

Serial Protocol over RS-232 on Ocean Spectrometers

Technical Note

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OceanOptics

PART OF OCEAN INSIGHT



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OVERVIEW OF RS-232

1.1 DEFAULT DEVICE CONFIGURATION

The figure below gives a high-level overview of how the ports are connected for RS-232 and the direction of data transmission for them.

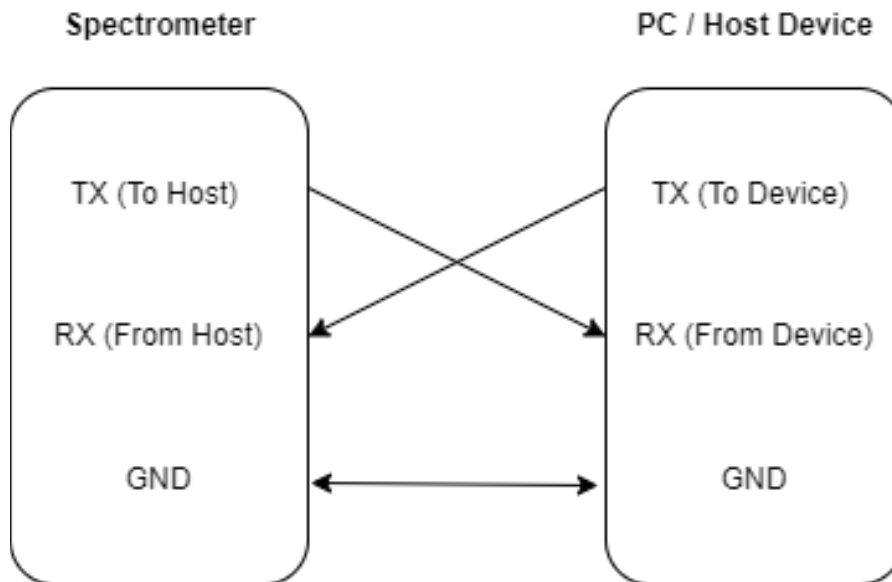


Figure 1. RS-232 Ports

The table below provides some specifications regarding the RS-232 implementation on Ocean spectrometers.

The voltage limits for TX (To Host) describe the voltage levels the spectrometer outputs when transmitting data. The voltage limits for the RX (From Host) describe the voltage levels the spectrometer can receive as inputs.

The RS-232 data configuration is fixed to (8N1). The default baud rate is also important to keep in mind when first interfacing with our spectrometers.

Your PC/Host Device will need to use the default baud rate **when first powering the Spectrometer.**

Voltage Limits		
	Minimum	Maximum
Tx (To Host)	-6V	+6V
Rx (From Host)	-30V	+30V
RS-232 Data Configuration (8N1)		
No Parity bit	1 stop bit	1 stop bit
Default Baud Rate		
115200		



1.2 CONNECTING TO A PC

Below is an example list of items for connecting your spectrometer to a PC/Host device. Figure 2 shows how all the listed parts are connected. Both the list and diagram reflect what was used during testing and development of RS-232 for our spectrometers.

1. Spectrometer
2. A serial to USB adapter
3. Ocean’s RS-232 accessory cable (CBL-ISDF-DB9)
4. PC/Host Device
5. External +5VDC power supply that is **center positive**.

Note: If you wish to use RS-232 you must have an external power source. You cannot use the USB-C cable to power our spectrometers when using RS-232. Our devices only allow one communication protocol at a time. If a USB cable is connected to the device, that will become the communication venue for the host.

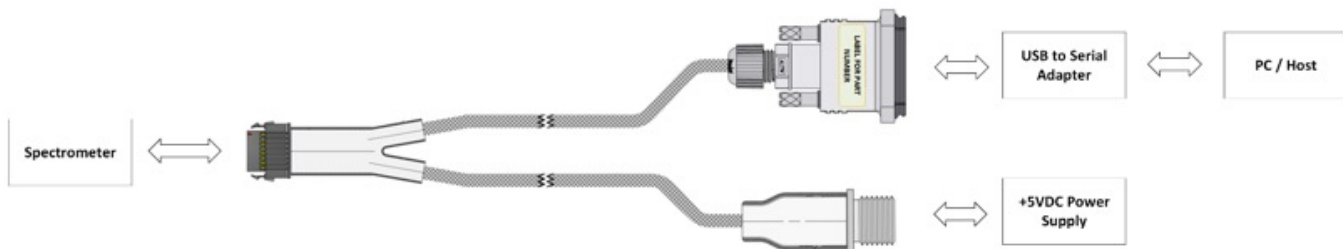


Figure 2 – Connecting Spectrometer to PC Host

1.3 DEVICE AND FIRMWARE SUPPORT FOR RS-232

1.3.1 Supported Devices

The following devices support RS-232. Note that the device must have a firmware version that supports RS-232.

Device	ST	SR2	HR2	SR4	HR4	SR6	HR6	NR
RS-232 Supported	✓	✓	✓	✓	✓	✓	✓	✓

1.3.2 Supported Firmware

For all devices, micro firmware versions **1.2.0** and above support RS-232.



CABLE DESIGN CONSIDERATIONS

The RS-232 accessory cable sold by Ocean may not be long enough for your application. If that is the case, then you can use some mating connectors to effectively extend the cable. The following connectors or cables are **examples** of what is compatible with Ocean’s accessory cable. There are similar alternatives on the market for these connectors or cables.

For power, you can mate Ocean’s RS-232 cable with the part listed below. This part takes full advantage of the locking mechanism on Ocean’s RS-232 accessory cable.

Note: This part does not come with cabling/wiring, it is just the connector.



Manufacturer	Manufacturer Part #	Description
Tensility International Corp	50-00011*	Power Barrel Connector Plug 2.50mm ID (0.098”), 5.50mm OD (0.217”) Free Hanging (In-Line)
CNC Tech	710-10011-00200**	D-Sub Cable Assembly DB09 Beige, Individual (Round) 6.56' (2.00m) Plug, Male Pins to Plug, Male Pins Shielded

If additional info related to the Samtec connector on our spectrometers is desired, refer to the device’s user manual.



2.1 OCEAN OPTICS RS-232 CABLE ASSEMBLY

Below is a drawing for the Ocean Optics RS-232 cable accessory with details on the pinouts and how they connect to the previously mentioned connectors/ports. This visual should help in the case a custom cable design is desired.

Keep in mind again that Tx and Rx are from the perspective of the spectrometer itself.

Another thing to note is that the power jack is center positive, so keep that in mind when choosing a +5VDC power supply.

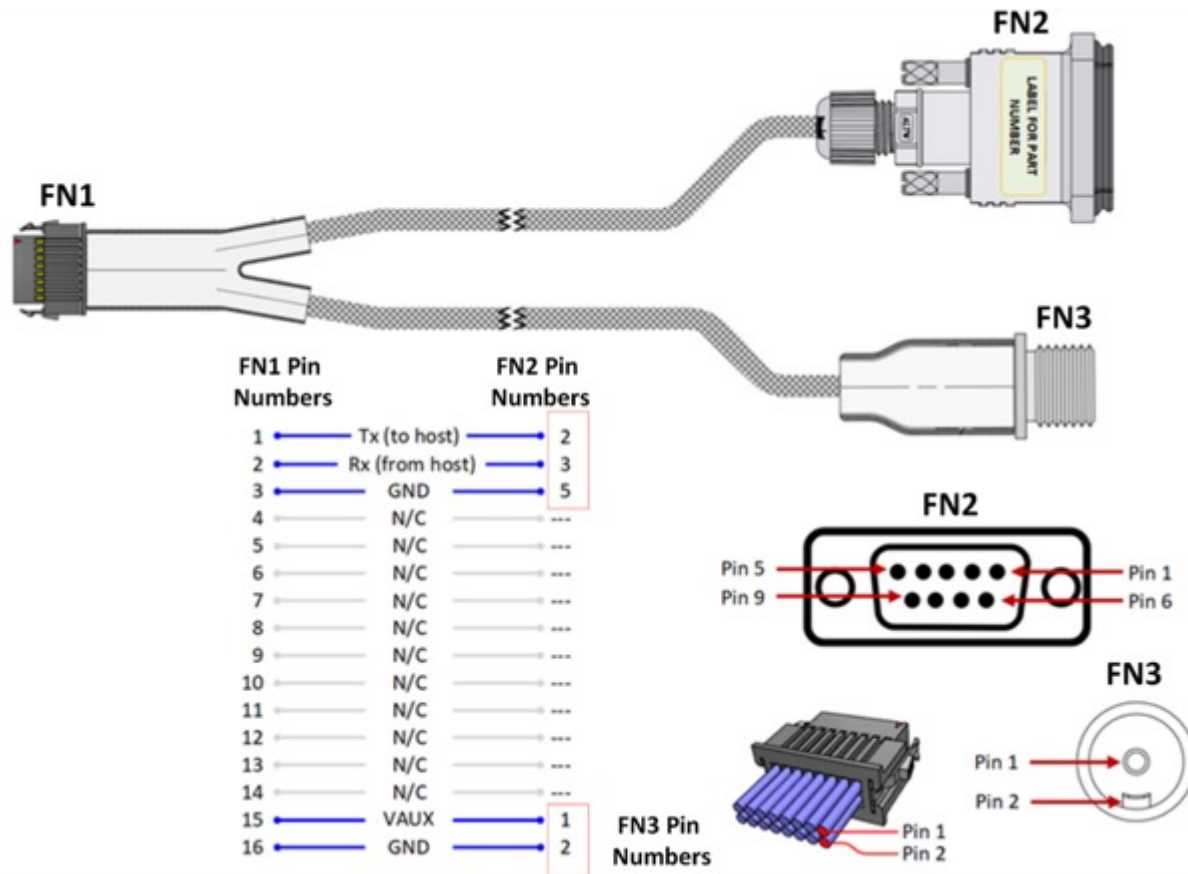


Figure 5 – Drawing of the Ocean Optics RS-232 Accessory Cable

2.2 SAMPLE PYTHON CODE

Contact your sales representative for sample code that exercises the RS-232 commands. Keep in mind when using this example program, you will need additional hardware to connect your development PC to the device RS-232 port.

Below is an example list of items used to effectively run the Python script on a PC.

- Spectrometer
- USB to Serial Adapter (Example: Digitus DA-70156)
- PC/Host Device
- Ocean RS-232 accessory cable.
- Python Development Environment (i.e. VSCode, Pycharm, Spyder, etc.)



COMMAND LINE SYNTAX

This section describes the general format and syntax of supported commands.

Keep in mind words enclosed in <angle brackets> are references to syntactical elements. Words enclosed in [square brackets] represent optional items that may be left out from the command line.

The brackets are not used when the words appear in the command line.

3.1 CONTROL CHARACTERS

Table 1 shows the Control characters used by the command protocol to manage the spectrometer. These control characters are not printable, and they are used to signal the length of the command strings.

Acronym	Hexadecimal Value	Definition
<CR>	0x0D	Carriage Return
<LF>	0x0A	Line Feed

Table 1 – Control Characters

3.2 COMMAND ENCODING

All command set and read operations are text-based using printable ASCII characters except for the Acquire Spectra command response, which is encoded as binary data.

The maximum ASCII character count response for any command is 16 ASCII characters.

3.3 SET COMMAND SYNTAX

<command>=<value><CR>

The process for sending a Set command is as follows.

- Start with the command name.
- An equal sign follows the command name.
- Value parameter follows equal sign. Multiple values are separated by commas.
- End command with Carriage Return.

Response	Description
OK	Request processed successfully
ERROR	Error condition encountered

Table 2 – Command response

The device responds with one of the response strings described in Table 2.



Figure 6 shows the command sequence to set a parameter.

```
I=10000<CR>  
OK<CR><LF>
```

Figure 6 – Set command sequence.

3.3 READ COMMAND SYNTAX

```
<command>?[option]<CR>
```

The process for Read commands is as follows.

- Start with the command name.
- A question mark follows the command name.
- Depending on the command an option argument may be given.
- End command with Carriage Return.

The Device responds with the requested information using one of the following formats:

- An alphanumeric string
- A numeric string
- Binary format

Figure 7 shows the command sequence for a Read operation. Notice control characters are used by the Host and Device.

```
N?<CR>  
ST00253<CR><LF>
```

Figure 7 – Read command example.

Check the following sections for a more in-depth description of each command.



COMMANDS

This section provides a summary of all commands and details for each individual command with examples.

4.1 COMMAND SUMMARY

NOTE: All command names are upper case, and they are case sensitive

Table 3 provides a summary of supported commands. All upper and lower limits for the command values can be found in the device's User Manual. Refer to Section 4.2 for details and examples for each command.

Name	Access	Response	Description
I	Read / Set	String	Integration Time
J	Read / Set	String	Lamp Enable Feature
K	Read / Set	String	Baud Rate
L	Read / Set	String	LED Status
M	Read	String	Spectrometer Model
N	Read	String	Serial Number
P	Read / Set	String	Partial Pixel Mode
S	Read	Binary	Acquire Spectra
T	Read / Set	String	Trigger mode
V	Read	String	Firmware version
X	Read	String	Calibration coefficients

Table 3 – Command Name List



4.2 COMMAND DETAILS

The following sections provide details on each command operation.

4.2.1 Integration Time

Refer to spectrometer user manual for minimum and maximum integration times.

Integration time value is specified in microseconds.

```
I=325910<CR>  
OK<CR><LF>
```

To query the value, use the read command pattern below.

```
I?<CR>  
325910<CR><LF>
```

4.2.2 Lamp Enable

The Lamp Enable command allowed values are listed below.

Lamp Enable	Description
Details	High=1 Low=0

A set operation is shown below.

```
J=1<CR>  
OK<CR><LF>
```

Current state of the parameter can be verified with a read operation as shown below.

```
J?<CR>  
1<CR><LF>
```



4.2.3 Change Baud Rate

The following table shows the supported baud rates:

When changing baud rates, the following sequence must be followed:

1. Host sends desired baud rate value, communicating at the current baud rate.
2. Device acknowledges request with OK, otherwise it responds with ERROR.
3. Host waits longer than 50 ms and switches to new baud rate.
4. Host resends the command baud rate value, communicating at the new baud rate.
5. Device confirms change, communicating at the new baud rate.

Baud rates
2400
9600
14400
19200
38400
115200

NOTE: If a deviation occurs at any step, the previous baud rate is utilized

```
K=9600<CR>  
OK<CR><LF>  
K=9600<CR>  
OK<CR><LF>
```

4.2.4 LED Indicator

The LED indicator allowed values are listed below.

LED indicator values
Enabled = 1
Disable = 0

A set operation is shown below.

```
L=1<CR>  
OK<CR><LF>
```

The current state of the parameter can be verified with a read operation as shown below.

```
L?<CR>  
1<CR><LF>
```



4.2.5 Spectrometer Model

Returns the spectrometer model.

```
M?<CR>  
OceanST<CR><LF>
```

4.2.6 Serial Number

Returns the device serial number assigned during manufacturing.

```
N?<CR>  
SR221234<CR><LF>
```

4.2.7 Partial Pixel Mode

Allows user to select which pixels are returned by an Acquire Spectra command. Note that all pixels are still acquired for every scan, but this command will allow the user to specify which ones are returned to the user.

Two values must be provided, the lower pixel first and then the upper pixel. Pixel values must be within a valid range. Refer to spectrometer user manual for the number of available pixels.

```
P=25,200?<CR>  
OK<CR><LF>
```

The current pixel range can be read back as shown below.

```
P?<CR>  
25,200<CR><LF>
```

4.2.8 Acquire Spectra

Acquires single spectra with the current set of operation parameters.

```
S?<CR>
```

Returned data is in binary format. Refer to section Spectra Data Format for more details.



4.2.9 Trigger Mode

Set which trigger mode the spectrometer will function with.

Trigger Mode	Value
Software Trigger	0
External Edge Trigger	1
External Level Trigger	2

A set operation is shown below.

```
T=1<CR>  
OK<CR><LF>
```

The current state of the parameter can be verified with a read operation as shown below.

```
T?<CR>  
1<CR><LF>
```

4.2.10 Firmware Version

Returns the spectrometer firmware version.

NOTE: The firmware version below is just a sample response.

```
V?<CR>  
1.2.0<CR><LF>
```



4.2.11 Calibration Coefficients

Returns values set by Ocean during manufacturing. Each individual calibration parameter is mapped to an index as shown below:

Index	Wavelength Polynomial Order
1	Wavelength Coefficient 0
2	Wavelength Coefficient 1
3	Wavelength Coefficient 2
4	Wavelength Coefficient 3
10	Non-linearity Polynomial Order
11	Non-linearity Coefficient 0
12	Non-linearity Coefficient 1
13	Non-linearity Coefficient 2
14	Non-linearity Coefficient 3
15	Non-linearity Coefficient 4
16	Non-linearity Coefficient 5
17	Non-linearity Coefficient 6
18	Non-linearity Coefficient 7

The example below shows the command to query the wavelength coefficient 1.

NOTE: All coefficients are IEEE single-precision floating-point values occupying 32 bits. Each coefficient query response is encoded as a string; maximum count is 16 characters.

```
X?2<CR>  
1.2857E-08<CR><LF>
```



SPECTRA DATA FORMAT

When using the Acquire Spectra command, the data is returned in binary format. First, the metadata header is received followed by the spectra data.

This section describes the formatting of the binary data.

5.1 METADATA HEADER FORMAT

The metadata header provides detailed information about the spectra data. It is the same format across all Ocean products.

Field	Bytes	Description
Metadata version	1	Metadata version 1
Trigger Mode	1	
Reserved	2	
Spectra Size	2	Spectra data length in bytes
Scan Count	4	
Tick Counter	8	Microsecond Counter
Integration Time	4	Time in microseconds
Reserved	10	
Total Bytes	32	



5.2 SPECTRA DATA FORMAT

Each pixel is encoded as an unsigned 16-bit number. See the table below for each pixel location within the binary

response stream. Refer to the spectrometer user manual for the total number of pixels. Note that if the Partial Pixel Mode command is used, only the requested range of pixels will be returned.

Pixel	Stream Byte Number	Description
0	0	Pixel 0 least significant byte
0	1	Pixel 0 most significant byte
1	2	Pixel 1 least significant byte
1	3	Pixel 1 most significant byte
N	$N * 2$	Pixel N least significant byte
N	$(N * 2) + 1$	Pixel N most significant byte



FLAME COMMAND COMPARISON

Below is a table that describes the differences between the current RS-232 commands described in this

document and commands that are supported on the Flame spectrometer.

Flame		New Product	
Letter	Description	Letter	Description
I	Set integration time	I	Set integration time
J	Set Lamp Enable Line	J	Lamp enable/disable
K	Change baud rate	K	Change baud rate
L	Clear Memory	L	Indicator LED Status
M	Set Data Storage Mode	M	Device Model
P	Partial Pixel Mode	P	Partial Pixel Mode
S	Start spectral acquisition with previously set parameters	S	Acquire Spectra
T	Set trigger mode	T	Set trigger mode
V	Provides microcode version	V	Read firmware version
x	Sets Calibration coefficients	X	Calibration coefficients are read-only