QVidium® TECHNOLOGIES, INC.

QVCodec4K™ 4K/UHD-HDR HEVC Low Latency Video Codec

For Broadcast and Professional Video Applications

Model: #**QVCodec4K**

User Manual v.6

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Application Firmware Version 227

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QVidium provides the capability to inter-operate with most Content Delivery Networks (CDNs). As a result, the QVCodec4K can send and receive to/from a CDN in one of two common protocols, RTMPS, DASH, and HLS, and can receive from a Web camera via RTSP. These capabilities are described in Chapter 12 with greater detail. This feature allows you to interoperate with large content gathering points such as Facebook and YouTube.

1 Introduction

Congratulations on purchasing your new QVidium® broadcast video networking product.

QVidium® QVCodec4K UHD/4K-HDR video codec – Front View (top), Rear View (bottom)

1.1 Overview

QVidium's QVCodec4K™ broadcast video codec is a high performance, high resolution video over IP networking device capable of encoding and decoding contribution quality broadcast video at resolutions up to 3840x2160 and at frame rates up to 60 frames per second. Utilizing a high-end, state-of-the-art field programmable gate array (FPGA) with a specialized on-chip hardware video codec core and multiple CPUs, the QVCodec4K can process video in real-time using HEVC/H.265 or MPEG4-AVC/H.264 compression. The QVCodec4K can transmit and receive both 4:2:2 and 4:2:0, 8-bit or 10-bit, UHD/4K video with HDR Meta-Data and a glass-to-glass delay of only 7 video frames. Alongside the video, the QVCodec4K can process up to 8 channels of audio (4 stereo pairs) with a selection of common audio encoding formats.

QVidium was the first company to invent a negative-acknowledgement feedback-based video transport and error correction mechanism, called QVidium ARQ (Automatic Retransmission request), for which it holds 2 U.S. patents and an Emmy© Award. QVidium ARQ enables the transport of broadcast quality video over nearly any Internet and wireless network, provided that it has sufficient bandwidth to carry the stream.

Like all other QVidium video encoder, decoder, gateway and server products, the QVCodec4K employs QVidium's patented ARQ. In addition, the QVCodec4K also offers other video transport and error correction with protocols such as Zixi, SRT, RIST for live video error correction and transport, and RTMP/RTMPS,HLS, and DASH for compatibility Content Delivery Networks (CDNs) such as Facebook, YouTube, and Ustream. As a decoder, the QVCodec4K can also pull in a video feed from an IP Webcam using standard RTSP protocol.

Content produced and received by the QVCodec4K has advanced video encryption and authentication technologies including DTLS for secure key exchange and authentication, and a variety of government and industry accepted ciphers up to 256-bit, including ECDSA/AES, RSA/AES, and Chacha20,

The QVCodec4K includes the ability to add an optional video daughter-card module to expand the

selection of interfaces it can offer. Specifically, a quad-port 3G-SDI daughtercard adds the ability to independently encode or decode video up to 1080p60 simultanesouly on all 4 3G-SDI ports with up to 8 channels of audio, including 4 stereo pairs, 5.1 AC3 and 7.1 AAC. Unique to the QVCodec4K, a user can configure any combination of encoders and decoders for these four ports. For example, the QVCodec4K can encode 4 video streams, decode 4 video streams, encode 3 streams with one return channel, decode 3 streams with one uplink feed, or configure 2 bidirectional channels, all with low latency.

Furthermore, because the QVCodec4K is designed around a very large and powerful FPGA, QVidium has the ability to add and support other encoding and decoding formats and to process a variety of meta-data over its SDI video interfaces. Please feel free to contact QVidium by e-mailing us at info@qvidium.com with any requests to add a feature that we do not currently provide.

The following sections and chapters explain how to configure and operate the QVCodec4K using screen snapshots and explanations of the various settings, and provide examples of the output you should expect.

1.2 Network Setup

The QVCodec4K™ includes one built-in gigabit Ethernet port, labeled **Ethernet 1** and an SFP port that can accommodate an optical or copper gigabit Ethernet interface, labeled **Ethernet 2**. (Ethernet 2 can be upgraded to bit rates up to 10 Gigabits/second.) The default factory setting enables DHCP on the built-in **Ethernet 1** port to automatically set its IP address and network configuration. The default setting for **Ethernet 2** on the SPF port sets a static IP address of 192.168.10.25. Both ports have a Netmask of 255.255.255.0.

QVidium provides software called **CodecManager** that you can download from the Support page at http://www.qvidium.com to configure and determine the IP address of the built-in Ethernet port of your QVCodec4K. Alternatively, you can use the QVCodec4K's built-in Web interface to change the network settings – assuming that you know the address assigned to your QVCodec4K by the DHCP server.

WARNING: If you change the IP addresses of the built-in **Ethernet 1** port or the SFP **Ethernet 2** port, you **must** make certain that they remain on **different** subnets. **Failure to keep the IP addresses of Ethernet 1** and **Ethernet 2 on separate subnets will confuse the operating system routing, and result in sporadic access or possibly complete loss of network connectivity.**

To configure the network settings of your QVCodec4K using CodecManager, follow these steps:

1) Download and install the QVidium CodecManager application from the Support page at http://www.qvidium.com. Before running CodecManager, please have your QVCodec4K connected to an Ethernet switch via a Cat5 or equivalent cable. Then have your PC or other network device connected to another port on that same switch and disable any wireless or other wireline network ports on your PC.
2) Make certain that your QVCodec4K is powered on and operational. It takes about 75 seconds for it to completely boot up into its operational state.
3) Run the CodecManager application. You should see the IP address of the QVCodec4K and any other QVidium devices connected to that switch. To avoid confusion, we recommend disconnecting or powering off any other QVidium devices or products that may be connected to that Ethernet switch.
4) Click once on the entry for the QVCodec4K that you want to configure and click on Edit to configure the IP address. For setting a static IP address, please be certain to disable DHCP mode. After clicking OK, you should see the IP address for the QVCodec4K entry change to the new address.
5) If a static IP address is desired, you can enter any valid IP address, Gateway, and Netmask. However, please be aware that if you want to connect to, and interact with the

web interface of the QVCodec4K, your PC must be on the same IP subnet that you had assigned to the QVCodec4K.

6) Assuming that you set up a valid IP address in Step 5, then you can then Double-click on the entry for the QVCodec4K to pull up a browser and enter the Graphical User Interface (GUI) to interact with the QVCodec4K.

TROUBLESHOOTING: If your QVCodec4K™ does not show up in CodecManager or if you have a Linux or MAC or other non-Windows PC, you can install Java and try running the Java version of CodecManager. This version will try all your PC's network interfaces to find the QVCodec4K. You can also log into your DHCP server to see what IP address was assigned to your QVCOdec4K.

NOTE: The QVCodec4K™ requires user authentication to enter the web interface. The factory preset **username** is "**admin**" and the **password** is preset to the **serial number of your unit** (found on the barcode label on the bottom of the unit). Enter these settings when prompted to access the system. The serial number that you will use for the default factory-preset password is case-sensitive and is of the form **QVC4K**dddddddddd, where "dddddddddd" is a 10-digit number.

To reconfigure the network interface using a Web browser, follow these steps:

1) Determine the IP address of the QVCodec4K™ from your DHCP server
2) Make certain that the IP address of your PC is on the same subnet as the QVCodec4K
3) Enter the IP address of the QVCodec4K into a web browser on your PC
4) Click on "`Configure`" under the "`Network`" menu on the left.

You should see a web page similar to the following network configuration web page:

3) Change settings as desired and click "**Apply**".

4) Power-cycle your QVCidec4K if changing to a static IP address.

5) If you change the IP address, you will need to change the URL in the web browser to point to the new address after clicking on "**Apply**".

The Network Configure panel allows you to modify the static IP address parameters and DNS server settings, or to have these settings automatically configured through DHCP. A Hostname panel allows you to specify the host name for use in conjunction with a DNS server to assign a predetermined IP address.

1.3 Reconfiguring and Resetting Network Settings

In case you are not able to connect to the QVCodec4K™ through the network port(s), we have provided 2 different mechanisms for resetting the IP addresses and network settings: through **CodecManager** and through the **USB console serial port**. Any one of these 2 methods we describe in this section will allow you to recover in case the IP address was changed or set to DHCP and you do not know its current value.

CodecManager: If you have a Windows PC or a Mac running a PC emulator, you can download and run the QVidium application, CodecManager™, to change or set the IP address for the built-in Ethernet port. You can download CodecManager from the Support page at http://www.qvidium.com. If you have more than one network adapter on your PC, you may need to select the proper Network Interface from the pull-down control in the lower left corner of the CodecManager application. Also, because CodecManager relies on low-level Ethernet-level multicasts, we recommend having both the QVCodec4K and your PC connected through a switch, and not via a direct Ethernet cable. If you do not see the QVCodec4K on CodecManager, even after clicking on the Discover button, then you should try connecting to the other LAN port on the QVCodec4K. If you still do not see the QVCodec4K, then we suggest either resetting the network interface using the USB stick method, below, or via the USB serial port.
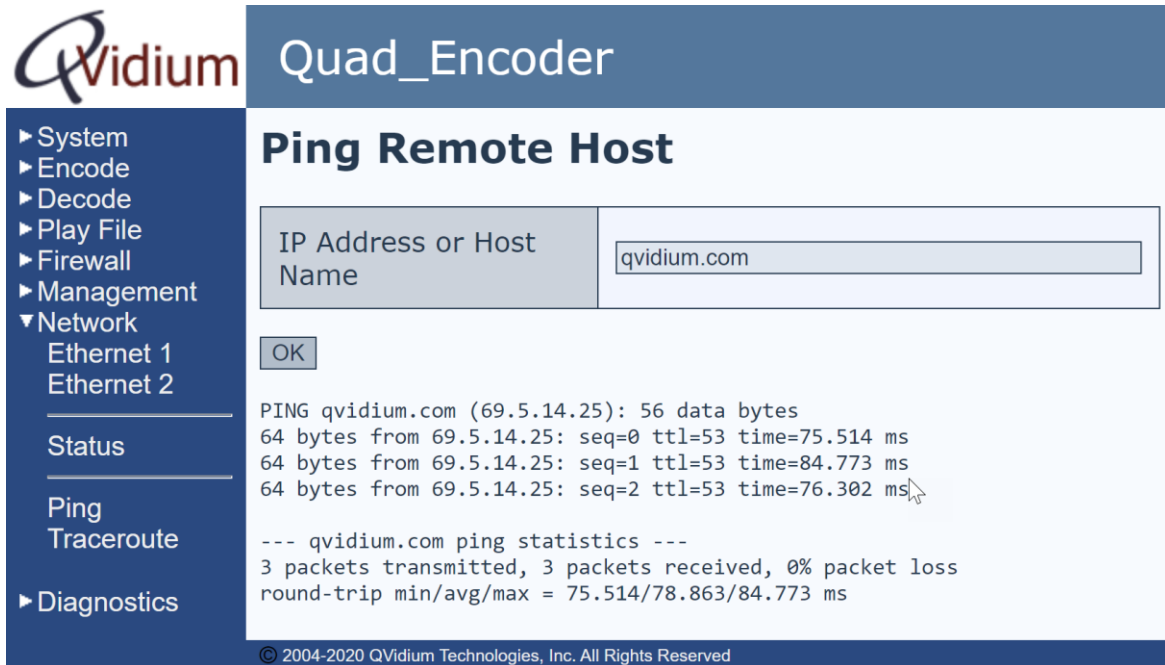
USB Console Port: Alternatively, you can connect a USB cable to the Console USB port to log into the Linux shell and change the IP address or other settings. To reset the IP settings to their factory defaults, connect a PC running a terminal emulator, such we Hyperterm or TeraTerm. You should then see 2 new COM ports on your PC. Try connecting the terminal emulator to the first USB port. (If that does not output anything upon power up, then try the other COM port.) The serial port settings should be set to 115,200 Baud (8-N-1, no flow control). Upon power-on, you should see a stream of characters as the system is booting, ending with the login prompt. Login as user "qvidium" with password "qvidium". Then type "shell" and hit **Enter**. Use the same password to get a root console prompt, "/ #". From this prompt, type **resetnetwork** followed by hitting the Enter key (carriage return) to reset the network settings to use DHCP. You can also type **ifconfig eth0** to see the current IP address.

If you have experience with network monitoring software, such as Wireshark (www.wireshark.org) or Ethereal, please note that upon power-up, the Codec will emit a gratuitous ARP packet from which you can determine its IP address by looking for the ARP packets that the QVCodec4K generates and analyzing its contents.

1.4 Ping and Traceroute

Selecting Ping allows you to test network connectivity by sending ping packets to an address or hostname you specify. However, to use a hostname in place of an IP address, you must have configured at least one DNS server.

Quad_Encoder

Ping Remote Host

- System
- Encode
- Decode
- Play File
- Firewall
- Management
- ▼Network
  - Ethernet 1
  - Ethernet 2

  Status

  Ping
  Traceroute
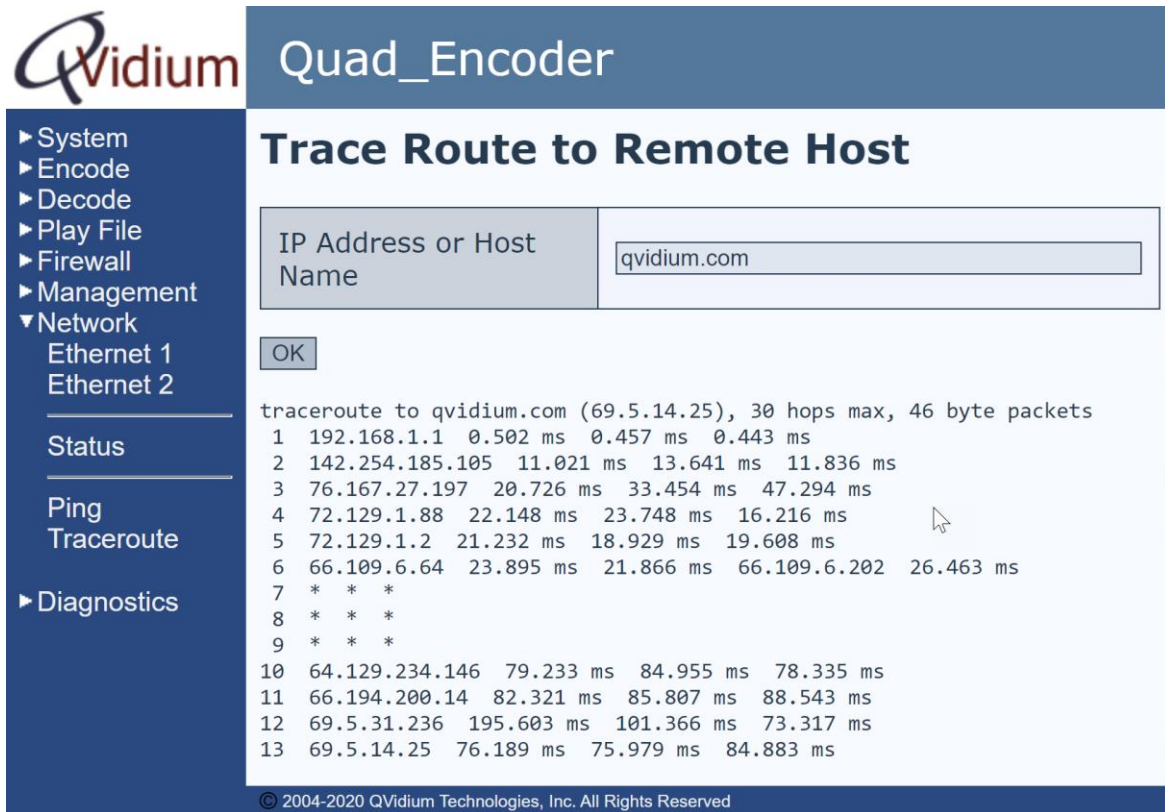
- Diagnostics

IP Address or Host Name	qvidium.com

`OK`

```
PING qvidium.com (69.5.14.25): 56 data bytes
64 bytes from 69.5.14.25: seq=0 ttl=53 time=75.514 ms
64 bytes from 69.5.14.25: seq=1 ttl=53 time=84.773 ms
64 bytes from 69.5.14.25: seq=2 ttl=53 time=76.302 ms

--- qvidium.com ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max = 75.514/78.863/84.773 ms
```

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Quad_Encoder

Trace Route to Remote Host

- System
- Encode
- Decode
- Play File
- Firewall
- Management
- ▼Network
  - Ethernet 1
  - Ethernet 2

  Status

  Ping
  Traceroute

- Diagnostics

IP Address or Host Name	qvidium.com

`OK`

```
traceroute to qvidium.com (69.5.14.25), 30 hops max, 46 byte packets
 1  192.168.1.1  0.502 ms  0.457 ms  0.443 ms
 2  142.254.185.105  11.021 ms  13.641 ms  11.836 ms
 3  76.167.27.197  20.726 ms  33.454 ms  47.294 ms
 4  72.129.1.88  22.148 ms  23.748 ms  16.216 ms
 5  72.129.1.2  21.232 ms  18.929 ms  19.608 ms
 6  66.109.6.64  23.895 ms  21.866 ms  66.109.6.202  26.463 ms
 7  *  *  *
 8  *  *  *
 9  *  *  *
10  64.129.234.146  79.233 ms  84.955 ms  78.335 ms
11  66.194.200.14  82.321 ms  85.807 ms  88.543 ms
12  69.5.31.236  195.603 ms  101.366 ms  73.317 ms
13  69.5.14.25  76.189 ms  75.979 ms  84.883 ms
```

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Likewise, you can use Traceroute to ping every router along the route from the QVCodec4K to the IP or DNS address you specify. Traceroute is very helpful in locating instances where an ISP might employ dynamic load balancing and other routing problems that can affect the quality of the video transport. Dynamic Load Balancing occurs where an ISP might specify an alternate route to send packets to balance the load across its network. This is fine for web pages that use TCP and can

tolerate random delays. However, this can cause video streams to become mis-ordered, jumbling the video content. Using the Jitter Buffer in the QVidium decoder or ARQ software can often restore correct packet order and stream integrity, at the cost of additional delay. You can also avoid Dynamic Load Balancing by requesting MPLS (Multi-Protocol Labeled Switching) service from your ISP.

1.5 Passwords and Security

The QVCodec4K™ requires a username and password to protect access to its configuration settings. This includes both Web access and SSH access. The default user name for the web interface is "**admin**" and the **default password is** set to its **serial number**. Logging in as the user **root** is not allowed.

Note on Resetting Password: If you lose the password and need to reset it, you can go to http://www.qvidium.com/reset, click on **Reset Password**, copy the "autorun" file onto a USB flash, and plug flash into QVCodec4K. (File must be saved as "autorun" and not "autorun.txt".). This will reset the admin password back to the serial number of the unit You must have physical access to the USB ports on the QVCodec4K to use this procedure.

As shipped from the factory, the QVCodec4K comes with SSH and root access disabled. The RPM update system used, as discussed in the next section on Updating, prevents any unauthorized firmware from entering the unit. Should the user require shell or SSH access to the unit, a public-private certificate-based system can be enabled that disallows shell login via username/password as a further security enhancement.

1.6 Updating

QVidium provides firmware updates from time to time to add new features, overcome limitations, or to fix bugs. The QVCodec4K firmware builds upon the RPM Package Manager to catalog, manage, automate, secure, and simplify the update process. With a clicm to System/Update, the QVCodec4K will connect with the QVidium update server to take inventory of which packages need to be updated and seamlessly keep the QVCodec4K running with the latest features and more robust firmware available. This secure mechanism forms a part of the overall protections that help to prevent malware and all non-authorized firmware from infecting the QVCodec4K.

To update to the latest firmware, make certain that your unit has access to the Internet and click on System/Update, then confirm that you wish to proceed. The system will connect to the QVidium server, take inventory of the packages loaded on your QVCodec4K, and then proceed to determine which packages need to be updated and download and install only those packages that need to be updated. After this completes, you must reboot your system for the update to take effect by clicking on System/Reboot from the web browser interface.

1.7 System View – QVCodec4K

Front View – Power Indicator

Indicator	Description
Power	Glows green when powered and booted. Glows red upon error condition.

Rear View – Power, Video/Audio I/O Connectors, & RS-232 Port

Ref	Component	Description
Bottom Row:		
1	**AC Power**	Auto-sense AC power input (100-240 VAC~, 50/60 Hz, < 60 W)
2	**DC Power**	8 to 20 VDC ⎓ (7.5 to 3 Amps) alternative DC power input
3	**MicroSD**	MicroSD memory card slot
4	**Ethernet 2**	SFP port for 2nd Ethernet interface (copper or optical), 10GigE max.
5	**SDI**	SFP port for 2nd SDI I/O port (optical or copper), 12G-SDI max.
6	**SDI**	12G-SDI Input/Output port, all SDI rates up to 12Gbps
7	**Genlock**	Genlock input (optional feature)
8	**DisplayPort**	DisplayPort video output
9	**USB**	USB-3.0 type A connector for additional memory
10	**Console**	Micro-B USB-2 connector for serial console port
11	**Ethernet 1**	Main GigE Ethernet port
12	**Indicators**	SDI lock / Genlock Lock / Raw input power indicators
	Top Row:	
	3G-SDI	Four 3G-SDI ports for daughter-card I/O (optional)

Note: Serial number (not shown) is located on the bottom of the unit.

1.8   IMPORTANT SAFETY INFORMATION – PLEASE READ

- ⚠ **Use this product only as specified in the manual. If the instrument is used in a manner not specified by the manufacturer, the protection provided by the instrument may be impaired, resulting in personal injury or damage to the product.**

- ⚠ **Only product safety-approved DC power supply unit based on all applicable local, state/provincial, and/or national regulations shall be used with this product.**

- **For PLUGGABLE EQUIPMENT, the socket-outlet shall be installed near the equipment and shall be easily accessible.**

- **CAUTION: The QVCodec4K Codec contains an internal 1.55V. Silver Oxide battery. RISK OF DAMAGE IF BATTERY IS REPLACED BY AN INCORRECT TYPE. USE ONLY IEC TYPE SR44 SILVER-OXIDE BATTERY SUCH AS ENERGIZER 357/303 OR EQUIVALENT. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.**

- **This equipment is not suitable for use in locations where children are likely to be present.**

- ⚠ ⛔ **Caution, risk of electric shock. Disconnect all power sources before opening. NO USER SERVICABLE COMPONENTS.**

2 Encoder Configuration

You can configure and operate the encoder from a web browser. All settings are stored in non-volatile flash memory, allowing the encoder to automatically recover after a power failure. This section explains how to configure the QVCodec4K encoding parameters with full access to the capabilities of the encoder.

2.1 Quickstart Encoder Configuration

Below is a simple procedure to quickly start streaming from one QVCodec4K for encoding to another QVCodec4K configured as a decoder. (An analogous quickstart procedure for the decoder can be found in section *4.1 Quickstart Decoder Configuration*.

1. Enter `http://<IPAddress>` where `<IPAddress>` is the IP address of the QVidium QVCodec4K™ HEVC UHD-HDR Video Codec unit that you want to configure as an encoder. (See section *1.2 Network Settings1.2* to get or set the IP address.)

2. Click on "`Profiles`" under "`Encode`" from the menu on the left. Then, either double-click on an existing encoder profile you wish to edit, or click on "`New`" to create a new encoder profile. The "`Encoder Profile`" interface should then display in the main area to the right of the menu system, as shown in Figure 1a.

3. Enter the Destination IP address and UDP port number for the decoder, media server, or network equipment that will be receiving the stream. You can use the default parameters for all the other settings. Or if desired, you can change the video and audio encoding settings to suit a specific application. By default, the IP Transport is set to QVidium ARQ to correct for packet loss and other video transport issues when transmitting over the Internet. For sending a video stream over a LAN or other private hardwired network, you can instead select UDP.

   Note: For ARQ and RTP IP Transport, you may enter up to 4 different destination IP addresses, separated by commas only (','), no spaces. The QVCodec4K will then send an individual copy of the video stream to each of the IP addresses that you list. An ARQ outbound stream is actually a standard RTP stream, and can be received as such be third-party non-ARQ decoders.

4. Press the "`Save`" button to save your changes. None of your changes will be saved nor have any effect unless you first save them. These changes are stored in permanent memory and will persist even after a power failure.

5. Click on **Encode/Start** (and select the desired profile if more than one profile exists) to then start the stream.

If you have connected a valid video stream to the SDI input and click on **Encode/Status**, the stats should now show that you are sending out a video stream at the desired bit rate.

2.2 Detailed Encoder Configuration

As shown in Figure 1a, the encoder profile configuration page lets you set the video and audio encoding format and bit rates. The QVCodec4K codec will automatically detect and adjust for the SDI input video resolution and format. The encoder contains a built-in video scalar that provides the QVCodec4K the ability to change the video resolution before it is encoded and output as a

stream. The QVCodec4K outputs the encoded video stream as a capped Variable Bit Rate (VBR) IP stream.

VBR video encoding only uses the amount of bandwidth needed to encode the video content. A VBR stream has the advantage of optimizing IP network efficiency by eliminating unnecessary null packets from the media stream. In general, the video rate may be less than this rate, depending upon video content. Thus, a VBR stream can have large variations in bit rate, and generally produces a much lower average bit rate than a constant bit rate stream.

Note: Be aware that the user interface will not warn you if you try to enter a bit rate beyond the operating limits of the codec. For more details on the range of **encoding bit rates**, please **see Appendix C** (Section 11.3). For more information on the various **video parameters** (Frame Rate, Encoding, Format, Resolution, etc.) please **see Appendix A** (Section 11.1). For UHD or HD video, you can select either HEVC or MPEG4-AVC (H.264) **Video Encoding**.

Figure 1a: Basic Encoder Configuration.

2.2.1 Basic Encoding Parameters

All the basic parameters you normally would need to set when creating a new encoding profile are grouped together under the **Encoder Profile** page, as shown in Figure 1a, below. We explain the Encoding options in the following paragraphs.

Below is a list of the basic encoding parameters and a short description for each setting:

Output: File or **Network**. Default is Network. This selects between recording to a file or streaming over the network. Recording gives priority to mounted USB storage, if present, and secondarily to internal flash memory. If a directory named "videos" exists, it will create the recording there. When Network is selected, the destination IP address and internal routing tables determine which Ethernet port to use (if both Ethernet ports are present).

Video Bit Rate: Defaut is **7,500**Kbps (7.5 Mbps). This sets the total output stream bit rate in kilobits per second (Kbps). The QVCodec4K sets an internal video bit rate by subtracting the audio bit rate from the Stream Bit Rate and setting an additional margin for IP packetization. For all stream modes, the output bit rate should not exceed this value. However, there may be a variation in output bit rate of up to about 5% over the value you set. If the bit rate is too low for the video content you have, then you can expect to see pixelization and blurring of the image for scenes with high motion. The minimum bit rate is set to 500Kbps (500). The maximum bit rate is 60Mbps (60000) per stream.

Resolution: Auto, **1920x1080**, **1280x720**, **960x540**, **640x360**, **480x270**. Default is **Auto**. The QVCodec4K has in internal video scalar. Setting resolution to "**Auto**" retains the resolution of the SDI signal. Otherwise, the scaler downscales the resolution to the selected value. **Note:** the QVCodec4K cannot de-interlace an interlaced signal, nor can it create interlaced video from progressive.

Video Format: 4:2:2 or 4:2:0, 8-bit or 10-bit. Default is 4:2:0 10-bit. The QVCodec4K incorporates a chroma converter that can change the video format fro the native 4:2:2 10-bit SDI input format to 4:2:0, if desired, and optionally reduce the bit depth from 10 bits to 8 bits for encoding. The encoder can encode video at any combination of 4:2:2 or 4:2:0 chroma and 10-bit or 8-bit pixel resolution.

Video Encoding: HEVC (H.265) or MPEG4-AVC (**H.264**). Default is **HEVC**. You can select between HEVC/H.265 encoding and MPEG4-AVC/H.264 (Main profile). HEVC requires about one-half 1/2) to one-third (1/3) of the bit rate for comparable video quality versus H.264 for UHD/4K video because it uses a much larger block size.

Video Refresh (GDR): Off, **Horizontal**, or **Vertical**. Default is Horizontal. This setting enables Gradual Decoder Refresh (GDR) during encoding, which results in lower latency and smaller packet bursts because it encodes the I-frame in horizontal or vertical slices, rather than waiting for an entire I-frame (aka. Key frame) to encode. We recommend enabling GDR when using another QVCodec4K as the decoder. **Note:** If sending to VLC as the decoding software, please note that VLC has a bug that requires VLC to be started before starting the encoder in order for it to properly decode the video stream.

Frame Rate: Full or **Half**. Default is Full. This setting allows you to reduce the frame rate to one-half of the original Standard video frame rates are normally 59.94 fps. or 50 fps. Halving the frame rate allows for half the stream bit rate.

Closed Captions: On or **Off**. Default is **Off**. When set to "**On**", the QVCodec4K will pass through CEA-708 Closed Captions on the ancillary data of the SDI input into the encoded stream.

Audio Bit Rate (bps): Defaul is **160**Kbps. This sets the total bit rate for the combination of the 2 audio channels (left and right channels of a single audio pair). (The default of 160Kbps actually produces the same TS Stream Bit Rate as setting the audio bit rate to 128Kbps because of size constraints for audio packet sizes that must fit within a fixed TS packet size.) The minimum audio bit rate is 16Kbps and the maximum is 320Kbps per channel. For 71. AAC, the stream bit-rate is overridden to a total of 320Kbps for the entire set of 8 audio channels.

    NOTE: The audio sampling rate is fixed at 48 KHz as this is standard for SDI.

Audio Channels: 0 (no audio), 2 (1 stereo pair), 4 (2 stereo pairs), 6 (3 stereo pairs), 8 (4 stereo pairs), 4 channels (independent), 5.1 channels (AC3 opt), or 7.1 channels (AAC). Default is **2 (1 stereo pair)**.

Audio Encoding: Opus or **AAC**. Default is **Opus**. You can select between **Opus** and **MPEG2 AAC** audio encoding formats on the QVCodec4K. For speech and verbal content, and to maintain the highest level of 3rd party compatibility, we recommend the default of Opus, which is used by Google in Android phones. For high fidelity audio, such as music or concerts, we recommend MPEG2 AAC.

Note: Please remember to always hit the SAVE button after making any changes or your changes will be lost. You must also restart the encoder with the updated profile for these changes to take effect.

2.2.2 Network Output Settings

The basic settings for configuring the network output are: IP Transport, Destination IP address, and UDP Port. Changing the **IP Transport** setting will automatically display the optional settings associated with that mode of operation, including any applicable encryption settings. This section describes these settings and the optional settings associated with each IP Transport option.

IP Transport: Default is QVidium **ARQ**. The current firmware release provides the following options for IP Transport: **UDP**, **ARQ**, **SRT**, **Zixi**, **RTMP/RTMPS**, **HLS**, **RIST Simple Profile**, and **RIST Main Profile**. Other protocol options can be added upon request, such as SMPTE-2022 FEC, DASH and RTSP.

IP Addr or Hostname: By default, this field is left blank. The most common mode of operation is "Push Mode" or sender-initiated operation, wherein you provide the IP address or hostname for the destination that is to receive the IP video stream. In this mode the receiver, usually a decoder, passively listens for the stream that you plan to send. However some IP Transport Options, currently QVidium ARQ and HLS, can operate in a "Pull Mode", i.e. a receiver-initiated mode of operation, In Pull Mode, you can leave the IP Address/Hostname field blank and the receiver tells the encoder to start or stop the stream.

For UDP and RIST Simple Profile, this can either be a unicast or a multicast IP address. For all other modes, this must be a Unicast address (first octet is less than 224).

For QVidium ARQ IP Transport, you can also supply up to 4 IP addresses, separated only by commas (','), no spaces.

For HLS, you can pull the stream using a URL of the form:
        *http://<IP address of QVCodec4K encoder>/**static/vid0/playlist.m3u8***

Note: For QVidium ARQ, a Pull-Mode of operation is available upon request. Under QVidium ARQ, you can both Push and Pull streams at the same time by entering an IP address/hostname to push streams while other receivers pull streams from your QVidium ARQ server.

UDP Port: Default is 10000. Live, real-time video streaming protocols such as ARQ, SRT, Zixi, and RIST use UDP protocol at the IP transport level. For the IP transport modes that require the specification of a UDP port, the value should be greater than 1023, so as not to potentially interfere with internally used ports, and less than 65536.

Note: CDN protocols, including RTMP/RTMPS and HLS, use TCP instead of UDP. TCP provides a form of error correction to replace missing packets, but can cause long pauses or freezing of the video when packets are not recovered, adds large delays into the stream, and limits the maximum stream bit rate as the packet round-trip delay increases. TCP-based protocols usually use a fixed and well-known port, so a port is usually not specified. (Should you need to change the TCP port for RTMP, you would affix a colon (':') and the port number after the IP address.)

2.2.3 Stream Encryption

Stream encryption is available in QVidium **ARQ**, **Zixi**, **SRT**, and **RIST Main Profile** IP transport modes. **Zixi** and **SRT** both use a pre-shared key that you must choose beforehand and provide to both the QVCodec4K encoder and decoder profiles. Please be aware that the encryption is only as good as the ability to keep this key private.

Alternatively, **QVidium ARQ** and **RIST Main Profile** use **DTLS** that implement a public/private key exchange. The use of a public key eliminates any sharing of your private key, thereby keeping your private key secure. As such, DTLS is considered to be far more secure than pre-shared key encryption.

2.2.4 Optional UDP Output

Regardless of the IP Transport you select, the QVCodec4K also allows you to send a plain UDP stream to any other IP address and UDP port you choose. This second copy of the encoded video stream does not include any encryption or error correction, but can be a multicast stream, so it is best suited for monitoring the encoded stream over a local area network (LAN).

WARNING: DO NOT ENTER THE SAME IP ADDRESS HERE AS IN THE DESTINATION "IP ADDRESS OR HOSTNAME" FIELD, ABOVE. Doing so will send two conflicting streams to the decoder. PLEASE LEAVE THIS IP ADDRESS FIELD BLANK UNLESS YOU INTEND TO USE THIS FEATURE.

2.3 QVidium ARQ Video Transport & Error Correction

The QVidium H.264 HD Video Codec™ features some of the most powerful and advanced error correction capabilities found in any video over IP product. The QVidium H.264 HD Video Codec™ implements QVidium's patented ARQ error correction and clock synchronization (US Patents #7,551,647 and #7,522,528) for robust video transmission with the lowest delay. QVidium's ARQ (Automatic Retransmission Request) is a dynamically responsive feedback error correction mechanism designed specifically to enable the highest quality video transport over wireless networks and the Internet. ARQ senses packet loss at the receiver and requests replacement packets from the server. ARQ can provide nearly flawless reproduction of a video stream even through extremely lossy or congested networks.

The QVCodec4K HEVC UHD Video codec minimizes network bandwidth and loading due to the high efficiency of HEVC encoding and ARQ video transport. The QVCodec4K™ implements HEVC (H.265) Main Profile video encoding, providing advanced coding techniques in hardware.

The QVCodec4K supports QVidium's patented ARQ error correction as well as new industry standard RIST and SRT protocols for interoperability with third-party encoders and decoders. ARQ is a robust feedback-based error correction that can successfully recover nearly all packet loss, even in harsh network environments.

In contrast with Forward Error Correction (FEC), ARQ employs a feedback mechanism that detects packet loss at the receiver and requests the retransmission of only those lost packets from a video source. A user-configurable buffer at the receiver (decoder) delays the video stream just long enough to allow the system to replace any missing packets and re-insert them in their proper order without disturbing play out of the video stream. Because ARQ senses actual packet loss, rather than attempt to predict packet loss, it can precisely and completely restore all lost packets without disturbing timing of the video play out. In contrast to FEC, ARQ can successfully recover lost packets regardless of the magnitude or pattern of the packet losses, provided that the network connection has enough capacity to send both the original video stream and the replacement packets.

ARQ shares similarities with robust packet transport protocols, such as TCP/IP in that both use feedback to create robust network packet transport. However TCP/IP uses a sliding window that limits the number of packets that a source can have in transit and requires a positive acknowledgement for each window of packets. This limits TCP's throughput, especially over links with long latencies. Furthermore, under heavy loss conditions, TCP/IP scales back the data transmission rates and provides no concise deadlines or constraints on packet delivery times. For real-time video, this limits the usefulness of TCP/IP, making it unacceptable for low-latency uses.

In contrast with TCP/IP, QVidium designed its patented ARQ error correction specifically for live, interactive, real-time video and audio signals to automatically recover nearly all lost packets with minimal latency and over nearly any link loss conditions. It adds a small configurable amount of delay to the network transport in exchange for significantly improving the robustness and reliability of video transport.

This section explains how to configure the video transport capabilities of the QVCodec4K H.264 HD Video Codec™ and how to enable ARQ error correction.

2.3.1 Configuring Video over IP Network Parameters

To configure the IP network parameters, within the Network Parameters section of the encoder profile, first select an IP Transport mode. Depending upon the IP Transport more that you select, tables of additional optional parameters relevant to that IP Transport will then appear. For more protocols, you will also be required to specify the destination IP address and UDP port number. The destination IP address is usually a unicast IP address, but for UDP and RIST Simple Profile, it can also be a multicast address.

For any IP Transport mode other than UDP, you may specify up to 4 comma-separated destination IP addresses for sending copies of the output to multiple destinations. For sending more than 4 output copies of a stream, either use an IP Transport that allows multicasting (and UDP or RIST Simple Profile) or send the stream to a server or PC running the QVidium QVARQ-TxRep QoS Proxy server (see http://www.qvidium.com/proxy).

The encoder internally encapsulates the video and audio signals as UDP packets in all cases, regardless of the type of packet transport you select. Specifying UDP eliminates the RTP header and encapsulates the encoder's multiplexed MPEG-2 transport stream directly as the payload of the UDP packet. All the other transport selections (except SRT, RTMP and HLS) add an RTP

header to the UDP packet stream. In the case of RTMP and HLS, the QVCodec4K converts the stream to TCP protocol. SRT uses a proprietary protocol called UDT that was originally designed for reliable file transfer.

The RTP header adds a timestamp and packet sequence number to the UDP packet and then adds the 188-byte MPEG-2 Transport Stream sections into the IP packet payload. A typical Ethernet/IP packet contains 7 of these MPEG Transport Stream sections. RTP protocol is a commonly used and widely interoperable protocol for sending video. The IP encapsulation adheres to the IETF/RFC3550 standard for video over IP that specifies that the packet payload must comprise an integral number of whole 188-byte MPEG-2 transport stream sections within an RTP header.

2.3.2 Error Correction - ARQ: Automatic Retransmission Request

To enable **A**utomatic **R**etransmission Re**q**uest (ARQ), you must first select ARQ transport from the `Profile` dialog. ARQ transport must also be enabled at the decoder. With ARQ selected and the encoder started, the encoder will begin to save outgoing packets for later retransmission, when necessary. Normally, the ARQ port should be set to the same value as the outgoing UDP port for the video stream, with a default value of 10000. This will allow the upstream ARQ retransmission-request packets to travel back through most encoder-side firewalls without requiring any special configuration at the encoder-side firewall. If you use a different ARQ port than video UDP port, then you must also be certain to configure any encoder-side firewalls to allow the upstream ARQ retransmission request packets through to the encoder. You may change the value of the ARQ port, but the ARQ and UDP port settings must match on both the encoder and decoder.

At the receiver, the ARQ error correction mechanism first buffers incoming packets in a synchronized network de-jitter buffer that maintains a constant, configurable delay for incoming packets. The de-jitter buffer processes RTP sequence numbers and reorders packets as necessary to restore proper packet sequence and to buffer against erratic network delays. Its goal is to output a smooth, consistent flow of packets with increasing sequence numbers. This output feeds the ARQ error correction mechanism.

The ARQ unit at the receiver watches for gaps in RTP sequence number from the de-jitter buffer output, and immediately sends out retransmission requests when necessary. Incoming retransmitted ARQ packets bypass the de-jitter queue and find their correct place in the ARQ buffer, so that by the time packet are output by the ARQ buffer, the ARQ error correction mechanism should no longer contain any missing packets.

When the encoder and decoder are both started, the decoder automatically measures the round-trip delay and packet jitter to the encoder and automatically configures ARQ for optimal operation according to a few basic user-specified parameters, as described in Section 2.3.2.

Note: For testing ARQ error correction, select ARQ transport at both the encoder and decoder and use the default ARQ parameters at the decoder (receiver).

2.4 Configuring Advanced Video Encoding Parameters

The encoder has a set of advanced configuration settings, configurable from the Advanced Encoder Profile tab, as shown below in Figure 1b, and from the Advanced Network Profile tab as shown in Figure 1c. The Advanced Encoding tab divides these parameters into 4 sections: Audio/Video Encoding parameters, Control parameters, Output parameters, and File parameters. All advanced IP/Ethernet network settings are located under the Advanced Network tab.
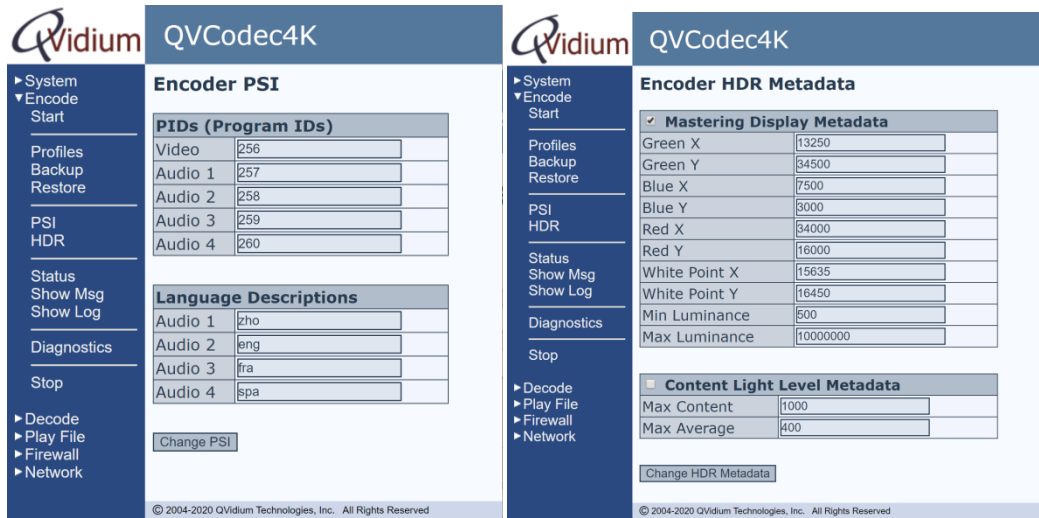
Figure 1b: Advanced encoding parameters: Setting PSI (Program Stream Information) and HDR Metadata for High Dynamic Range color processing.

2.5 Additional Protocol-Specific Parameters

Certain protocols, specifically RIST Main Profile, RTMP, and Zixi have additional features with their associated additional parameters that will appear in the configuration settings when selected.

RIST Main Profile created a virtual private network tunnel when started. It therefore has additional parameters to configure related to this feature. RTMP adds a Key and URL. Zixi has username/password authentication for connecting to their server and a bonding feature that allows you to use both of the QVCodec4K Ethernet network ports for bonding and failover features. Please contact QVidium for further details, should you require any assistance in these additional configurations.

3 Encoder Operation

This section explains how to start and stop the QVCodec4K for video encoding. Once the encoder has started, you can also dynamically change the video encoding bit rate. This section assumes that you have already created one or more encoding profiles as per Section 2, above.

3.1 Starting and Stopping the Encoder

Enter `http://IPAddress` where `IPAddress` is the IP address of the encoder.

1. Select the `Encoder` menu on the left side of the web page.

2. Click the `Start` menu option underneath the `Encoder` menu. With only a single profile, the encoder should now start. If you have more than one profile, then double-click on the desired profile to start the encoder.

3. To confirm that the encoder has started, click on Status and confirm that the `Bit Rate` is non-zero. If you have trouble starting the encoder, please check that the SDI Lock indicator light on at the back right side of the codec is lit. If not, then check your source. The Status page should also provide details about the SDI video input, including its format, frame rate, and number of embedded audio channels.

4. If you are still experiencing problems, click on Show Msg to check the encoder's initialization messages. Near the end of that page you should see the line, "`Start encoding OK`". If the video source is absent or invalid, the last line of the log may read: "`Video NOT locked: waiting for valid input`".

5. Clicking `Stop` will stop the encoder. You can edit any encoder parameters while the encoder is running, both for the current profile and other profiles. However, to change settings or profiles, you must first click Stop and then click on `Start` to restart the encoder with a new or updated profile.

Note: If you wish to reconfigure the encoder, remember to first **Save** any configuration changes **before** restarting the encoder. A message will appear at the top of the page to confirm that your changes have been saved.

3.2 Dynamically Changing the Video Encoding Bit Rate

Once encoding has begun, you can instantaneously vary the video encoding bit rate for VBR streams. This can be useful when connecting to wireless modems and other network connections with limited, but unpredictable, time-varying throughput characteristics. As described in this section, we provide several mechanisms for dynamically adjusting the video encoding bit rate. In particular, this can allow a modem to feed back link throughput constraints directly to the encoder to dynamically optimize video quality over such bandwidth-constrained networking links.

Note: At present, this feature is only supported for VBR (variable bit rate) streams.

3.2.1 URL Control

The "`Encode/Bit Rate`" link in the web UI allows you to dynamically change the stream bit rate while the encoder is running through a browser. Alternatively, you can programmatically control the encoder by sending control packets. Upon request, QVidium can provide source code to a sample control application called `command_request` to set or return the encoder bit rate.

This software application can be involed as follows:

cmd_request --ipAddr <QVCodec4K IP Addr> --port <Command port of QVCodec4K> --cmd "setbitrate <Desired bitrate in bps>"

For example, the following sets the bit rate to 7.5 Mbps from a QVCodec4K at address, 192.168.1.19:

cmd_request --ipAddr 192.168.1.19 --port 600 --cmd "setbitrate 7500000"

Here is an example to return the current stream bit rate:

cmd_request --ipAddr 192.168.1.19 --port 600 --cmd "getbitrate"

4 Decoder Configuration and Operation

As with the encoder, the decoder can be configured and operated from a web browser. This section describes how to configure and operate the decoder.

4.1 Quickstart Decoder Configuration

Below is a simple procedure to quickly start receiving and decoding a stream from a QVCodec4K for encoder. (An analogous quickstart procedure for the encoder was provided in section *2.1 Quickstart Encoder Configuration*.)

1. Enter `http://<IPAddress>` where `<IPAddress>` is the IP address of the QVidium QVCodec4K™ HEVC UHD-HDR Video Codec unit that you want to configure as the decoder. (See section *1.2 Network Settings1.2* to get or set the IP address.)

2. Click on "`Profiles`" under "`Decode`" from the menu on the left. Then, either double-click on an existing encoder profile you wish to edit, or click on "`New`" to create a new decoder profile. The "`Decoder Profile`" interface should then display in the main area to the right of the menu system, as shown in Figure 3a. You may wish to change the "`Profile Name`" for later ease of reference.

3. By default, the IP Transport is set to QVidium ARQ to correct for packet loss and other video transport issues when transmitting over the Internet. However if the encoder is sending an ARQ stream, then you must set the IP Transport to match that of the encoder. Under "Network Input", set the "`UDP Port`" number to match the stream that the encoder, media server, or network equipment that will be sending. You can usually use the default parameters for all the other settings.

4. Press the "`Save`" button to save your changes. None of your changes will be saved nor have any effect unless you first save them. These changes are stored in permanent flash memory and will persist even after a power failure.

5. Click on **Decode/Start** (and select the desired profile if more than one profile exists) to then start receiving and decoding the stream.

If you are receiving a properly formatted IP video stream on the Ethernet network input, then clicking on **Decode/Status** should now show the status of the stream that you are receiving. You can also click on **Decode/Show Msgs** to see how the decoder interpreted the format of the video and audio of the incoming stream.

4.2 Decoding Profile Settings

This section will descript the optional settings and modes of operation for the decoder that we did not discuss in Section 4.1.

4.2.1 Basic Decoder and Network Settings – UDP Input

Figure 3a, below, shows the Decoder Configuration settings when IP Transport is set to UDP. Aside from labeling the new profile with a Profile Name, you can set the Delay Mode to either Normal or Low Delay, and set the basic Network Input settings, as described, below.

Figure 3a: Decoder profile

Delay Mode: Normal or **Low Delay**. Default is Normal. The Normal delay for UDP transport from the input of a QVCodec4K encoder to the output of the QVCodec4K decoder, not including additional network delay is about 166ms. In Low Delay mode, this delay can drop to as low as 117ms. However, the lack of buffering in Low Delay mode can cause some loss of smoothness in the output video for certain video content. If Low Delay is important for your application, you may wish to try this setting to see if it works for your specific video content.

IP Transport: ARQ, UDP, **RIST-simple, RIST-main, SRT, RTMP/RTMPS, RTSP**. Default is QVidium ARQ. This setting configures the decoder for to receive a video stream with the specified transport protocol. **UDP** is the simplest, but has no error correction, so it should only be used on a private network with no packet loss. **ARQ** configures the decoder to receive a stream with QVidium ARQ (Automatic Retransmit reQuest) that adds QVidium's patented video transport and error correction. ARQ uses feedback to request the encoder to resend any lost packets. **RIST** and **SRT** are other, standardized ARQ protocols. Both QVidium ARQ and RIST-simple are compatible with RTP protocol. **RTMP** and **RTMPS** (secure) are TCP-based transport protocols used by CDNs. Facebook, for example, uses RTMPS protocol. **RTSP** is used by webcams, and is configured to use TCP for its error correction.

Each of these IP Transport modes is associated with a unique set of parameters. An appropriate form will appear for when selecting each particular IP Transport mode. Additional parameters for various protocols include encryption settings, settings to adjust the ARQ tradeoff between delay and robustness, and URL settings for CDN-based protocols, such as RTMP and RTSP.

Multicast Address (default: blank)**:** If you wish to receive a multicast stream over a local-area network (LAN), you must set the **IP Transport** to **UDP** and enter the Multicast Address here.

Because the Internet filters out multicast packets and all the other IP Transport modes are designed for Internet use, this settings is only appropriate for UDP transport. It should be disregarded for all other protocols.

Source Address (default: blank)**:** This setting is only used when receiving a multicast stream over a LAN using **UDP** protocol. It should be left blank otherwise. Enter the IP address of the device sending the multicast stream here when receiving a multicast stream.

5.1 Starting the Decoder

Enter `http://IPAddress` where `IPAddress` is the IP address of the decoder.

1. Select the `Decoder` menu on the left side of the web page.

2. Click on the `Start` button. If you only have a single decoder profile, the decoder should now start. If you have multiple decoder profiles, then double-click on the profile you wish to start.

3. When a valid video over IP stream is being received and decoded, the Video Status page will show bit rate and other statistics related to the incoming video stream. You can also click on Show Log to see what type of audio and video data the decoder has detected.

5.2 Stopping and Reconfiguring the Decoder

Enter `http://IPAddress` where `IPAddress` is the IP address of the decoder.

1. If the `Decoder` menu is not shown, select `Decoder` on the left side of the web page.

2. Select the `Stop` menu option underneath the `Decoder` menu. You should see the following message at the top of the web page main area: "`Decoder is Stopped.`"

5.3 Configuring Packet Transport & Error Correction

This section explains how to configure the video transport and error correction capabilities of the QVidium QVCodec4K Video Codec™ and how to configure its decoder for proper operation of these error correction mechanisms. Section 5.3.1 describes the configuration of the decoder's network transport for ARQ video transport and error correction, and Section 5.3.2 describes the ARQ error correction mechanisms of the QVCodec4K™ in detail.

5.3.1 Configuring the Decoder's IP Transport for ARQ Error Correction

Within the **Network Input** section of the decoder profile, select among ARQ, RTP, or UDP packet transport. Also, specify the UDP port number. The **Multicast Address** specifies the IP multicast address, if any, to listen to for the Video/IP stream. If expecting a unicast video/IP stream, leave this field blank. The decoder interprets the video and audio signals as UDP/IP packets in all cases, regardless of the type of packet transport you select. Specifying UDP treats the packet payload as raw MPEG-2 Transport Stream data. All the other transport types will assume that the incoming packets have an RTP header at the start of the payload, as per IETF/RFC 2733 and related standards.

The network interface to the decoder includes QVidium's patented synchronized network de-jitter buffering mechanism. In the decode interface, you may specify a delay for this de-jitter buffer in milliseconds. When using ARQ or RTP network transport mode, the de-jitter buffer holds the specified number of milliseconds of packets to give the decoder ample time to account for random delays and to allow the decoder to correct packet ordering. The decoder uses RTP sequence numbers of incoming packets to insert incoming packets into their proper place in the de-jitter buffer before releasing those packets into the MPEG decoder. The de-jitter buffer also uses the RTP timestamp to synchronize the decoder's network clock with the video source to adjust the de-jitter buffer hold time.

In addition to the de-jitter packet buffer, you can specify the size (in milliseconds) of the decoder's low-level video data buffer. In contrast to the de-jitter buffer, this video input buffer always exists, even when error correction is disabled. It buffers out variations due to both network-induced jitter and operating-system jitter, to insure that the decoder never runs out of video or audio data, despite variations in CPU processing and packet arrival times.

5.3.2 ARQ: Automatic Retransmission Request

Automatic **R**etransmission Re**q**uest (ARQ) tries to recover any packets lost during transport to the decoder by adding a small amount of delay at the decoder during which time the decoder would have time to detect and request any missing packets. The size of this delay should also include adequate time for the missing packet to be received and inserted into the play out queue so that the video stream can continue to flow smoothly and unimpeded to the MPEG decoder.

To enable ARQ, you must first select ARQ transport from the `Profile` dialog. Also, ARQ transport must be enabled at the encoder. With ARQ selected and the decoder started, the decoder will watch for gaps in the RTP sequence numbers from the output of the jitter buffer. When it detects missing packets, it sends retransmission requests to the encoder so that the encoder can quickly resend any missing packets. Incoming retransmitted ARQ packets bypass the network de-jitter queue and find their correct place in the ARQ buffer, so that by the time packet are output by the ARQ buffer, the output of the ARQ buffer should no longer contain any missing packets.

ARQ has three parameters that can be configured in `manual` mode: `Round-Trip Time`, `Number Retries`, and `Burst-Drop` time. In `automatic` mode, the system automatically measures and calculates the `Round Trip Time` and `Number Retries`. Automatic mode only uses three parameters: `Target Latency` and `Burst-Drop` time and `Robust mode`. In most cases automatic mode and the default parameters should be adequate.

Of the required parameters, the first parameter, `Target Latency`, specifies the total delay, in milliseconds, allotted for the request, retransmission, and recovery process. The ARQ mechanism will attempt as many retries as possible within this target latency time. Thus, larger target latency times increase the delay before video is output, but allows for more chances of requesting and recovering any missing packets. However, automatic mode also sets an internal maximum limit based on its measurements that may be less than the target latency time.

The `Burst Drop` delay can be specified to delay any retransmission requests for a time equal to the maximum expected packet loss time, such as from dynamic router changes of other sources of burst loss.

`Robust Mode` can also be selected for `Auto` mode of operation. When selected (checked), a minimum of two tries will be attempted for recovering any missing packets. When not selected (unchecked), ARQ will always try at least once to recover any missing packets.

To help with firewall configuration and to handle potential port conflicts, the user can change the default port that ARQ uses to send upstream retransmission requests, `ARQ Port`. However, you must make certain that the same ARQ port number is set in both the encoder as in the decoder.

Although the automatic measurement of the round-trip time uses multiple measurements to take into account random network delays, for some networks you might wish to specify a larger round-trip value, or to specify a larger number of retries in case the upstream link loses some of the retransmission request messages. In automatic robust-mode of ARQ operation, the system automatically measures the round-trip time and divides that number into your specified Target

Latency to determine the number of retries to use. However in `Manual Mode`, you can force ARQ to always use a specified number or retransmission requests.

Note: *For testing ARQ error correction, select ARQ transport at both the encoder and decoder and use the default ARQ parameters at the decoder (receiver). Please also be certain that ARQ has also been selected at the encoder.*

6 Importing, Exporting, & Resetting Profiles

Under the **Encoder** and **Decoder** menu sections, you will find a **Backup** and a **Restore** menu. These operations provide a simple means for saving and restoring the encoder or decoder configuration or transferring the configuration of one QVidium QVCodec4K™ to another QVCodec4K ™.

To save all the encoder or decoder profiles, from the Web browser interface click **Backup** from under the **Encode** or **Decode** menu, as desired, enter a name for the backup, and click **Backup**. The encoder backup file will have the suffix, epbk. The decoder backup file will have the suffix, dpbk. To configure another codec with the same parameters, just point the browser to the second QVCodec4K that you want to configure.

You can then click on **Restore** and browse for the backup file that had previously been created. You should then see all of the encoder or decoder profiles restored, with all of their previously saved settings. Please note that the **Restore** operation will overwrite any profiles that make have been later added with the same name as an earlier profile and rewrite any changed settings for those profiles. However, this operation will not affect any additional profiles that you may have created since that previous backup.

You may find it useful to use a USB flash memory stick to store these configuration profiles. All configurations a stored as Unix text files. If you have a text editor such as Notepad++, which has a Unix editing mode, you have the option of editing an encoder configuration profile manually. All parameters are stored in JSON format.

Clicking on **Profile** under the **Encoder** or **Decoder** menu, and then clicking on **New** will create a new profile with all of the default settings. If you are having problems with a particular profile, it is often helpful to try creating a new profile that uses all the default settings, and to only make required changes, such as the IP Transport mode, the UDP port, and for the encoder, the destination address. Try then saving this default profile without changing any other settings and see whether that helps to get a working configuration.

7 Codec Manager & System Resets

7.1 Codec Manager

QVidium supplies an application we call **CodecManager™** as a free download for its customers under the **Downloads** section of the QVidium web site at http://www.qvidium.com. **CodecManager** will detect any QVidium® Video Codecs, Encoders, and Decoders connected through Layer-2 switches over the local-area network. At launch, **CodecManager** sends a Layer-2 MAC broadcast to which the QVidium products respond with their MAC address, IP Address, and name. From this application, you can double-click on a Codec to launch a browser window to that Codec. In addition, CodecManager makes it simple to change the IP Address, launch a Telnet window, or edit other settings of any Codec it detects directly from the **CodecManager** application, even if several codecs are mis-configured with the same IP address. You can also instantly stop all codecs by the simple click of a button.

We encourage you to download and use the **CodecManager** application to manage your QVidium products, since it is easier, more convenient, and less intrusive than resetting the Codec through the console.

Note: CodesManager may not work when the Ethernet cable is connected directly between the PC and the QVidium product, as it requires connection through a switch to multicast the identification packets. Also, you may need to disable network adapters other than the Ethernet network adapter, such as any WiFi adapters.

7.2 Resetting the Network Parameters

If you cannot determine the IP address using **CodecManager**, you can connect to the internal Linux command console through the USB Console port with a USB cable having a Micro-B USB2 connector on one end for the Console Port on the QVCodec4K, and a USB2 Type-A connector for connecting to a PC.

After connecting the QVCodec4K to a PC and starting the Terminal emulator program, you should see that two new serial ports have become available to select. We recommend using **TeraTerm** for the terminal emulator, but other software such as **Putty** or **Hyperterm** also work. Try selecting the first of the two serial ports and set the serial configuration to 115,200 Baud, 8 data bits, 1 stop bit, and no flow control, then click "<enter>". If you do not see a prompt or any legible text, then try selecting the second of the two serial ports. You can also try power cycling the QVCodec4K with the USB console port connected to the PC runnign the terminal emulator to see that there is the startup text when the unit boots.

If you do not see any text on either of the two virtual USB serial ports immediately after power-cycling the QVCodec4K, then please e-mail QVidium at **support@qvidium.com** to troubleshoot.

Once you see a prompt, type "**ifconfig eth0**<enter>" to find the IP address. It will be listed as "**inet addr**". To find the serial number, type "**qvc4k_read_sn.py**<enter>".

7.3 Resetting the System Configuration

To reset all of the system settings and configuration to the Factory Defaults, First log into the USB Console as per **Section 1.3**. Then type, "**clean4k**<enter>". Lastly, reboot the system by typing: "**sync;reboot**<enter>". Your system will reboot as it was when first shipped from QVidium.

7.4 Resetting the Password

If you lose the root password and cannot gain access to your codec, you can log into the QVCodec4K via the USB console port with a terminal emulator program, as described in **Section 1.3** under the paragraph heading, "**USB Console Port**". At the login prompt, you can log in as "qvidium" with the password, "qvidium". SSH and Telnet are disabled by default, so you must have physical access to the unit to log in as root. Once you have logged in, type "**resetpasswd**" (note the spelling). This will reset the password for the web interface (with username admin) to the serial number found on the bar code label on the bottom of the unit.

7.5 Re-installing the Application Software

If for some reason the QVCodec4K™ codec becomes completely unresponsive, or you suspect that as a result of a failed update procedure the application memory had somehow become corrupted, you can completely reinstall the application software with the following procedure. The Linux Kernel is loaded into a separate area of memory and is unlikely to become corrupted, so if the system does not respond to this procedure, you may have a hardware problem and you should consult a QVidium technical expert.

NOTE: for this procedure, your QVCodec4K must have access to the Internet.

Complete Reload Procedure:
(NOTE: <enter> denotes pressing the Enter or Return key on your keyboard.)

1) Connect to the USB console as per **Section 1.3** and log in as user, "**root**" (password: "qvidium")
2) Type: "**sync;reboot**<enter>".
3) Hit any character during the countdown to stop the boot process.
4) Type, "**service=true**<enter>", then type, "**boot**<enter>".
5) Once the system completes booting, type:

"wget https://qvidium.tv/rootfs/qvcodec4k/2020.1/install_all<enter>"
"sh install_all clean<enter>"

6) After the system installation completes, type, "**sync;reboot**<enter>".

The system will reboot, installing more software during the process. When it completes, your system will be ready to use.

NOTE: This process will save and retain any licenses and basic system settings.
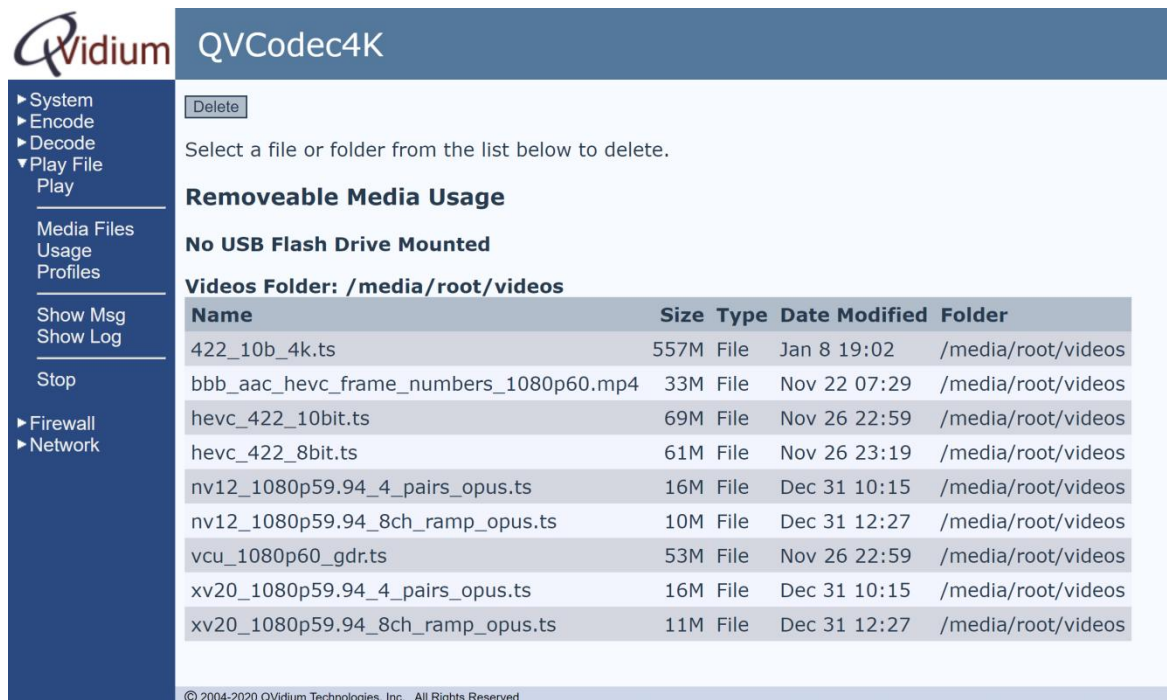
8 Encoding & Decoding to/from Files

The QVCodec4K each have two USB interfaces that allow you to connect a USB Flash stick or an external disk drive. You can encode a video stream directly to a file on this storage device with the QVCodec4K and you can also play back a saved file from this external storage device with a QVCodec4K. You can access external storage via either the web interface or a command-line interface. You can access external storage via the command-line interface in one of two ways: 1) through the USB Console port (115.2 KBaud, 8-N-1, No Flow Control, Null Modem cable) or 2) SSH (port 22).

8.1 Web Interface.

8.1.1 Playback: The File Menu Interface

Once you have content recorded on a mounted memory device, playing out video clips is simple, and accomplished through the **File** menu interface. Available commands are: **File**, to list, and optionally delete, the files in the memory; **Usage**, to show how much of the memory has been used and how much is still available; **Play**, to bring up the interface to play a video clip, **Status**, to show the current status of the play-back (this is the same as Decoder Status); **Show Log**, to show the log file in case of problems; and **Stop Play**, to stop play back of a video clip. Figure 7, below, shows and example of the **Files**, **Usage**, and **Play** menus. The **Files** menu lists all the files on the drive, including files that do not contain video content. You can also delete files to make room for new ones. While recording, the **Usage** menu can help you determine how much space remains.

To play a video clip, simply click on **File/Play**, then select the file you want to play by clicking once on it. Next select the output resolution you desire, and click the **Play** button above the list of files. MPEG files must have a ".ts" suffix. If the file has another suffix, but contains valid a MPEG TS content, then you will need to change the suffix to end in ".ts".

*Figure 7: Screen shots from **Files**, **Usage**, and **Play** menus.*

8.2   Command-Line Interface

8.2.1   Mounting and Un-mounting an External Storage Device

When you connect a NTFS or FAT formatted external storage device to the USB interface, the embedded Linux 2.6 Operating System will automatically mount the file system. (If you wish to connect a Linux formatted Filesystem, such as ext2 or ext3, you will have to manually mount the

file system.) The initial mount point is `/media/sda1`. From the command-line interface, first type "`cd /media/sda1`" then use "`ls`" for a listing of the files on the storage device.

However, if you wish to remove a mounted storage device, you must first unmount it. To unmount the disk or storage device, you must first stop any programs that are accessing the device, then you must `cd` away from the mounted directory, such as "`cd /`". You can then issue the unmount command: "`umount /media/sda1`". After this command successfully completes, you can safely remove the external storage device and, if desired, insert another storage device. As long as you first unmount the old storage device, the next storage device will be mounted as `/media/sda1`. If you do not unmount the storage device, or mount a second storage device, the second device will mount at location `/media/sdb1`. Currently, there us a limit of only 2 different mount points, `sda1` and `sdb1`. Additional partitions on a given storage device will auto-mount as `/media/sdaX` or `/media/sdbY`, where X and Y are partition numbers starting with 2, and incrementing up to the number of partitions on that storage device.
.

8.2.2 Playing Video From a File

To decode and play out a stored file, `cd` to the external media directory (such as `cd /media/sda1`) and type:

```
/qvidium/qvplayer <filename>
```

Where <filename> is the file name referenced to the current directory. For example, if the file on a USB Flash stick is called test.mp4, then use `test.mp4` as the filename:

```
/qvidium/qvplayer /media/sda1/test.mp4
```

The decoder knows to automatically set the format type, the resolution, the bit rate, and all other relevant encoding parameters.

9 Built-in Firewall

QVidium offers firewall software for the QVCodec4K codec product. This firewall is based on a "white list" of allowed IP addresses and IP address ranges that you specify and add to a list. You can individually enable and/or disable any particular entry in the list by clicking on the checkbox before the entry in the list and then clicking on the **Change Firewall Configuration** button at the bottom of the page. By default, QVidium has included its own addresses to allow remote QVidium access from the **Technical Support Access** setting. You can disable this access if you wish by changing the setting to **No**. When enabled, this internal firewall will block all access from any from any device with an IP address not on this list.

To enable the firewall, simply click **Yes** on the first setting called "**Firewall**" and then clicking on the **Change Firewall Configuration** button at the bottom of the page.

WARNING: Before enabling the firewall, please make certain that your IP address is in the list so that you will continue to have access to the device. If your device is remotely accessing your QVidium codec, you can determine its external IP address to add to the **white list** by going to the URL: http://www.ipchicken.com, Also, you must specifically allow access to the IP address(es) of any other QVidium device(s) you are sending to or receiving data from. If, for example, you fail to add the IP address for your decoder from your encoder, then ARQ will be blocked from functioning.

To specify a range of addresses, you can use the notation: XXX.XXX.XXX.XXX/YY, where XXX.XXX.XXX.XXX is the IPv4 IP address of the device to which you want to grant access, and YY is a number from 1 to 32 that tells the firewall software how many of the most-significant-bits (MSBs) in the IP address you specify to pay attention to. In other words, The value 32-YY is the number of least0significant-bits in the IP address that can be set to any value and still gain access. For example, to set a range of addresses in a small subnet of addresses from 202.91.33.32 to 202.91.33.47, you would add 202.91.33.32/28 to this list. Since 32-28 = 4, this tells the firewall that any combination of 1's and 0's in the last 4 bits of the IP address you specified will be granted access. In this case, it would be a total of 2^4 = **16** addresses.

For further information, please see the instructions on the Firewall page mentioned above.

10   T Troubleshooting & Support

The QVCodec4K ™ includes a number of features to aid in system security and logging.

10.1 Troubleshooting – Common Problems

In general, if you are having trouble getting video from the encoder to the decoder, follow the following procedure:

1. Check the **Encoder/Status** page for a valid bit rate to make certain that the encoder is running - if not please check the video input, or for SDI input check the Diagnostics page, or click on Show Log and e-mail the log output to us at info@qvidium.com along with your phone number or Skype ID so that we can contact you.
2. Delete your current profiles and start with the Default settings on the encoder and decoder and avoid changing any Advanced Settings.
3. Restart the encoder using the default settings (only changing the bit rate, video input, and destination IP address. If still no input, then please check the **Encoder/Show Msg** page for errors. Remember, if using SDI without embedded audio, you must change the **Audio Channels** setting to "0".
4. Try sending a copy of the encoder stream to a local PC running VLC (on a local area network, not over the Internet). NOTE: If GDR is enabled, you must start VLC before starting the encoder for VLC to work with GDR.
5. If you can receive the stream over your LAN using VLC, but the **Decoder/Status** page shows **No Data**, then you likely have a firewall before the decoder blocking the traffic. You must add a Port Forwarding rule on the decoder-side firewall to allow UDP traffic on port 10000 (or whatever UDP port you had set on the encoder).

If this does not help, or for other problems, please see below:

No response from web browser or cannot ping system

1. Make certain that device is powered on and connected to your network.

2. Check that green LAN light in front is lit and link light at RJ-45 port is on.

3. Make certain that device is on the same subnet as the computer you plan to connect to. (Either use a cross-over Ethernet cable to connect directly to the computer or connect through the same switch as your computer.)

4. Use QVidium's **CodecManager** application to find IP address of system and to confirm that Codec is online. You can download **CodecManager** from QVidium's Download page (http://www.qvidium.com/), click on **Downloads**, and scroll down to the **QVidium Codec Management Software** section. Download and install the file: QVidiumCodecManager-X.msi (X is the current version number). If that fails to locate your Codec, then try the other LAN port. If still not seeing the code, then continue to step 5.

   NOTE: CodecManager requires that any intermediate switches or other network equipment between your PC and the QVCodec4K Codec must pass Ethernet Broadcast packets. (If not, then you can try using a cross-over Ethernet cable and connecting the QVCodec4K codec directly to the PC. If **CodecManager** still does not appear to find the QVCodec4K-Codec, even after selecting the correct Network Interface (if not grayed out)

and clicking on the Discover button, and you are certain that the switch passes Ethernet broadcast packets, then try the other LAN port. By default, the QVCodec4K codec will output broadcast Ethernet packets back to CodecManager on LAN1. However, these multicast discover packets may go out on LAN2 if selected as the multicast interface.

5. Open a shell window (On Windows™ select "Start/Run…" and type "cmd").

6. Clear the ARP cache by typing "arp –d" and hit Enter.

7. Try pinging the system by typing "ping 192.168.1.23".

8. If all else fails, you can reset the network settings by going to: http://www.qvidium.com/reset. Then copy the file "autorun" to a USB flash stick, and plugging it into your codec. The **autorun** file must be saved directly, not first converted to a text file. It should not be saved as "autorun.txt". On Internet Explorer, use the **Save Target As…** command and select **All Files** for the File Type. Then, plug the flash stick into the QVCodec4K. It will then reset all the network settings back to the defaults (192.168.1.23).

Cannot Receive Encoded IP Packet Stream at Decoder

1. On the encoder, check that is is powered-on, and check the **Encoder/Status** page to make certain that the encoder bit rate is non-zero. It the bit rate is zero, then go to the next step to get a valid output packet stream.

2. Make certain that decoder is powered on and connected to your network.

3. Check that the LAN link-light and activity lights for the RJ-45 Ethernet port on both encoder, decoder, and switch(s) are lit.

4. Make certain that you have entered the correct IP address for the destination (under Encoder/Profile) and the correct gateway (under Network/Configure) if the receiver is on another subnet.

5. Try pinging the destination IP address for the decoder from the encoder clicking on Network/Ping and entering the IP address for the decoder device.

6. If you cannot ping the decoder from the encoder, then your stream may be blocked by a firewall at the decoder side. If necessary, add a Network Address Translation (NAT) rule to the decoder-side firewall to port-forward incoming packets from the UDP port you set on the encoder to be forwarded to the decoder.

Encoder does not start or is not outputting any packets

1. Check that a valid video signal is connected to the video **Input** you have configured. Use the Encoder/Profile page to select the video input that you have connected and wish to use. The SDI input will auto-sense and select among SD-SDI, HD-SDI, and 3G-SDI signals. Make certain that you **Saved** the profile and **afterwards** hit the **Start** menu item.

2. If the bit rate is zero, then check for a valid video input.

3. If you have a valid video input, then check **Encoder/Show Log** to see whether there are any errors.

4. If the log says "**Video not LOCKED: waiting for valid input"**, then check whether there is embedded audio on the SDI or HDMI feed. At present, the codec requires an embedded audio signal to lock onto before it can start encoding.

5. If you are trying to encode interlaced video, such as 1080i, make certain that the **Video Encoding** is set to **HEVC**. (The QVCodec4K does not support H.264 encoding for interlaced video.)

6. If you are getting error messages in the log such as `Command Timed Out`, then check whether you have a valid embedded audio signal on the SDI input. If not, then set the number of **Advanced Channels** to "0".

Cannot get decoder to display video

1. Use network monitor software on look for blinking link lights to be certain that the encoder is sending packets to your decoder. If not, follow the steps for "Cannot get encoder to send IP packets". .

2. Make certain that device is powered on and connected to your network.

3. Check that green LAN light in front is lit and link light at RJ-45 port is on.

4. Try pinging the encoder by entering the IP address for the source device. For a H.264 HD Video Codec™, try clicking on "Network/Ping".

5. Make certain that both encoder and decoder are set to the same transport type (ARQ, RTP, or UDP). For a Set-Top Box, such as an Amino, make certain that the encoder is set to Transport & UDP.

6. Make certain that the encoder is not sending CIF or SIF resolution. The decoder can only decode "FULL" or HD resolutions. The decoder cannot scale the incoming video resolution.

Color loss on decoded video

a. Network losses or other interruptions that can cause breaks in the input video stream may cause the decoder to lose sync and get into a state where it cannot decode color, resulting in a complete loss of color on the decoded video output.

b. To help increase the tolerance of the decoder to these issues, try increasing the Video Buffer Size to a minimum of 500 ms, or increasing it up to 1000 ms.

c. Enable "Detect Video Break" so that the decoder will restart when it detects a break in the packet stream to help prevent the decoder from getting into a bad state.

Audio pauses, clicks, or gaps or video freezes during decoding

• Excessive network jitter, such as on satellite, long-distance Internet, or 3G wireless links, can result in pauses or short gaps or clicks in the audio output. To fix this, increase the size of the decoder's **Video Input Buffer Size** to buffer out any excessive jitter on the video input stream.

Audio distortion

• A *tinny* or metallic quality to the audio or a distortion that seems to appear only during periods of relatively louder audio passages can be the result of clipping of the input audio signal. This occurs when the input audio signal level exceeds the voltage level limits of the audio input circuitry. To fix this problem, increase the audio attenuation in the Volume control on the Encoder when the encoder is running, until the distortion is gone.

Other problems with encoding and decoding video

1. First eliminate any network problems by connecting the encoder and decoder to the same Ethernet switch. Use CodecManager, running on a PC also connected to that switch, to verify that the IP and MAC addresses are all different.

2. Click on Defaults on the Encode and Decode sides to reset all your profile settings to their factory default values.

3. Verify that the Destination IP address and port specified on the encoder match their configured values on the decoder. For unicast, leave the "multicast address" blank on the decoder. For Multicast, make certain that you have specified the same multicast address on the decoder as well as on the encoder. If multicasting through a router, make certain that the router supports IGMP v3 and that it is enabled.

10.2 Support

For specific technical help, we kindly ask that you first contact the reseller or distributor from whom you purchased your QVidium product. If you still require further assistance, or you purchased your product directly from QVidium, please contact QVidium Technologies, Inc. by either phone or e-mail at:

Phone: (858) 792-6407
Phone Support Hours: Monday - Friday 9:00 am to 5:00 pm PST

E-mail: support@qvidium.com
E-mail response time: within 24-hours

Technical support is limited to the basic functionality found in the Web user interface and to standard network applications. For example, we cannot provide detailed command-line support unless the user has sufficient experience and knowledge of Unix or the Linux operating system. For Broadband Wireless networking applications, because of the inherent low bit rate constraints, bit rate and link variability, and complexities of found in Broadband Wireless networks, we cannot directly provide support for applications over Broadband Wireless Networks. In these cases, we would be glad to refer you to one of our vertical marketing and system integration partners for help with your specific application.

11   **Appendices**

11.1 Appendix A: Encoder Configuration Parameters

This section explains the parameters related to the analog input signals and encoding settings and how they relate to the operation of the encoder and error correction and network transport setup.

Video Encoding Bit Rate: Total peak stream bit rate for Variable Bit Rate (VBR) video encoding. The resulting transport stream bit rate is the sum of the bit rates of the video program, audio program and program stream information. The video bit rate is specified in bits per second and can range from 128 Kbps for CIF resolution to 19 Mbps for 720x480 (NTSC) or 720x576 (PAL) standard definition resolutions, or can range from 4 Mbps to 19 Mbps for high definition video resolutions. The higher the bit rate, the better the video quality.

Audio Bit Rate (compressed): The audio bit rate determines encoding audio quality and allows you to trade off audio throughput for quality. The audio bit rate can be set to one of 64,000, 128,000, 192,000, 256,000 or 384,000 bits per second. Increasing the audio bit rate, up to a maximum value of 384 Kbps increases the audio fidelity. Regardless of the audio signal level on either channel, selecting an audio bit rate of 64 Kbps or higher will always force the encoder to send 2 channels of audio (stereo audio). Each audio channel uses one-half of the selected audio bit rate. The H.264 HD Video Codec™ encodes audio using either MPEG-1 Layer II encoding, MPEG2 AAC, or MPEG4 AAC audio encoding.

For minimizing the audio bit rate, we provide the option of setting the number of audio channels to 1 and the audio bit rate to 16 Kbps or 32 Kbps. Do not use an audio bit rate less than 64 Kbps unless you set the number of audio channels to 1. Even then, setting the number of audio channels to 1 has the potential to cause unexpected halting of the encoder. So, please be aware that this option may impact the reliability of the encoder.

Audio Sampling Rate (Hz): The audio sampling rate specifies the clock rate for capturing and digitizing the incoming analog audio signal. Because of anti-aliasing filtering, the maximum audio frequency that can be digitized is limited to a frequency of about 1/3 to 1/2 of the audio sampling rate. Internal anti-aliasing filters severely attenuate audio signals above a frequency of about 1/3 of the sampling rate. Thus, for a standard music CD rate of 44.1 KHz, the maximum audio frequency that the encoder can pass is about 14.7 KHz. The valid selectable audio sampling clock rates are 32 KHz, 44.1 KHz, and 48 KHz.

SDI formatting requires that the audio sampling rate be fixed at 48 KHz, so the current user interface disables setting this value.

(SD Only) Video Frame Rate (Full Frame Rate and fractions thereof): Select Full Frame Rate for normal video. This will encode the video signal at 29.97 frames per second for NTSC and 25 fps for PAL video format. If you need to produce lower video bit rates, and reducing the resolution is not sufficient or undesired, you can use this feature to sacrifice frame rate for lower bit rates.

Video Encoding: The H.264 HD Video Codec™ converts a digital SDI or HDMI video input signal according to the ITU-R.BT-656 standard, performs a 4:2:2 to 4:2:0 conversion and compresses the digitized video using either the MPEG-2 video encoding standard (MP@ML, ISO/IEC-13818-2) or MPEG4-AVC (H.264) high profile compression, depending upon your selection.

We suggest that you select H.264 compression. The QVCodec4K codec incorporates High Profile, Level 4.0 to 4.1 MPEG4-AVC (part 10) video encoding. This nearly always produces better video than MPEG-2 video encoding. However, we provide the option to select MPEG-2 video encoding for backward compatibility with other devices.

Video Format: *The QVCodec4K Codec automatically senses and selects the correct video input format (NTSC or PAL along with the correct resolution). NTSC captures interlaced video at 29.97 frames per second, while PAL captures interlaced video at 25 frames per second. Thus, Video Format is not listed in the user interface.*

(SD Only) Video Resolution (NTSC and PAL): *The video resolution for Standard Definition video (D-1 resolution) is 720x480 pixels for NTSC resolution (480i) and 720x576 pixels for PAL video format (576i). This is the resolution commonly used for DVDs and Standard Definition broadcasting. When you need to encode the video at lower bit rates, the H.264 HD Video Codec™ allows you to select lower CIF resolution (352x240 for NTSC and 352x288 for PAL).*

Video Aspect Ratio (4:3 or 16:9): *Standard Definition NTSC video has a 4:3 aspect ratio. This is the default setting. However, many new HD Camcorders and video mixing equipment can output a 16:9 SD video feed by squeezing the image to a 4:3 aspect ratio before outputting. Setting the Aspect Ratio to 16:9 in the encoder sets bits in the MPEG elementary stream that tell an MPEG decoder to stretch the incoming video stream back to a 16:9 aspect ratio. This option does not actually change the encoding resolution. Rather, it only tells the decoder to stretch the output video to match the original 16:9 aspect ratio.*

Video Input: *This allows you to select between SDI and HDMI video inputs. The QVCodec4K H.264 HD Video Codec™ requires embedded digital audio from the SDI and HDMI inputs when you select the SDI or HDMI video input.*

Closed Captioning / TeleText: *This switch enables the encoder to capture and pass through VBI Close Captioning or TeleText (depending upon whether it senses NTSC or PAL video input, respectively). This feature is not yet supported, but planned for a future firmware release.*

Low Delay: *This mode minimizes internal buffering to reduce the end-to-end delay (encoder to decoder) to less than 300 ms. (To be supported in a future firmware release.)*

Video Filtering: *You can select this feature to add a special filter to the input video that helps reduce noise and thereby improve compression efficiency as well as clean up the picture.*

Network Parameters

The fields below relate to Ethernet/IP video transport settings.

IP Transport: *This selects the type of video IP packet encapsulation and error correction used by the codec in generating a Video/IP stream. All packetized video transport mechanisms encapsulate a multiplexed variable bit rate MPEG-2 transport stream.*

- *ARQ uses QVidium's patented error correction mechanism based on a time-constrained selective packet retransmission algorithm, in place of FEC. It also encapsulates the video as per COP3.2 (without the FEC) and RFC 2733. However it relies upon an upstream channel on UDP port 7020.*
- *RTP disables all error correction mechanisms, but still encapsulates the MPEG-2 multiplexed data according to RFC2733.*

- *UDP is similar to the RTP transport above, but does not add the RTP header to the UDP packets. Instead it simply encapsulates the MPEG-2 transport stream data directly into the UDP/IP packet payload.*

Destination IP Address or Hostname: *This specifies the IP address or Hostname for the Video/IP stream.*

UDP Port: *This specifies the UDP port number (P), base 10, for the Video/IP stream.*

TS packets per IP packet: *This field allows specification of the number of 188-byte MPEG-2 Transport Stream packets per IP packet. The standard MTU for Ethernet packets permits a maximum of 7 TS packets per IP packets, which is the default.*

ARQ

The parameters below ONLY pertain to ARQ error correction. They will be ignored when ARQ IP Transport is not selected.

ARQ Port: *By default, ARQ normally sends upstream retransmission request packets on UDP port 7020. You can change this ARQ Port setting to any valid and non-conflicting UDP port. However, you must make certain that you specify the same port number at both the encoder and the decoder.*

11.2 Appendix B: Decoder Configuration Parameters

This section explains the parameters related to the setup and operation of the MPEG Decoder, the error correction algorithms, and network transport configuration.

Input & Output Parameters

Input: *On the QVCodec4K and QVCodec4K-LITE, you can choose either* "Network" *or* "ASI" *as the input source. Network selects the Ethernet port as the decoder input. ASI listens for an DVB-ASI stream on the SDI BNC connector.* **Warning:** *Detect Video Break only works for Network input. If you use ASI input, then the decoder may get into a bad state if there is an interruption in the input stream.*

Network Parameters

The fields below relate to Ethernet/IP video transport settings.

IP Transport: *This selects the type of video IP packet decapsulation and error correction expected by the codec in receiving a Video/IP stream. All packetized video transport mechanisms expect to receive a multiplexed constant or variable bit rate MPEG-2 transport stream to decapsulate and decode.*

- *ARQ uses QVidium's patented error correction mechanism for lost packet recovery. ARQ encapsulates the video stream as a standard MPEG-2 Transport Stream as the payload of UDP packets with an RTP packet header as per RFC2733. It relies upon an upstream channel on UDP port 7020.*
- *RTP mode decapsulates the MPEG-2 multiplexed data according to RFC2733. It will process the data through the de-jitter buffer (if set to a non-zero value) and the reorder buffer (also if set to a non-zero value), but will not send out ARQ retransmission requests. Because RTP headers include a timestamp and sequence numbing, RTP protocol has the advantage of providing lost packet and other network statistics.*
- *UDP mode disables all error correction. It expects raw UDP packets without an RTP header, and expects to receive an MPEG-2 transport stream directly from the UDP payload. Use this setting for interoperability with some Set-Top Boxes.*

Multicast Address: *This specifies the IP multicast address, if any, to listen to for the Video/IP stream.* **For receiving a unicast video/IP stream, leave this field blank.**

UDP Port: *This specifies which UDP port number (P), base 10, to listen on for the Video/IP stream. Be certain to open also your firewall to port P+2 and P+4 for ProMPEG FEC. (P+2 for column parity and P+4 for row parity packets.)*

Jitter Buffer: *The IP packets of incoming video streams may lose their ordering or suffer variable delays during transport through an IP network. If the value of the Jitter Buffer is non-zero, the QVidium QVCodec4K H.264IP Codec will process all incoming video/IP packets through a time-based buffer that removes variations in packet arrival times, also known as packet jitter, and reorders RTP encapsulated packets by their RTP sequence number. The Jitter Buffer parameter specifies the size of this incoming packet buffer in milliseconds of delay, and holds incoming packets for this amount of time before releasing them. You can specify zero (0) here to disable this additional buffering when latency needs to be minimized. This buffer can only exist in ARQ and RTP modes.*

Video Buffer Size: This value, specified in milliseconds, adjusts a buffer in the video decoder that helps prevent the decoder from running out of data and losing sync due to jitter or variability in the delivery of data to the decoder. If you notice audio clicks or pauses, or if the decoded video occasionally freezes or loses lip-sync, especially over long network distances, increasing this value may help. The default value should be 300ms, but for operation over a WAN, we would suggest increasing this value to 500ms or larger. Increasing this value will increase overall latency, so you should minimize this value to minimize latency.

Out-of-Order buffer: When in ARQ mode, the decoder includes an optional additional buffer, in addition to the Jitter Buffer, that reorders incoming packets in case the network is causing some of the packets in the incoming video stream to arrive out of order. This buffer will re-order any packets within it to be output in the order of the RTP sequence number. To enable this feature, you must specify a buffer size in terms of the number of packets this buffer must hold until any packets are output to the decoder. This feature is most useful if you choose to use Network Bonding on the decoder which causes the outgoing video stream to be interleaved between the two Ethernet ports. In this case, varying network delays may cause packets to arrive out of sequence, which this feature helps to fix.

Detect video break: This feature only works for Network input. It monitors the PCR timestamps in the incoming MPEG2 Transport Stream for discontinuities and unexpected values and then automatically restarts the decoder when it detects a problem.

Detect video break limit: This parameter lets you set the minimum discontinuity time-out of between 100ms and 2000ms (2 seconds). If the decoder detects a break in the incoming IP stream larger than this value, then it will restart the decoder to prevent the decoder from getting into a bad state.

ARQ Parameters

The parameters below ONLY pertain to QVidium ARQ error correction. They will be ignored unless ARQ is selected for IP Transport.

Mode: Auto *or* Manual. *In "*Auto*" mode, immediately after clicking on* Start*, the decoder sends out a series of packets upstream to the encoder to measure the round-trip time and automatically set the number of retries and round-trip time parameters based on the* Target Latency *parameter. The results of these measurements can be seen in the decoder's log file by clicking on* Show Log *and scrolling towards the bottom of the log file. Clicking on Status will show the resulting value of these parameter based on the measurements seen in the log file.*

 *In "*Manual*" mode, the codec uses the Number Retries and Round Trip Time parameters to create an ARQ buffer with the ARQ delay = Number Retries * Round Trip Time. In Manual mode, the decoder's ARQ mechanism ignores the Target Latency parameter and does not take any upstream link measurements.*

Target Latency: QVidium's ARQ error correction operates through the addition of a small additional buffering delay to provide enough time to request and receive replacement for each lost packet. Target Latency gives the ARQ mechanism a target value for determining the necessary ARQ delay. The ARQ divides the Target Latency, specified in milliseconds, by the round-trip time to the video encoding source to determine the number of request attempts. Unless Robust Mode is enabled, it sets a minimum ARQ latency of one round-trip time. A larger Target Latency allows the system to increase the number or repeat requests, although the system will limit the maximum number of retries to a maximum of 5, even if the Target Latency value would have otherwise allowed more retries. Thus depending upon the Round-Trip time, the maximum delay may end up being less than the specified Target Latency value.

Max Burst Drop: *Burst packet losses are common occurrences in many IP networks and the Internet. IP networks may dynamically change paths in response to load balancing, link failure avoidance, and for other reasons. During a re-route, a sequence of queued packets on a discontinued path may be dropped. A burst of packets may be dropped when higher priority packets stall a lower priority buffer. ARQ will notice a burst packet loss when the first packet after the loss arrives at the codec. Setting the Max Burst Drop Delay (in milliseconds) will delay the ARQ repeat request by this amount to handle packet burst losses.*

Robust Mode: *Normally, the ARQ will only require that a minimum of one repeat request is sent to the video encoding source device, regardless of the Target Latency. However, enabling Robust Mode will increase the minimum number of repeat requests to a minimum of two retries.*

ARQ Port: *By default, ARQ normally sends upstream retransmission request packets on UDP port 7020. You can change this ARQ Port setting to any valid and non-conflicting UDP port. However, you must make certain that you specify the same port number at both the encoder and the decoder.*

11.3 Appendix C: H.264 HD Video Codec™ Bit Rate Limits

Encode Bit Rate Limits:

The video encoding bit rate limits specified below are subjective suggestions based on limited empirical testing. The QVCodec4K codec will allow you to enter any video stream bit rate from 500 Kbps to 120 Mbps, and will attempt to produce the best video quality it can, based on the video bit rate you set. The encoder outputs the stream as a Capped Variable Bit Rate (VBR) stream, meaning that it uses the value you specify as an upper limit on the peak bit rate. Unless noted otherwise, all bit rates below assume full NTSC (59.94 fps) or PAL frame rates (50 fps). Please keep in mind that the encoder will only use the bit rate necessary to render the video content you are feeding it. ***The encoder may never reach this maximum bit rate.*** Therefore, we have provided the values here are only as a general guideline to help with estimating the expected network loading:

Maximum Video Encoding Stream Bit Rates: 120 Mbps (See text above.)

Minimum Suggested Stream Bit Rates for general content, such as movies:
(assumes audio bit rate of 160 Kbps)

> *H.265 /HEVC (GDR-enabled):*
> - 12 Mbps for 2160p video resolution
> - 6 Mbps for 1080p video resolution
> - 4 Mbps for 1080i video resolution
> - 2 Mbps for 720p video resolution

Note: Video quality is subjective and content dependent. The minimum bit rates suggested above may not produce acceptable video for any given application. As a general rule we suggest that you use HEVC (H.265) encoding with GDR (Gradual Decoder Refresh) enabled for the best streaming video quality, and adjust the bit rate based on your own observations to suit your needs.

Decode Bit Rate Limits

Bit rate limits related to receiving MPEG Transport Stream video from the network:

Maximum MPEG TS bit rates: 120 Mbps

Minimum MPEG TS bit rates: 500 Kbps

11.4 Appendix D: Hints for Minimizing Bit Rates

Audio Notes

To minimize wasted audio overhead and minimize audio bit rates, you should set one of the following:

1. Set the Audio bit rate to 56 Kbps and the Sample Rate to 48 KHz. Encoding MUST be AAC (results in 63 Kbps); or
2. Set the Audio bit rate to 64 Kbps and the Sample Rate to 32 KHz. Any audio encoding (results in 84 Kbps)

At low bit rates, we have found that MPEG1/Layer2 Audio Encoding sounds best.
(Note: setting MPEG1/Layer2 to 56 Kbps results in a total of 126 Kbps audio overhead.)

Low-Bit Rate Encoder Settings

On the Encoder menu:

1. Click on "Default" to reset the Encoder Profile.
2. Then set the following:

   On basic tab:
   Video Bit Rate: 500
   Video Encoding: H265 (GDR-enabled)
   Audio Bit Rate: 64000
   Audio Encoding: MPEG1/Layer2
   Audio Sampling Rate: 48000

11.5 Appendix E: Technical Specifications

Below is a summary of the specifications common to the QVENC, QVDEC, and QVCodec4K, meant as a general guide only. For the must up-to-date and more complete specs, please see the datasheet for the relevant model QVidium product at http://www.qvidium.com.

For video input and encoding, the specs are only relevant to the QVCodec4K and QVENC.
For video output and decoding, the specs are only relevant to the QVCodec4K and QVDEC.

Specifications

Network Interface:
- IEEE 802.3 1000/100/10 Base-TX Gigabit Ethernet (RJ-45 port)
- IEEE 802.3 1000/100/10 Base-TX Gigabit Ethernet (SFP port)

IP Network Stream Conditioning & Error Correction (EC):
- QVidium patented ARQ error correction
- SRT
- RIST (Simple and Main Profiles)

Network Protocols:
- IP Encapsulation: RTP/UDP/IP and UDP/IP
- UDT (UDP-based Data Transfer Protocol used for SRT)
- IGMP v.3 Multicast
- RTSP, RTMP/RTMPS, and HLS
- DHCP client

Encryption:
- AES-128
- AES-192
- AES-256

Video Interfaces:
- 1x 12G-SDI (compatible with SD-SDI / HD-SDI / 3G-SDI) video input / output BNC connector ((SMPTE 259M/292M/425M)
- 1x 12G-SDI (compatible with SD-SDI / HD-SDI / 3G-SDI) video input / output SFP connector ((SMPTE 259M/292M/425M

Transport Stream Bit Rate (Audio/Video):
- 500 Kbps to 120 Mbps (encoding UDP/IP output for IP Transport mode)

Audio:
- Opus (Google) audio encoding
- AAC-LC audio encoding
- Stereo bit rates: 56, 64, 128, 192, 256 & 384 Kbps
- Sampling: 48 KHz
- SMPTE 272M-ABC SDI 4-stereo pairs & 7.1 Surround-Sound (8-channel) Audio

Video:
- 4:2:2/4:2:0 HEVC (H.265) UHD encoding, Level 5.2
- 4:2:2/4:2:0 8-bit & 10-bit H.264/MPEG-4 AVC High Profile (Advanced Video Coding, Part 10), Level 5.1
- UHD/HD SDI Input/Output: 3840x2160,1920x1080, & 1280x720 @ 60 or 50 fps
- UHD/HD encoding/decoding: 3840x2160, 1920x1080, & 1280x720 @ 50 or 60 fps progressive
- Encode VANC Closed Captioning (CEA-608 and CEA-708)
- Video Down Scaling
- Minimum End-to-end latency (QVCodec4K to QVCodec4K): ~117 ms,

Closed Captioning:
- CEA-608 and CEA-708 Vertical Ancillary Data (VANC) on SDI input for QVENC encoding
- CEA-608 and CEA-708 VANC on SDI output for QVDEC decoding

Serial Interfaces:
- 1 Micro-B USB2 Console Interface
- 1 USB 2.0 Type-A Port for Flash disk drives
- 2 USB 2.0 Ports for video storage

Configuration and Monitoring:
- Web setup & monitoring interface over IP network

Electrical:
- AC Power Input: 100-240VAC, 150 mA, 50/60Hz
- DC Power Input: 7 VDC @ 3 A max, to 20 VDC @ 1 A max
- Auto sensing AC power adapter included

Mechanical: (see relevant datasheet)
- Unit Weight: 4 lbs
- Rack mount bracket, up to 2 units in 1 RU

Environmental:
- Operating temperature: 0 to 55° C
- Operating humidity: 0 to 90% R.H., non-condensing
- Non-operating temperature: -20 to 70° C
- Non-operating humidity: 0 to 95% R.H., non-condensing

Regulatory:
- RoHS, CE, and FCC compliant

Warranty:
- Parts and labor: 1-year

11.6 Appendix F: Product Warranty Terms and Conditions

1)   Warranty Statement
Thank you for purchasing a QVidium product. All QVidium products come with a one-year limited warranty against defects in material and workmanship during the warranty period. If a product proves to be defective in material or workmanship during the warranty period, QVidium will, at its sole option, repair or replace the product with a similar product. Replacement Product or parts may include remanufactured or refurbished parts or components. The replacement unit will be covered by the balance of the time remaining on the customer's original limited warranty. QVidium provides no warranty for the third-party software included with the product or installed by the customer. QVidium does not warrant that the operation of any product will be interrupted or error free and QVidium is not responsible for damage arising from failure to following instructions relating to the product's use.

2)   Warranty Conditions
The warranty is valid only for the first consumer purchaser and is not transferable. Proof of purchase will be required for any limited warranty. The warranty does not cover: 1) any product on which the serial number has been defaced, modified or removed or 2) Damage, deterioration or malfunction resulting from: a) Accident, misuse, neglect, fire, water, lightning, or other acts of nature, unauthorized product modification, or failure to follow instructions supplied with the product; b) Repair or attempted repair by anyone not authorized by QVidium; c) Damage to or loss of any programs, data or removable storage media; d) Software or data loss occurring during repair or replacement; e) Any damage of the product due to shipment; f) Removal or installation of the product; g) Causes external to the product, such as electric power fluctuations or failure; h) Use of supplies or parts not meeting QVidium's specifications; i) Normal wear and tear; j) Failure of owner to perform periodic product maintenance; k) which has been subjected to unusual physical or electrical stress, misuse, abuse, power shortage, or negligence or; l) Any other cause which does not relate to a product defect.

3)   Warranty Procedure
For the duration of the warranty period, QVidium will replace or repair defective products. If a product is suspected of being defective, the owner should contact the reseller or distributor that sold the product. A representative will authorize the exchange or repair of the defective item. Products must be shipped in the original or comparable packaging with shipping and insurance charges prepaid in U.S. currency.

4)   Limitation of Warranty
Neither QVidium nor its third party suppliers make any other warranty or condition of any kind whether expressed or implied, with respect to the QVidium products, and specifically disclaim the implied warranties or conditions of merchantability, satisfactory quality, and fitness for a particular purpose.

5)   Limitation of Liability
Except for the limited obligations specifically set forth in this warranty statement, in no event shall QVidium or its third party suppliers be liable for direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory and whether advised of the possibilities of such damages.

Some states do not allow limitations on how long an implied warranty lasts or the exclusion or limitation of incidental or consequential damages, so the above limitations and/or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from state to state.

11.7 Appendix G: **FCC Notice**

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NOTE: This equipment has been tested and found to comply with the limits
for a Class A digital device, pursuant to part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against
harmful interference when the equipment is operated in a commercial
environment. This equipment generates, uses, and can radiate radio
frequency energy and, if not installed and used in accordance with the
instruction manual, may cause harmful interference to radio
communications. Operation of this equipment in a residential area is
likely to cause harmful interference in which case the user will be
required to correct the interference at his own expense.
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