

10GbE Network Configuration Guide for **SM200C** Operation.

10GbE Network Configuration Guide

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Introduction

1 Introduction

The purpose of this document is to

- Outline hardware requirements for 10GbE networks interfacing the SM200C.
- Provide recommendations for 10GbE networking components.
- Provide a brief overview of 10GbE networking for customers new to the interface.

1.1 10GbE Networking Overview

The SM200C operates over a single 10GbE link. Commands and data are sent using a proprietary format over UDP at rates up to 6.4Gb/s. 10GbE is full duplex and can operate over a number of physical channels. The two most common are copper and fiber cables. In addition to cabling there are a number of interfaces and connector types used in 10GbE networking, the most common is the SFP+ module. This connector form factor is what the SM200C uses and what we recommend customers use for their networks.



Figure 1: SFP+ 10GBASE-SR (fiber optic) module

Standard 10GbE network copper cables are terminated with two SFP+ connectors and can be seen in the picture below. Copper cables are ideal for local applications where cable distances don't need to exceed more than a few meters. Copper cables are less complex than fiber alternatives but will have data reliability issues at longer lengths.

Introduction



Figure 2: 10GbE copper cable. Terminated with two non detachable SFP+ modules.

Fiber cables are constructed from a length of fiber cabling and two detachable SFP+ transceiver modules. The type of fiber cabling and paired SFP+ module must be compatible for the assembled cable to work. The type of fiber cable used will depend on the SFP+ transceiver module. There are a number of SFP+ fiber transceiver standards, some of the most common and the ones recommended by Signal Hound are the 10GBASE-SR, LR, ER, and ZR. Each standard uses a different light wavelength, fiber cable type, and has a different reach (maximum cable length).

| Standard Name | Wavelength | Cable Type | Reach in km |
|---------------|------------|-------------------|-------------|
| 10GBASE-SR | 850nm | OM3/4 multi-mode* | 0.3/0.4 |
| 10GBASE-LR | 1310nm | OS2 single-mode | 10 |
| 10GBASE-ER | 1550nm | OS2 single-mode | 40 |
| 10GBASE-ZR | 1550nm | OS2 single-mode | 80 |

*Figure 3: *While compatible with several other fiber types, we recommend OM3/4.*

Introduction

The two types of optical fiber used for 10GbE networks are single-mode and multi-mode. Single mode is commonly used for long distance communications while multi-mode is used for distances less than 0.3km. Single-mode cables are typically yellow while multi-mode cables are orange/aqua. Long runs of single mode fiber can have increase data reliability issues causing increased disconnection issues with the SM200C. If you experience this, we recommend moving to a higher range module.

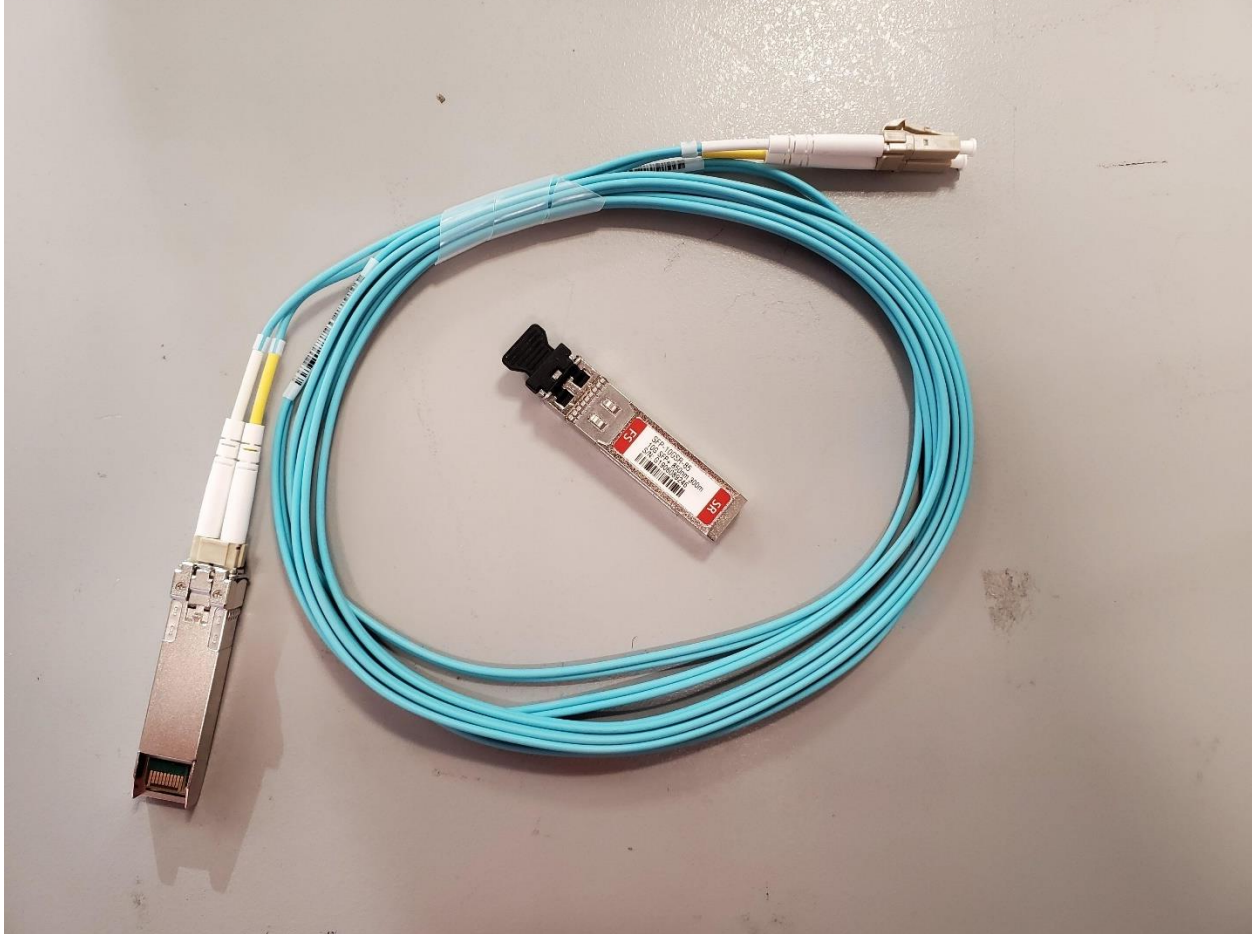


Figure 4: Multi-mode fiber cable with two SFP+ SR modules, one attached and one not.

The SM200C has an SFP+ interface on the front panel. A cable will be connected from the SM200C to a PC. The two most common ways to connect a 10GbE SFP+ cable to a PC is through a PCIE 10GbE network interface card (NIC) or a Thunderbolt 3 to SFP+ adapter. We provide recommendations for both in this document.

Introduction



Figure 5: Left to right, Thunderbolt 3 to SFP+ adapter and 2xSFP+ 10GbE NIC adapter card.

The SM200C is a network device and thus has a network address that includes a media access control (MAC) address, (internet protocol) IP address, and Port address.

The MAC address uniquely identifies a network device. No two network devices will have the same MAC address. Customers cannot change the MAC address and should never need to know the SM200C MAC address, although it is used by your computer in the address resolution protocol (ARP) table which correlates MAC address with IP addresses.

The IP address is a label assigned to each device on a given network. The IP address is the most important address for interfacing the SM200C. Each SM200C is configured with a default IP address of 192.168.2.10. This address can be changed using the API or with the network configuration utility in Spike. When interfacing an SM200C, the IP address of the device must be specified to establish communication.

SM200C 10GbE Network Compatibility Guide

The port address is another important number used in networking. The default port number is 51665. Its purpose is to ensure the data is delivered to the right application on the two network devices (in this case, your PC and the SM200C).

The SM200C uses the UDP protocol to transmit information over the network. One of the main factors in determining network speed is the maximum transmission unit (MTU) size. MTU refers to the largest packet that can be sent over the network. MTU often defaults to 1500 bytes, and must be set to 9000 bytes (also referred to as jumbo packets) for correct SM200C operation. This document outlines how to do this. There are operating system specific settings that must also be configured and they are detailed in the OS setup sections below.

2 SM200C 10GbE Network Compatibility Guide

This section outlines the hardware requirements for networking the SM200C and includes several recommendations for many hardware components.

2.1 Adapters and Cables

Signal Hound recommends fiber cables with SFP+ fiber adapters. The SM200C will work with single and multi-mode fiber cables with appropriate transceiver modules.

The SM200C has also been tested with passive copper cables up to 2 meters. Longer passive cables may have increased data reliability issues.

Tested Transceivers and Cables

- FS SFP-10GSR-85
- FS SFP-10GLR-31
- FS SFP-10GZR-55
- FS-OM3 50/125 multi-mode fiber patch cables
- FS 9/125 single mode fiber patch cable
- 10GTek CAB-10GSFP-P2M (passive copper cable 2-meters)

2.2 Recommended 10GbE Network Interface Cards

- Intel X722-DA2/4 adapter cards
- Intel X520*DA2 adapter cards
 - ZR modules may have issues with this card on Windows 10.
- Asus 10Gbps PCIe Adapter (XG-C100F)
 - https://www.amazon.com/gp/product/B07VLC7LT3/ref=ppx_od_dt_b_asin_title_s00?ie=UTF8&psc=1

SM200C 10GbE Network Compatibility Guide

2.3 Recommended Thunderbolt To 10GbE Adapters

- QNAP Thunderbolt 3 to 10GbE Adapter (QNA Series) (Recommended)
- Sonnet Solo10G SFP+ (Thunderbolt 3 Edition)

2.4 Alternative Connection Methods

It is possible to adapt an M.2 key to a PCI-E X4 interface, followed by a standard PCI-E network interface card (listed above). Conversion from M.2 to PCI-E can be performed with a part such as

https://www.amazon.com/gp/product/B074Z5YKXJ/ref=ppx_od_dt_b_asin_title_s00?ie=UTF8&psc=1

PCI-E can be extended with a part like

https://www.amazon.com/gp/product/B07QRP65M1/ref=ppx_od_dt_b_asin_title_s00?ie=UTF8&psc=1

2.5 Operating Systems

Signal Hound recommends the following operating systems.

- Windows 10
- Linux Ubuntu 18.04
- CentOS 7

2.6 Processor Requirements

All measurement capabilities other than the 200MS/s I/Q streaming of the SM200C have modest processor requirements. Typical i5/i7 processors will have the necessary performance. For 200MS/s I/Q streaming, single threaded CPU performance is critical. Signal Hound recommends CPUs that can sustain 4GHz single threaded performance and 8th generation or newer Intel processors.

The use of Thunderbolt 3 to SFP+ adapters has shown to reduce processor requirements and, in many cases, standard laptop processors can be sufficient.

2.7 Recommended PCs

This section recommends specific PCs and processors that Signal Hound and its customer have had success with as well as some that have been reported to have issues.

Several factors affect success running the SM200C, and what has worked for customers in the past may not work for you, and vice-versa, what has not worked in the past may work for you.

Windows 10 Setup

If you would like to add an item to this list, please contact aj@signalhound.com.

2.7.1 PCs with Reported Success

- Dell XPS 15 9570 (laptop) using both SFP+ to TB3 adapters (Win).
- Dell XPS 8930 (desktop) with Intel i7-8700 and X722-2 NIC (Win).
- Dell 7540 and 7740. (Linux)
- Intel NUC NUC6iKYK using SFP+ to TB3 adapters (Win/Linux).
- Desktop with i7-6700 CPU and Intel X520-2 NIC (Win).
- Desktop with i7-4700 CPU and Intel X722 NIC (Linux).
- Intel NUC NUC7i7DNHE with m.2 to PCIe4 to NIC adapter (Win).
- GIGABYTE AERO 15 YB laptop with Intel i9-10980HK using both QNAP and SONNET SFP+ adapters (Win).

2.7.2 PCs With Reported Issues

- HP Omen laptops (Win)
 - Customers have reported issues with these laptops using the SFP+ to TB3 adapters.
- Intel Core i7-6820HQ processor in laptop form factor (Win).
- Intel Core i7-7820HQ processor in laptop form factor (Win).
- Intel Core i7-5820K processor in desktop form factor (Win).
 - This CPU worked for all measurements except full 200MS/s I/Q streaming.

3 Windows 10 Setup

This section guides you in setting up your Windows 10 machine for SM200C operation.

These instructions assumes you have already installed a 10GbE NIC or are using a thunderbolt to SFP+ adapter. If using an adapter, you have already installed the proper drivers and enabled the thunderbolt device.

The SM200C should be powered up and connected to the network interface via provided fiber cable and SFP+ connectors.

This section will step you through the three main steps in configuring the 10GbE network interface.

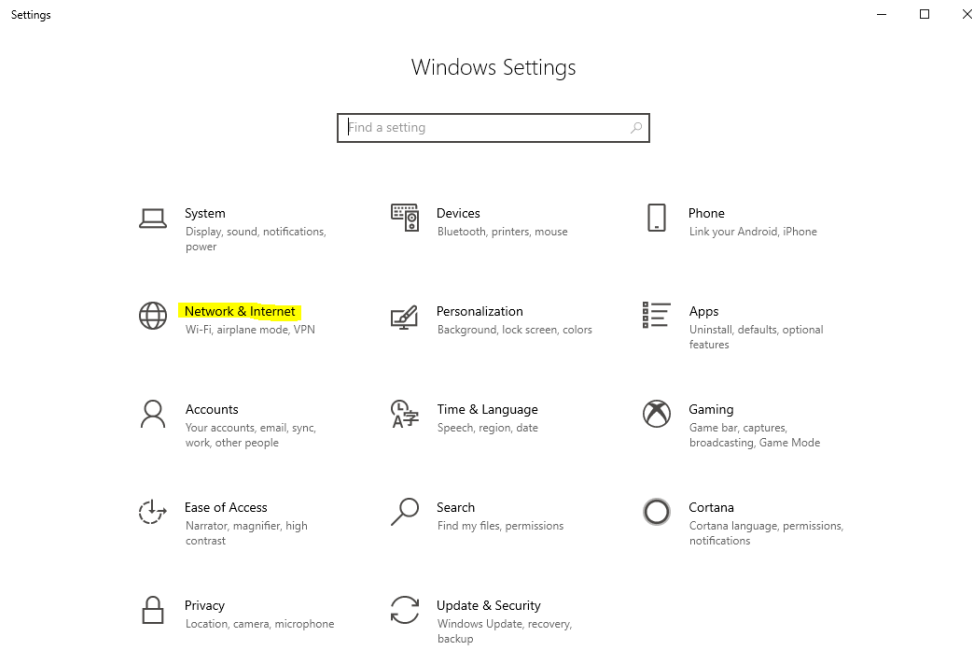
- Specifying a fixed IP for the network interface.
- Increasing the MTU size, (enable jumbo packets)
- Verifying remaining network parameters.

The default IP address for the SM200C is 192.168.2.10 and uses port 51665. These instructions assume you have not modified the default network configuration of the SM200C.

Windows 10 Setup

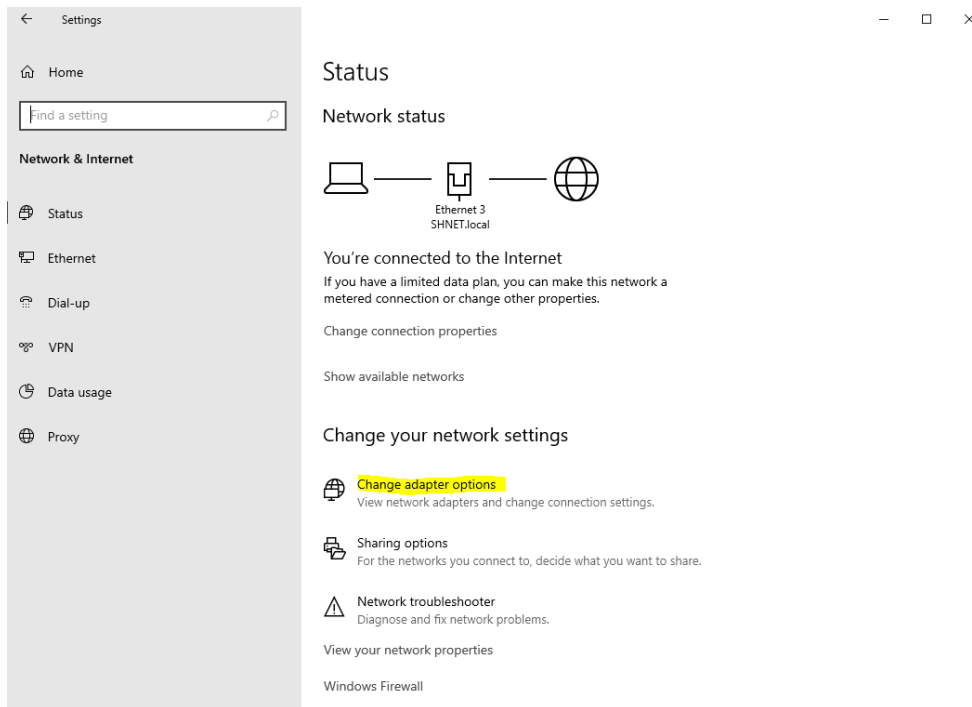
3.1 Configuration Steps

First, you must navigate to the network settings. Start by going to the system settings and select “Network and Internet”.



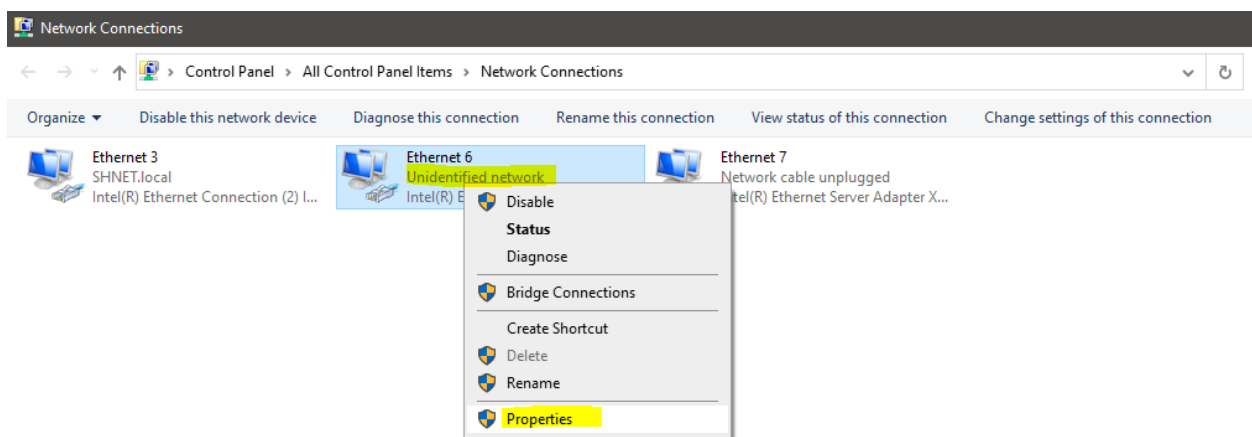
Windows 10 Setup

Once in the Network and Internet settings, select “Change adapter options”



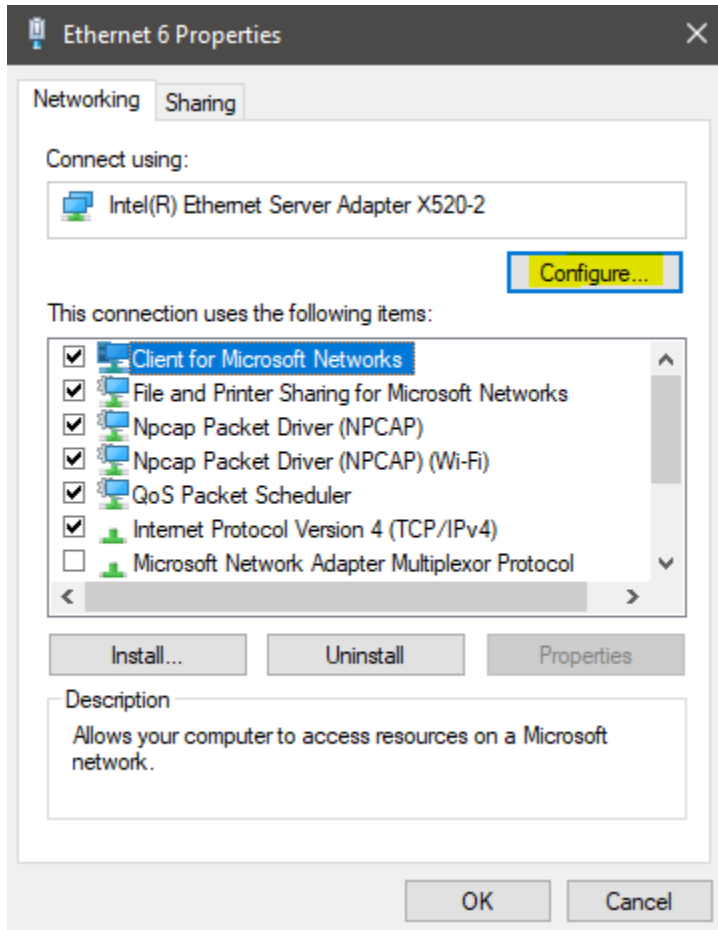
You should now see the “Network Connections” dialog. You should see your 10GbE network interfaces listed here.

When an SM200C is connected powered on and connected, one of the 10GbE interfaces will report “Unidentified network”. Right click that interface and select properties to configure the interface.



Windows 10 Setup

First, we must configure the network adapter settings. In the network interface properties press the “Configure” button. This will bring up the 10GbE adapter settings.



Windows 10 Setup

In the adapter properties dialog, select the “Advanced” tab and configure the adapter with the following settings. If any are missing, move on. When finished press OK.

Flow Control – **Rx & Tx Enabled**

Interrupt Moderation – **Enabled**

Interrupt Moderation Rate – **Adaptive**

Jumbo Packet – **9014 Bytes**

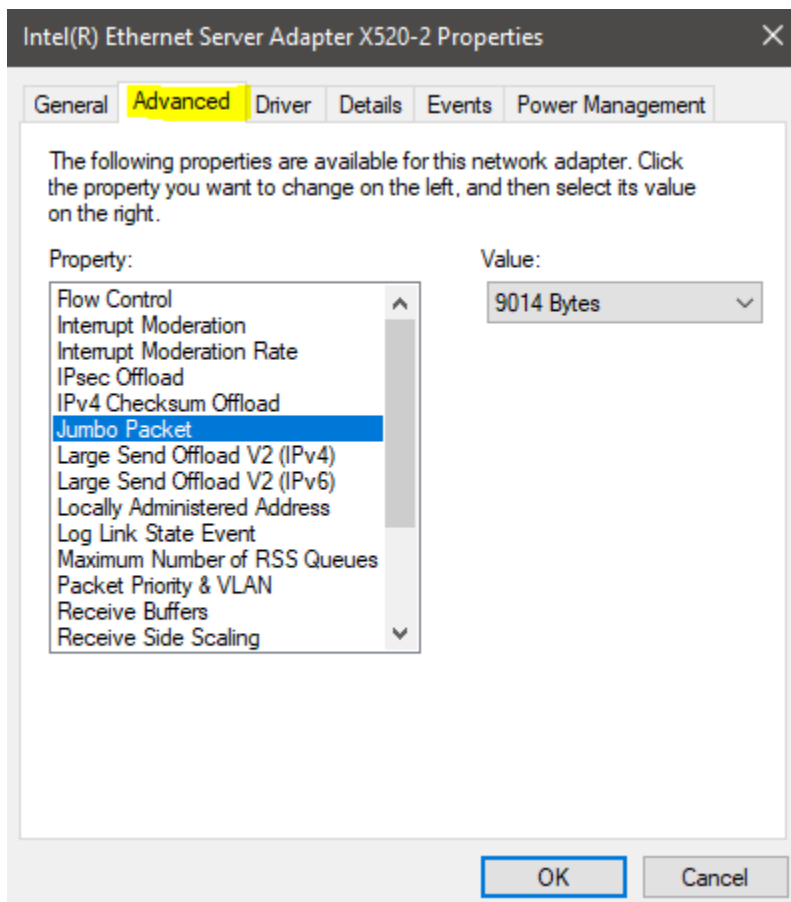
Receive Buffers – **4096**

Transmit Buffers – **4096**

Any checksum offloads – **Enabled**

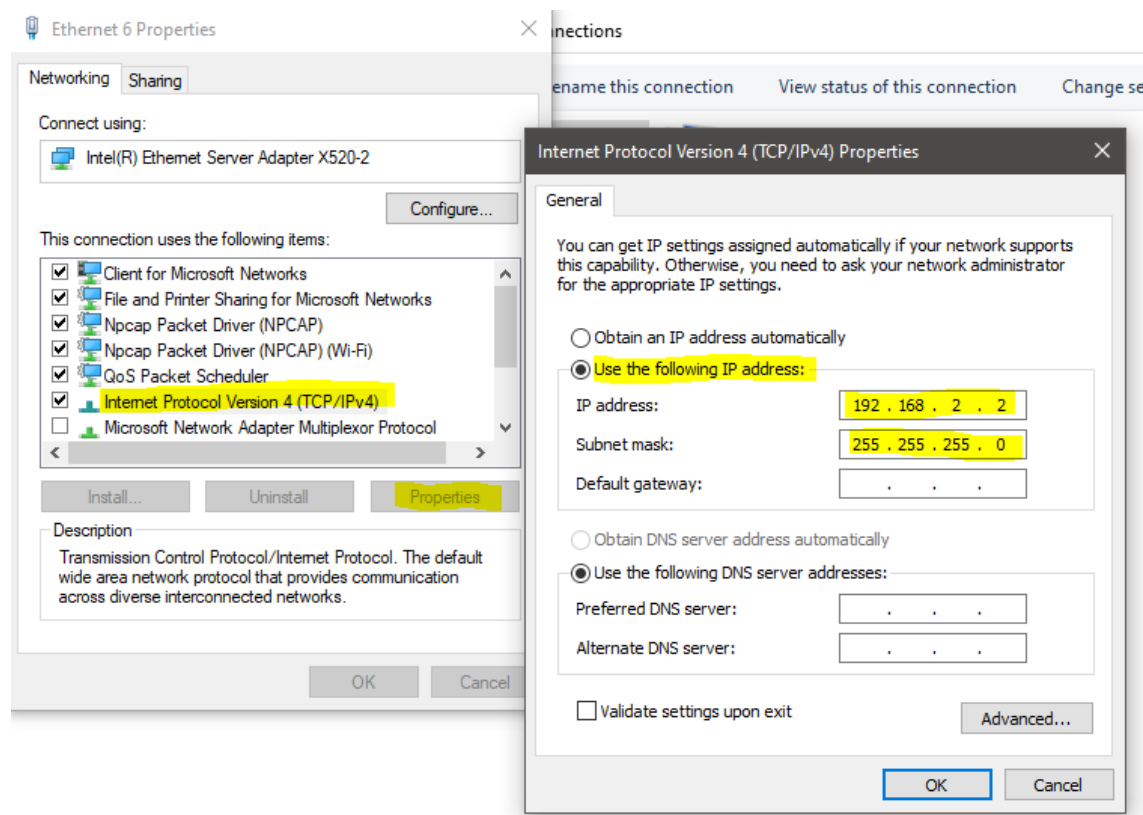
And Large Send/Receive offloads – **Enabled**

Speed & Duplex – **10Gbps Full Duplex**



Windows 10 Setup

The next step is to setup the TCP/IPv4 IP address and subnet mask. Re-enter the interface properties menu and select the Internet Protocol Version 4 (IPv4) line and press properties to bring up the IPv4 properties dialog. In this dialog, select “Use the following IP address” and manually fill out the highlighted lines with the corresponding values. Select OK when done.



At this point the interface should be properly configured and the SM200C can be connected in Spike. Use the File->Manage Ethernet Devices menu in Spike, add a new device using the default network parameters, and connect to the device using the File->Connect menu.

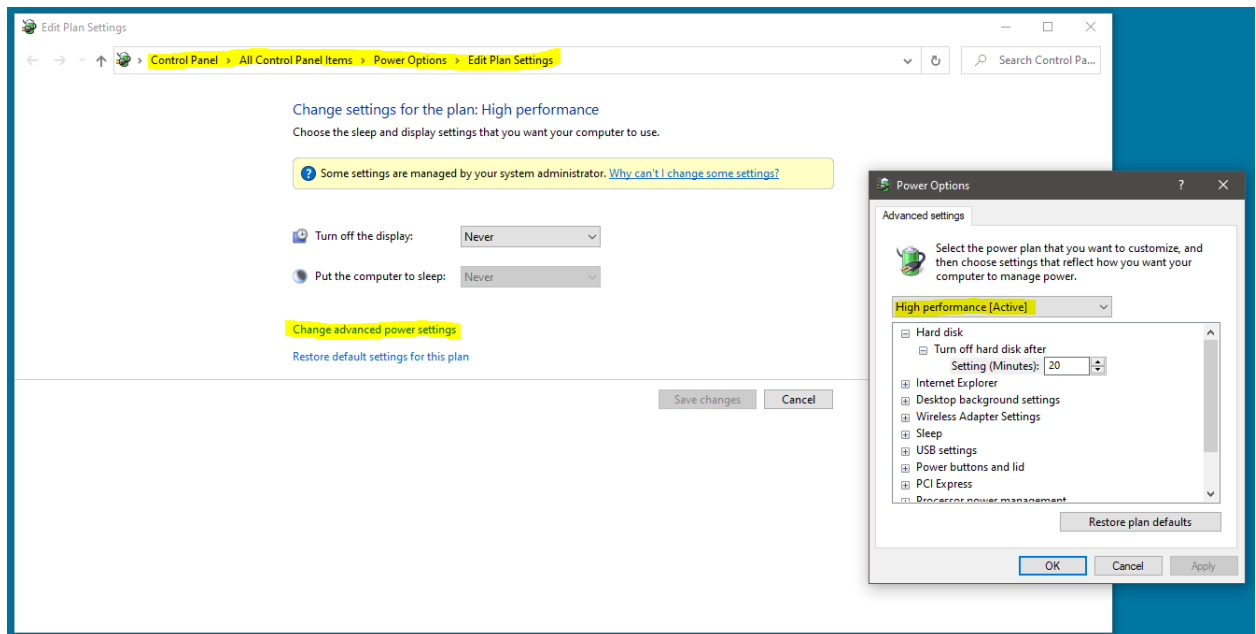
3.2 Troubleshooting

If you are having difficulties connecting to the SM200C in Windows 10, or are having issues with continuous uninterrupted operation, here are some additional troubleshooting steps.

- Verify the SM200C is connected to the correct network interface, the SM200C power cable is plugged in and the LED is on the SM200C is solid green. The LED should be solid green ~12 seconds after power is applied if a valid network connection is detected.

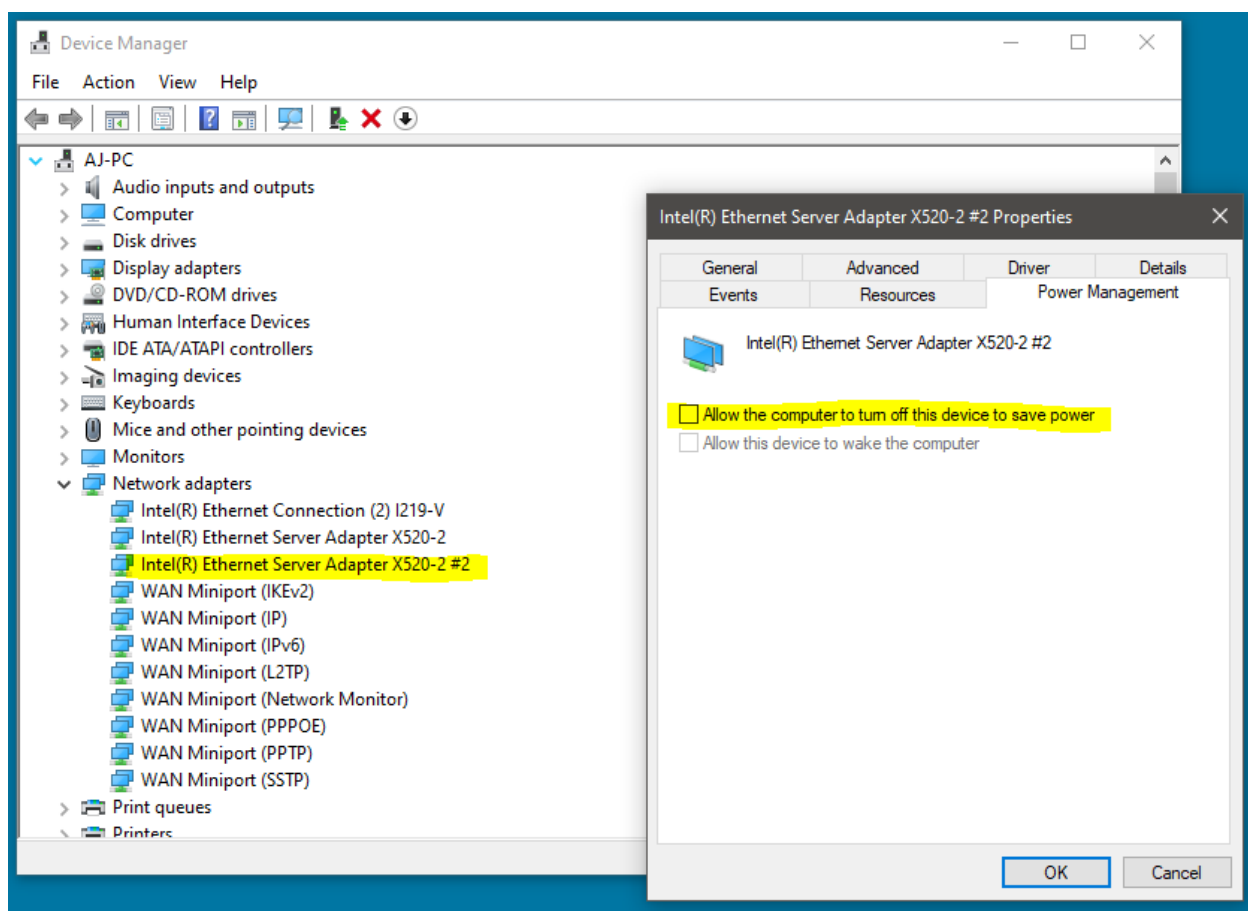
Windows 10 Setup

- In the Network Connections dialog, you should see “Unidentified Network” listed next to the network interface that the SM200C is connected to.
- Verify that the network interface that the SM200C is connected to has been configured properly and no settings were reverted.
- Ensure the high performance power plan is enabled. (See picture below)



- Disable any anti-virus software temporarily. Anti-virus software has been known to scan network traffic increasing CPU substantially which might limit network throughput or introduce network data loss.
- Verify proper power management settings for the adapter/NIC. This is more important for adapters on laptops. Find your adapter/NIC in the device manager, and right-click and view properties for that device. Under the power management tab, verify the PC is not allowed to turn off the device to save power (unchecked). If checked, the PC might disable this device during operation which will cause data loss and the SM200C to disconnect. (See picture below)

Ubuntu 18.04 Setup



- Disable hyperthreading. If you find that during operation (such as I/Q streaming) one of the CPU cores is at or near 100%, this could be the source of data loss. Network traffic is handled on a single thread in the kernel. If that thread is saturated, and unable to handle the transfer rates of the SM200C, data loss can occur leading to device disconnection events. Disabling hyper threading could increase the single threaded performance of the PC alleviating this issue. You can disable hyperthreading in the BIOS of some PCs. If this has no effect, Signal Hound recommends re-enabling hyperthreading as it can impact the performance of other heavily threaded applications.

4 Ubuntu 18.04 Setup

This section guides you in setting up an Ubuntu 18.04 machine for SM200C operation.

These instructions assume you have already installed a 10GbE NIC or are using a thunderbolt to SFP+ adapter. If using an adapter, you have already installed the proper drivers and enabled the thunderbolt device.

Ubuntu 18.04 Setup

The SM200C should be powered up and connected to the network interface via provided fiber cable and SFP+ connectors.

This section will step you through

- Specifying a fixed IP for the network interface.
- Increasing the MTU size, (enable jumbo packets)
- Setting socket/network buffer sizes and ring parameters.

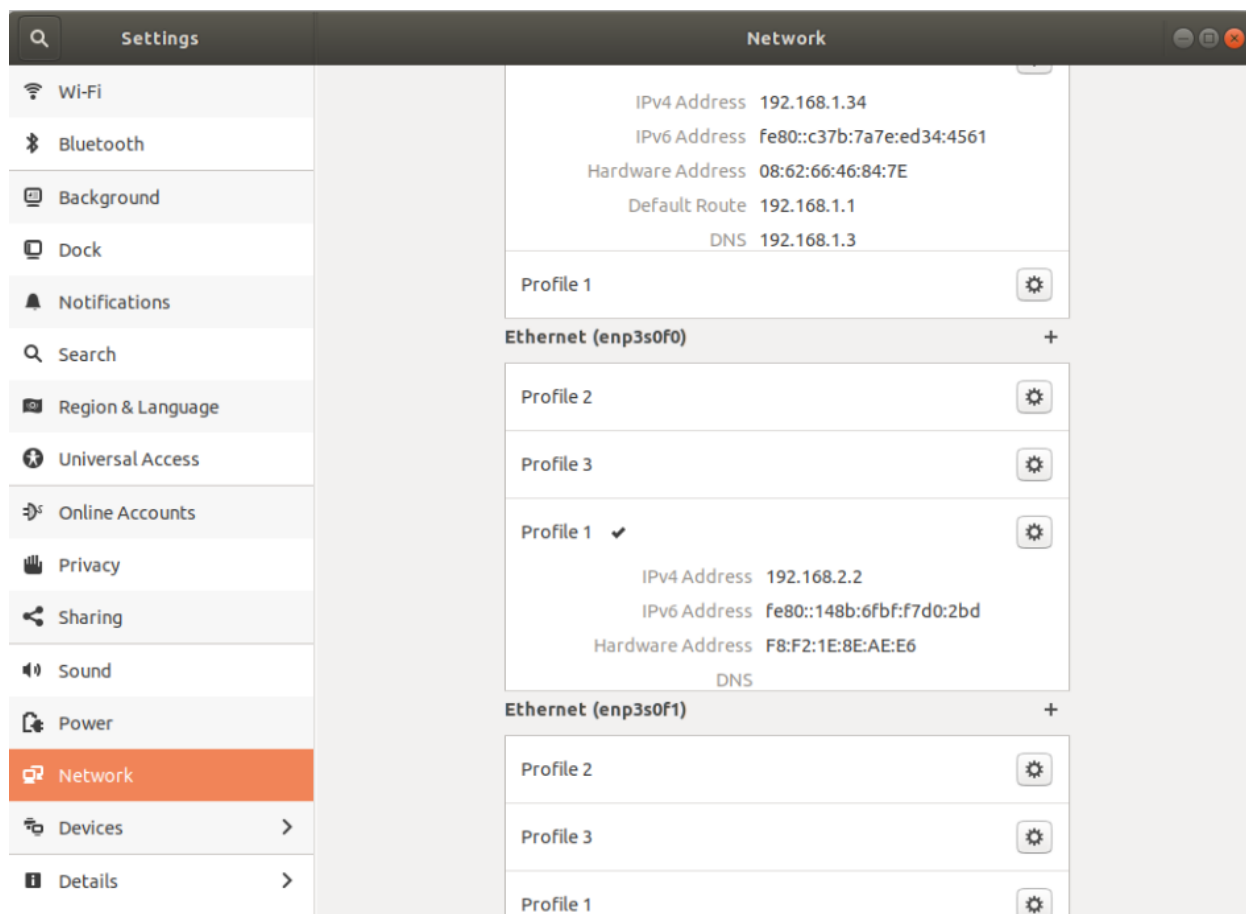
The default IP address for the SM200C is 192.168.2.10 and uses port 51665. These instructions assume you have not modified the default network configuration of the SM200C.

The steps outlined in the Configuration Steps section will allow you to permanently set the network configuration, meaning the configuration is not lost after a network interface restart. For a more temporary approach, see the network configuration commands.

4.1 Configuration Steps

With the SM200C connected to a valid 10GbE network interface, navigate to the Network Settings.

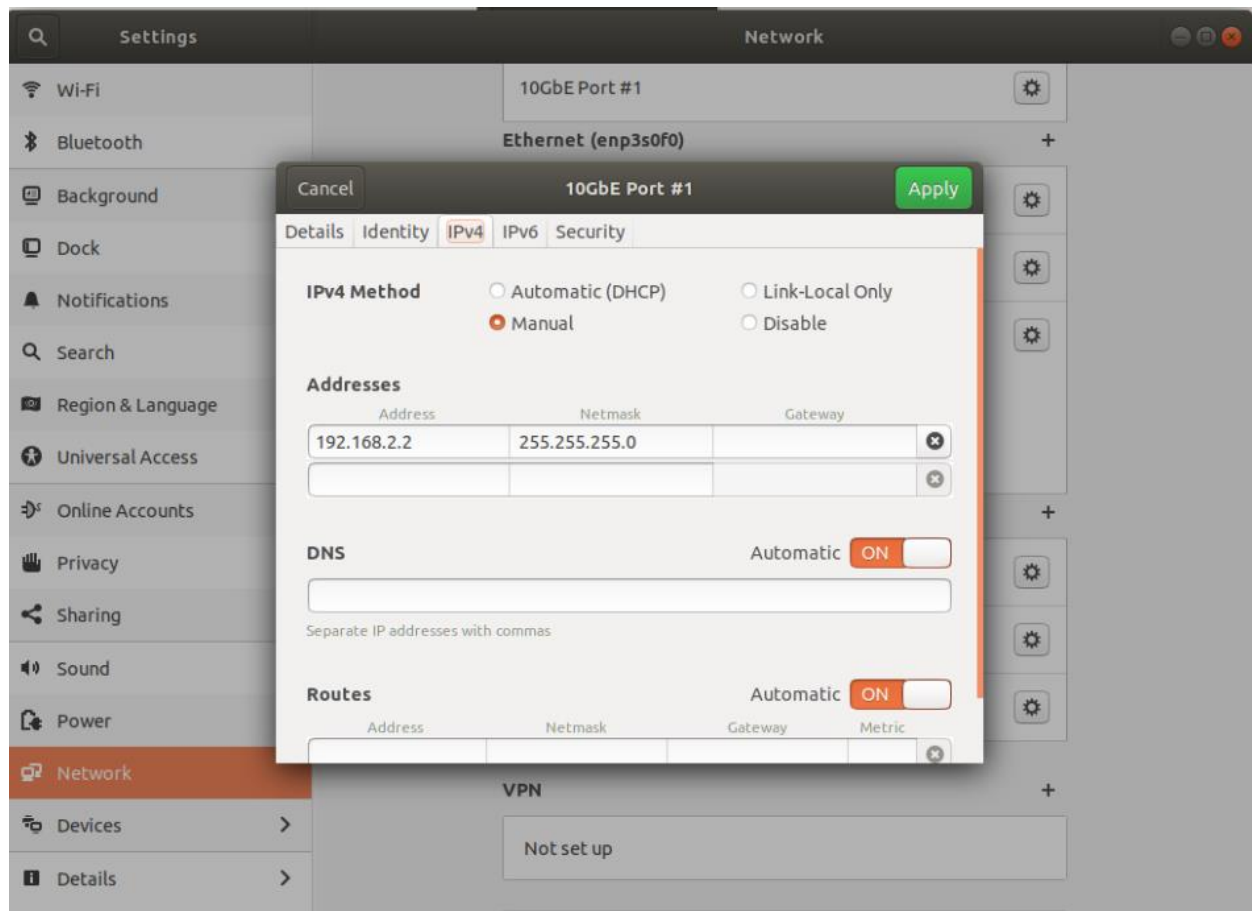
Ubuntu 18.04 Setup



Find the 10GbE network interface in the list, and create a new profile using the '+' button located to the right of the interface name. Please note the interface name (enp3s0f0 in the picture above) as it will be used in the commands documented here.

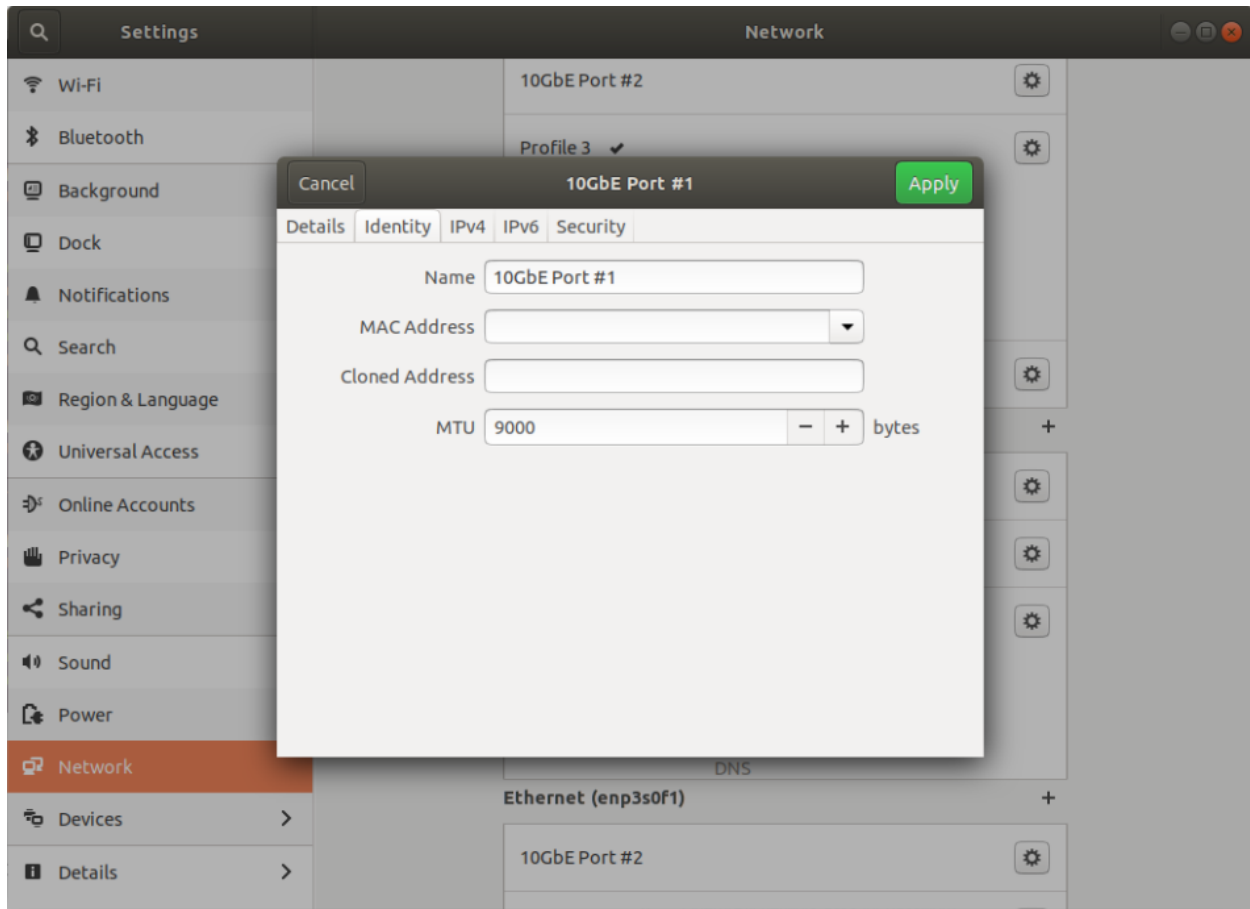
In the new profile, under the IPv4 tab, set a manual IPv4 address of 192.168.2.2 and netmask of 255.255.255.0.

Ubuntu 18.04 Setup



Set the MTU size to 9000 bytes in the Identity tab. Also set a profile name here (if desired).

Ubuntu 18.04 Setup



Hit apply when finished, and verify the new profile is selected. The profile will have a checkmark next to its name when selected.

Next is to configure the read and write socket buffer sizes. The SM200C can keep up to 32MB of UDP traffic in flight at any given time. We will configure the maximum buffer sizes to 50MB. To do this, edit the `/etc/sysctl.conf` file and add the following lines at the end of the file,

```
net.core.rmem_default=10000000
net.core.rmem_max=50000000
net.core.rmem_default=10000000
net.core.rmem_max=50000000
net.core.netdev_max_backlog=100000
```

These settings will take effect the next time the network interface/PC is restarted.

The rx/tx ring parameters and `txqueuelen` must also be updated. Signal Hound recommends setting the rx/tx ring entries to 4096. This can be performed permanently by modifying the `/etc/network/interfaces` file by appending the following line

Ubuntu 18.04 Setup

```
pre-up /sbin/ethtool -G iface-name rx 4096 tx 4096
pre-up /sbin/ethtool -A iface-name rx on tx on
up ifconfig iface-name txqueuelen 10000
```

This modification will run the proper ethtool command to modify the ring parameters the next time the network interface is restarted.

Restart the computer for all settings to take effect. Use the commands in the next section to verify the settings have been applied properly upon restart. The SM200C should now be able to be interfaced.

4.1.1 Network Configuration commands

The following commands can be used from the terminal to configure the network interface. The changes that occur for all of the following commands is temporary and will not persist through a network interface restart. See the main configuration steps for permanent methods. Also included are commands that can be used to verify the network settings are configured properly.

These commands can be used in a configuration script that is ran on program startup or run manually as needed. For all commands, replace *iface-name* with the name of the network interface the SM200C is connected to.

Set the MTU size.

```
$ sudo ip link set iface-name mtu 9000
```

View the current MTU sizes.

```
$ ip link show | grep "mtu"
```

Set the socket buffer sizes.

```
$ sudo sysctl -w net.core.rmem_default=10000000
$ sudo sysctl -w net.core.rmem_max=50000000
$ sudo sysctl -w net.core.wmem_default=10000000
$ sudo sysctl -w net.core.wmem_max=50000000
$ sudo sysctl -w net.core.netdev_max_backlog=100000
```

Read socket buffer sizes

```
$ cat /proc/sys/net/core/rmem_default
$ cat /proc/sys/net/core/rmem_max
$ cat /proc/sys/net/core/wmem_default
```

Ubuntu 18.04 Setup

```
$ cat /proc/sys/net/core/wmem_max  
$ cat /proc/sys/net/core/netdev_max_backlog
```

Set rx/tx ring parameters for a network interface

```
$ sudo ethtool -G iface-name rx 4096 tx 4096
```

Read rx/tx ring parameters for network interface

```
$ ethtool -G iface-name
```

Set flow control

```
$ sudo ethtool -A iface-name rx on tx on
```

Read the current flow control variables

```
$ ethtool -a iface-name
```

Set txqueuelen

```
$ sudo ifconfig iface-name txqueuelen 10000
```

Read the txqueuelen

```
$ sudo ifconfig iface-name
```

4.2 Troubleshooting

If you are having difficulties connecting to the SM200C in Ubuntu 18.04, quickly verify proper setup with the following steps.

- Verify the SM200C is connected to the correct network interface, the SM200C power cable is plugged in and the LED is on the SM200C is solid green. The LED should be solid green ~12 seconds after power is applied if a valid network connection is detected.
- Verify the correct profile is selected in the Network Settings for the given network interface.
- Use the commands in the Network Configuration commands section to view and verify all network parameters have been properly set.

Ubuntu 18.04 Setup

- Use the following commands to determine if any network errors or overruns have occurred.

```
$ netstat -su
```

```
$ netstat -i
```

```
$ ip -s link
```

- Disable hyperthreading. If you find that during operation (such as I/Q streaming) one of the CPU cores is at or near 100%, this could be the source of data loss. Network traffic is handled on a single thread in the kernel. If that thread is saturated, and unable to handle the transfer rates of the SM200C, data loss can occur leading to device disconnection events. Disabling hyper threading could increase the single threaded performance of the PC alleviating this issue. You can disable hyperthreading in the BIOS of some PCs. If this has no effect, Signal Hound recommends re-enabling hyperthreading as it can impact the performance of other heavily threaded applications.