AXTRINET

AXTRINET

Ethernet Packet Generator

USER GUIDE

Version 3.2

APG4   APG8   APG208

Hardware Versions

This document applies to the following hardware versions:

Version 1 (APGV1)	**Launched: 2016 with API 161016**
	Products: APG4, APG8, APG200, APG208
	Port Speeds: 1Gbps, 10Gbps, 40Gbps
	Processing Cores: 6.X (10Gbps) 7.X (1Gbps) Note: Cannot mix 10Gbps and 1Gbps ports
	Capture Buffer: 64MB/port (10G) 256MB/port (40G)
	Timestamp Resolution: 8ns
Version 2 (APGV2)	**Launched: 2023 with API 161016**
	Products: APG4V2-10, APG8V2-10
	Port Speeds: 1Gbps, 10Gbps **2.5Gbps, 5Gbps (optional)**
	Processing Core: 10.X (10Gbps/1Gbps)
	Capture Buffer: 128MB/port
	Timestamp Resolution: 2.5ns

Software Versions

This document applies to the following software versions:

	Version 1 (APGV1)	**Version 2 (APGV2)**
APG API	**161016**	**161016**
APG Unit Firmware	**Version 2.3**	**Version 1.6**
APG Processing Core	**Version 6.010E (10Gbps)** **Version 7.0103 (1Gbps)** Datecode: 01 March 2019	**Version 10.3** Datecode: 6 August 2024
APG Control Interface	**Version 3.4**	**Version 3.4**

Revision History

Date	Version	Changes
4 July 2016	0.4	Restricted Customer Release • Missing Linux installation information
11 August 2016	1.0	General release • Added Linux Installation (Section 2.3) • Modified 10GBase-T SFP limitations (Section 3.1.1) • Modified Front Panel LED behaviour (Section 3.1.3.1) • Added File-Save (Section 6.3.1) • Added Tools-Upgrade (Section 6.3.8)
3 November 2016	1.1	• Added APG200
7 June 2017	2.0	• Updated FCC statement • Added Port Topology changes (Sections 3.1.2 and 5.3), including 40Gbps / 4x10Gbps support on QSFP+ interfaces. • Added Burst Mode (Section 6.5.1) • Added Packet/Second Mode (Section 6.5.1) • Added Packet Timestamps (Section 6.5.3) • Added Deep Packet Capture (Section 6.11) • Added 'Save to PCAP' (Section 6.11)
5 September 2017	2.0.2	• Added Capture Buffer limits (Section 5.5) • Added Transmit Frame Length limits (Section 6.5.1) • Modified Capture Control description (Section 6.10.3)
8 February 2018	2.1	• Added Save/Load Configuration (Section 6.3.2 & 6.3.3) • Local capture buffer sizes increased to 64KB (10Gbps), and 256KB (40Gbps) (Sections 5.5 & 6.11)
27 January 2019	2.2	• Added 1G Topology (Section 5.3.1) • Added 1Gbps SFP support • Added Copper Transceiver support for SFP+/SFP ports
21 February 2023	3.0	• Added Hardware Versions and extended Software Versions • Added UKCA Statement • Removed APG200, added APGV2 10Gbps units • Added clarification to APGV1 and APGV2 features • Removed unused orange port LED state (Section 3.1.3.2) • Added SYNC interface electrical specification (Section 3.2.3) • Added Rear Panel Clock Interfaces, CLOCK-IN and CLOCK-OUT electrical specifications (Section 3.3) • Added Inter-Unit Synchronisation Concepts: synchronous clock, timestamp and transmission (Section 5.6) • Updated Edit-Settings pop-up window with Display and Sync Tabs (Section 6.3.5) • Updated Control Panel with Reset Timestamp button (Section 6.6) • Added Unit Sync option to Counter Panel (Section 6.7) • Added Unit Control pop-up window (Section 6.9)
14 December 2023	3.1	• Added Port BERT Option (Section 6.10.4)
17 September 2024	3.2	• Removed CD from Box Contents (Section 2.1) • Added 5Gbps/2.5Gbps Topology changes • Corrected fan alert description (Section 6.9.1.4)

Document Conventions

INFORMATION:	**Additional information to clarify functionality or usability**

WARNING:	**Clarification of unexpected or restricted functionality**

CRITICAL:	**Unit failure - contact Axtrinet for further support**

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Preface

About This Document

This document describes the Axtrinet Packet Generator hardware, the installation procedure, and the User Manual for the APG Control Interface. It contains the following sections:

Section	Description
1. INTRODUCTION	Key features and benefits of the Axtrinet Ethernet Packet Generators
2. INSTALLATION	Installation procedures for the Microsoft™ Windows™ and Linux USB drivers and Control Interface
3. HARDWARE INTERFACES	Physical properties of the unit
4. MANAGEMENT INTERFACES	Introduction to the Management Interfaces of the unit
5. TEST ENVIRONMENT & CONCEPT	Introduction to Ethernet packet generation, packet structures and control
6. CONTROL INTERFACE	Detailed guide to the APG Control Interface

Related Documentation

[1] APG-GSG   Axtrinet APG Getting Started Guide

[2] APG-TCL-UG   Axtrinet APG TCL API Guide

[3] APG-HDR   Axtrinet APG Header Definitions

[4] APG-SW-TC   Axtrinet APG Software License Terms and Conditions

Visit **www.axtrinet.com/axtrinet-support** for the latest documentation.

Glossary

APG	Axtrinet Packet Generator
API	Application Programming Interface
BER	Bit Error Rate
BERT	Bit Error Rate Test
FCS	Frame Checksum
FPGA	Field Programmable Gate Array
Gb	Gigabits
Gbps	Gigabits per Second
IBG	Inter-Burst Gap
IFG	Inter-Frame Gap
LAN	Local Area Network
MB	Megabytes
Mbps	Megabits per Second
PLL	Phase Locked Loop
pps	Packets per Second
PPS	Pulse per Second (clock)
PRBS	Pseudo-Random Bit Sequence
QSFP+	Quad Small Form-Factor Pluggable (40Gbps)
SFD	Start-of-Frame Delimiter
SFP	Small Form-Factor Pluggable (1Gbps)
SFP+	Small Form-Factor Pluggable (10Gbps, 5Gbps, 2.5Gbps)
TCL	Tool Command Language
USB	Universal Serial Bus

Contents

1. INTRODUCTION

Thank you for purchasing an Axtrinet™ APG Ethernet Packet Generator.

The Axtrinet APG Ethernet Packet Generators provide compact and affordable 40Gbps and 10Gbps/5Gbps/2.5Gbps/1Gbps Ethernet Packet Generator/Analysers with a simple-to-use Control Interface and an open TCL API for third party scripting.

Ideally suited to applications in R&D, Test and Manufacturing environments, and 'on the road' with Field Sales and Application Engineers, the Axtrinet APG Ethernet Packet Generators allow reliable and affordable development and testing of:

- Ethernet network equipment such as switches, routers, firewalls and network monitoring devices with 10Gbps/5Gbps/2.5Gbps/1Gbps Ethernet Interfaces

- Data storage equipment with 1Gbps/10Gbps and 40Gbps (APGV1 only) Ethernet interfaces

- Specialist devices such as FPGA accelerator NIC cards and offload appliances

- Ethernet infrastructure installations encompassing cabling and switches

1.1 MAIN FEATURES

- Highly configurable Ethernet Packet Generation

- Full wire-speed operation on all ports

- Industry standard QSFP+ and SFP+/SFP ports

- Real-time packet counts and error detection

- Packet Capture for post-test analysis

- Simple to use Control Interface for configuration and control

- Clear LED status indication for unit operation and Ethernet traffic generation/reception

- USB 2.0 port for easy set up and local management and 10/100Mbps Ethernet LAN connection for flexible remote management

1.2 BENEFITS

- Low cost allows multiple units to be deployed in a development environment – one per desk

- Easy to set up and use. Avoids the need for complex vendor specific programming skills

- Ideal for integration into a manufacturing test environment using TCL scripting interface

- Flexible choice of interfaces allows use with different speeds and media types, maximising the investment across multiple projects

- Small size, 1U high (44mm) and 146mm wide, for desk-top or rack shelf mounting (1/3 rack width)

1.3 SAFETY INFORMATION

⚠️ **To prevent possible electrical shock, fire, personal injury, or damage to the product, carefully read this safety information before attempting to install or use the product.**

In addition, follow all generally accepted safety practices and procedures for working with and near electricity.

The product has been designed in accordance with the European standard publication EN 61010-1:2010, and left the factory in a safe condition.

1.3.1 External Connections

⚠️ **To prevent injury or death, only use the power adapter and cord supplied with the product.**

⚠️ **To prevent injury, ensure that light or laser light sources (eg from SFPs and QSFPs) are extinguished during connection or disconnection to optical fibre inputs. Never direct an optical source towards a naked eye.**

1.3.2 Environment

⚠️ **To prevent injury or death, do not use in wet or damp conditions, or near explosive gas or vapour.**

ℹ️ **To prevent damage to the Packet Generator, use and store in the recommended environment:**

	Temperature	Humidity	Altitude
Operating:	0°C - +40°C	5% to 90% RH (non-condensing)	2000m
Storage:	-20°C - +55°C		

1.4 CARE OF THE PRODUCT

The Axtrinet Packet Generator contains no user-serviceable parts. Repair and servicing require specialised test equipment and must only be performed by Axtrinet. There may be a charge for these services unless covered by the Axtrinet one year warranty.

ℹ️ **Use a soft damp cloth to clean the Axtrinet Packet Generator.**

⚠️ **Do not allow liquids to enter the product casing, as this may cause damage to the electronics inside.**

⚠️ **Do not tamper with or dismantle the Packet Generator. Internal damage may affect performance and void the warranty.**

⚠️ **Do not block the air vents at the front of the Packet Generator or the fan exhaust at the rear. Overheating may affect the performance and damage the internal electronics.**

⚠️ **Do not insert any objects through the air vents. Internal interference may damage the internal electronics.**

1.5   ENVIRONMENTAL

Disposal of Waste Electrical & Electronic Equipment

When an Axtrinet Packet Generator reaches the end of its useful life, Axtrinet will arrange the responsible recycling of returned products. Where the customer wishes to return the unit to Axtrinet, the customer will be responsible for shipping the unit back to our facility. Before returning the unit, contact Axtrinet Customer Services at **support@axtrinet.com** for more information.

1.6   CONFORMANCE

1.6.1 UKCA Notice

The product meets the intent of the Electromagnetic Compatibility Regulations 2016 and is designed and certified to BS EN IEC 61326-1:2021 Class A Emissions and Basic Immunity standard.

This product is in conformity with the protection requirements of Electromagnetic Compatibility Regulations 2016 relating to electromagnetic compatibility. Axtrinet cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product.

The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Warning: This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

The product meets the intent of the Electrical Equipment (Safety) Regulations 2016 and has been designed to meet BS EN 61010-1:2010+A1:2019 Safety requirements for electrical equipment for measurement, control, and laboratory use.

1.6.2 CE Notice

The product meets the intent of the EMC directive 2014/30/EU and is designed and certified to EN61326-1:2013 Class A Emissions and Basic Immunity standard.

This product is in conformity with the protection requirements of EU Council Directive 2014/30/EU on the approximation of the laws of the Member States relating to electromagnetic compatibility. Axtrinet cannot accept responsibility for any failure to satisfy the protection requirements resulting from a non-recommended modification of the product.

The limits for Class A equipment were derived for commercial and industrial environments to provide reasonable protection against interference with licensed communication equipment.

Warning: This is a Class A product. In a domestic environment, this product may cause radio interference, in which case the user may be required to take adequate measures.

The product meets the intent of the Low Voltage Directive 2014/35/EU and has been designed to meet EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use.

1.6.3 FCC Notice

This equipment is intended for use solely as industrial test equipment, and is therefore exempt under Section 15.103(c) exemption rules.

However, this equipment has been <u>verified</u> to comply with the limits for a Class A digital device, pursuant to Part 15 (CFR 47) 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 their own expense.

1.7 LIMITED HARDWARE WARRANTY

Axtrinet warrants upon delivery, and for a period of one year unless otherwise stated from the date of delivery, that the product will be free from defects in material and workmanship.

Axtrinet shall not be liable for a breach of the warranty if the defect has been caused by wilful damage, negligence, abnormal working conditions or failure to follow Axtrinet's written advice on the storage, installation, commissioning, use or maintenance of the product; or if the Customer alters or repairs the product without the written consent of Axtrinet.

The maximum liability of Axtrinet under this warranty is limited to the purchase price of the product covered by the warranty.

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Should a product fail to perform as described above within the warranted period, it will be repaired or replaced with the same or functionally equivalent product by Axtrinet, at its discretion, free of charge provided you: (1) return the product to a Axtrinet designated repair facility with shipping charge prepaid or by using the Returns Label provided, and (2) provide Axtrinet with proof of the original date of purchase.

Prior to returning any defective product, the end customer or the reseller from whom the end customer originally purchased the product must obtain a Return Materials Authorisation (RMA) number from Axtrinet. Unless otherwise agreed, all defective products should be returned to Axtrinet with shipping charges prepaid. Axtrinet will not accept collect shipments.

Repaired or replacement products will be returned to you with shipping charges prepaid.

Replacement products may be refurbished or contain refurbished materials. If Axtrinet, by its sole determination, is unable to repair or replace the defective product, it will refund the depreciated purchase price of the product.

An Extended Hardware Warranty is available for purchase; please contact Axtrinet or your reseller for more information.

1.8   SOFTWARE LICENCES AND SUPPORT

See the Axtrinet APG Software License Terms & Conditions [4].

Email based software support is included in the purchase price for the first 12 months after delivery. Extended Software Support is available for purchase; please contact Axtrinet or your reseller for more information.

1.9   CONTACT DETAILS

Technical assistance is available from Axtrinet at the following address:

Address: Xentech Solutions
                            Suite 6 Stanta Business Centre
                            3 Soothouse Spring
                            St Albans
                            AL3 6PF
                            UK

Phone: +44 (0)1727 867795

Email:
Technical Support: **support@axtrinet.com**
Sales: **sales@axtrinet.com**

Web Site: **www.axtrinet.com**

2. INSTALLATION

This section describes the driver, APG Control Interface and TCL API installation process on a host PC running Linux or Windows.

2.1   BOX CONTENTS

The shipping carton contains:

- APG Unit
- Universal Desktop 12Vdc 5A Power Supply & local mains lead
- 1m USB Type B lead
- Getting Started Guide
- 4x Rubber Feet

Visit **www.axtrinet.com/axtrinet-support** for the latest documentation and software.

2.2   MINIMUM SYSTEM REQUIREMENTS

Processor	Pentium-class processor or equivalent
Memory	2GB (4GB recommended)
Disk Space	15MB
OS	64bit (x86_64) Linux systems Microsoft Windows 7 Microsoft Windows 8.x Microsoft Windows 10.x Microsoft Windows 11.x
Interfaces	Minimum: USB 2.0 Preferred: USB 2.0 & 10/100Base-T

2.3   LINUX INSTALLATION

The Axtrinet APG Linux package contains the GUI application and the system configuration file. The GUI requires X-Windows to be running.

There are 4 installation formats provided for convenience:

- Simple tar
- Pacman
- RPM
- Deb

Pick the one that suits the distribution and the package should install with the normal package handling tools or use the commands below.

Currently all packages are for 64bit (x86_64) linux systems. The package files may not have all package dependencies because package names vary between different linux distributions.

See the notes in the Dependencies section below for package dependencies.

Pacman

Install with

```
pacman -U apgcontrol-3.4-1-x86_64.pkg.tar.xz
```

Remove with

```
pacman -R apgcontrol
```

RPM

Install with

```
rpm -U apgcontrol-3.4-1.x86_64.rpm
```

or

```
yum localinstall apgcontrol-3.4-1.x86_64.rpm
```

Remove with

```
rpm -e apgcontrol
```

There are a set of MD5/SHA1/SHA256 sums for the package files.

The package includes a desktop link that should appear under Network tools.

If it doesn't work

Provided the package install worked, once installed there should be an executable 'apgcontrol' in /usr/bin. If it does not run then check for missing libraries with:

```
ldd /usr/bin/apgcontrol
```

Dependencies

The following base packages are required but will normally already be installed:

fontconfig, **libxft**, **libx11**

The following optional dependencies are also required for some functionality:

- To connect to USB ports **libusb** (libusb-1.0.so) is required.
  If it is not present, USB connected units will not appear.

- In addition to run the scripting interface you will require to have a **tcl** package (provide tclsh, libtcl8.6.so) installed and to run the test suite **tk** (provide wish) to run the UI and **texlive** or **texlive-bin** (provide pdflatex) to create the pdf report documents.

2.4 WINDOWS INSTALLATION

1. Insert the CD.

2. Locate "apg-install.exe" in the Windows directory

3. Run the installation file and follow the on-screen instructions to install the USB driver, APG Control Interface GUI and the APG TCL API.

> 🚫 **DO NOT CONNECT THE AXTRINET PACKET GENERATOR TO THE WINDOWS PC UNTIL THE INSTALLATION IS COMPLETE.**

4. Read and accept the software Licence Agreement:
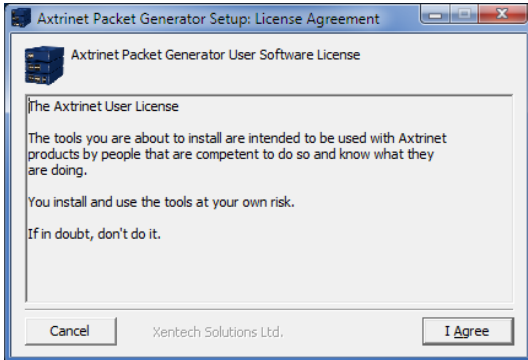
5. Select the components to install:
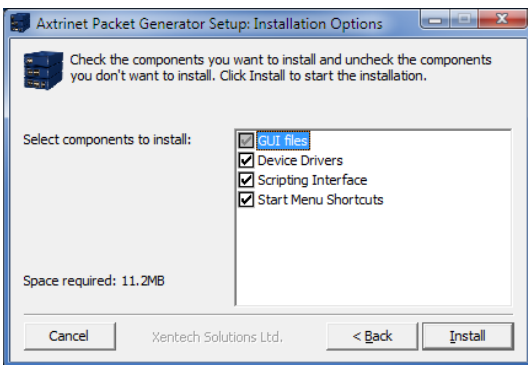
> ⚠️ **The installer will only update the installed components if a newer component is available.**

Click ⬚ Install to start installing the selected components.

6. The window changes to display the installation progress.
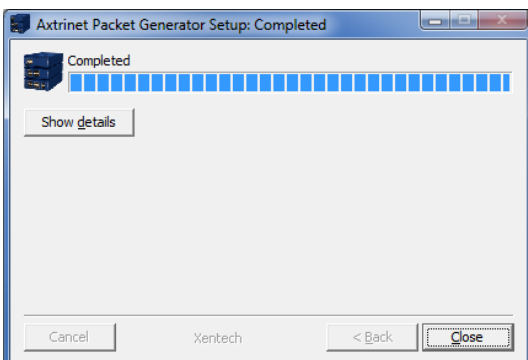
7. ⬚ Close completes the installation process.

8. In addition, to run the scripting interface you will require to have a **tcl** package (provide tclsh) installed; to run the Test Suite GUI you will require **tk** (provide wish); and to generate test reports you will require **TexLive** or **MiKTex** (provide pdflatex).

2.5   CONNECTING THE HARDWARE

- Attach the ac mains supply lead to the power adapter, connect the adapter to the unit and apply power.

  ➢ The POWER LED will be illuminated ORANGE for ~60 seconds while the hardware configures.

  > AN APGV1 unit will complete hardware configuration in ~60 seconds.
  > AN APGV2 unit will complete hardware configuration in ~25 seconds.

  ➢ The POWER LED will turn GREEN after successful configuration, or RED if the hardware has failed to configure.

  > **If the POWER LED turns RED after configuration, contact AXTRINET for further support.**

- Connect the management PC to the APG unit using the USB Type B lead (provided).
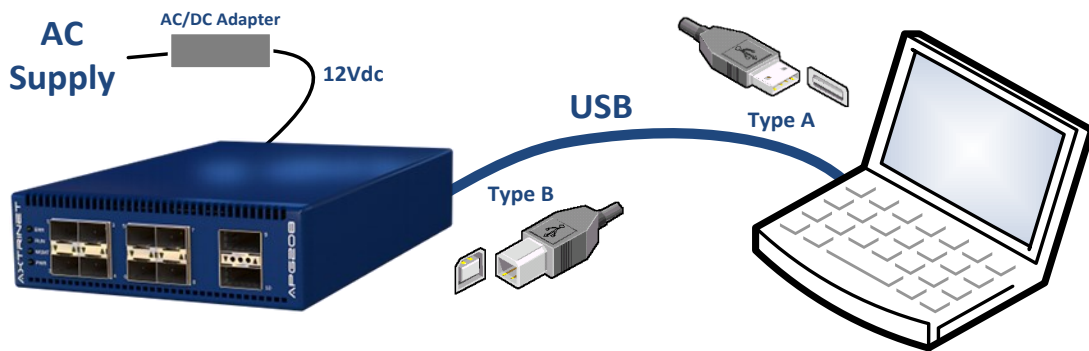
2.6 TESTING THE INSTALLATION

- Start the APG Control Interface:
  - ➢ On Linux, click the **home / Axtrinet Control** icon or execute **user/bin/apg_control**
  - ➢ On the Windows Start menu, locate the Axtrinet directory and click on the **APG Control** icon.

- The APG Control Interface management window will be displayed and the new unit will appear as a USB connection:
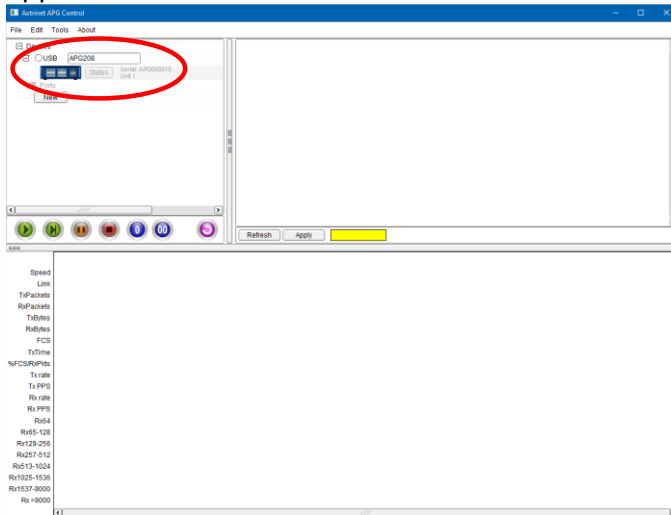
⚠️ **If the unit does not appear in the Control Interface, check that the unit is turned on and the USB lead is connected.**

⚠️ **If installing the drivers onto a PC for the first time, it may be necessary to re-run the installation process after the device has been connected as the USB drivers may not be enabled.**

- To connect to the unit, click on the Checkbox next to the device.
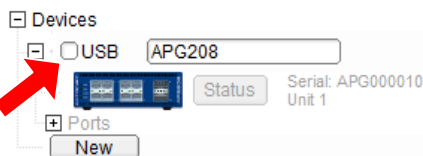
The unit port counters and unit Status button are displayed:
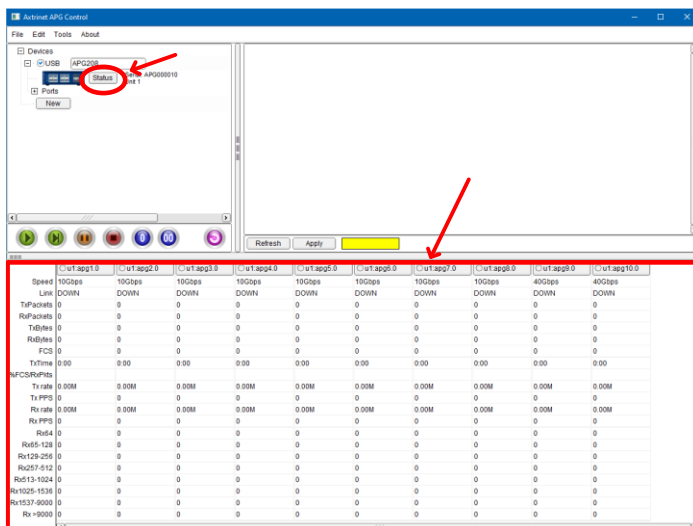
- The drivers and APG Control Interface have been successfully installed.

2.7   SETTING THE IP ADDRESS

The default settings are:

IP Address	**192.168.1.100**
Mask	**255.255.255.0**
Gateway	**0.0.0.0**

⚠️ **You may need to contact your Network Administrator to obtain the required IP and Gateway Addresses**

To change the IP Address of the unit:

- On the MENU BAR: Edit → Network Configuration.
  The IP Configuration Window opens:
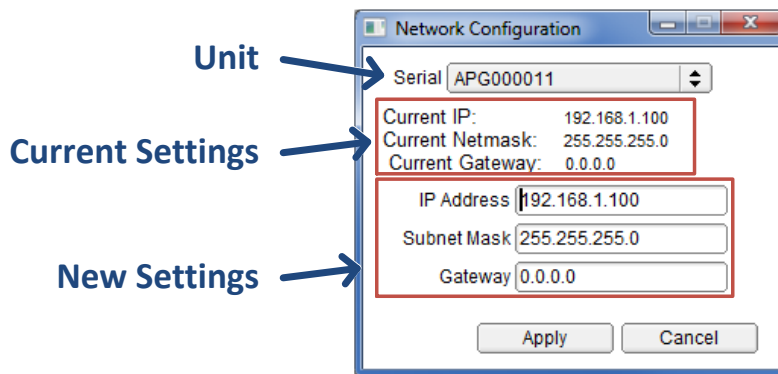
- Set the IP Address, Mask and Gateway Address, then click APPLY

For further details, see Section 6.3.6.

3. HARDWARE INTERFACES

The packet generator ports (SFP+/SFP & QSFP+) are on the front of the unit, and the management and power interfaces are on the rear.

3.1   FRONT PANEL INTERFACES

APG4
APG4V2-10

APG8
APG8V2-10
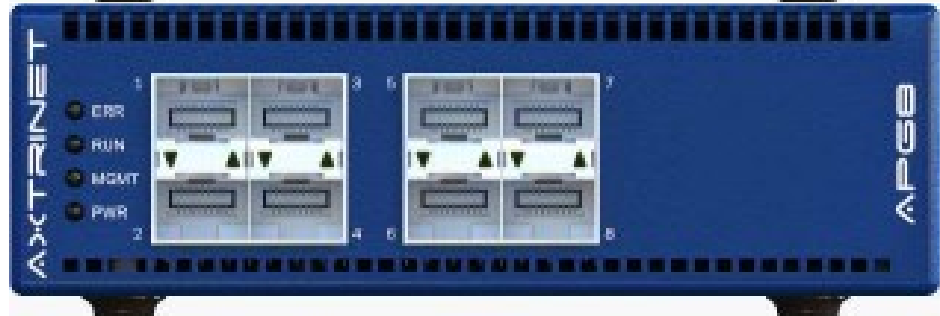
APG208
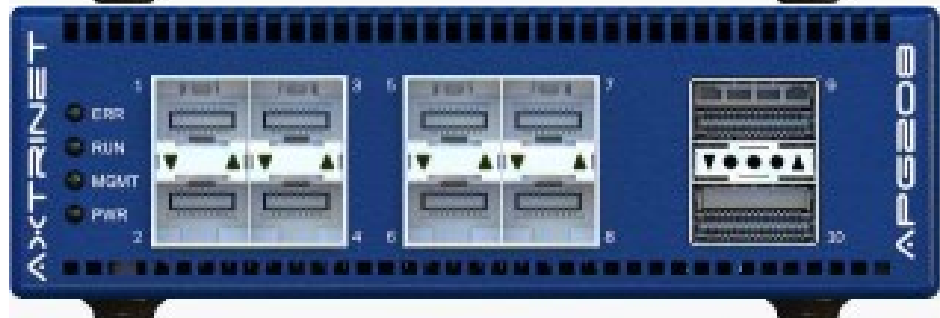
| Status LEDs | 10Gbps/1Gbps SFP+/SFP | 10Gbps/1Gbps SFP+/SFP | 40Gbps QSFP+ |

	Up to 10Gbps/1Gbps SFP+/SFP	40Gbps QSFP+
APG4 APG4V2-10	4	0
APG8 APG8V2-10	8	0
APG208	8	2

3.1.1 SFP+/SFP Interfaces

The SFP+/SFP interfaces will support 10Gbps/5Gbps/2.5Gbps SFPs that meet SFF-8431 MSA and 1Gbps SFPs that meet INF-8074 MSA.

The list of verified SFPs is available on the Axtrinet website:
https://www.axtrinet.com/axtrinet-support

The SFP+/SFP interfaces will also support certain 10GBase-T transceivers that exceed the SFF-8431 power budget of 1W, but only in the upper ports (1,3,5,7) due to thermal limitations.

> Up to 8x **Axtrinet AXB891-2-5-10GBT** transceivers can be supported in an APGV2 unit when operating in 1000Base-T or 2500Base-T mode over the full operating temperature range.
>
> When operating in 8x 5000Base-T or 10GBase-T modes, it is recommended to operate in an ambient temperature < 25°C otherwise the unit may overheat and shut down.

> If **not** using the Axtrinet 10GBase-T SFPs, it is recommended that 10GBase-T transceivers are only used in the upper ports (1,3,5,7). 10GBase-T transceivers in the lower ports (2,4,6,8) may overheat.

> 1000Base-T transceivers can be used in any SFP port

3.1.2 QSFP+ Interfaces (APG208 only)

The QSFP+ interfaces will support 40Gbps QSFPs that meet SFF-8436 MSA.

The list of verified QSFPs is available on the Axtrinet website:
https://www.axtrinet.com/axtrinet-support

The QSFP+ interfaces can be configured in 40Gbps mode (default) or 4X10Gbps mode, where each of the 10Gbps lanes that comprise the 40Gbps link are managed independently (Section 5.3). Switching between 40Gbps and 4x10Gbps modes is performed in the Port Control Window (Section 6.10.1).

3.1.3 LED Indicators
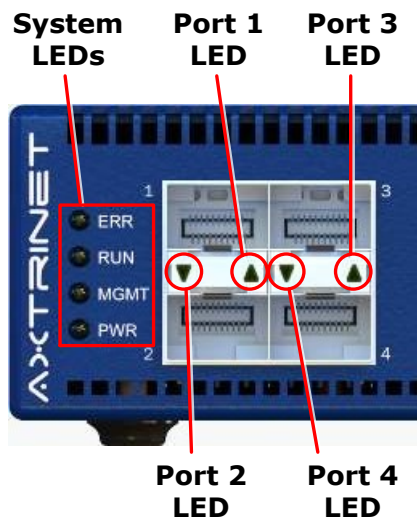
> Some APG units are fitted with SFP Cages with four LEDs per vertical port pair. In all cases, only the outer LEDs are used. The inner two LEDs are not used.

3.1.3.1   System LEDs

LED	Colour	Description
ERR	RED	Operational Unit Error eg over-temperature
	OFF	Unit OK
	OFF	Normally OFF
MGMT	GREEN	Configuration or Status information is being read from the unit
	AMBER	Configuration or Status information is being written to the unit
	OFF	Unit is not being actively managed
PWR	GREEN	Unit is powered and OK
	AMBER	Unit is powered and configuring the hardware
		After applying the power on an **APGV1** unit, the POWER LED will be illuminated ORANGE for ~60 seconds while the hardware configures. After applying the power on an APGV2 unit, the POWER LED will be illuminated ORANGE for ~25 seconds while the hardware configures.
	Flashing AMBER	Processing downloaded file (3-4 minutes)
	RED/AMBER	Failed to configure the hardware
		Power cycle the unit. If the problem persists, contact AXTRINET for Technical Support.
	RED	Initial state immediately after the power has been applied. If the LED remains on for >5 sec, critical hardware fault detected
		Power cycle the unit. If the problem persists, contact AXTRINET for Technical Support.
	OFF	Unit is not powered

3.1.3.2   Port LEDs

One LED per port, integrated into the transceiver cage:

Colour	Meaning	
GREEN	Steady	Link OK, no traffic
	Flashing	Transmit or Receive Traffic Activity
RED	Steady	Transmit disabled → set TXENABLE on Port Control tab (Section 6.10.1)
OFF	No Link	

3.2   REAR PANEL INTERFACES

USB and 10/100Base-T Ethernet interfaces provide management access to the device.
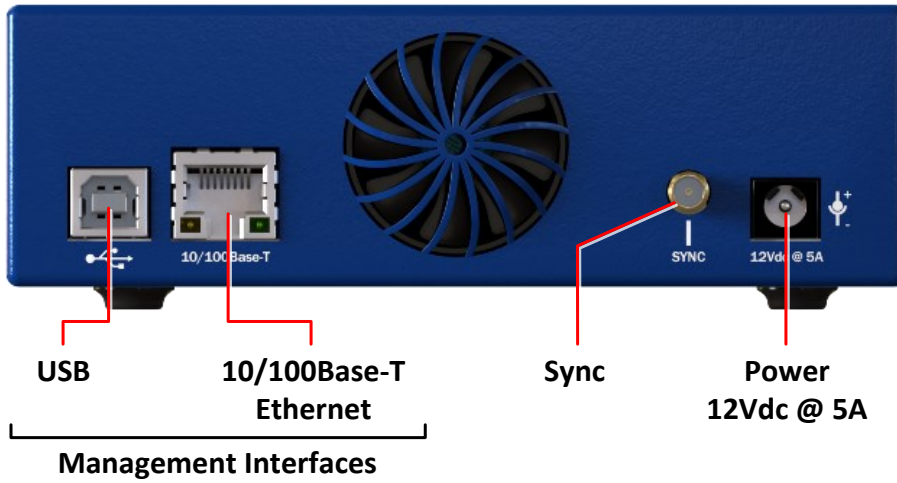
3.2.1 USB Interface

The USB 2.0 Type B interface can be used to provide a connection to the PC running the Control Interface Application Software.
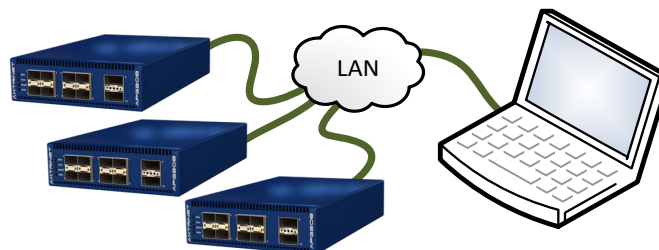

a) Direct Connection   b) Multiple APG units connected through USB Hub

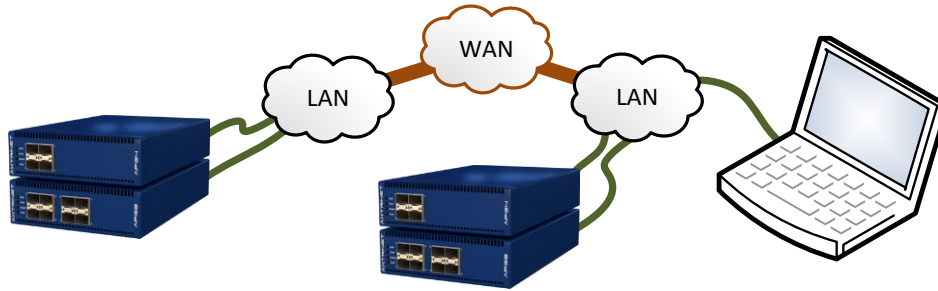After installing the Control Interface Application Software, no further configuration is required to enable the USB interface.

3.2.2 10/100Base-T Ethernet Interface

The 10/100Base-T RJ45 interface can be used to provide a network connection to the PC running the Control Interface Application Software or TCL API Scripting.

The Ethernet connection can be direct, or across a LAN, or WAN to a remote office.

c) Multiple APG units connected through LAN

d) Multiple APG units connected through WAN

After installing the Control Interface Application Software, the Network Interface must be configured using the USB Interface to set the IPV4 Address, Mask and Gateway (Section 6.3.6).

> Up to two Ethernet connections are supported by the Ethernet Interface, eg two Control Interface sessions or one Control Interface session and one TCL session.

3.2.3 SYNC Interface

The SYNC Interface allows multiple Axtrinet units to be connected together to enable synchronisation functions:

- Synchronous start of packet generation

- Synchronous timestamp reset (APGV2 only)

The SYNC Interface provides an ANSI/TIA/EIA-485 interface from a standard female SMA connector on the rear panel for connection to a standard male SMA connector on a cable or T-piece. Coaxial cable is recommended.

The SYNC interface is bi-directional, acting as an output in SYNC master mode, and an input in slave mode.

The maximum cable length between connected units is recommended to be less than 1m.

> With short co-axial cables, a single 120Ω SMA termination is recommended at one **end** of the connecting cable(s).

	Min	Typ	Max
Input High	2.0V		7.0V
Input Low	-3.0V		1.3V
Input Pulse Width	5ns		
Input Impedance	12KΩ		
Input Current			2mA

	Min	Typ	Max
Output High	2.0V		3.3V
Output Low	0V		0.8V
Output Pulse Width		5ns	

3.2.4 Power

The APG unit requires a 12V 5A from the ac/dc power supply provided.

The DC Jack is 2.1mm internal diameter, 5.5mm external diameter, 9.5mm minimum length, with the centre pin positive.
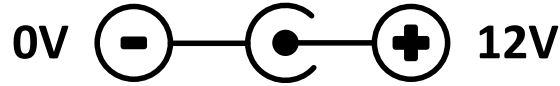
	Min	Typ	Max
Input Voltage	9.0V	12.0V	14.0V

3.3 REAR PANEL CLOCK INTERFACES (APGV2 UNITS ONLY)
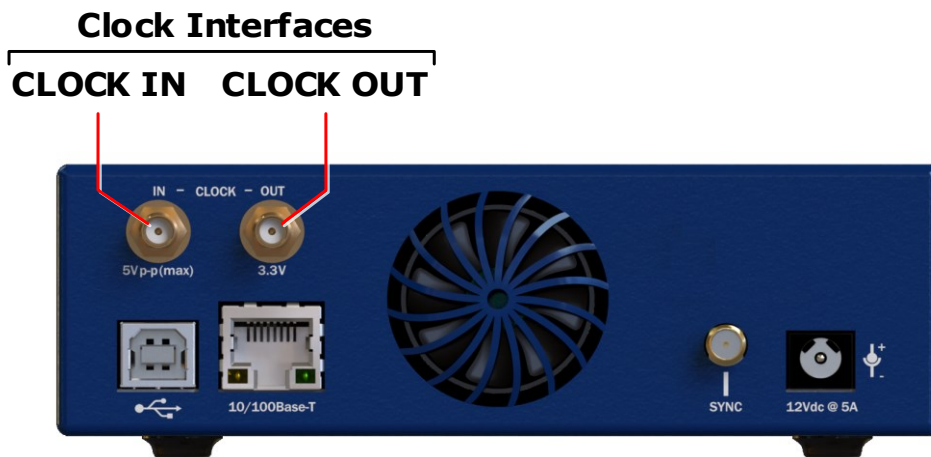
The CLOCK-IN and CLOCK-OUT Interfaces provide ANSI/TIA/EIA-485 interfaces from standard female SMA connectors on the rear panel for connection to a standard male SMA connector on a cable or T-piece. Coaxial cable is recommended.

The maximum cable length between connected units is recommended to be less than 1m.

> With short co-axial cables, a single 120Ω SMA termination is recommended at one **end** of the connecting cable(s).

3.3.1 CLOCK-IN

The clock input is used to synchronise the internal system clock to an external reference (1PPS or 1MHz)

0V ⊖—⊙—⊕ **CLOCK-IN**
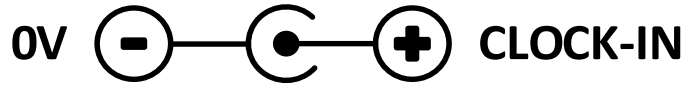
	Min	Typ	Max
Input High	2.0V		7.0V
Input Low	-3.0V		1.3V
Input Current			2mA
Input Impedance	12KΩ		

	1PPS (1Hz) Mode	1MHz Mode
Frequency	1Hz	1MHz
PLL Lock Time	120 sec	2 sec
Tolerance	±100ppm	±100ppm

The internal system clock state is displayed in the Unit Configuration window in the APG Control Interface (Section 6.9).

3.3.2 CLOCK-OUT

All Axtrinet units output a 1PPS or 1MHz reference clock on the CLOCK-OUT, depending on the clock source setting.

0V ⊖—⊙—⊕ **CLOCK-OUT**

	Min	Typ	Max
Output Low	0V		0.8V
Output High	2.0V		3.6V

3.4 PHYSICAL SPECIFICATIONS

- Width: 140mm (5.51")
- Depth: 228mm (8.97")
- Height: 44mm (1.73")
- Weight: 1.20 kg (2.65 lb)

4. MANAGEMENT INTERFACES
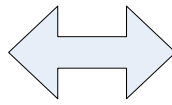
APG Control Interface

APG TCL Scripting

4.1   APG CONTROL INTERFACE
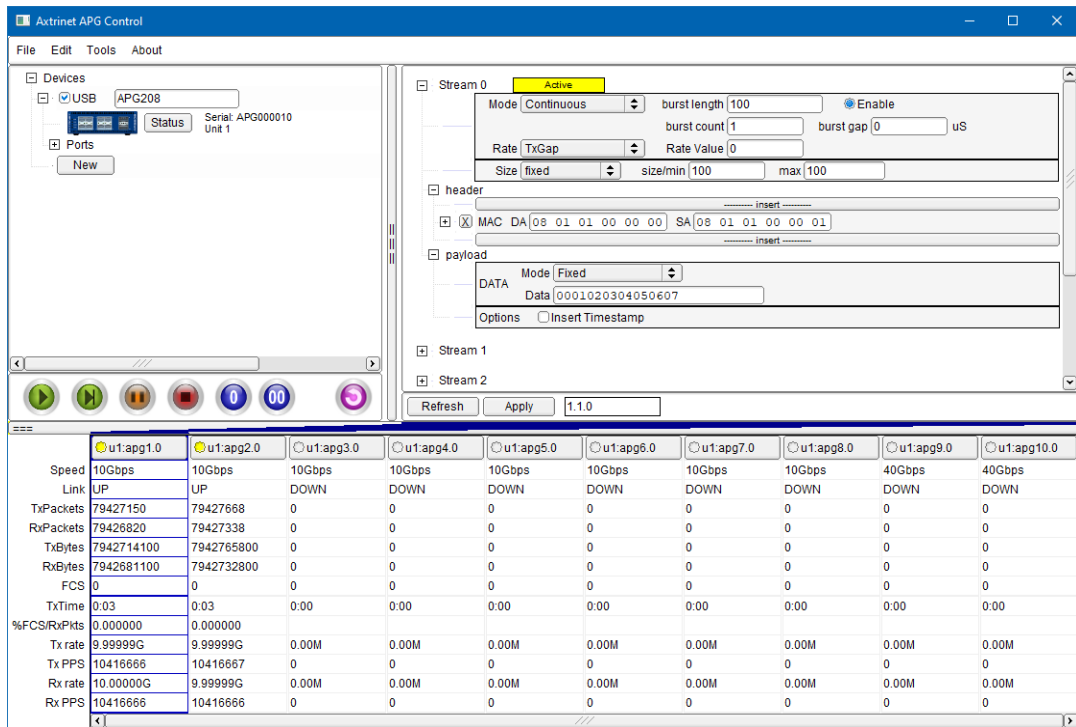
The Axtrinet APG Control Interface is a custom application providing:

- unit, port and stream configuration and status
- port control (start, step, stop)
- packet counters (packets, bytes, errors)
- receive packet capture tools

The Axtrinet APG Control Interface is described in Section 6.

4.2   TCL SCRIPTING

The Axtrinet APG API provides a TCL scripting interface for automated test generation.

The API provides access to:

- unit, port and stream configuration and status
- port control (start, step, stop)
- packet counters (packets, bytes, errors)
- receive packet capture tools

The Axtrinet APG API Interface is described in the TCL API Guide [2].

5. TEST ENVIRONMENT & CONCEPTS

The Test Environment consists of one or more Axtrinet Packet Generators. A single unit may be connected over a direct USB connection, or multiple units may be connected over USB or Ethernet. The units may be located in the same location, or in geographically separate locations connected by a WAN.
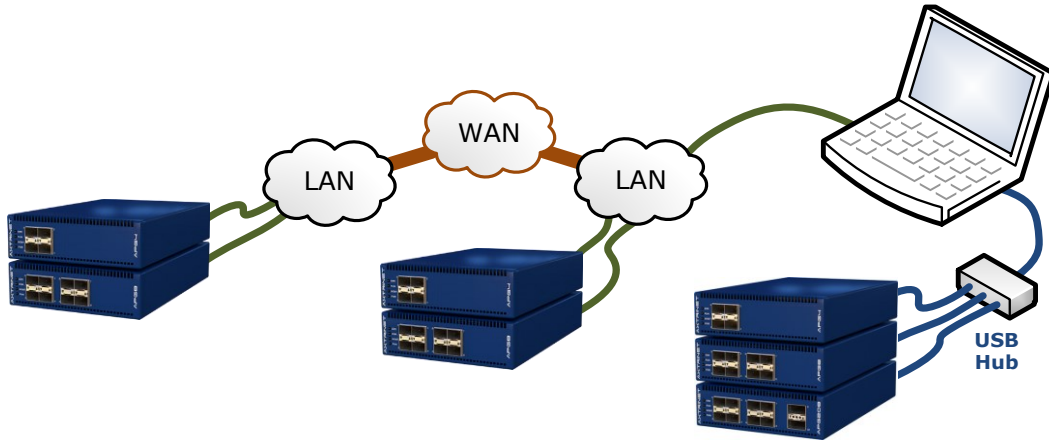
All accessible units can be managed through the same Control Interface or TCL scripting interface.

5.1 DEFINITIONS

UNIT	A unit is a single physical Axtrinet Packet Generator (eg APG208).
	A unit is assigned a UNITID when the management connection is first opened using the Control Interface (or TCL API). The UNITID is fixed for the duration of the Control Interface session, and is used to uniquely identify a unit during the session. The UNITIDs will be reassigned if the application is restarted.
	The UNITID can be seen in the Connection Panel (Section6.4) and in the port label in the Counters Panel (Section 6.6).
PORT	A PORT is a physical aperture on the unit (SFP+/SFP or QSFP+).
	The port-level functions configure the port settings and monitor the port status (Section 6.10.1) and view the captured packets (Section 6.10.2).
	Ports must be selected (Section 6.6) to start/step/stop transmission (Section 6.6).
SUBPORT	Where a QSFP+ port can be configured into different topologies (eg 40Gbps or 4x10Gbps), the PORTID is qualified with a SUBPORT.
	Subports are numbered from 1.
MODULE	A MODULE is a SFP+/SFP or QSFP+ transceiver, and must be inserted into a port aperture to enable a link.
	The module-level functions configure the module settings (Section 6.10.1), and monitor the module status (Section 6.10.2).
STREAM	A transmit stream generates a controlled number of Ethernet frames with a defined length and rate (Section 6.5.1); fixed header configuration with a fixed or varying header contents (Section 6.5.2); and a fixed or varying payload (Section 6.5.3).
	The outputs from the eight stream generators are multiplexed into a single stream for transmission from a port.

5.2 UNIT CONFIGURATION

The unit, port and stream configuration is stored on the unit.

The APG Control Interface provides a graphical interface to view and modify the configuration stored on the unit, to view the counters and the captured data. The current configuration can be saved locally to a named file and then loaded onto a unit later.

Unit, port and stream configurations can be modified within the Control Interface and APPLIED to the unit.

The unit will retain its configuration over a power cycle.

5.3 PORT TOPOLOGY

Port Topology defines the physical port configuration (eg 40Gbps, 4x10Gbps), rather than the interface type (eg QSFP+).

5.3.1 SFP+/SFP Ports

The SFP+/SFP Port Topology can be 10Gbps, 5Gbps, 2.5Gbps or 1Gbps .

> ⚠️ **On APGV1 units only**, the unit will reboot after switching 10Gbps/1Gbps Topology.

5.3.2 QSFP+ Ports (APG208 only)

The QSFP+ interface is a composite port made up of 4x 10Gbps. The topology can be configured in 40Gbps mode (default) or 4X10Gbps mode, where each of the 10Gbps lanes that comprise the 40Gbps link are managed independently.

Changing the port topology of a QSFP+ port changes both the transmit and receive paths.
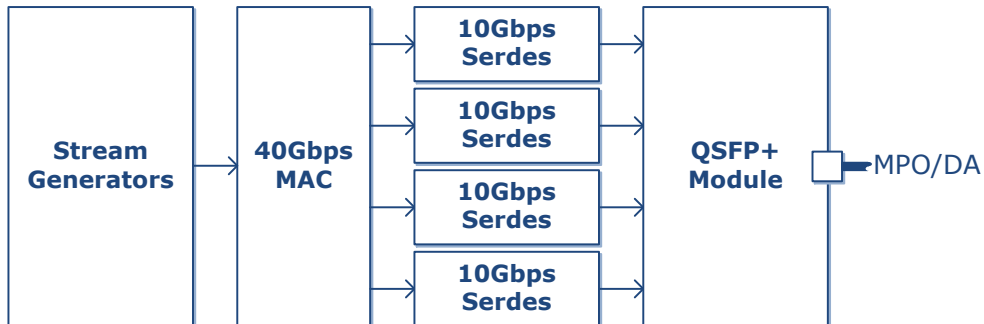
a) QSFP+ Port in 40Gbps Topology (default)
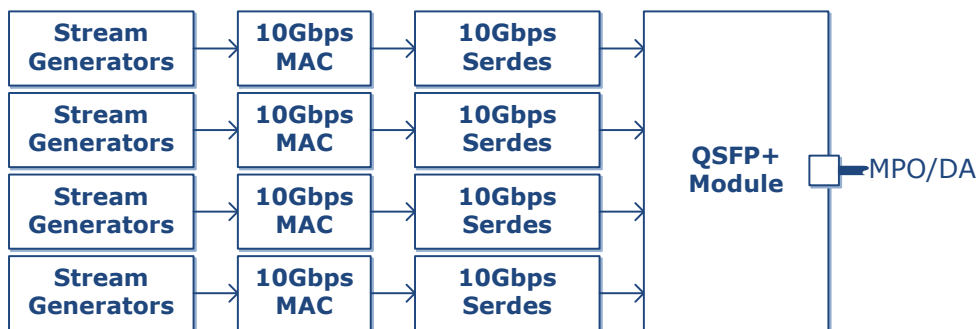
b) QSFP+ Port in 4x10Gbps Topology

Switching between 40Gbps and 4x10Gbps topologies is performed in the Port Control Window (see Section 6.10.1).

> ⚠️ Mixed topology of the QSFP+ ports is **only** available with Port 9 at 4x10Gbps, and Port 10 at 40Gbps.   Setting Port 9 to 40Gbps or Port 10 to 4x10Gbps topologies will automatically switch the other port into the same mode.

5.4 TRANSMIT PATH

Each port contains a transmit engine that comprises:

• 8 parallel independent configurable Ethernet stream generators

• Stream multiplexer

• Transmit port configuration and status

• Module configuration and status
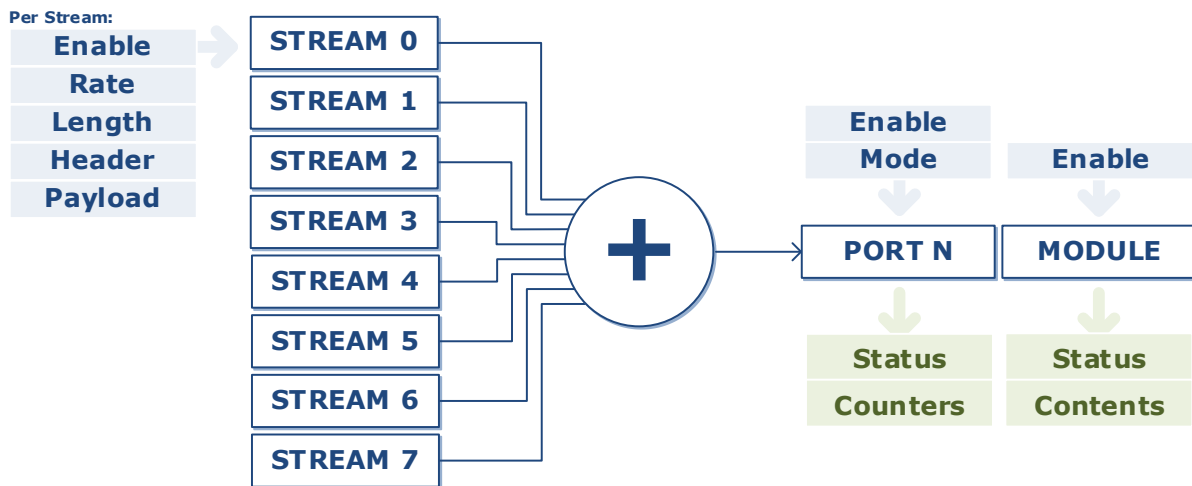
The streams are processed in a round-robin sequence, transmitting a packet if it queued and ready to send.

> ℹ️ To bring a link up, both the port and module must be enabled.
> To transmit a stream, the port, module and stream must be enabled.
> The transmit mode must be CONTINUOUS or a non-zero BURST.

> ℹ️ Transmit PRBS Mode is supported on APGV2 units only.

5.4.1 Stream Generation

The Stream Generator defines an Ethernet frame:
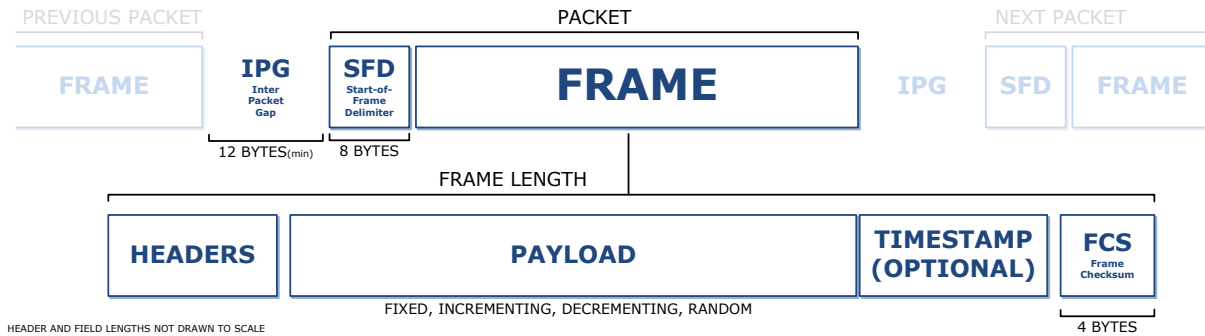
A transmit stream generates a controlled number of Ethernet frames at a controlled length and rate; with a fixed header configuration, fixed or varying header contents, and a fixed or varying payload.

Each stream can be enabled or disabled (Section 6.5.1).

The stream transmit mode defines how the packets are generated: either Continuously; as a Single Burst of BURST LENGTH packets; or a Multiple Burst of BURST LENGTH packets, repeated BURST COUNT times, separated by BURST GAP (Section 6.5.1).
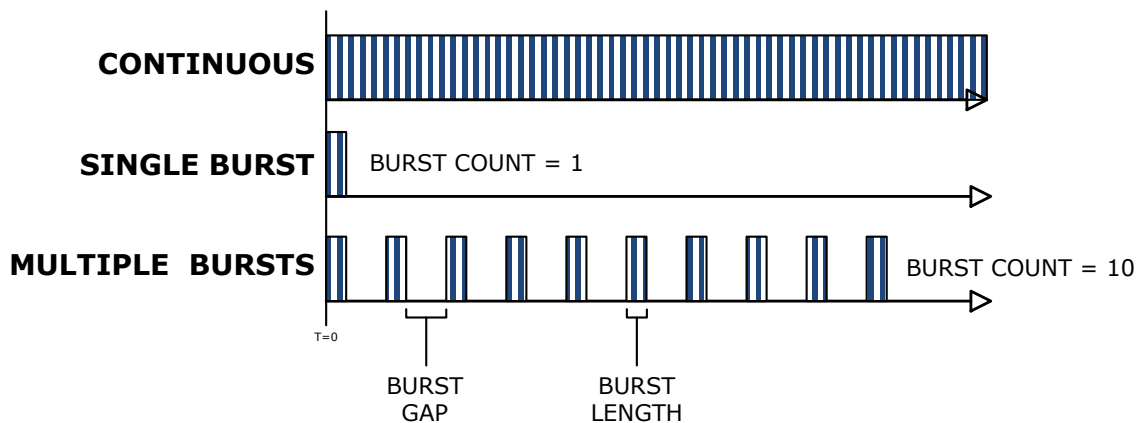
The stream transmit rate defines how quickly the packets are generated; either a percentage of the maximum rate; packets per second; or a gap defined by transmit clock cycles (Section 6.5.1).

> Care should be taken to ensure that the cumulative stream transmit rates does not exceed the port capacity.
>
> If the cumulative stream transmit rates does exceed the port capacity, the port will transmit at wire rate, but the streams will transmit at a lower rate than configured.

The length defines the total length of the frame in bytes, including the headers, payload, timestamp (if enabled) and 4-byte Frame Checksum (FCS). The length can be fixed, or incrementing, decrementing or random over a range (Section 6.5.1).

The HEADER is created by adding header types (eg MAC, VLAN, IPV4) to the stream (Section 6.5.2).
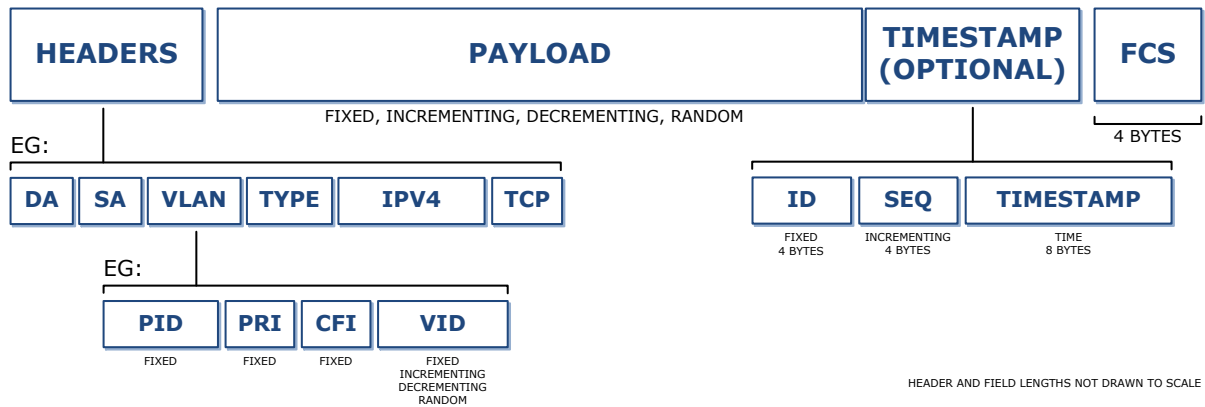
The payload can be fixed, or incrementing, decrementing or random (Section 6.5.3)

The payload may optionally include a 'Timestamp' field, comprising an ID, sequence number and timestamp (Section 6.5.3).

⚠ **The Timestamp ID field is fixed at 0x0 in APG Control Interface Version 3.4.**

⚠ **The Sequence Number is set to zero when the unit powers up, and increments continuously for each packet transmitted with the Timestamp field enabled.**

The Sequence Number will wrap after 2^{32} (4,294,967,296) packets. Wire-rate 64 byte packets at 40Gbps will take 1 min 12 secs.

The Sequence Number can be reset in APG Control Interface Version 3.2.

⚠ **On a APGV1 unit, the Timestamp indicates the time in 8ns cycles since the unit was reset. It is not possible to reset the timestamp**

ℹ On a APGV2 unit, the Timestamp indicates the time in 2.5ns cycles since the unit was reset. The Timestamp **can** be reset in APG Control Interface Version 3.2.

A port can be enabled or disabled (Section 6.6), or run in PRBS mode (Section 6.10.4).

Port link status, link speed and transmit counters (Section 6.6) are available.

A module can be enabled or disabled (Section 6.10.1).

The module type, vendor and capabilities are available (Section 6.10.2).

5.5   PORT CONTROL

On the APG Control Interface Counter Panel (Section 6.7), ports can be selected individually or grouped for control using the Control Panel (Section 6.6).

The START button starts packet generation of the enabled streams.

STOP stops the packet generation. START will restart the packet generation from the first packet.

PAUSE interrupts the packet generation. START continues the packet generation from where it was paused.

STEP generates only the next packet, then pauses.
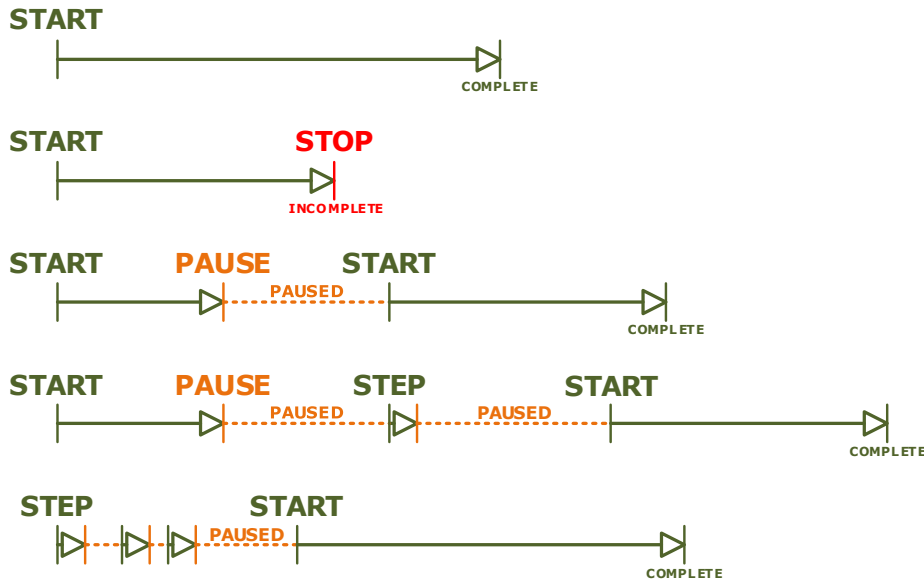
5.6   INTER-UNIT SYNCHRONISATION (APGV2 UNITS ONLY)

The Axtrinet unit uses an internal oscillator to clock a PLL-based clock synthesiser to generate the system clocks for the Ethernet Packet Generator, Ethernet and USB management interfaces. The clocks on separate APG units are free-running and will not be frequency or phase locked to each other.

Each unit has a SYNC interface and CLOCK-IN / CLOCK-OUT interfaces. The SYNC interfaces on each unit must be connected together; and the CLOCK-OUT from the master unit must be connected to the CLOCK-IN interfaces on the slave units for inter-unit synchronisation.

5.6.1 Clock Synchronisation

The Clock Interfaces allow multiple units to be connected together to synchronise system clocks to an external 1PPS (1HZ) or 1MHz reference. The reference can be generated locally from one of the connected Axtrinet units; or from an external timing reference source.

The synchronisation signal is a 1PPS or 1MHz clock. The electrical specification is defined in Section 3.3.1.

a) Multiple APG units synchronised locally
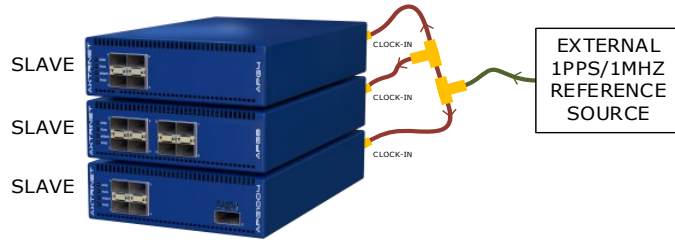
b) Multiple APG units synchronised from external source

Clock source is a unit function, and is set in the Unit Configuration window in the APG Control Interface (Section 6.9.1). If using a locally generated clock source, **one** unit must be set to the INTERNAL clock source (ie Clock Master); and the other units must be set to EXTERNAL clock source (ie Clock Slaves). If using an external reference source, all units must be set to EXTERNAL clock source. The synchronisation frequency (1PPS or 1MHz) must match on all connected units.

The clock status is displayed on the Unit Clock Control Configuration window (Section 6.9.1)

> Short co-axial cables (<50cm) are recommended to connect the CLOCK-OUT to the CLOCK-IN interfaces. Very short cables (<20cm) are preferable.
> For optimum performance, a single 120Ω termination load is recommended at a 'slave' end of a short (<50cm) clock connection.
> 120Ω terminations loads are recommended at **both** ends of a long clock connection.

> **System clocks on the slave units will be frequency and phase locked to the master clock. If the CLOCK-OUT is enabled on the slave units, the 1PPS or 1MHZ output on the synchronised units will not be phase aligned.**

5.6.2 Timestamp Synchronisation

Timestamp synchronisation requires the rear panel SYNC interfaces are connected between the units (Section 3.2.3); and access to the APG Control Interface (Section 6.7)

The synchronisation pulse can be generated locally from one of the connected Axtrinet units; or from an external pulse generator. The electrical specification is defined in Section 3.2.3.

a) Multiple APG units synchronised locally

b) Multiple APG units synchronised from external source

By default, the APG Control Interface will manage the timestamp synchronisation automatically by allocating the master and slave units within the 'unit synchronisation group'. Alternatively, the group and master can be selected manually on the Unit Sync Control Configuration window (Section 6.9.2).

The timestamp reset mode can be set in the Edit Setting – Sync window (Section 6.3.5.2) to zero or current (Unix) time.

> Very short co-axial cables (<20cm) are recommended to connect the SYNC interfaces. For optimum performance, a single 120Ω termination load is recommended at a 'slave' end of a short (<50cm) sync connection.
> 120Ω terminations loads are recommended at **both** ends of a long sync connection.

The 'synchronised' ports will reset the timestamp on the rising edge of the synchronisation pulse.

5.6.3 Transmit Synchronisation

Transmit synchronisation requires the rear panel SYNC interfaces are connected between the units (Section 3.2.3); and access to the APG Control Interface (Section 6.7)

The synchronisation pulse can be generated locally from one of the connected Axtrinet units; or from an external pulse generator. The electrical specification is defined in Section 3.2.3.

a) Multiple APG units synchronised locally   **b) Multiple APG units synchronised from external source**
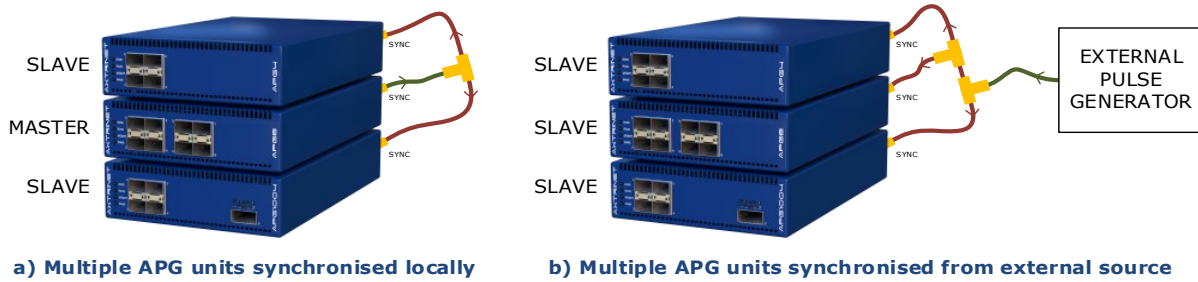
By default, the APG Control Interface will manage the transmit synchronisation automatically by allocating the master and slave units within the 'unit synchronisation group'. Alternatively, the group and master can be selected manually on the Unit Sync Control Configuration window (Section 6.9.2).

> Very short co-axial cables (<20cm) are recommended to connect the SYNC interfaces. For optimum performance, a single 120Ω termination load is recommended at a 'slave' end of a short (<50cm) sync connection.
> 120Ω terminations loads are recommended at **both** ends of a long sync connection.

The 'synchronised' ports will start transmitting on the rising edge of the synchronisation pulse.

> The transmit timestamp of the **first** transmitted packet will be within ±1 clock cycle across any port on any unit (APGV1 ±8ns, APGV2 ±2.5ns)

5.7   RECEIVE PATH

Each port contains a receive path that comprises:

- Receive port mode, status and counters

- Configurable Capture Buffer
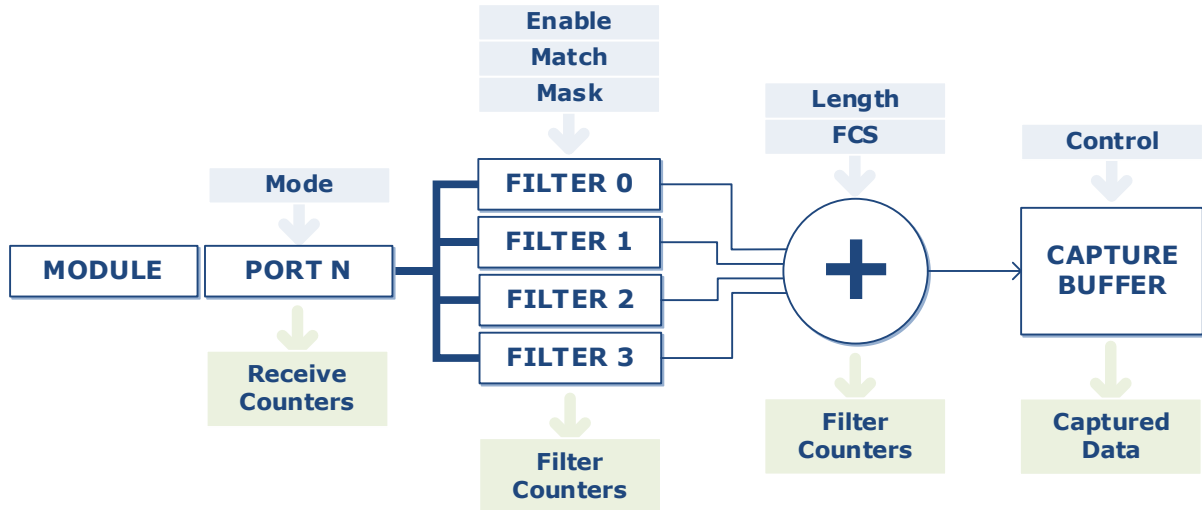
ℹ️   Receive PRBS Mode is supported on APGV2 units only.

⚠️   **Configurable Capture Filters are not supported in APG Control Interface Version 3.4.** All received port traffic is forwarded to the capture buffer.

A 64KB capture buffer is available per 10Gbps port, that can be enabled or disabled, cleared and displayed (Section 6.10.2).

A 256KB (4x64KB) capture buffer is available per 40Gbps port (APGV1 only), that can be enabled or disabled, cleared and displayed (Section 6.10.2).

ℹ️   The 10Gbps Capture Buffer will capture undersize packets in the range 17-63 bytes. The 40Gbps Capture Buffer does not capture undersize packets. (APGV1 only)

An extended deep capture buffer is available, shared between the ports.

On an APGV1 unit, an extended 1GB capture buffer is available, allocated as follows:

ℹ️   64MB is allocated to each 10Gbps port
256MB is allocated to each 40Gbps port

On an APGV2 unit, an extended 2GB capture buffer is available, allocated as follows:

ℹ️   128MB is allocated to each port

Access to the 'deep' capture memory can be enabled or disabled per port.

The port receive counters and captured packets (Section 6.10.2) are available.

6. CONTROL INTERFACE

The section describes the Control Interface for Windows and Linux.

6.1 RUNNING THE CONTROL INTERFACE

6.1.1 Linux

Click on the **home / Axtrinet Control** icon or execute **usr/bin/apg_control**

6.1.2 Windows

Click on the APG Control icon in the Start Menu \ Axtrinet directory.

6.2 OVERVIEW

The APG Control Interface comprises 5 areas:

Menu Bar	APG Control Interface configuration and settings. See Section 6.3
Connection Panel	Open/Close management connections to the packet generator units. See Section 6.4
Stream Configuration Panel	Port Stream Configuration See Section 6.5
Control Panel	Start/Stop packet generator and clear counters See Section 6.6
Counter Panel	Packet Generator counters and port control. See Section 6.7
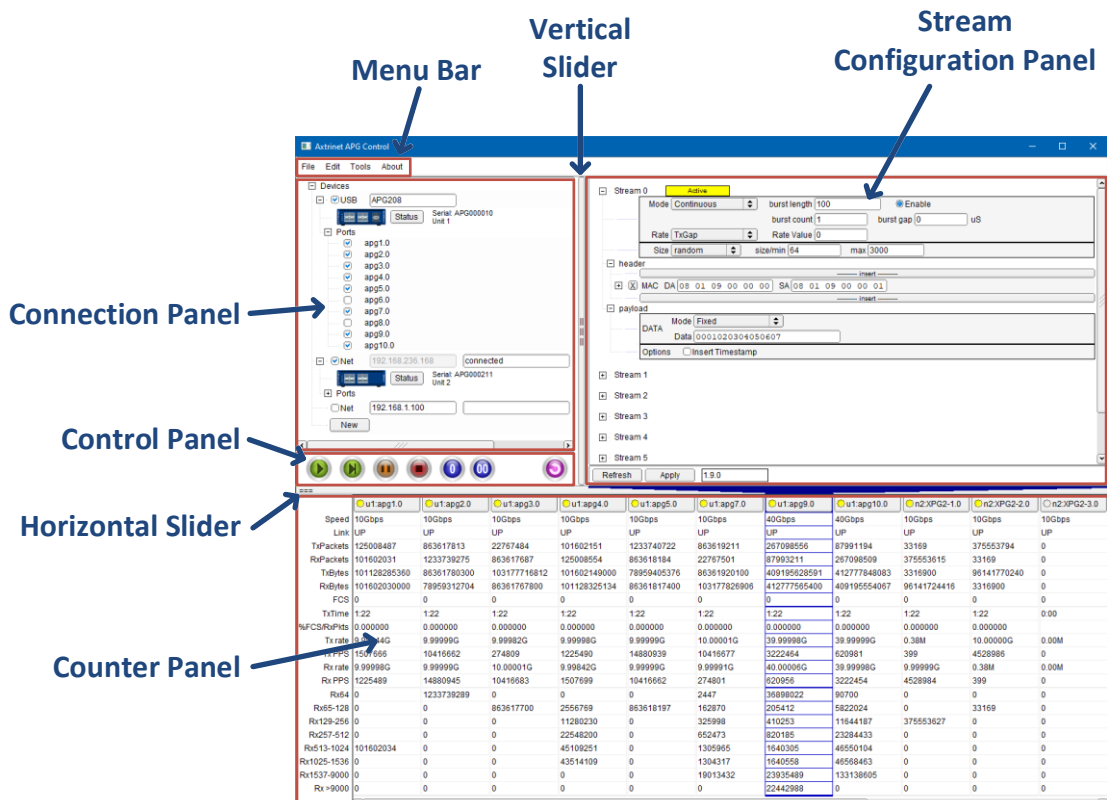
6.3   MENU BAR

File	Edit	Tools	About
Save	Settings	Upgrade Unit	
Save As	Network Configuration		
Load	Counter Configuration		
Exit			

6.3.1 File – Save

Saves the <u>default</u> Control Interface configuration:

* IP Addresses of known units

* Connection status

* Counter configuration and Panel settings

* Port visibility

The default configuration is used when the Control Interface starts.

6.3.2 File – Save As

Saves the current Control Interface configuration, including:

* APG Control Interface layout, settings and port counters

* Port and Stream configuration for <u>all</u> connected units

A "File Save As" window appears to select the save file name and location.

The saved configuration file has a .apg extension.

Saved configurations can be applied using the Load Configuration option.

6.3.3 File – Load

Loads a saved configuration file to selected unit(s).

The "Load Config from File" window appears to select the configuration file and select the data to be applied to the current configuration.
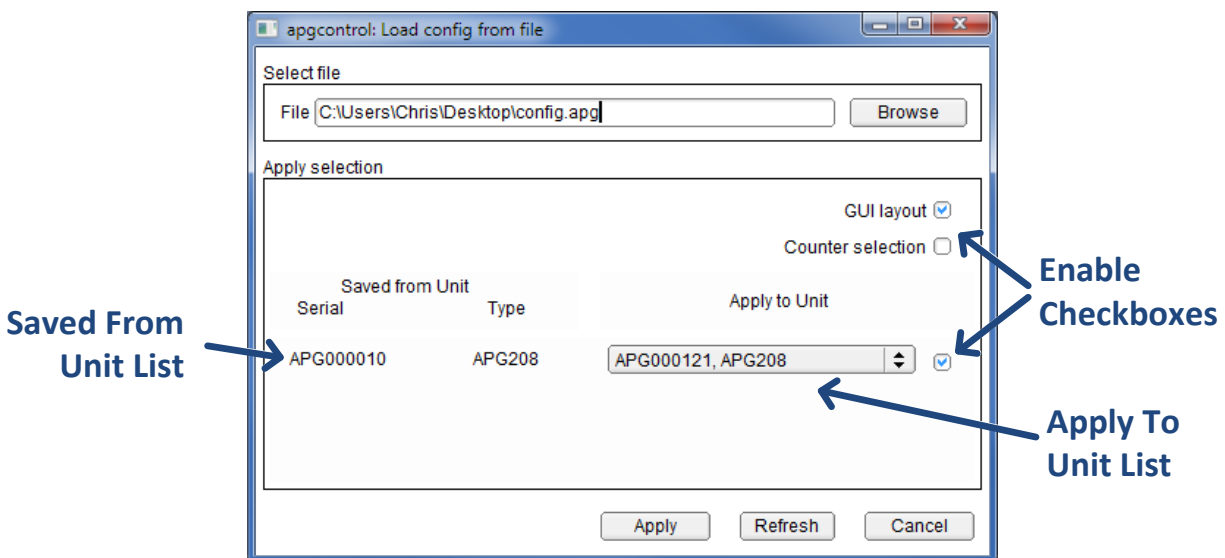
Button	Action
Browse	Opens the "File Load" window to select the load file name and location. Alternatively, the path and filename can be entered manually. The path and filename default to the last used settings.
☐\☑	Disable\Enable Configuration change
Apply	Applies the saved configuration to the selected options
Refresh	Refreshes the list of connected units
Cancel	Closes the Load Configuration window without applying the changes.

Select the saved configuration file either by entering the path and filename (.apg extension) manually or by clicking the Browse button to open the File Selection window to select the directory and filename.

Opening the selected file automatically parses the saved configuration where the contents are analysed to determine how many units were included in the saved configuration.

The saved 'GUI Layout' and 'Counter Selection' will be applied if the corresponding checkbox is enabled. The stream configuration is always applied.

A list of saved serial numbers and unit types are displayed, with a corresponding 'apply' list of currently <u>connected</u> units. The connected unit list can be updated using the Refresh button.

The checkbox must be enabled to load the saved configuration onto the target unit.

The 'apply' unit does not have to be the same serial number or type, and saved ports will be applied if the port exists on the target unit.

The configuration is applied to the APG Control Interface and connected units using the Apply button.

6.3.4 File – Exit

Closes the connections to APG units and close the Control Interface.

> The APGs will continue to run and generate packets when the Control Interface is not connected.

6.3.5 Edit – Settings

6.3.5.1 Display Tab

The APG Control Interface can be configured on the Display Settings tab:

Formatting
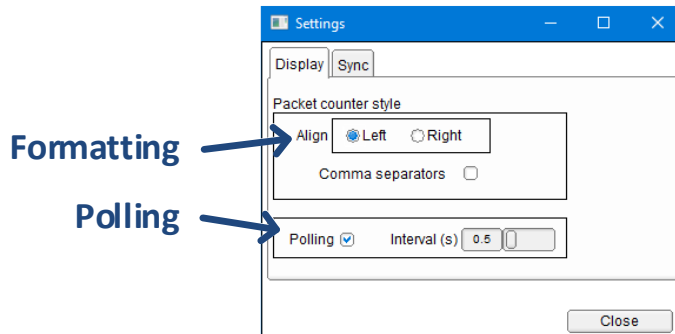
Polling

Option	Description
Align	Align counter values LEFT or RIGHT
Comma Separators	Add 'thousand' separators to the counter values
Polling	Automatically poll the connected units every 'interval' The polling interval is adjustable between 0.5 – 2 seconds.

6.3.5.2 Sync Tab (APGV2 units only)

The Timestamp Reset Mode is an APG Control Interface setting, and can be configured on the Sync tab:
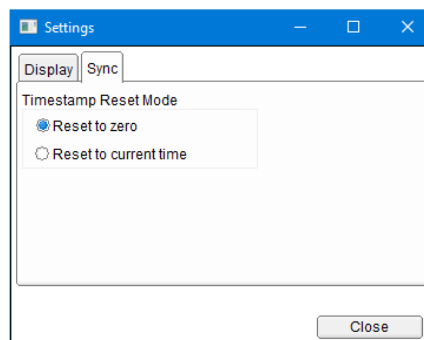
Option	Description
Reset to zero	Resets the packet timestamp counter to zero
Reset to current time	Resets the packet timestamp counter to Unix time, measured in APG unit clock cycles (APGV1 = 8ns; APGV2 = 2.5ns)

⚠️ **Timestamp Reset is not supported on APGV1 units.**

6.3.6 Edit – Network Configuration

The network configuration is entered using the Network Configuration window:
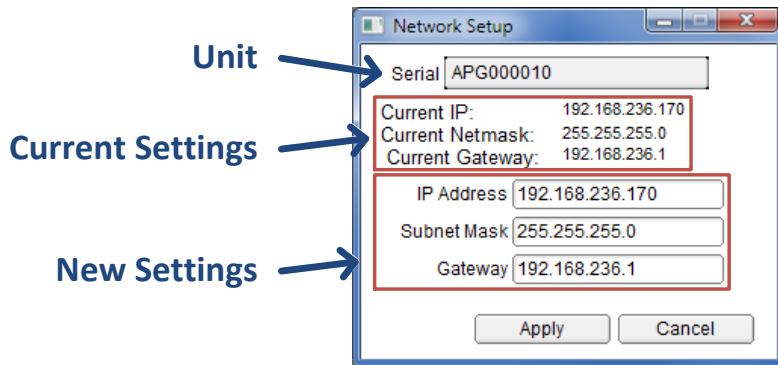
> ⚠️ **You may need to contact your Network Administrator to obtain the required IP and Gateway Addresses**

The serial number of the target unit is displayed. If more than one unit is connected through the APG Control Interface, select the desired unit from the drop-down list of available unit serial numbers.

The current IP settings of the selected unit are displayed.

The default settings are:

IP Address	**192.168.1.100**
Mask	**255.255.255.0**
Gateway	**0.0.0.0**

Button	Action
Apply	Applies the Network Configuration changes to the unit.
	⚠️ **Changing the Network Configuration while connected to the unit over a network connection will immediately disconnect the unit from the APG Control Interface.** Open a new connection with the new address to continue to manage the unit.
Cancel	Closes the Network Configuration window without applying the changes.

6.3.7 Edit – Counter Configuration

Counters (eg TxPackets), status indicators (eg Speed) and calculated values (eg TxRate) can be added or removed from the Counter Panel display list, and re-ordered within the display list.

All counters are always active, so can be viewed or hidden without affecting the counter values.

Counter management is performed using the Counter Configuration window:
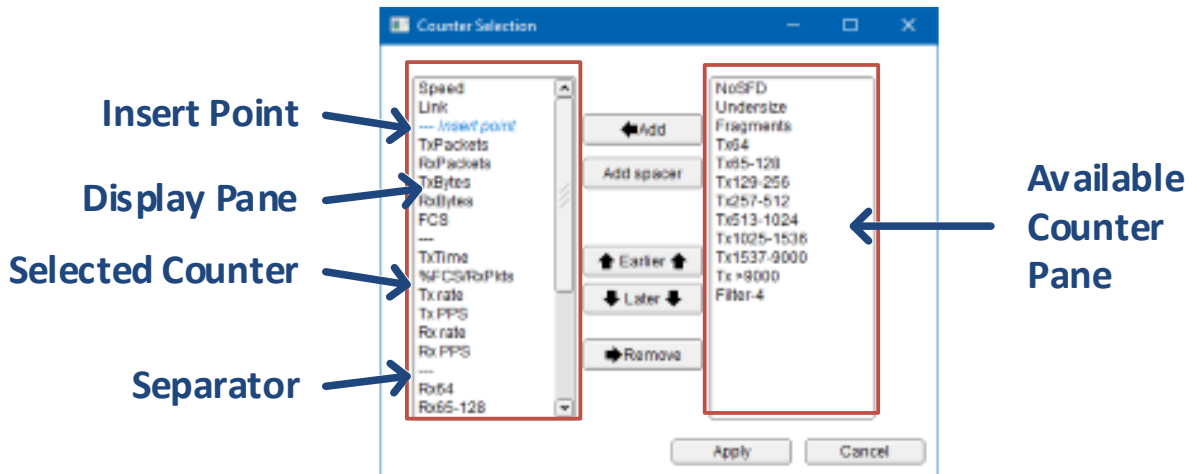
The following control buttons are available:

Button	Action
◀Add	Adds the selected counters to the DISPLAY COUNTER pane at the *insert point*. The *insert point* can be moved UP and DOWN using the EARLIER and LATER buttons.
Add spacer	Adds a spacer to the DISPLAY COUNTER pane at the *insert point*
⬆ Earlier ⬆	Moves the currently selected counters in the DISPLAY COUNTER pane UP
⬇ Later ⬇	Moves the currently selected counters in the DISPLAY COUNTER pane DOWN
➡Remove	Removes the selected counters from the DISPLAY COUNTER pane
Apply	Applies the Counter Configuration changes to the Control Interface. The displayed counters will update immediately.
Cancel	Closes the Counter Configuration window.

The following status indicators are available:

Status	Description
Speed	1Gbps, 2.5Gbps, 5Gbps, 10Gbps or 40Gbps 10Mbps, 100Mbps with 1000Base-T SFP Transceiver
Link	UP or DOWN
TxTime	Time in seconds since the START button was pressed

The following transmit counters are available:

Transmit	Description
TxBytes	Transmit Bytes
TxPackets	Transmit Packets
Tx64	Transmitted Packets with length equal to 64 bytes
Tx65-128	Transmitted Packets with length between 65 and 128 bytes
Tx129-256	Transmitted Packets with length between 129 and 256 bytes
Tx257-512	Transmitted Packets with length between 257 and 512 bytes
Tx513-1024	Transmitted Packets with length between 513 and 1024 bytes
Tx1025-1536	Transmitted Packets with length between 1025 and 1536 bytes
Tx1537-9000	Transmitted Packets with length between 1537 and 9000 bytes
Tx>9000	Transmitted Packets with length greater than 9000 bytes

The following receive counters are available:

Receive	Description
RxBytes	Receive Bytes
RxPackets	Valid Receive Packets
Rx64	Valid Receive Packets with length equal to 64 bytes
Rx65-128	Valid Receive Packets with length between 65 and 128 bytes
Rx129-256	Valid Receive Packets with length between 129 and 256 bytes
Rx257-512	Valid Receive Packets with length between 257 and 512 bytes
Rx513-1024	Valid Receive Packets with length between 513 and 1024 bytes
Rx1025-1536	Valid Receive Packets with length between 1025 and 1536 bytes
Rx1537-9000	Valid Receive Packets with length between 1537 and 9000 bytes
Rx>9000	Valid Receive Packets with length greater than 9000 bytes

> ⚠️ **Capture Filters are not supported in APG Control Interface Version 3.4**

The following error counters are available:

Errors	Description
FCS	Frame Checksum Errors Received
Undersize	Short packets (<64 bytes) with a valid SFD and FCS
Fragments	Packets without a valid SFD
NoSFD	Received Packet without a valid SFD

The following calculated values are available:

Calculated	Description
TxRate	Transmit Bit Rate in gigabits per second
Tx PPS	Transmit Packets per Second
RxRate	Receive Bit Rate in gigabits per second
Rx PPS	Receive Packets per Second
%FCS/RxPkts	FCS Error Rate (percentage)

6.3.8 Tools – Upgrade Unit

The embedded software and FPGA firmware can be updated through the download window:
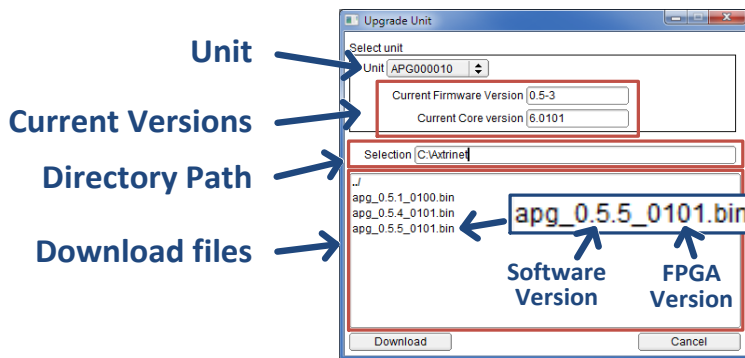
Select the target unit by the serial number from the dropdown list.

The current embedded software and FPGA firmware versions loaded on the unit are displayed.

Select the directory and download image from the file browser. The download image contains both the embedded software and FPGA firmware images.

Option	Action
Download	Applies the download file to the unit.
Close	Closes the window without downloading new software.

To continue the firmware download, click 'yes' when the confirmation window appears:

If an invalid file is selected, the following message is displayed:

The progress window appears while the image is downloaded to the unit:
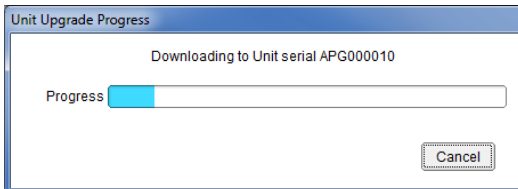
> An image download on an APGV1 unit takes 2-3 minutes
> An image download on an APGV2 unit takes ~40 seconds

When the download completes, the "download complete" message is displayed and the unit reboots:
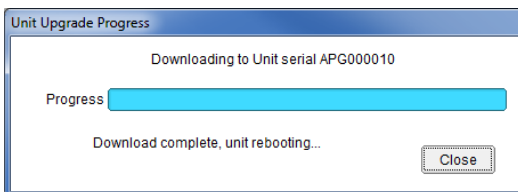
The PWR LED flashes amber while the new image is processed and saved into FLASH memory.

> Re-FLASH on an APGV1 unit takes 3-4 minutes
> Re-FLASH on an APGV2 unit takes ~1 minute.

The unit then boots normally.

6.3.9 About

Displays the current APG Control Interface version:
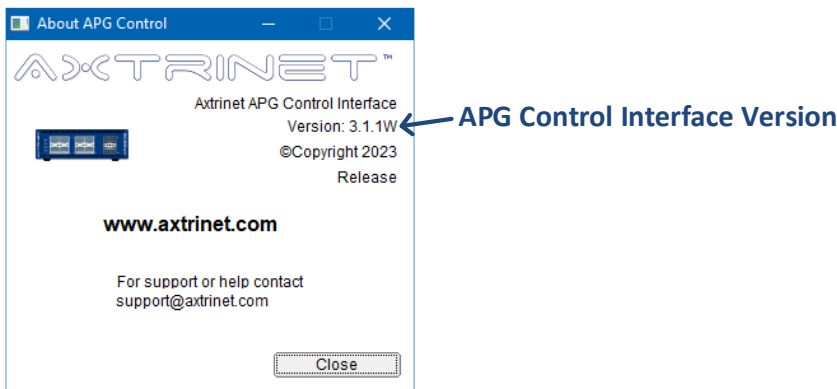
6.4 CONNECTION PANEL

Connection to APG units using USB or Ethernet management interfaces is achieved through the Connection Panel. Units using the USB interface will always be visible in the Connection Panel.

Connections to networked units must be defined using the New button.

Click on the Connect Checkbox to toggle the management connection.

ℹ	The USB interface does not display a connection status. The Unit Status, serial number and ID are greyed out when not connected.

ℹ	The visible ports are automatically added to the counter pane when the management interface is connected.

⚠	**If an attempt is made to connect using the USB <u>and</u> the Ethernet interfaces on the same unit from the same APG Control interface, the second attempted connection will fail.**

The Ethernet management status is displayed next to the IP address:

Status	Description
	Connection not attempted during this APG Control Interface session
connecting..	Connect Checkbox ticked, connecting to the APG
connected	Connection successful and management interface active.
disconnecting..	Connect Checkbox cleared, disconnecting from the APG
closed	Management connection closed
Unit API not supported	If the Unit API is incompatible with the GUI API, the management connection is refused.

> ℹ️ Download the latest Embedded Software from
> **https://www.axtrinet.com/axtrinet-support**
> Then use the "Upgrade Unit" tool (Section 6.3.8)

Status	Description
connect failed	Failed to connect to the APG management interface

> ⚠️ **If the connection fails, check:**
> - **IP Address**
> - **Can you ping the APG unit?**
> - **Is the APG unit connected to the network?**
> - **Is the IP address configured on the APG unit?**
> - **If trying to connect from a different subnet or network, is the gateway address configured on the APG unit?**

The PORT EXPANDER opens the PORT VISIBILITY list.
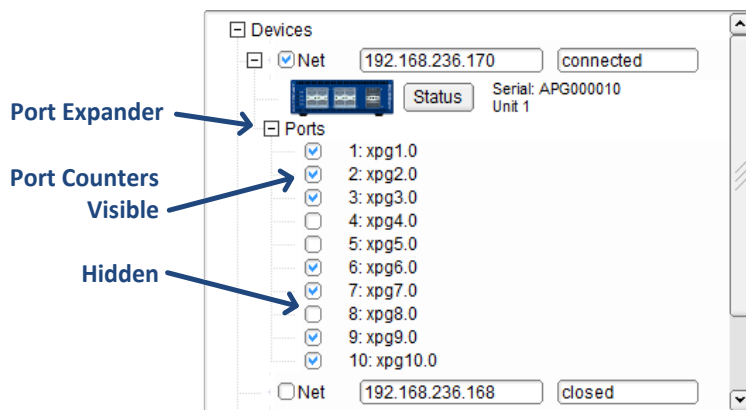
Checkboxes next to each port change the port visibility in the Counter Pane.

6.4.1 Status Window
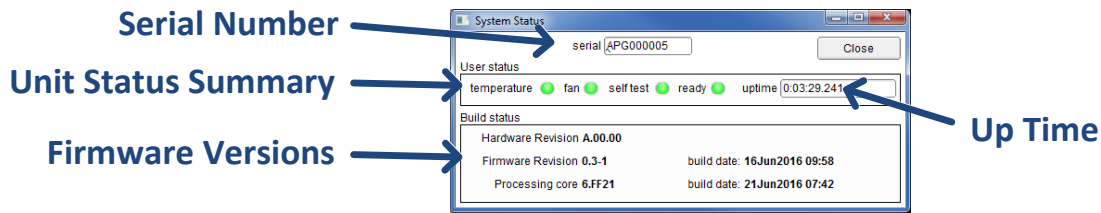
The System Status summary displays the following information:

Option	Function
Serial Number	Serial number of the unit
Unit Status	**TEMP:** 🟢 Temperature OK 🟠 Temperature Warning – fan speed will increase 🔴 Over-Temperature – front panel disabled
	FAN: 🟢 Fan OK 🟠 Fan is running faster than expected 🔴 Fan has failed or is running at full speed
	SELF-TEST: 🟢 Self-Test passed 🟠 Self-Test running 🔴 Self-Test Failed (READY status will also be RED)
	READY: 🟢 Unit OK and ready to generate Ethernet Traffic 🟠 Unit booting 🔴 Unit failed
Up Time	Time since the unit was turned on
Versions	Hardware, Embedded Software and Processing Core (FPGA) versions and date codes.

6.5   STREAM CONFIGURATION PANEL

Stream Configuration is defined in the Stream Configuration Panel.

Each port contains 8 parallel independent configurable Ethernet stream generators.

Each stream generates a controlled number of Ethernet frames at a controlled length and rate; with a fixed header configuration, fixed or varying header contents, and a fixed or varying payload.
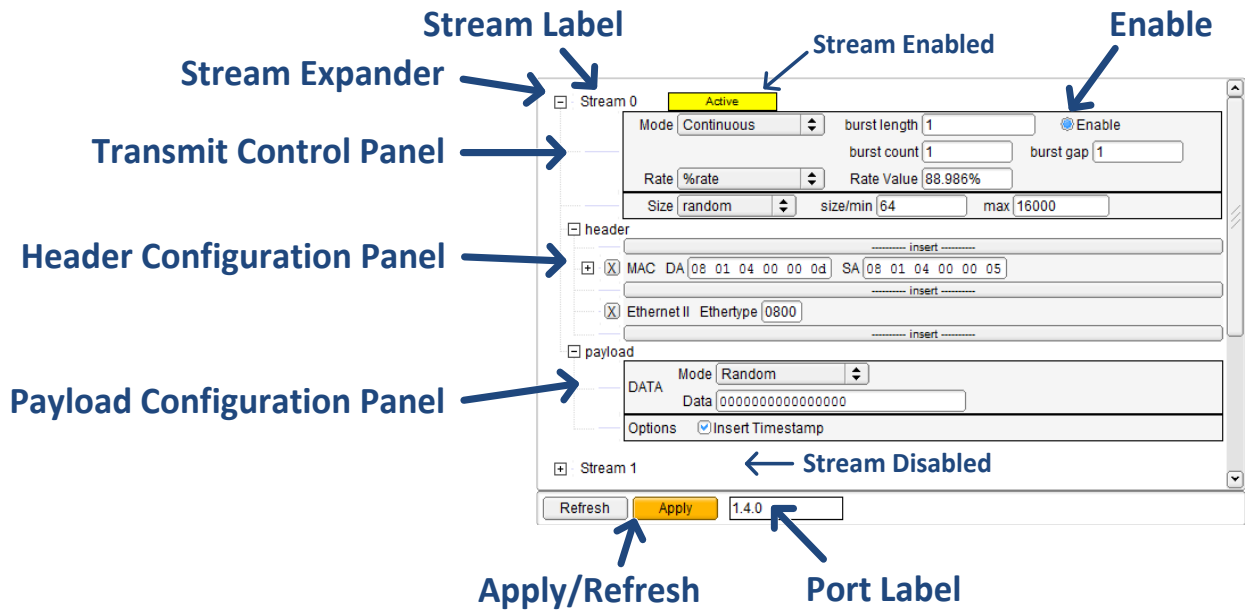
6.5.1 Transmit Control

The stream transmit mode, rate and length are configured in the Transmit Control Panel.

Option	Setting	
ENABLE	ON	Enable stream for port transmission.
	OFF	Disable stream
MODE	CONTINUOUS	Transmit continuously until STOPPED or PAUSED
	SINGLE BURST	Transmit **BURST LENGTH** packets, or until STOPPED or PAUSED
	MULTIPLE BURSTS	Transmit **BURST LENGTH** packets, wait **BURST GAP** cycles, and repeat **BURST COUNT** times, or until STOPPED or PAUSED
BURST LENGTH		Number of packets transmitted in a burst.
BURST GAP		Measured in μs
BURST COUNT		Number of bursts transmitted.

Option	Setting	
RATE	TXGAP	Inter-Packet Gap
		At 10Gbps, **RATE VAL** defines the number of bytes added to the 12-byte minimum IPG.
		At 40Gbps, **RATE VAL** defined the number of 8-byte words added to the 12-byte minimum IPG.
	PACKET/SECOND	Packets transmitted per second
	%RATE	Percentage of maximum packet rate.
RATE VAL		Value of the **RATE** setting.
		⚠️ The **RATE VAL** will remain the same value if the **RATE** changes, which can lead to unexpected results. Eg changing from an TXGAP of 0 (max rate) to %RATE will stop the stream.
SIZE	FIXED	Transmit packets of a single packet length only
	INCREMENT	Transmit packets with incrementing packet length, starting with **SIZE MIN** to **SIZE MAX**, wrapping to **SIZE MIN**.
	DECREMENT	Transmit packets with decrementing packet length, starting with **SIZE MAX** to **SIZE MIN**, wrapping to **SIZE MAX**.
	RANDOM	Transmit packets with random packet length between **SIZE MAX** and **SIZE MIN**
SIZE FIXED/MIN		Packet Length if **SIZE** is FIXED. Minimum packet length for variable **SIZE** modes.
		ℹ️ The minimum allowable packet length at 10Gbps is 13 bytes. The minimum allowable packet length at 40Gbps is 37 bytes. The minimum valid packet length is 64 bytes.
		⚠️ At 10Mbps, the packet size must be less than 1600 bytes
SIZE MAX		Maximum packet length for variable **SIZE** modes. Not used if **SIZE** is FIXED.
		ℹ️ The maximum packet length at 10Gbps and 40Gbps is 16000 bytes.

6.5.2 Header Configuration

The packet headers and contents are configured in the Header Configuration Panel.
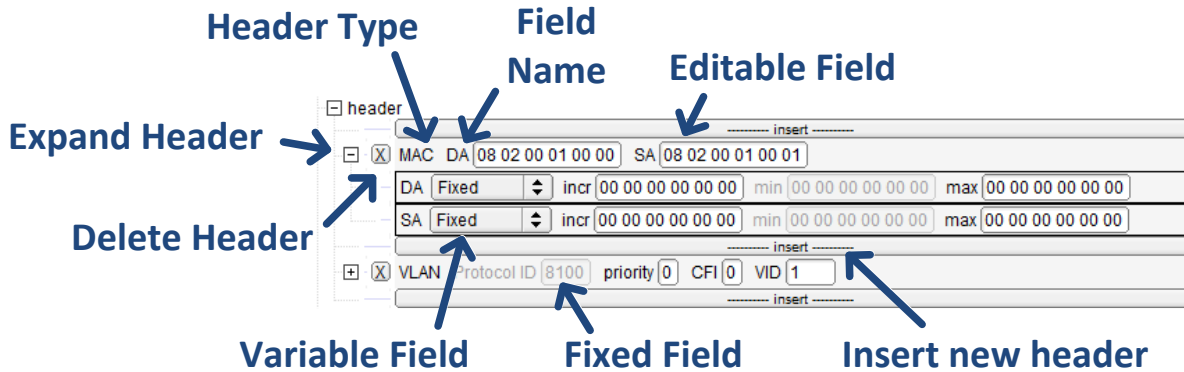
The available headers are extracted from an external configuration file when the APG Control Interface starts. Header support is defined in the APG Header Guide [3].

Headers can be added or deleted:

Status	Description
----- insert -----	Insert Header. The 'next header' option depends on the previous header eg: ETHERNET_II or VLAN headers can follow a MAC Header.
X	Delete Header

Editable fields are identified by a white editing box, and allow user values to be entered.
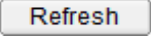
Fixed fields are greyed out, and cannot be changed.

Variable fields can be FIXED or INCREMENTING. A fixed field uses the field setting only. Incrementing fields operate at byte level, not across the whole field. The **incr** value defines the **step**, and max defines the maximum value.

6.5.3 Payload Configuration

Option	Setting	
MODE	FIXED	Fixed, repeating DATA pattern
	INCREMENT	Incrementing data byte, starting from the DATA byte, wrapping from 0xFF to 0, repeating to the end of the payload field.
	DECREMENT	Decrementing data byte, starting from the DATA byte, wrapping from 0 to 0xFF, repeating to the end of the payload field.
	RANDOM	Random byte generator
DATA		8 bytes (hex) eg: 00 11 22 33 44 55 66 77 Repeated to the end of the payload field ⚠ A **DATA** setting shorter than 8 bytes is extended to 8 bytes with 00hex
OPTIONS	TIMESTAMP	Insert Timestamp checkbox

6.5.4 Apply/Refresh

Option	Action
Apply	Applies the configuration to the unit.
Apply	The button is highlighted orange when a configuration change has been made but not applied.
Refresh	Refresh cancels the configuration changes and reloads the configuration from the unit.

6.6 CONTROL PANEL

Button	Action
	START – Start transmitting on the <u>selected</u> ports. If the unit is in synchronisation mode, all selected ports on the synchronised units will start transmitting simultaneously.
	STEP – Transmit a single packet on the <u>selected</u> ports
	PAUSE – Pause transmission on the <u>selected</u> ports. If the stream is configured to transmit a fixed length burst, the transmit count is paused. Pressing the START button will continue the transmit burst.
	STOP – Stop transmission on the <u>selected</u> ports.
	CLEAR SELECTED COUNTERS – Clear counters on the <u>selected</u> ports only.
	CLEAR <u>ALL</u> COUNTERS
	RESET TIMESTAMPS – Reset timestamps to zero or current time (Section 6.3.5.2)

> To transmit a stream, the port, module and stream must be enabled and the BURST LENGTH must be non-zero or continuous.

> If all enabled streams configured on a port are in SINGLE BURST mode and have finished sending packets, the packet transmission automatically stops. Pressing **START** will load the stream configurations into the <u>selected</u> ports before starting transmission.
>
> If the port is transmitting packets, the **STOP** button must be pressed <u>before</u> the **START** to load the stream configurations into the <u>selected</u> ports.

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6.7 COUNTER PANEL

The Counter Panel provides access to:

- Port control group selection
- Port selection for Stream Configuration and Status Window
- Hide Port display
- Link Speed and Status display
- Port transmit and receive counters and rates
- Port Options Menu

The Counter Panel is configured using the Edit – Counter Configuration menu (Section 6.3.7), or by right-clicking in the Counter Panel, then selecting 'Counter Configuration'.

Option	Setting	
Port Selector	⬤	Port selected for transmit control
	⬤	Port **not** selected for transmit control Click on the Port Label toggles the port selection
Speed		1Gbps, 2.5Gbps, 5Gbps, 10Gbps or 40Gbps 10Mbps, 100Mbps with 1000Base-T SFP Transceiver
Link Status		Link is UP or DOWN, or the port is in PRBS mode. If TRANSMIT ENABLE (Section 6.10.1.1) is not set (ie module disabled), the Link Status is followed by **(txd)** PRBS is displayed if the port is in PRBS mode (Section 6.10.4) and the port counters are greyed out.
Port Counters		Displays the port transmit, receive and error counters. Use **Edit – Counter Configuration** to select the displayed counters (Section 6.3.7)
Calculated Values		Displays the calculated rate values Use **Edit – Counter Configuration** to select the displayed calculated values (Section 6.3.7)

6.8 PORT OPTIONS MENU

Right-clicking in the counter pane opens the Port Options menu:

Option	Function
Hide	Hides the current port counters. Hidden port counters can be displayed by opening the port expander in the Connection Panel (Section 6.4) and selecting the hidden port checkbox.
Unit Control	Opens the Unit Control window (Section 6.9)
Port Control	Opens the Port Status window (Section 6.10)
Capture Buffer	Opens the Capture Buffer window (Section 6.10.3)
Counter Configuration	Opens the Counter Configuration window (Section 6.3.7)
Unit Sync	Toggles the synchronisation mode on the unit. All ports on 'sync enabled' units are highlighted gold.

A Synchronisation Group contains two or more units in sync-enabled mode. Timestamp and transmit synchronisation functions will only operate on a Synchronisation group.

> ⚠ **The APG Control Interface only supports <u>one</u> Synchronisation Group.**

6.9 UNIT CONTROL WINDOW (APGV2 UNITS ONLY)

The Unit Control window can be accessed only from the Port Options Menu.
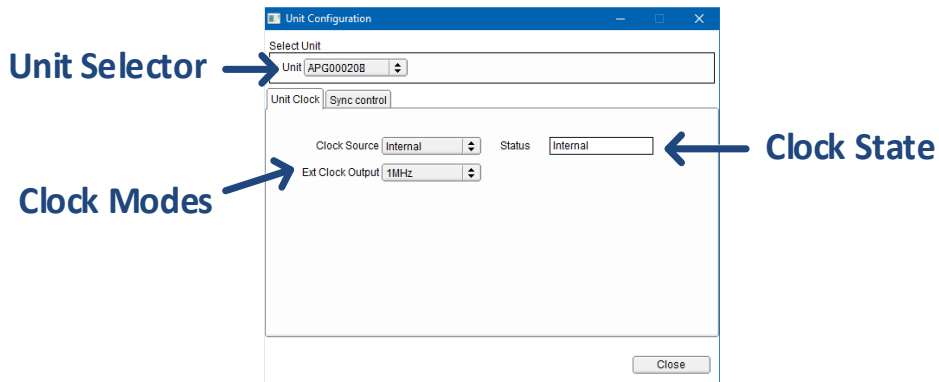
The Unit Control window provides access to:

- Clock Configuration
- Synchronisation Control

> ⚠ **Unit Control functions are not supported on APGV1 units.**

6.9.1 Unit Clock Tab

The Unit Clock tab allows configuration of the input and output clocks, using the CLOCK-IN and CLOCK-OUT interfaces on the rear panel (Sections 3.3 and 5.6.1)

6.9.1.1 Unit Selector

The Unit Selector shows the connected units capable of supporting Unit Clock Modes.

The required unit must be selected before changing the clock configuration.

6.9.1.2 Clock Source

The clock source options are:

Option	Function
Internal	Use the internal free-running oscillator to generate the system clocks (default). Internal mode must be selected if using an Axtrinet unit as the clock master.
External 1PPS	Synchronise to an external 1PPS (1Hz) input on the CLOCK-IN interface.
External 1MHz	Synchronise to an external 1MHz input on the CLOCK-IN interface.

> For improved clock stability, External 1MHz mode is recommended over External 1PPS mode.

6.9.1.3 External Clock Output

The external clock output options are:

Option	Function
1PPS	Generate a 1PPS (1Hz) output on the CLOCK-OUT interface.
1MHz	Generate a 1MHz output on the CLOCK-OUT interface.

> If using an Axtrinet unit as the clock master, the external clock output frequency (eg External 1MHz) must match the internal clock source (eg 1MHz).

6.9.1.4 Status

The clock status displays the current state of the internal system clock generator:

| State	Description
UNKNOWN	Unable to determine status
INTERNAL	INTERNAL clock source selected
HOLDOVER	EXTERNAL clock source selected – external source not detected
	⚠️ **If it remains in this state for more than a few seconds, the external clock source may have failed, not be generating a clock, may be at the wrong frequency, or may not be connected.**
ACQUIRING	EXTERNAL clock source selected – external clock source detected and attempting to acquire lock.
	ℹ️ Acquisition can take up to 40 seconds with a 1PPS input. Acquisition is <100ms with a 1MHz input.
TRACKING	EXTERNAL clock source selected – acquired external clock and improving clock stability.
	ℹ️ Tracking may take up to 90 seconds with a 1PPS input. Acquisition is < 2 seconds with a 1MHz input.
LOCKED	EXTERNAL clock source selected – internal clocks frequency-locked to the input clock. It will remain in the LOCKED state until the external clock fails, where it will enter the HOLDOVER state.

6.9.2 Sync Control Tab

The Sync Control tab allows configuration of the unit synchronisation mode of the connected units. Unit Synchronisation mode must be enabled to enable the inter-unit timestamp and transmit synchronisation functions, using the SYNC interfaces on the rear panel (Sections 3.2.3, 5.6.2 and 5.6.3).
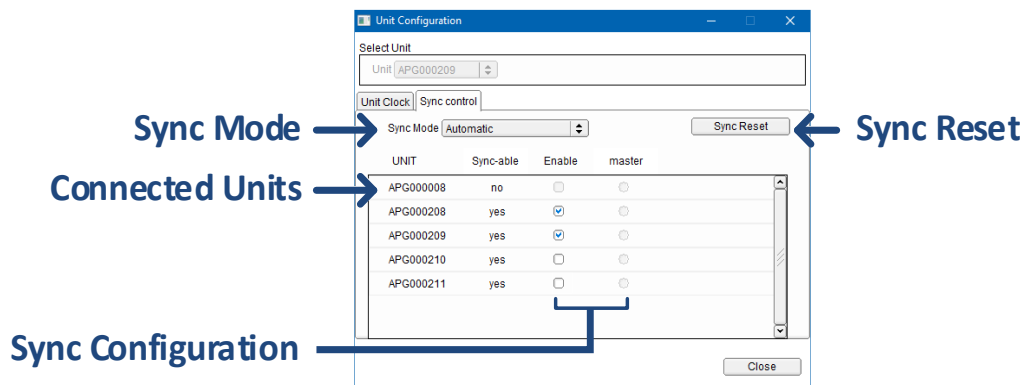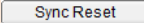
6.9.2.1 Sync Mode
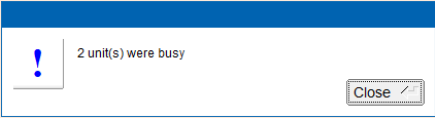
The Sync Mode drop-down list offers the following options:

Mode	Description
AUTOMATIC	The APG Control Interface automatically selects the master unit based on the Synchronisation Group and the ports selected for control.
SELECT MASTER	Manually select the Synchronisation Group master unit using the 'master' radio button.
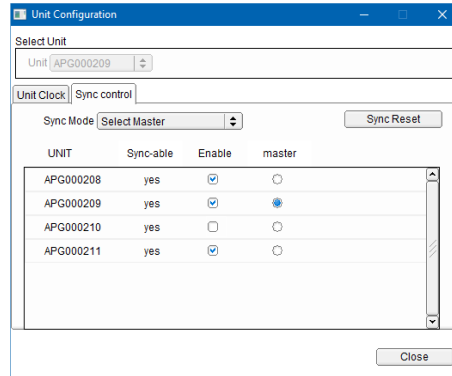
EXTERNAL	Configure the Synchronisation Group to expect an external synchronisation signal **after** pressing the START or RESET TIMESTAMP buttons.

> ⚠️ **The Synchronisation Group enters an 'armed' state, then waits for the external synchronisation trigger.**
> **The units will not respond to another command until the trigger is received, the armed state is reset with the** `Sync Reset` **button, or the units are removed from the Synchronisation Group.**
> **Attempting to control the units while in the 'armed' state will generate a pop-up 'busy' warning message:**

6.9.2.2 Connected Units

Lists the connected units and the sync capability.

Only sync-capable units can be enabled.

6.9.2.3 Sync Configuration

Enable/Disable unit synchronisation mode on each connected unit to add/remove the unit from the Synchronisation Group.

If operating in 'Select Master' mode, the 'Master' radio buttons are enabled.

6.9.2.4 Sync Reset

Clears the 'armed' state from the Synchronisation Group.

6.10 PORT STATUS WINDOW

The Port Status window can be accessed in two ways:

- Right-click in the counter pane to open the Port Menu, then select "Port Control", or
- Middle-click in the counter pane

The Port Status window provides access to:

- Module control and status signals
- Module information
- Packet Capture Summary (all ports)
- PRBS Bit Error Rate testing (all ports)

6.10.1 Control Tab
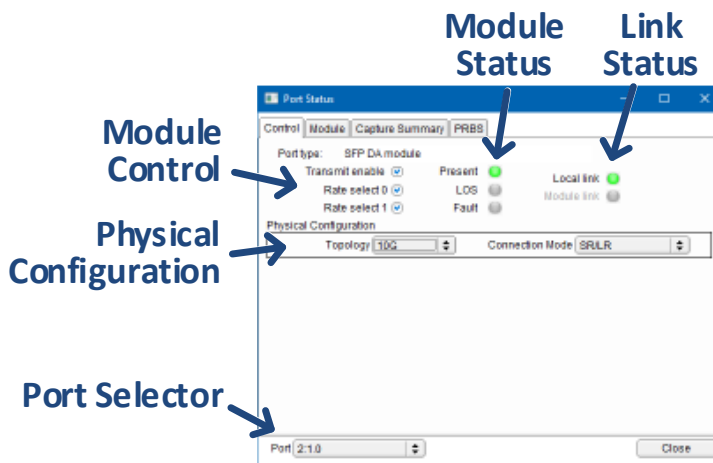
The content of the Control Tab varies depending on the inserted module.

6.10.1.1 Module Control & Status

The Module Control bits can be set by the user:

Option	Function
Transmit Enable	Set to enable the transceiver If not set (ie module disabled), the Link Status in the counter panel (Section 6.7) is followed by **(txd)**
Rate Select 1/0	Rate Select bits are normally set for 10Gbps operation, but the actual behaviour is defined by the transceiver vendor.

The Module Status bits are read-only, and set by the transceiver:

Status	Definition
Present	Transceiver detected in port
LOS	"Loss of Signal" flag
Fault	"Fault" flag

Where: 🟢 Set   🔴 Not Set   ⚪ Not Available

The Link Status bits are set by the transceiver:

Status	Definition
Local Link	Displays the link status of the Packet Generator MAC to the link partner. For fibre optic and direct attach cables, this is the end-to-end link status.
	Where the module contains an additional active linking device, eg the 10Gbase-T and 10/100/1000Base-T modules contain a PHY, the 'Local Link' is the MAC-to-PHY link status.
Module Link	For fibre optic and direct attach cables, the 'Module Link' is not available.
	Where the module contains an additional active linking device, eg the 10Gbase-T and 10/100/1000Base-T modules contain a PHY, the 'Module Link' is the external link status to the link partner.

6.10.1.2 Physical Configuration

Port Topology and Connection Mode are configured in the Physical Configuration settings to the applicable port.

### 6.10.1.3 Module Configuration (optional)

The Control Tab will display additional module configuration options if they are available, eg for the 2.5G/5G/10Gbase-T modules:

The 2.5G/5G/10Gbase-T and 10/100/1000Base-T Configuration comprises the Auto-Negotiation and Advertised Capabilities settings, the partner capabilities, and MDI/MDIX and Master/Slave configuration.
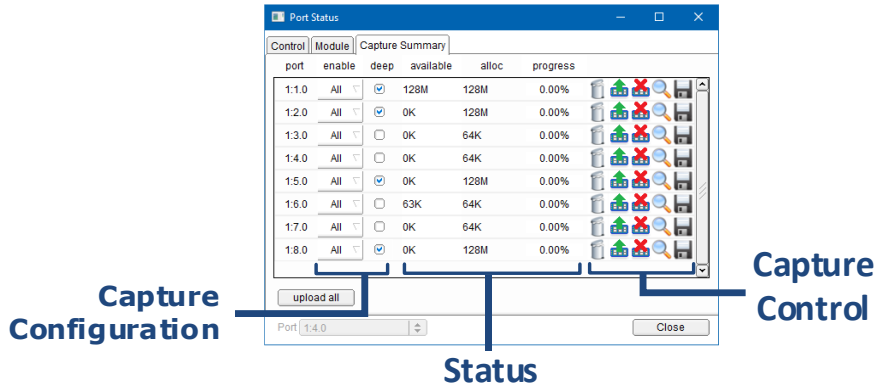
6.10.2 Module Tab

The Module tab shows the raw and decoded vendor fields from the inserted module.
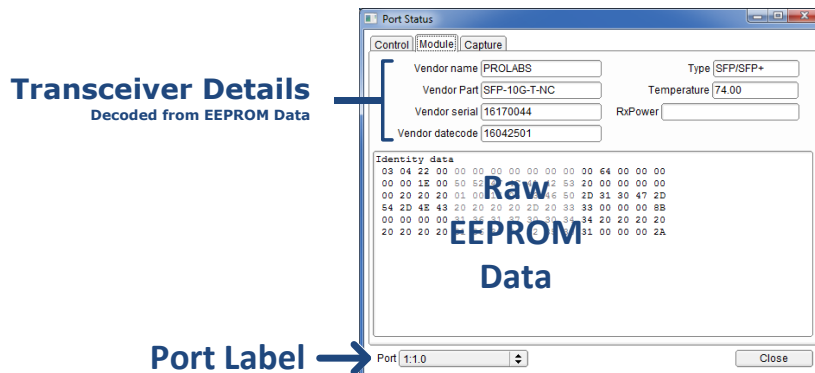
6.10.3 Capture Tab

The capture tab displays a summary of the capture buffer configuration, status and control for **all** available ports.

The capture configuration shows the ENABLE and DEEP setting for each port.

> ⚠️ **On an APGV1 unit, Deep Capture can only be enabled on one port.**
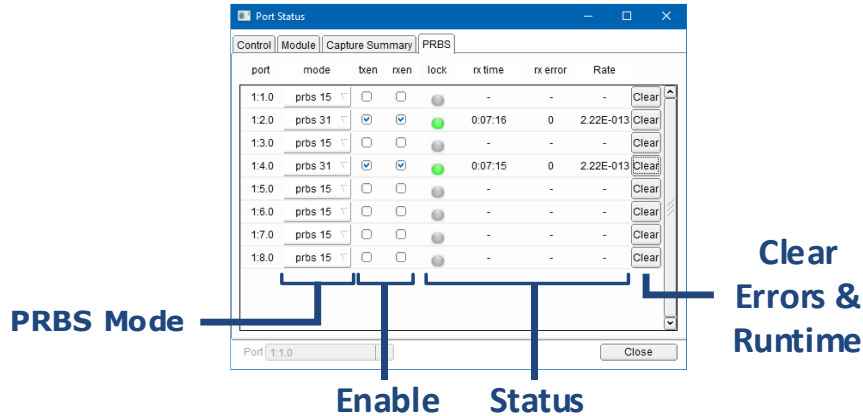
The status values show the data captured in bytes (available), buffer space allocated in bytes (alloc) and upload progress (yellow bar and %).

The port capture buffers can be controlled with the buttons:

Control	Function
🗑	Clear the packet capture buffer and restart the capture.
	ℹ️ Click the VIEW button to display the captured packets.
🔼	Upload the Packet Data window with the latest captured data.
	ℹ️ Updating the Packet Data window without clearing the packet capture buffer will reload the same captured packet data.
❌	Stop the port capture
🔍	View the uploaded data in the Capture Data Display window (Section 6.11)
💾	Save the captured port data to a PCAP file.
upload all	Uploads all captured port data.

6.10.4 PRBS Tab

The PRBS tab displays a summary of the PRBS configuration, status and control for **all** available ports.

| Status	Definition
Mode	Dropdown PRBS pattern for each port. The options are: PRBS7 $(x7 + x6 + 1)$ PRBS9 $(x9 + x5 + 1)$ PRBS15 $(x15 + x14 + 1)$ PRBS23 $(x23 + x18 + 1)$ PRBS31 $(x31 + x28 + 1)$
TXEN / RXEN	Separate Transmit and Receive enables: ☐ Disabled ☑ Enabled Port PRBS mode is enabled is either is set.
Locked	Receiver synchronised to transmit pattern: ⚪ Not Locked 🟢 Locked The receiver will report locked after 15 bits have been received without error. It will break lock after ~80µs if continuous errors are detected.
RX Time	Time since first locked
RX Error	Number of receive bit errors detected since locked.
Rate	Bit Error Rate
Clear	Clear the error counter and timer. The Bit Error Rate is a calculated value and will clear automatically. ℹ️ Bit errors may be detected as the receiver locks to the transmit bit stream. Clear the errors and timer before starting a test run.

6.11 CAPTURE DATA DISPLAY

The Capture Data Display window is accessed either through the Port Status Capture Tab, or by right-clicking in the counter panel to open the Port Menu, then selecting 'Capture Buffer'.

Packet Capture can be enabled per port by selecting the ENABLE checkbox. When enabled, the buffer captures continuously until full. Clearing the buffer deletes the captured packets, and immediately starts a new capture.

Each port has a 64KB capture buffer to store a few packets (depending on packet length) which is useful for analysing single step behaviour or rare events. Alternatively, access to the 1GB shared extended packet capture can be enabled by selecting the DEEP checkbox, to store large packet streams. The 64KB buffer is disabled when the deep packet capture is enabled.

> ⚠️ **On an APGV1 unit, Deep Capture can only be enabled on <u>one</u> port.**
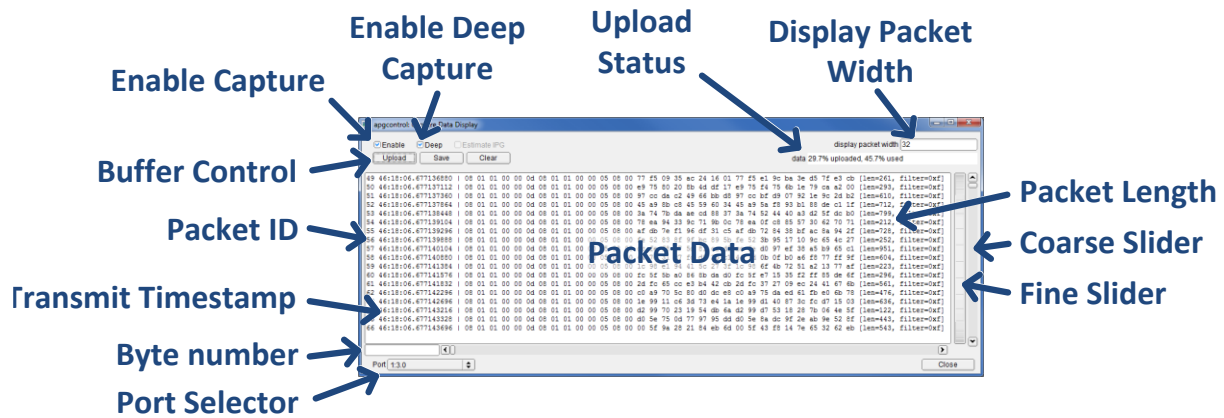
The buffer control is performed with the following buttons:

Control	Function
Upload	Update with the latest captured packet data to the Capture Data Display window.
	The UPLOAD STATUS bar displays the Buffer Status (% used), and the upload progress (% uploaded).
Save	Saves the captured data to PCAP file. Opens a FILE SAVE window to select save directory and filename.
Clear	Clear the packet capture buffer and restart the capture.

> ℹ️ Click 'UPLOAD' button to display the captured packets.

The display window shows the 'Captured Packet Number', the transmit timestamp, the packet data (showing 'Display Packet Width' bytes), and packet length.

6.12 SLIDERS

Vertical and horizontal slider allows adjustment of the panel sizes to suit viewing requirements.

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