

Configuring and Managing AVB on EXOS Switches

EXOS Switch Basics

Management IP Address

Each EXOS switch has data ports (used for the network), a serial port (RJ45 or USB), and an out-of-band management port. The serial and oob management ports can be found on the front, e.g. 5320, 5420, or on the back, e.g. 5520.

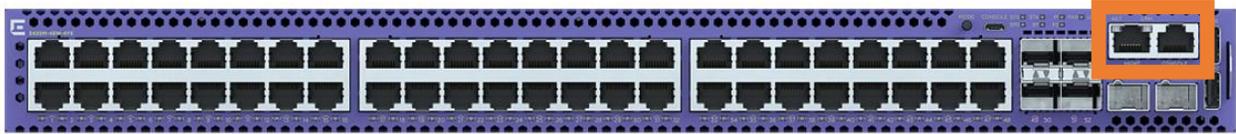


Figure 1. Example 5420M-48W-4YE front panel

Depending on the model, the baud rate is either 115200 or 9600. The rest of the serial settings are 8/None/1, XON/XOFF flow control.

Once the serial port is accessed, the default username is admin, and password is left blank (i.e. hit return).

If for some reason there is some older configuration on the switch, it can be factory defaulted with the following command:

```
unconfigure switch all
```

By default, the switch boots up running a DHCP client on both the Default VLAN (VID = 1) and the MGMT VLAN associated with the oob mgmt port. Further, all the data ports are members of the Default VLAN (untagged).

If DHCP assignment of IP addresses is not desired, the following commands disables the DHCP clients on the Mgmt and Default VLANs:

```
disable dhcp vlan default  
disable dhcp vlan mgmt
```

With DHCP client disabled, an IP address can be assigned to a VLAN manually, e.g.:

```
configure vlan mgmt ipaddress 192.168.62.100/24
```

If a DHCP server is present to offer an IPv4 address and serial console access is not available, the VLAN mgmt and Default interfaces will eventually be self-configured with an IPv4 link-local address and can be accessed via that address.

The IPv4 link-local address will be in the form of 169.254.x.y/24 where the last 2 numbers in the IP address will be the lower two bytes of the switch's MAC address (which can be found on the sticker on the switch with the serial number and model number).

For example, if the switch MAC address is 00:04:96:A1:F3:BA, then the address will be 169.254.243.186.

Further more, Chalet, the switch's web interface, can be accessed where the URL is either <http://169.254.243.186> or <http://0xa9fe3xyy> where, in the latter case, the highlighted are the lower two bytes of the switch's MAC.

Chalet can be used to easily license and configure AVB on an EXOS switch. Please see pages 45-47 of the [Chalet User Guide](#). To enable Chalet to use TLS/SSL instead of HTTP, configure the certificate (typically self-signed) and enable https, e.g.:

```
config ssl certificate privkeylen 4096 country US organization avblab.net common-name switch7
enable web https
disable web http
```

Upgrading the Switch

The Default or Mgmt VLAN IP address can be used to upgrade the switch. The version of EXOS running on the switch can be determined by the 'show version' command.

Upgrading the image can be accomplished either via TFTP or by SFTP. Please find the instructions for upgrading via TFTP [here](#). SFTP requires that SSH be enabled on the switch using the following command:

```
enable ssh
```

Then, once the SFTP session is established (e.g. sftp [admin@192.168.62.100](#)), then change the mode to binary in the SFTP session. Upload the EXOS image to the switch with the 'put' command. Then, after a time, use the 'install image' command from the switch CLI to install the new image and then reboot the switch with the 'reboot' command.

AVB Support & Licensing

AVB is supported on the following switches running EXOS without the need for an AVB license:

- X870
- X695
- X690
- X590
- 5720
- 5520

5420 - U1 & U2 ports require the 'disable stacking-support' command
5320

AVB is supported on the following switches running EXOS with the addition of an AVB license:

X465-24XE - Front-panel ports only as well as only on the following VIMs VIM5-4X/2Y/4Y/2Q
X465-24S - Front-panel ports only as well as only on the following VIMs VIM5-4X/2Y/4Y/2Q
X465i-48W - Front-panel ports only as well as only on the following VIMs VIM5-4X/2Y/4Y/2Q
X460-G2
X450-G2
X440-G2 - On 48-port models only on the front-panel ports 1–24 and 51–52
X435

Use the 'show license' command to ensure that the AVB Feature License is installed. If not, it must be installed with the 'enable license <AVB license key>' command.

Other Limits

AVB is not supported when MACsec is enabled, when the Network Timing Feature License is installed, or on switch stacks.

Preparing the Switch for AVB

Flow control on the switch needs to be disabled as it can be disruptive to AVB traffic. The following commands should be issued:

```
disable flow-control tx-pause ports all  
disable flow-control rx-pause ports all
```

By default, spanning-tree is enabled (multiple rapid spanning-tree) as stp s0 and it is configured to auto-bind to the ports within the Default VLAN. Ensure this is the case by issuing the 'show. stp s0' and observing that the s0 instance is enabled, its operational mode is MSTP, and the Default VLAN is participating and auto-bound to it. For example:

```
# show stp s0  
Stpd: s0          Stp: ENABLED          Number of Ports: 15  
Rapid Root Failover: Disabled  
Operational Mode: MSTP          Default Binding Mode: 802.1D  
MSTI Instance:      CIST  
802.1Q Tag: (none)  
Ports: 1,2,3,4,5,6,7,8,9,10,  
       11,12,13,14,16  
Participating Vlans: Default  
Auto-bind Vlans: Default
```

...

Neighbor Discovery Protocols

Another consideration are neighbor discovery protocols like EDP and LLDP which are on by default now in EXOS. They can be left on if desired but may add unwanted network traffic in large installations. The CPU overhead should not be too great and it can be optionally left running without affecting AVB traffic. However, it is recommended in larger networks to turn off the two neighbor discovery protocols (they are on by default), by issuing the following commands:

```
disable lldp port all
disable edp port all
```

At this point, LLDP should be re-enabled on inter-switch ports and ports connecting to devices where LLDP is required for proper PoE+ negotiation. (For example, ports connected to Biamp's Tesira AMP-450P and Tesira TCM-1 family of products.)

To enable LLDP on inter-switch ports, simply issue the command:

```
enable lldp port <inter-switch-port-list>
```

To enable LLDP on ports where PoE negotiation is required, issue these commands:

```
configure lldp port <port-list> advertise vendor-specific dot3
power-via-mdi with-classification
```

```
enable lldp port <port-list>
```

Concurrent AVB with Dante

If Dante will be used on the AVB enabled switch you will need to either disable IGMP snooping (IGMP snooping is enabled by default in EXOS) or add a querier IP address to one (and only one) switch in the Dante VLAN. If no querier is present, then IGMP snooping will cause Dante clock discovery to fail. You will see multiple Master Clock devices shown in Dante Controller, the Dante devices will lose clock sync, and latency will increase until audio stops.

A router in the network, if on the Dante VLAN, can serve, if supported, as an IGMP querier. However, if that is not present, which is often the case, a switch will have to serve as an IGMP querier in the Dante VLAN. To configure that, an IP address must be configured on the Dante VLAN on at least one switch in the network. For example:

```
config vlan dante_vlan ipadd 10.10.10.1/24
```

With this configuration on one switch in the network, IGMP snooping can be left on (which it is by default). The querier will solicit multicast reports from receivers and the switches will snoop and prune multicast from ports on which that multicast is not subscribed to by receivers.

If this is determined to be unnecessary, due to the low level of multicast, then IGMP snooping can simply be disabled on the Dante VLAN, e.g.:

```
disable igmp snooping vlan dante_vlan
```

However, it is recommended that IGMP snooping be enabled, particularly in larger networks. If IGMP snooping is ineffectual due to there being no multicast reporting solicited by a querier to be snooped, multicast becomes, essentially, broadcast and the network can be degraded considerably.

Saving the EXOS switch configuration

Lastly, remember to save the configuration of the switch with the 'save config' command after switch preparation for AVB, and after enabling AVB in the next section.

Quick Start to Enabling AVB

To enable AVB and activate it on all the ports on the switch, issue the following commands:

```
enable avb
enable avb port all
```

A message may be issued: "Dot1p 7 was mapped from QP8 to QP6 to support AVB". This is expected.

Confirm the AVB configuration with the 'show avb' command. For example:

```
# show avb
gPTP status      : Enabled
gPTP enabled ports : *1s      2d      3d      4d      5d
                   6d      7d      8d      9d     10d
                   *11m     12d     13d     14d     15d
                   16d

MSRP status      : Enabled
MSRP enabled ports : *1ab     2       3       4       5
                   6       7       8       9      10
                   *11ab    12      13      14      15
                   16

MVRP status      : Enabled
MVRP enabled ports : *1       2       3       4       5
                   6       7       8       9      10
```


Typically, the commands presented in the Quick Start section above are sufficient. The “avb” commands in that section effect the following:

```
[ enable | disable | unconfigure ] network-clock gptp { ports [ all | port_list ] }  
[ enable | disable | unconfigure ] mvrp { ports [ all | port_list ] }  
[ enable | disable | unconfigure ] msrp { ports [ all | port_list ] }
```

However, there are times when adjustments need to be made to the configuration of some of the protocols underlying AVB.

gPTP

The Priority1 value (the key factor in determining which device in the network is elected the Grand Master Clock) may need to be adjusted. The lower value is a higher priority in the election. The default Priority1 value for an EXOS switch is 246 vs. that of the endpoints which is 248. By default it is probable that one EXOS switch will be elected the GMC.

The following command can be used to adjust the priority1 value:

```
config network-clock gptp default-segt priority1 { 0 - 255 }
```

where 0 is highest priority and setting it to 255 disables GMC capability.

If it is desired for a switch in the network to be elected the GMC, it is best practice to lower the priority1 value on a switch centrally positioned in the network to evenly reduce the number of hops to the GMC from any one endpoint or other switch. That, and it is useful to manually determine where the GMC is in steady state.

In the case where the AV software is on a virtual machine or a media converter is used, it may be necessary to change the peer delay threshold from the default settings using the following command:

```
configure network-clock gptp ports {port-list} peer-delay  
neighbor-thresh {time value} {time metric}
```

MRP

MRP can only be configured from the CLI, and the only values that may be configured are timer-values. Typically, the defaults should be sufficient, but where there are many streams, it may be necessary to increase the leave-all, leave timer, and join timer values. For example, the following:

```
configure mrp ports all timers leave all 25000  
configure mrp ports all timers leave 5000
```

```
configure mvrp ports all timers join 200
```

MVRP

By default all VLANs, including non-AVB VLANs are advertised via MVRP. In some cases, endpoints can be confused by seeing non-AVB VLAN advertisements. Non-AVB VLAN advertisement can be disabled using the following command:

```
configure mvrp tag { VID } ports all transmit off
```

Other non-default configuration of MVRP is not required.

MSRP & FQTSS

There is typically no configuration required for MSRP, however, FQTSS settings are generally managed by MSRP, so there are settings for FQTSS that may be adjusted via MSRP configuration commands.

By default, AVB traffic is allowed to use 75% of the bandwidth of each link. This setting can be adjusted separately for class A and class B traffic. These settings are “delta bandwidth” values because class A traffic can use the class A percentage, but class B traffic can use the class A percentage plus the class B percentage.

Traffic Class	Delta BW	Effective BW
A	75%	75%
B	0%	75%

Table 2. Default settings for Delta Bandwidth and Effective Bandwidth

To change these defaults, use the following commands:

```
configure msrp ports all traffic-class A delta-bandwidth { dBW% }  
configure msrp ports all traffic-class B delta-bandwidth { dBW% }
```

Another configuration consideration regarding MSRP regards the Default VLAN. It is required that a port connecting to an endpoint be in an untagged VLAN for the transmission of IEEE 1722 and 1722.1 control packets. The Default VLAN is the obvious choice for this. Inter-switch links may be tagged into the Default VLAN, but it is best to have those inter-switch links members of the Default VLAN as untagged as that will allow the Default VLAN serve as the carrier VLAN for spanning-tree instance S0. This is the default configuration.

in large networks with many streams, scaling challenges may arise. There are two configuration options for MSRP that can help AVB scale. These are Talker VLAN Pruning (TVP) and Extended Refresh.

When TVP is enabled, talker attributes are only advertised over ports that belong to the VLAN identified in the Talker attribute DataFrameParameters. Any talker attributes that contain a VLAN ID of which a port is not a member are not sent out that port, thus “pruning” the communication of talker attributes. Talker VLAN Pruning can be enabled with the following command:

```
configure msrp talker-vlan-pruning on
```

Extended Refresh is used when MSRP is advertising many streams, and those streams are not being refreshed quickly enough. Enabling Extended Refresh uses different refresh timers and Registrar State to extend available refresh time while preserving the faster reaction time when a stream is intentionally removed. Extended Refresh can be enabled with the following command:

```
configure mrp ports all timers refresh auto-refresh
```

As mentioned earlier the Leave All and Leave timers and may need to be increased on the switches in conjunction with these two last commands. This may be necessary on the attached endpoints as well.

Limits on the total number of active streams supported on platforms can be found in the Release Notes for each version of EXOS. As of this writing, EXOS 31.7 shows the following limits for active AVB streams for AVB supported EXOS switches:

AVB (audio video bridging)— maximum number of active streams.	ExtremeSwitching X435	512
AVB (audio video bridging)— maximum number of active streams.	ExtremeSwitching X450-G2, X460-G2, X620, X440-G2, 5320, 5420	1,024
	ExtremeSwitching X465, X670-G2, X695, X870, 5520, X690, X590	4,096

Showing More Detailed AVB Information

The complete set of show commands are documented in the ExtremeEXOS User Guide and Command Reference found [here](#). However, below are some commonly used commands:

gPTP	
<code>show network-clock gtp ports</code>	This command can be used to view the gPTP properties of a given port which is useful for debugging when the summary avb command shows that the port is not operational for gPTP

MSRP	
<code>show msrp</code>	This command shows the summary information output by the show avb command, but also displays the total number of streams and reservations on the switch.
<code>show msrp streams</code>	This command displays all of the streams of which the switch is aware.

<code>show msrp listeners</code>	This command displays all of the listeners of which the switch is aware. If the declaration type is "Ready" or "RdyFail", a reservation exists and the Stream Age will show the length of time that reservation has been active.
<code>show msrp streams propagation</code>	This command is useful for troubleshooting regarding the propagation of talkers and listeners for each stream.

MVRP	
<code>show vlan</code>	VLANs created via MVRP are named "SYS_VLAN_XXXX", where the "XXXX" is the VLAN ID. The "d" flag indicates a dynamically created VLAN.
<code>show vlan SYS_VLAN_XXXX</code>	Specifying the VLAN name with the show VLAN command displays details about the VLAN.

Other EXOS Switch Configuration Considerations

Link Aggregation Groups (Port Sharing) and AVB

LAGs can be used on EXOS switches in AVB networks. The following command is an example of how to configure a LAG (port sharing group) on an EXOS switch:

```
enable sharing 1 group 1-4 algorithm address-based L3_L4 lacp
```

It is recommended that the L3_L4 be used as the "hashing" algorithm which the switch uses to determine over which port in the LAG a given packet is forwarded because it tends to provide more traffic load-balancing over the LAG.

Regarding MRP/MSRP, there are two modes supported for calculation of the effective bandwidth: single-port mode (the default) or cumulative mode. In single-port mode, the bandwidth of the master port (port 1 in the above example) is used in the effective bandwidth calculation. The formulas for single-port mode are as follows:

effective bw = the bandwidth of master port
MSRP reservable bw = deltaBandwidth * effective bw

In single-port mode, the LAG member ports (ports 2-4 in the example above) are neither used in the effective bw calculation or for traffic reservations. Therefore, they are simply used for redundancy in terms of bandwidth reservations. Single-port mode is the default mode.

In cumulative mode, all ports in a LAG are used for the effective bw calculation and used for traffic reservations. Cumulative mode must be configured with a "beta" percentage value that is used in the effective bw calculation. The beta % can be set from 0 to 100%.

The formulation is as follows:

effective bw = the bandwidth of master port + beta * sum (bw of all other active member ports)
MSRP reservable bw = deltaBandwidth * effective bw

So given the example configuration above with 1 Gb ports 1-4 in a LAG, if the beta % is set at 50, the effective bw for that LAG = $1 + (.5 * 3) = 2.5$ Gbs.

The command for configuring cumulative mode is as follows:

```
configure msrp sharing port { mstr-port | all } bandwidth { beta%}
```

The reservable bw would then be calculated using the deltaBandwidth * the effective bw as shown above.

Configuration Mistakes to Avoid

- Do not modify QoS Profiles in anyway. This can interfere with AVB.
- Do not configure rate limiting or traffic metering on ports, traffic queues, or VLANs.
- Do not modify the configuration of the dot1p or dscp mapping tables.
- Do not remove ports as members from VLAN 1. Interswitch links where AVB is enabled can be tagged members of VLAN 1 but are preferably untagged (due to STP considerations mentioned above). Ports connected to AVB endpoints should be untagged members of VLAN 1.
- Do not enable or configure VLAN translation of AVB VLANs. This is not supported.

Useful Show Port Commands

```
show port {port_number} {no-refresh}
show port {port_number} rxerrors {no-refresh}
show port {port_number} txerrors {no-refresh}
show port {port_number} collisions {no-refresh}
show port {port_number} statistics {no-refresh}
```