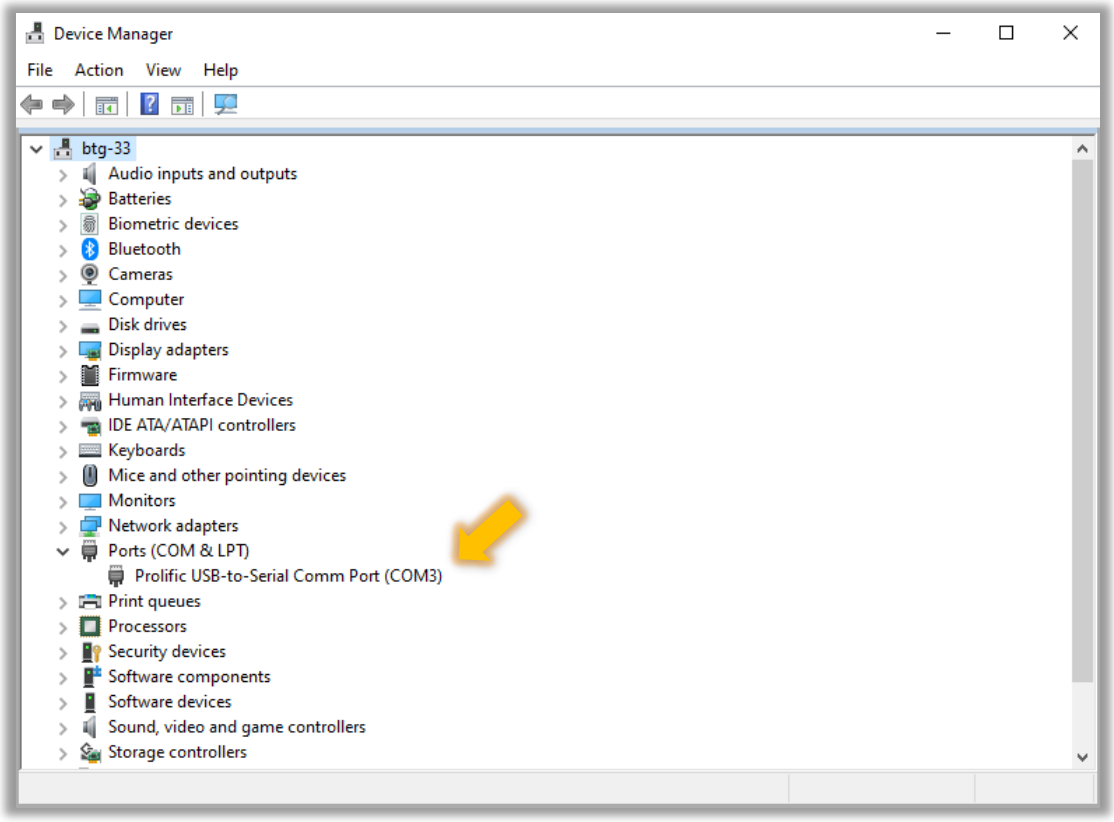
Certain assumptions are made in this section about the hardware available as well as the Surface Analyst setup.

- There is a USB to serial connected to the laptop, then a Female-Female Null Modem Adaptor, then the USB to serial adaptor plugged into the Surface Analyst.

- The MC commands have been entered (MC:uest, MC:uesvt)

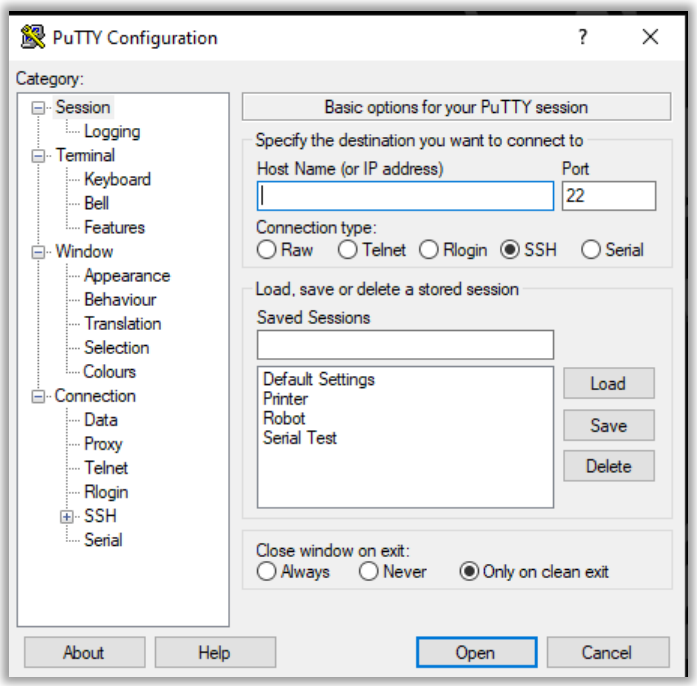
The following steps outline the testing procedure:

- Find out the serial port number of the USB to serial device under windows
  - Click start menu and type “device” and select device manager
  - Look for Ports and expand the selection to see what com port has been assigned

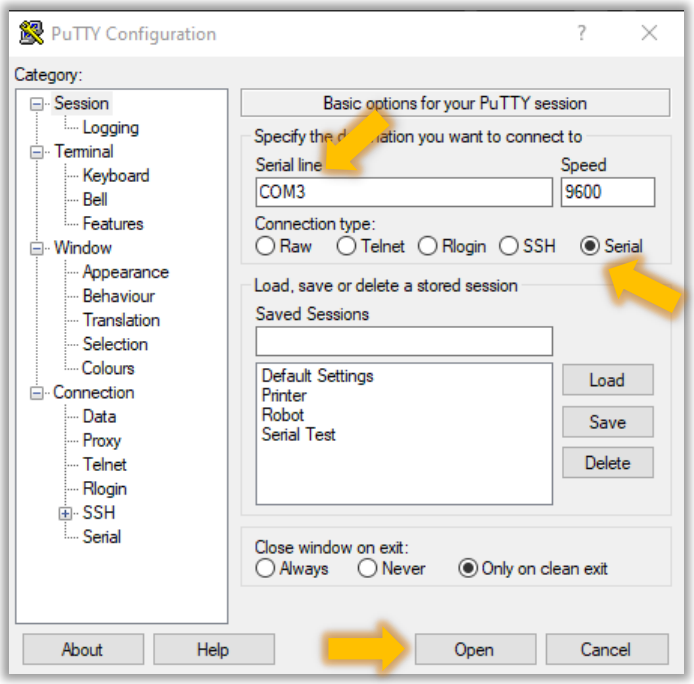


  - In this case we see that we are using COM3

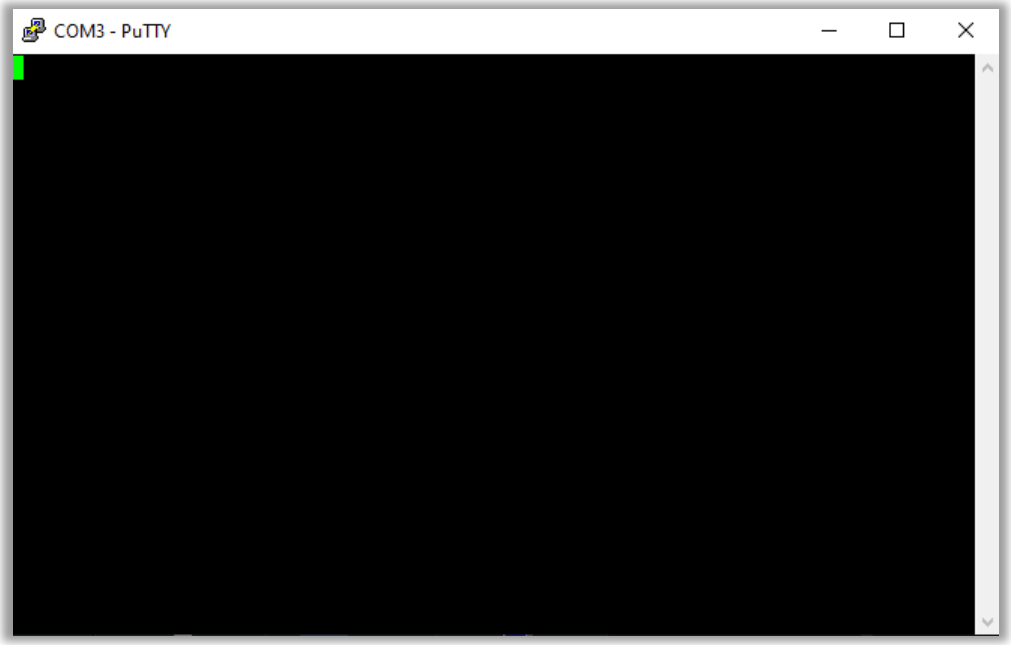
- This guide assumes you have already downloaded and installed Putty
  - Start Putty



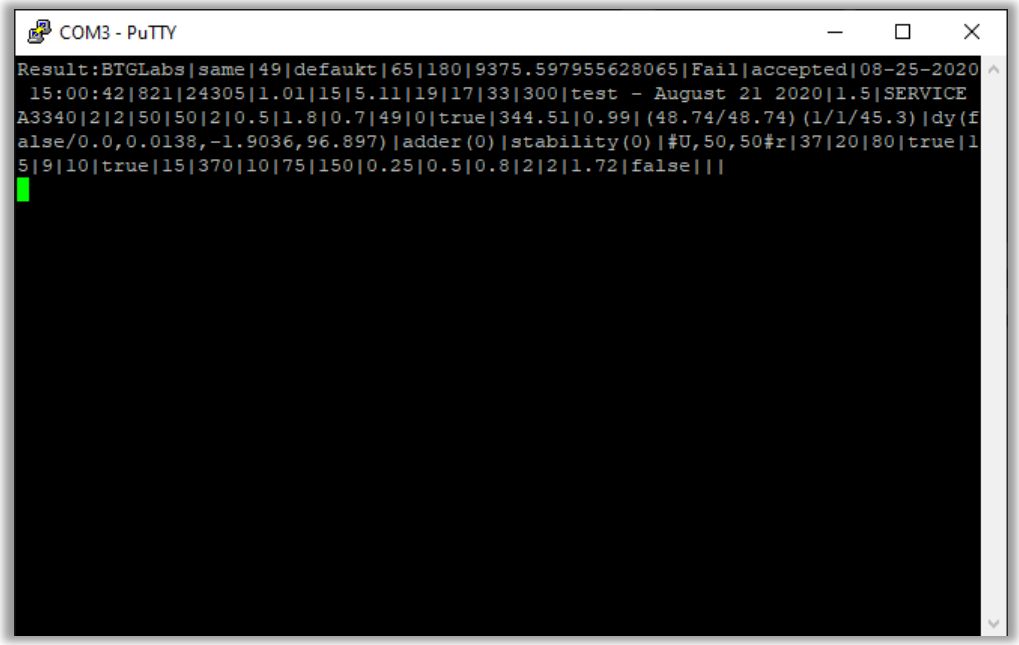
  - Change the option on the top right to "Serial", and Enter the COM port you found in Device manager - it will now look like this (I Entered COM3 - you should use what you found in Device Manager)



- Click the "Open" button at the bottom right to start a terminal window



- Now go to the surface Analyst and run an inspection (make sure you accept the drop detection . . .)



- Each inspection should result in a new set of data showing up in the terminal window.
  - Example shown above is for verbose mode.
    - If verbose mode is turned off then only the contact angle will be shown.
  - If something shows up but it is garbage characters, that indicates the communication settings do not match between the terminal application and the Surface Analyst settings.
    - Re-enter the MC commands for communications settings on the Surface Analyst, or check the terminal settings to make sure they match the settings entered into the Surface Analyst.