Ethernet Packet Generator

USER GUIDE

Version 2.1

APG4 APG8 APG200 APG208

Software Revisions

This document applies to the following software revisions:

APG Unit Firmware	**Version 2.1**
APG Processing Core	**Version 6.010E**
APG Control Interface	**Version 2.1**

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 6.9) • Added 'Save to PCAP' (Section 6.9)
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 6.8.3)
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 & 6.9)

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/documentation** for the latest documentation.

Glossary

API	Application Programming Interface
FCS	Frame Checksum
IBG	Inter-Burst Gap
IFG	Inter-Frame Gap
pps	Packets per Second
QSFP+	Quad Small Form-Factor Pluggable (40Gbps)
SFD	Start-of-Frame Delimiter
SFP	Small Form-Factor Pluggable (1Gbps)
SFP+	Small Form-Factor Pluggable (10Gbps)
TCL	Tool Command Language
USB	Universal Serial Bus

Contents

1. INTRODUCTION 6
1.1 Main Features 6
1.2 Benefits 6
1.3 Safety Information 7
1.4 Care of the Product 7
1.5 Environmental 8
1.6 Conformance 8
1.7 Limited Hardware Warranty 9
1.8 Software Licences and Support 9
1.9 Contact Details 10

2. INSTALLATION 11
2.1 Box Contents 11
2.2 Minimum System Requirements 11
2.3 Linux Installation 12
2.4 Windows Installation 13
2.5 Connecting the Hardware 14
2.6 Testing the Installation 15
2.7 Setting the IP Address 16

3. HARDWARE INTERFACES 17
3.1 Front Panel Interfaces 17
3.2 Rear Panel Interfaces 20
3.3 Physical Specifications 21

4. MANAGEMENT INTERFACES 22
4.1 APG Control Interface 22
4.2 TCL Scripting 22

5. TEST ENVIRONMENT & CONCEPTS 23
5.1 Definitions 23
5.2 Unit Configuration 24
5.3 Port Topology 24
5.4 Transmit Path 25
5.5 Receive Path 27

6. CONTROL INTERFACE 29
6.1 Running the Control Interface 29
6.2 Overview 29
6.3 Menu Bar 30
6.4 Connection Panel 37
6.5 Stream Configuration Panel 40
6.6 Control Panel 43
6.7 Counter Panel 44
6.8 Port Status Window 45
6.9 Capture Data Display 48
6.10 Sliders 48

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 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
- Data storage equipment with 10Gbps and 40Gbps 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+ 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 choices 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.

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.

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 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.

1.6.2 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 verified 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
- Axtrinet Resource CD for Windows and Linux:
  - USB Drivers
  - APG Control Interface Application
  - APG TCL API
  - Documentation

Visit **www.axtrinet.com/documentation** 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
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-2.1-1-x86_64.pkg.tar.xz
```

Remove with

```
pacman -R apgcontrol
```

RPM

Install with

```
rpm -U apgcontrol-2.1-1.x86_64.rpm
```

or

```
yum localinstall apgcontrol-2.1-1.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:

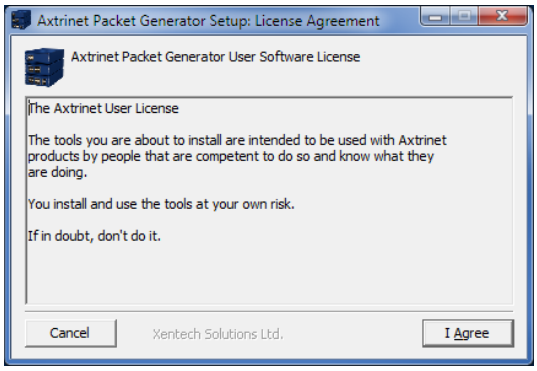
- To connect to USB ports **libusb** (libusb-1.0.so) is required.
  If it is not present, USB connected units will not appear.
- In addition to run the scripting interface you will require to have a **tcl** package (provide tclsh, libtcl8.6.so) installed and to run the test suite **tk** (provide wish) to run the UI and **texlive** or **texlive-bin** (provide pdflatex) to create the pdf report documents.

2.4 WINDOWS INSTALLATION

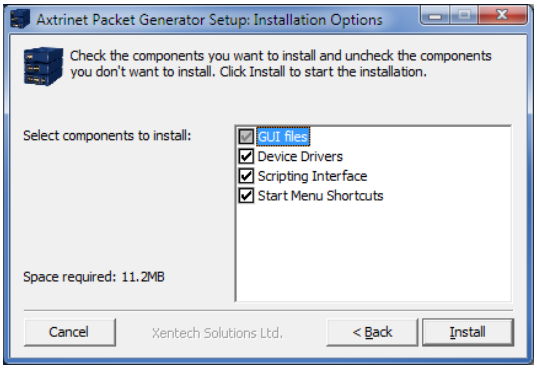
1. Insert the CD.
2. Locate "apg-install.exe" in the Windows directory
3. Run the installation file and follow the on-screen instructions to install the USB driver, APG Control Interface GUI and the APG TCL API.

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

4. Read and accept the software Licence Agreement:



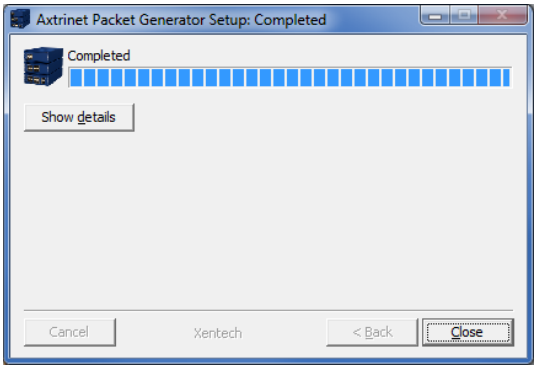
5. Select the components to install:



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.



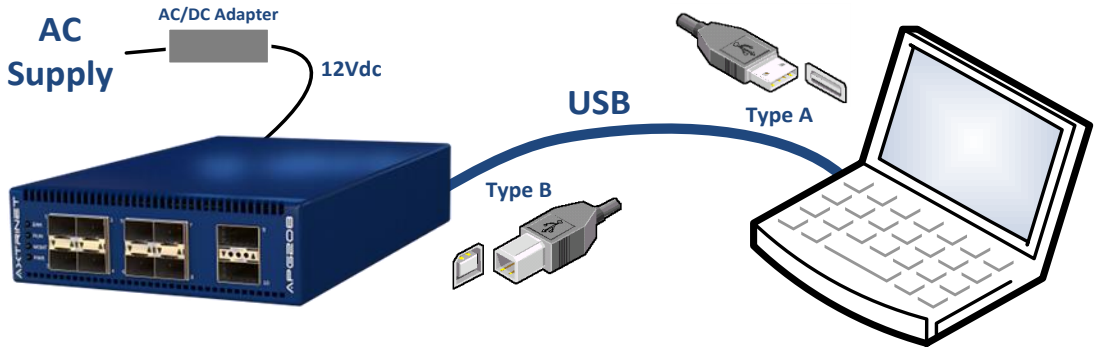
7. Close completes the installation process.
8. In addition, to run the scripting interface you will require to have a **tcl** package (provide tclsh) installed; to run the Test Suite GUI you will require **tk** (provide wish); and to generate test reports you will require **TexLive** or **MiKTex** (provide 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.
  - The POWER LED will turn GREEN after successful configuration, or RED if the hardware has failed to configure.

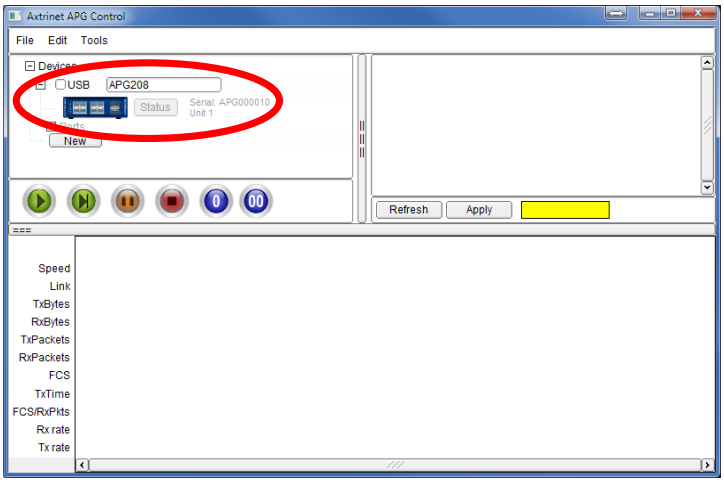
If the POWER LED turns RED after configuration, contact AXTRINET for further support.

- 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:

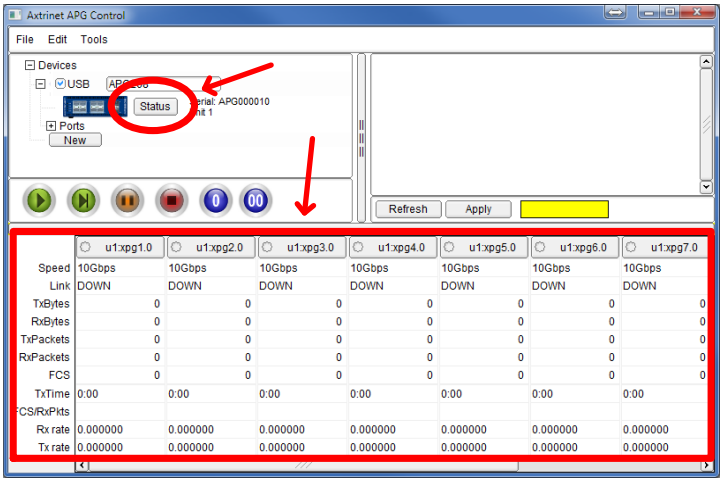


If the unit does not appear in the Control Interface, check that the unit is turned on and the USB lead is connected.

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

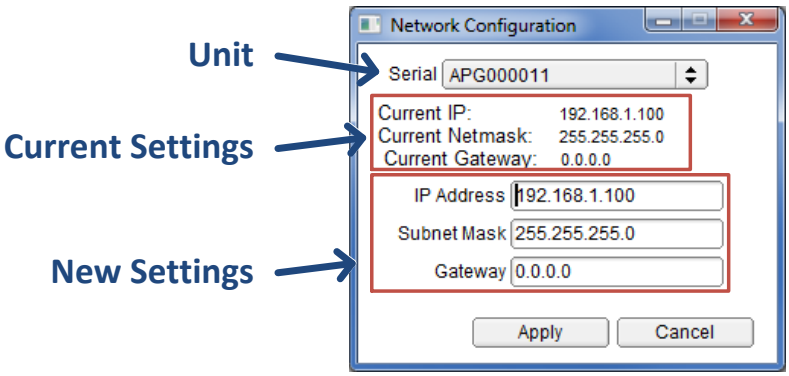
The default settings are:

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.

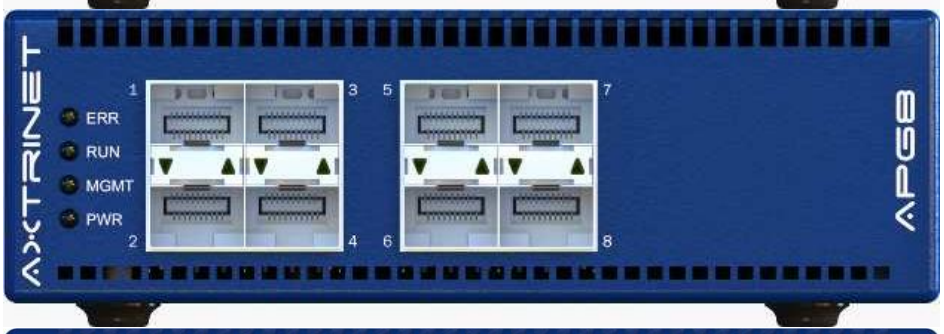
3. HARDWARE INTERFACES

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

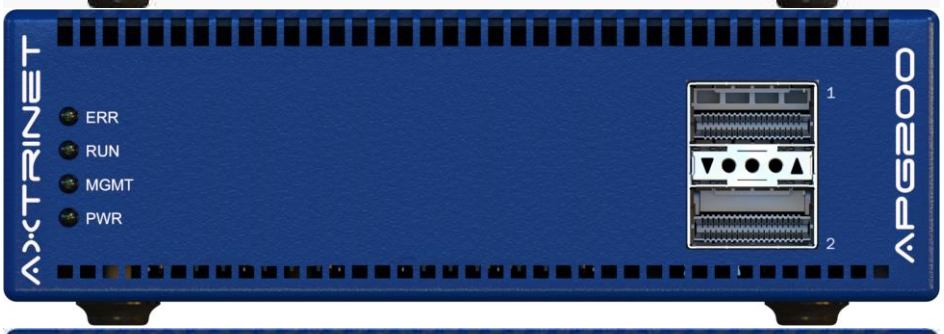
3.1 FRONT PANEL INTERFACES

APG4

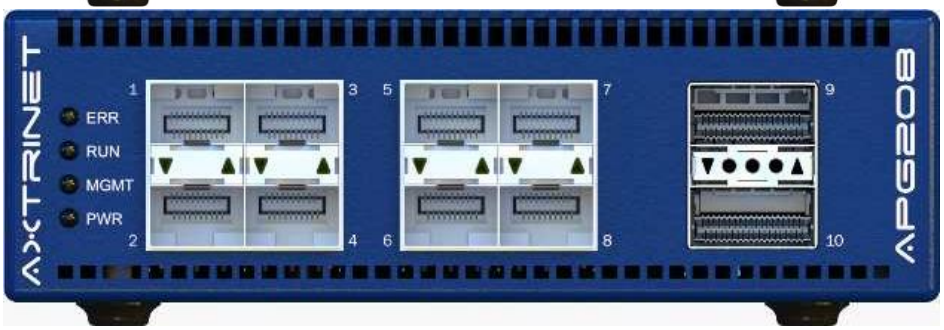
APG8



APG200



APG208



Status LEDs | **10Gbps SFP+** | **10Gbps SFP+** | **40Gbps QSFP+**

	10Gbps SFP+	40Gbps QSFP+
APG4	4	0
APG8	8	0
APG200	0	2
APG208	8	2

3.1.1 SFP+ Interfaces

The SFP+ interfaces will support 10Gbps SFPs that meet SFF-8431 MSA.

> **Only** 10Gbps transceivers are supported in **V2.1** Embedded Software

The list of verified SFPs is available on the Axtrinet website:
www.axtrinet.com/transceivers.html

The 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.

> 10GBase-T transceivers are disabled in the lower ports (2,4,6,8)

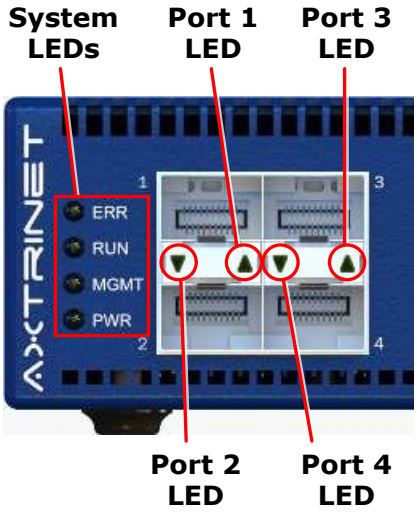
3.1.2 QSFP+ Interfaces

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

The list of verified QSFPs is available on the Axtrinet website:
www.axtrinet.com/transceivers.html

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 6.8.1).

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
RUN	ON	Green/Amber/Red on/flashing under automated test control
	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, the POWER LED will be illuminated ORANGE for ~60 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

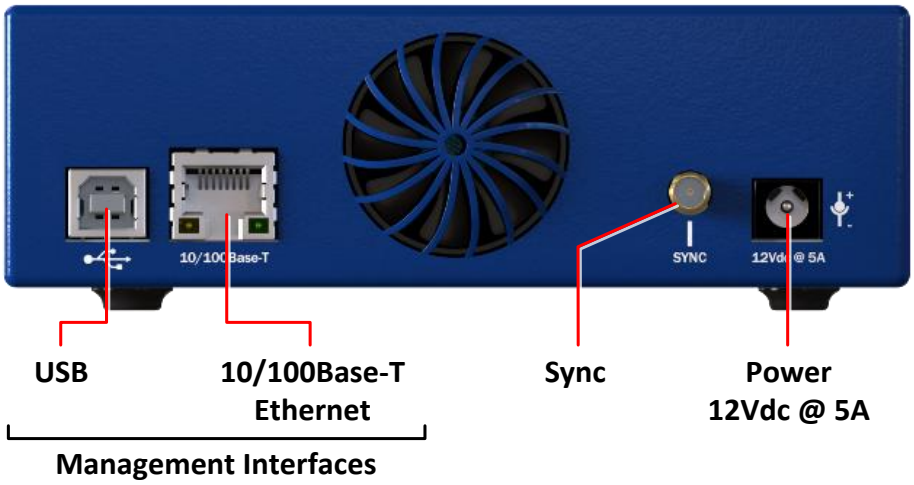
3.1.3.2 Port LEDs

One LED per port, integrated into the transceiver cage:

Colour	Meaning	
GREEN	Steady Flashing	Link OK, no traffic Transmit or Receive Traffic Activity
ORANGE	Steady	Cable detected, Transmit disabled → set TXENABLE on Port Control tab (Section 6.8.1)
RED	Steady	No cable detected, Transmit disabled → set TXENABLE on Port Control tab (Section 6.8.1)
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.

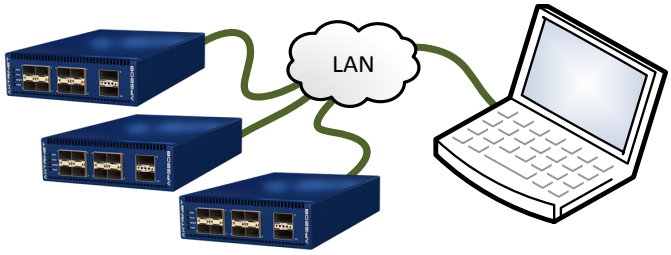
a) Direct Connection **b) Multiple APG units connected through USB Hub**

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

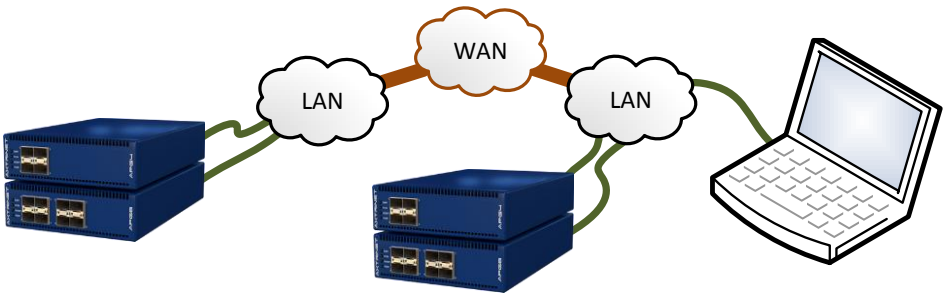
3.2.2 10/100Base-T Ethernet Interface

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 units to be connected together for synchronous transmit START, STEP and STOP control.

The Sync Interface is reserved for future use

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.

3.3 PHYSICAL SPECIFICATIONS

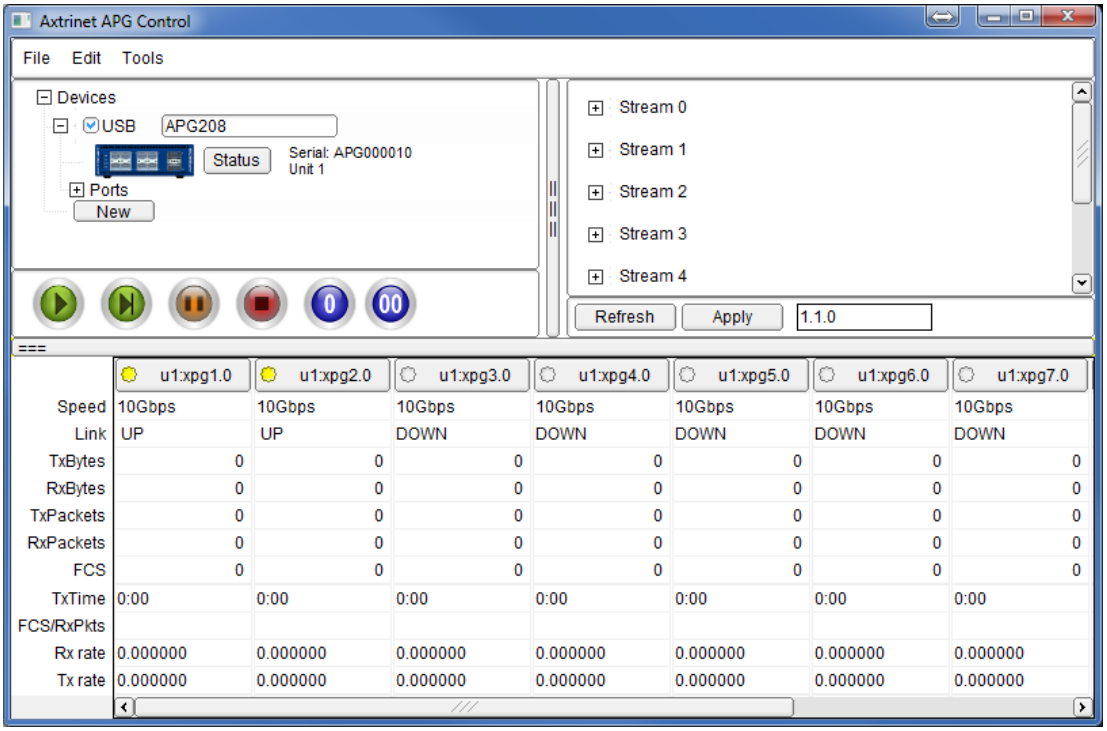
- Width: 140mm (5.51")
- Depth: 228mm (8.97")
- Height: 44mm (1.73")
- Weight: 1.20 kg (2.65 lb)

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)
- 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.

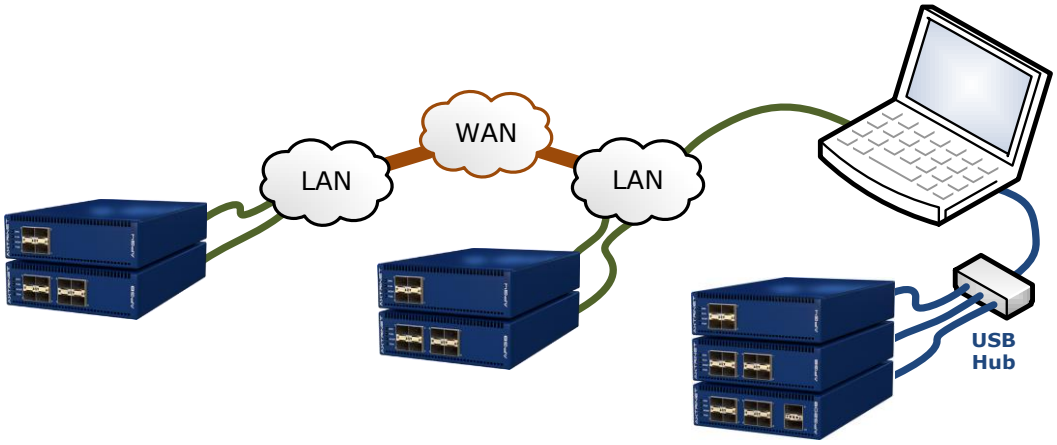
The API provides access to:

- unit, port and stream configuration and status
- port control (start, step, stop)
- packet counters (packets, bytes, errors)
- 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+ or QSFP+). The port-level functions configure the port settings and monitor the port status (Section 6.8.1)and view the captured packets (Section 6.8.2). 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+ or QSFP+ transceiver, and must be inserted into a port aperture to enable a link. The module-level functions configure the module settings (Section 6.8.1), and monitor the module status (Section 6.8.2).
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+).

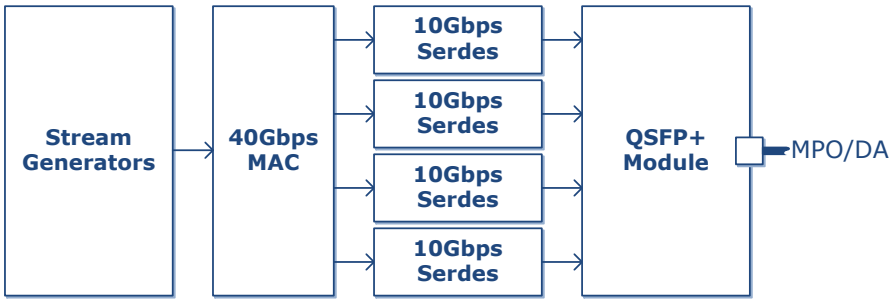
5.3.1 SFP+ Ports

The SFP+ Port Topology is fixed 10Gbps only.

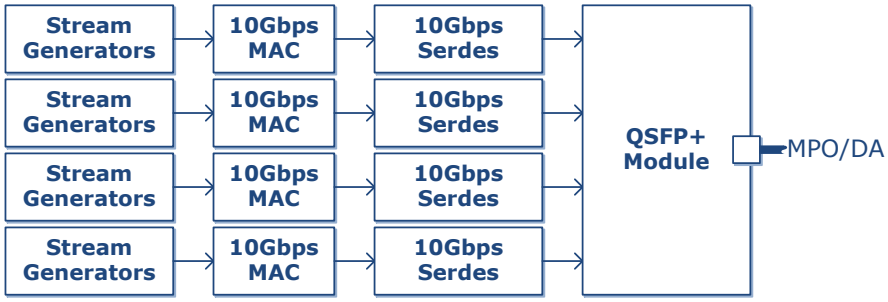
5.3.2 QSFP+ Ports

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

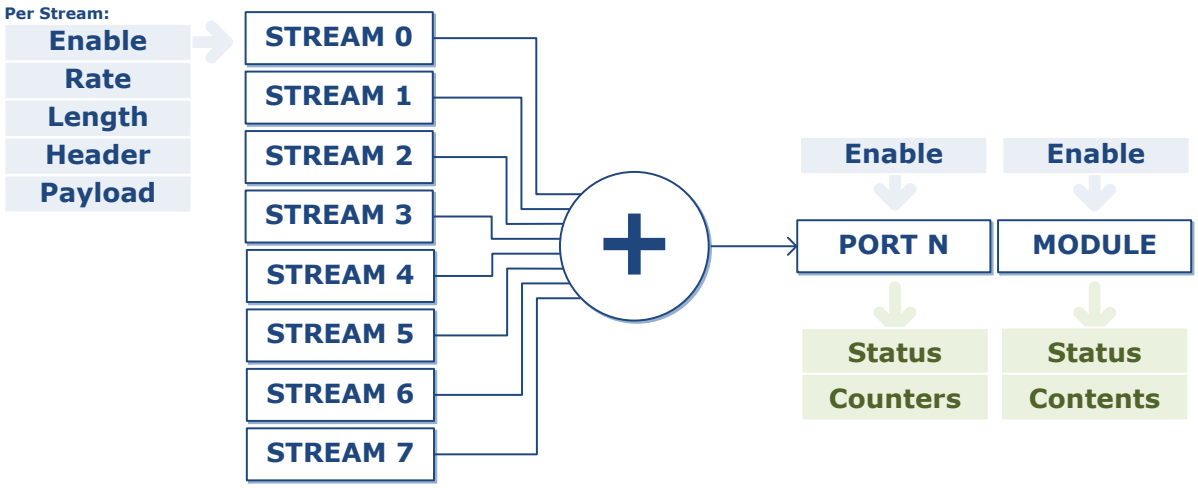
Switching between 40Gbps and 4x10Gbps topologies is performed in the Port Control Window (see Section 6.8.1).

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

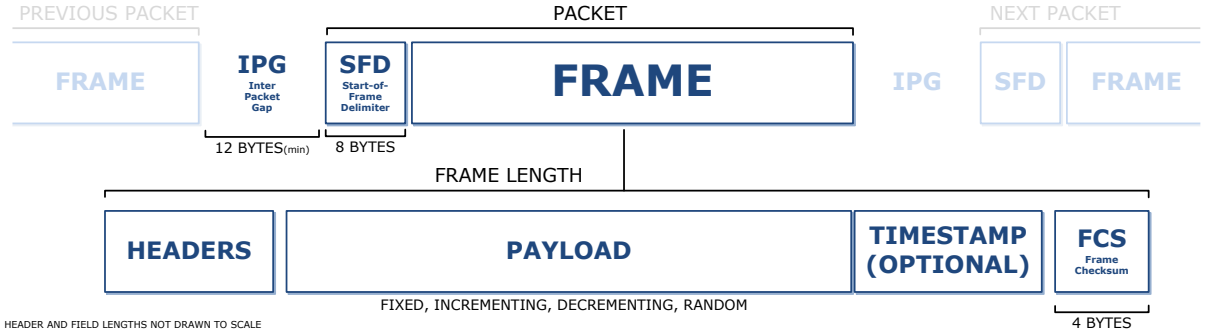


The streams are processed in a round-robin sequence, transmitting a packet if it queued and ready to send.

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.

5.4.1 Stream Generation

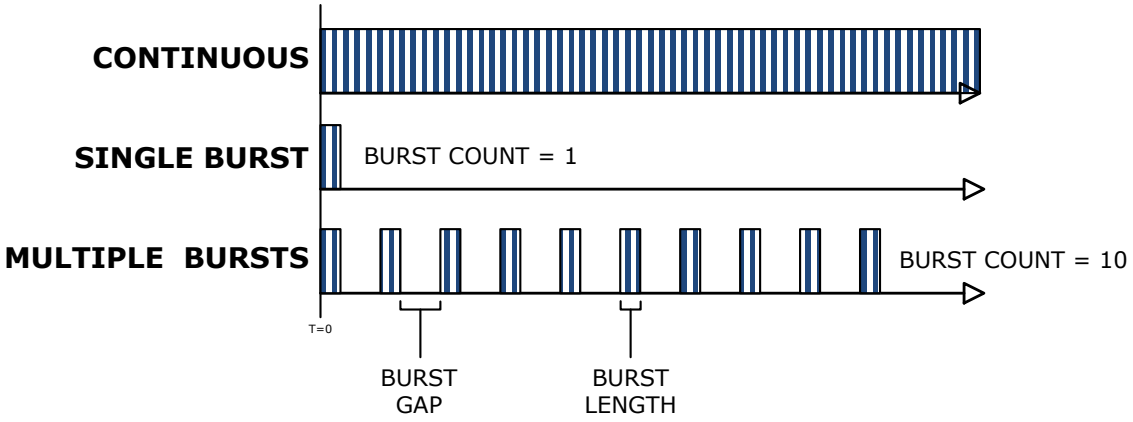
The Stream Generator defines an Ethernet frame:



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).



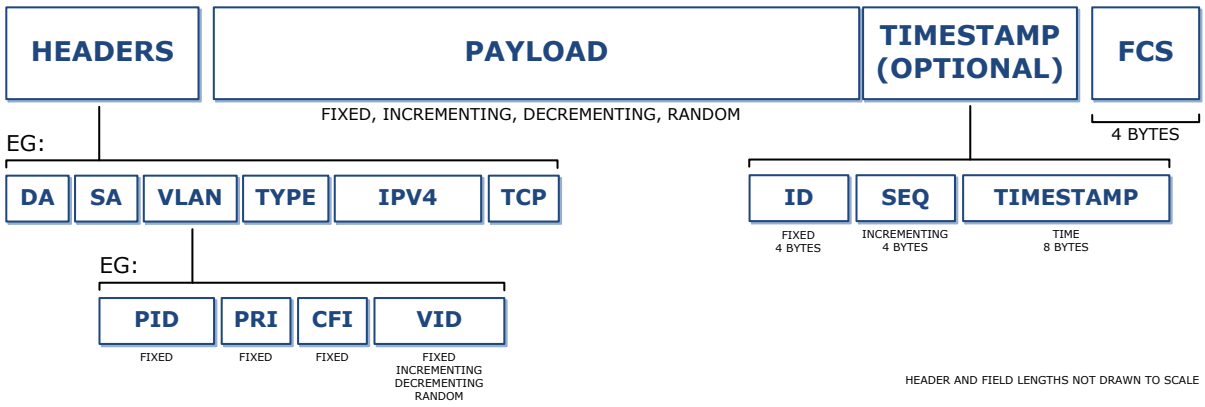
The stream transmit rate defines how quickly the packets are generated; either a percentage of the maximum rate; packets per second; or a gap defined by transmit clock cycles (Section 6.5.1).

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 2.1.

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.

It is not possible to reset the Sequence Number in APG Control Interface Version 2.1.

The Timestamp indicates the time in 8ns cycles since the unit was reset.

It is not possible to reset the Timestamp in APG Control Interface Version 2.1.

A port can be enabled or disabled (Section 6.6).

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

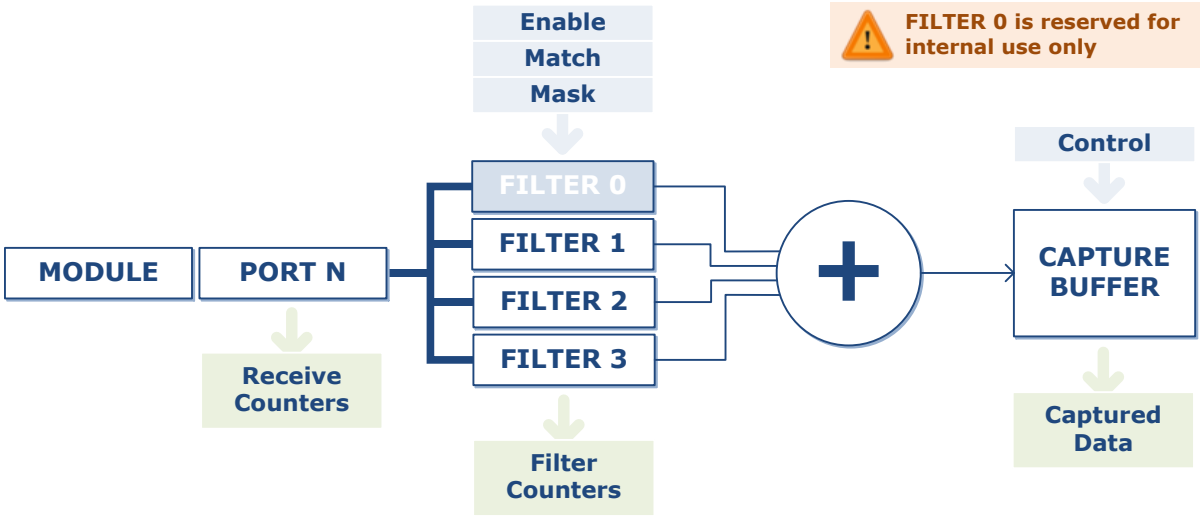
A module can be enabled or disabled (Section 6.8.1).

The module type, vendor and capabilities are available (Section 6.8.2).

5.5 RECEIVE PATH

Each port contains a receive path that comprises:

- Receive port status and counters
- Filter stream multiplexer
- Configurable Capture Buffer



Configurable Capture Filters are not supported in APG Control Interface Version 2.1. 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 6.8.2).

A 256KB (4x64KB) capture buffer is available per 40Gbps port, that can be enabled or disabled, cleared and displayed (Section 6.8.2).

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

The local buffer sizes increased from 16KB and 64KB in the Version 2.1

An extended 1GB capture buffer is available to the unit, shared between the ports. Access to the 'deep' capture memory can be enabled or disabled per port.

The Deep Capture Memory is divided equally between the total possible number of 10Gbps lanes in APG Control Interface Version 2.1.

Each 10Gbps port is allocated 64MB.

Each 40Gbps port is allocated 256MB.

The port receive counters (Section 6.7) and captured packets (Section 6.8.2) 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**

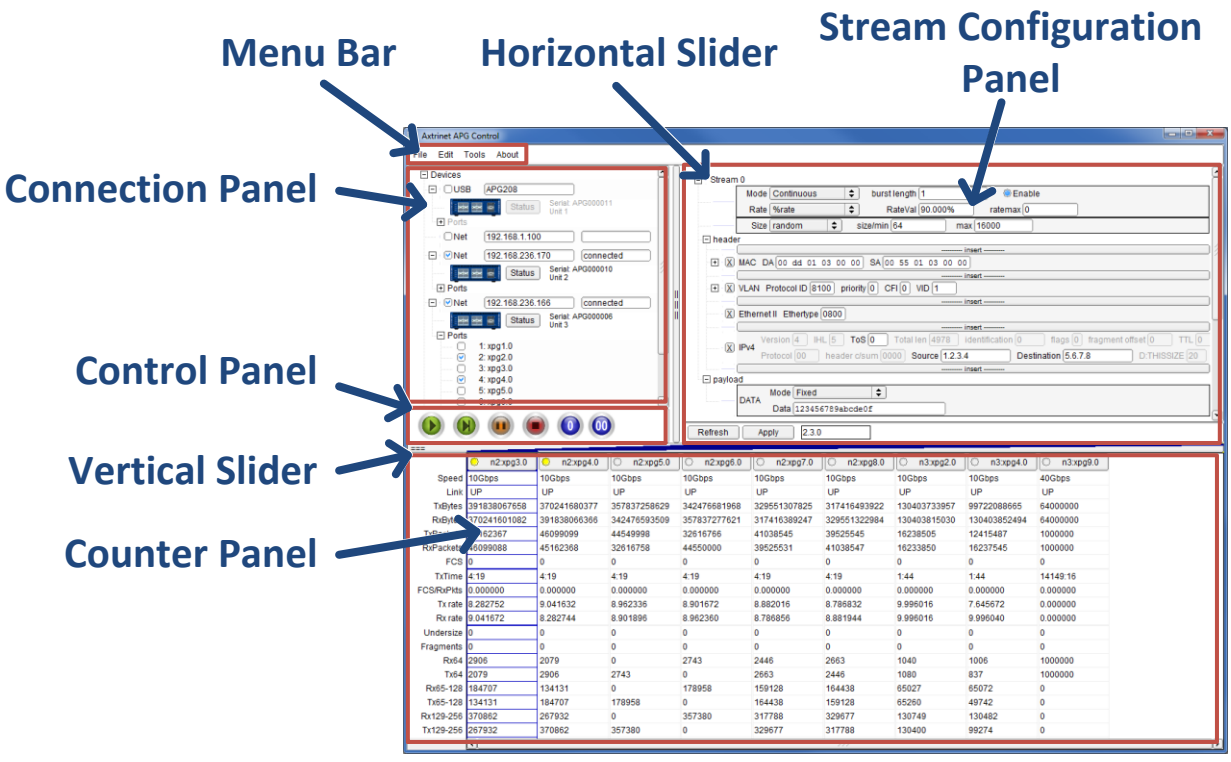
6.1.2 Windows

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 Save As Load Exit	Settings Network Configuration Counter Configuration	Upgrade Unit	

6.3.1 File – Save

Saves the default 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 all connected units

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

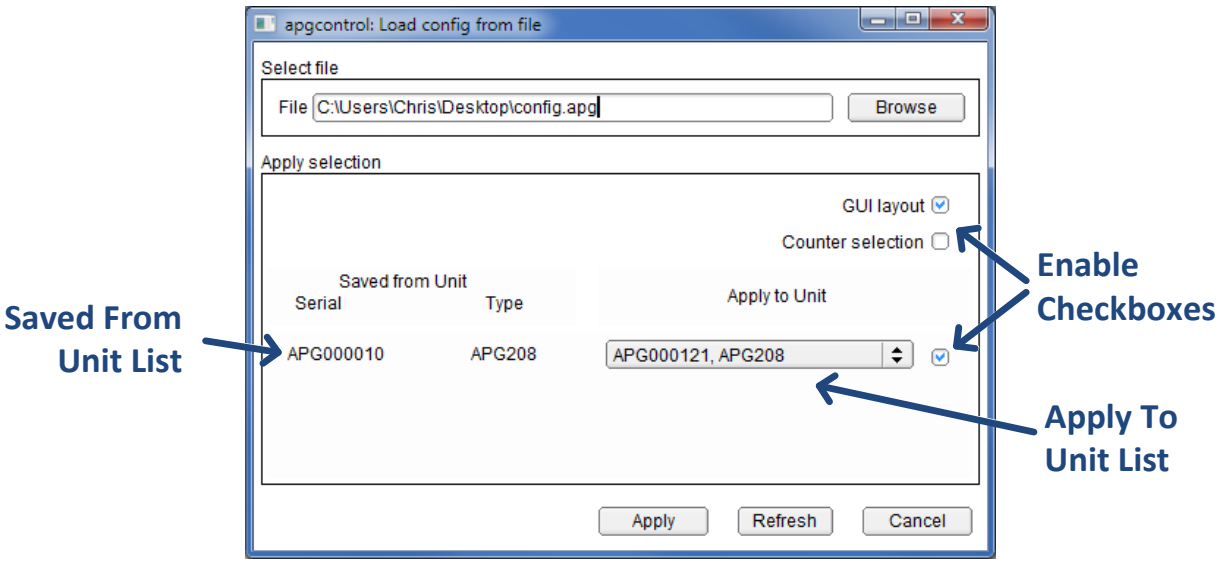
The saved configuration file has a .apg extension.

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 connected 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.

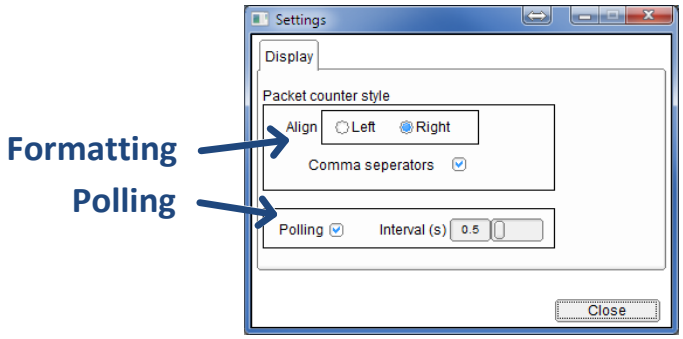
6.3.4 File - Exit

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

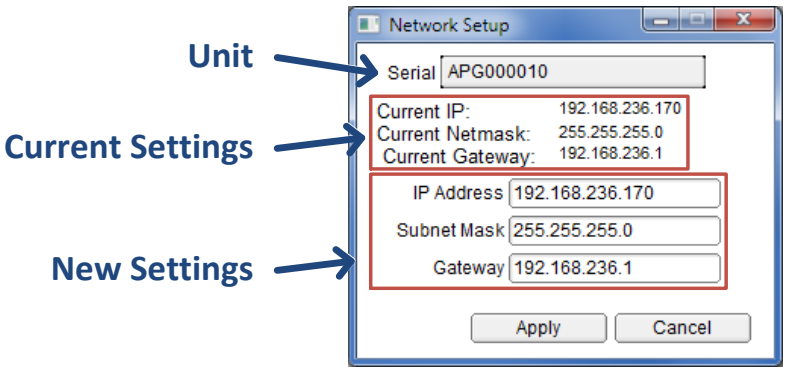
The APG Control Interface can be configured using the Settings option:



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.

6.3.6 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**

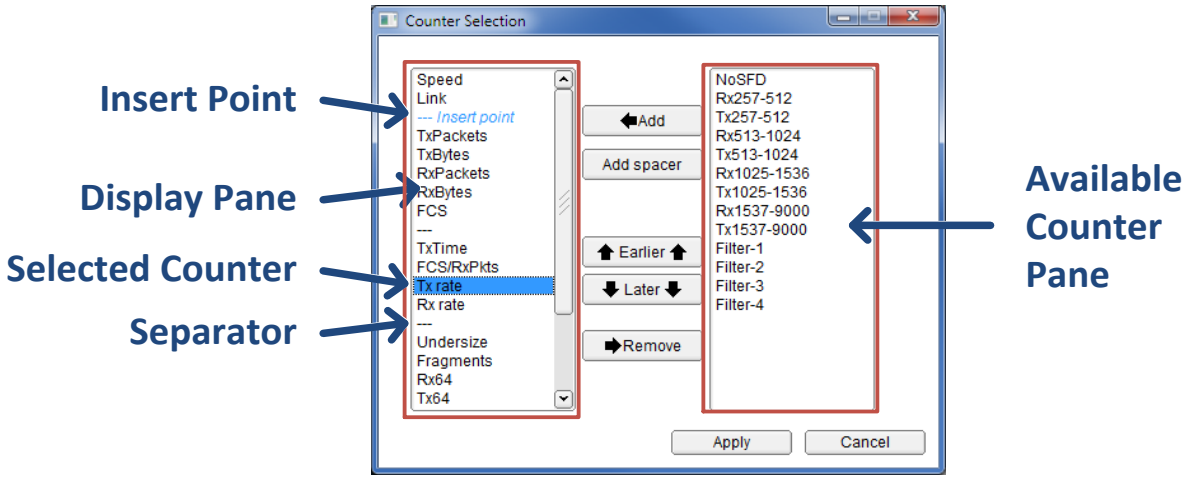
Button	Action
Apply	Applies the Network Configuration changes to the unit. **Changing the Network Configuration while connected to the unit over a network connection will immediately disconnect the unit from the APG Control Interface.** Open a new connection with the new address to continue to manage 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	10Gbps or 40Gbps
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 2.1

The following error counters are available:

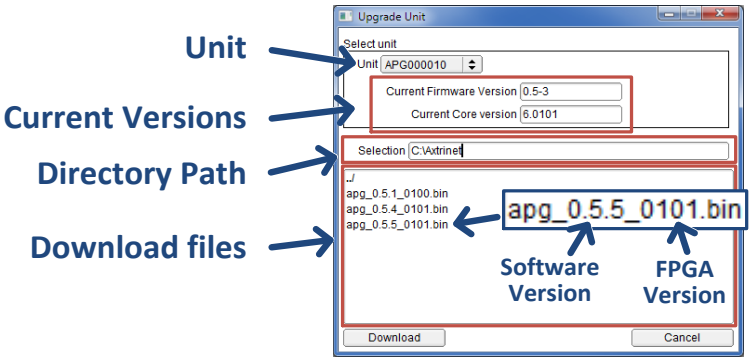
Errors	Description
FCS	Frame Checksum Errors Received
Undersize	Short packets (<64 bytes) with a valid SFD and FCS
Fragments	Packets without a valid SFD
NoSFD	Received Packet without a valid SFD

The following calculated values are available:

Calculated	Description
TxRate	Transmit Bit Rate in gigabits per second
Tx PPS	Transmit Paclets 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:



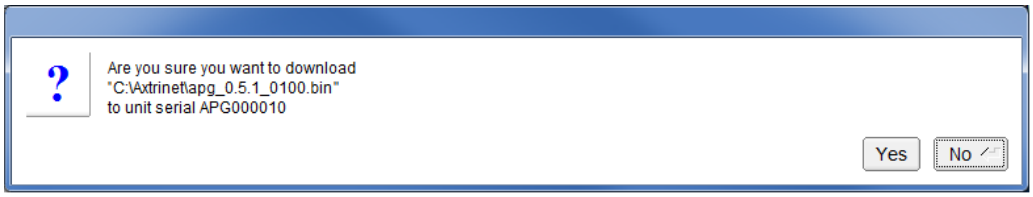
Select the target unit by the serial number from the dropdown list.

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:

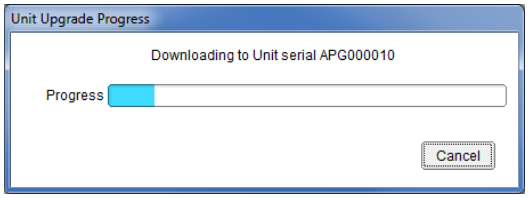
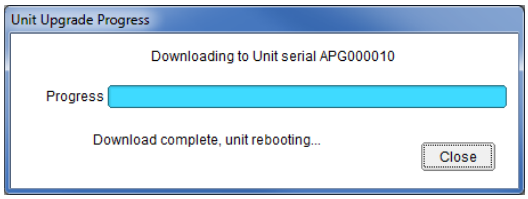


Image download takes 2-3 minutes. When the download completes, the "download complete" message is displayed and the unit reboots:



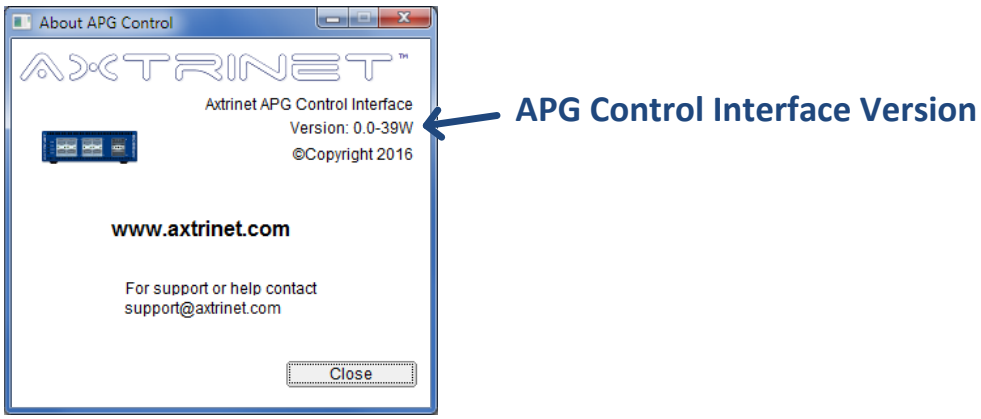
The PWR LED flashes amber while the new image is processed and saved into FLASH memory. The re-FLASH process takes 3-4 minutes.

The unit then boots normally.

Total download, re-FLASH and reboot time is 6-8 minutes.

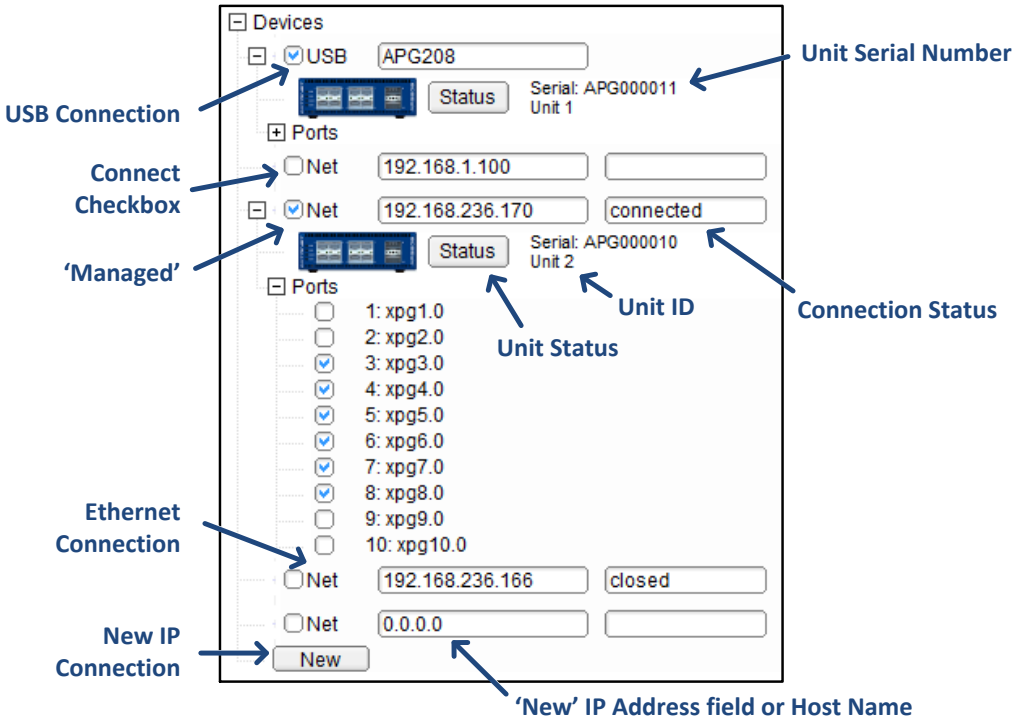
6.3.9 About

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.

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

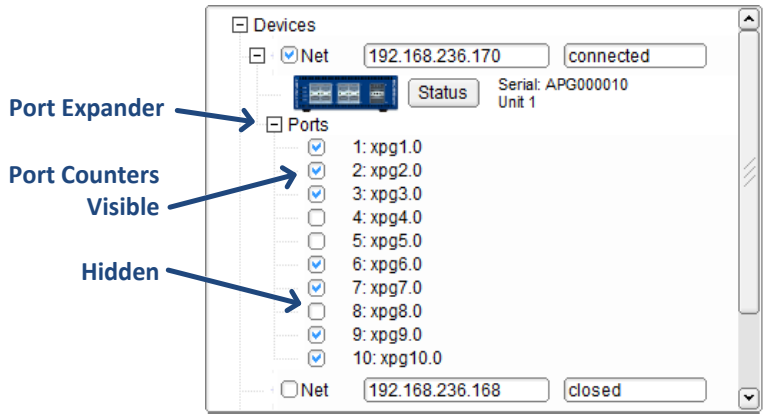
The visible ports are automatically added to the counter pane when the management interface is connected.

If an attempt is made to connect using the USB and 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:

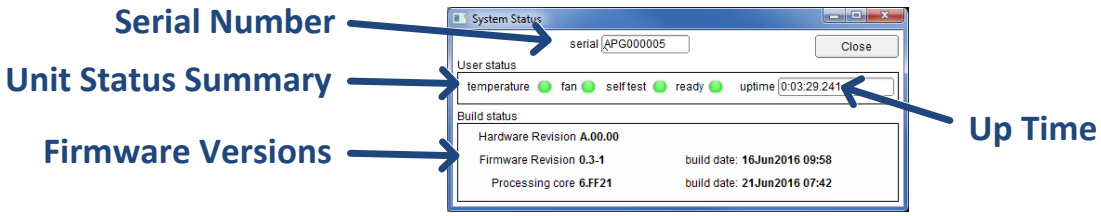
Status	Description
	Connection not attempted during this APG Control Interface session
connecting..	Connect Checkbox ticked, connecting to the APG
connected	Connection successful and management interface active.
disconnecting..	Connect Checkbox cleared, disconnecting from the APG
closed	Management connection closed
Unit API not supported	If the Unit API is incompatible with the GUI API, the management connection is refused. Download the latest Embedded Software from www.axtrinet.com/software.html Then use the "Upgrade Unit" tool (Section 6.3.8)
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:

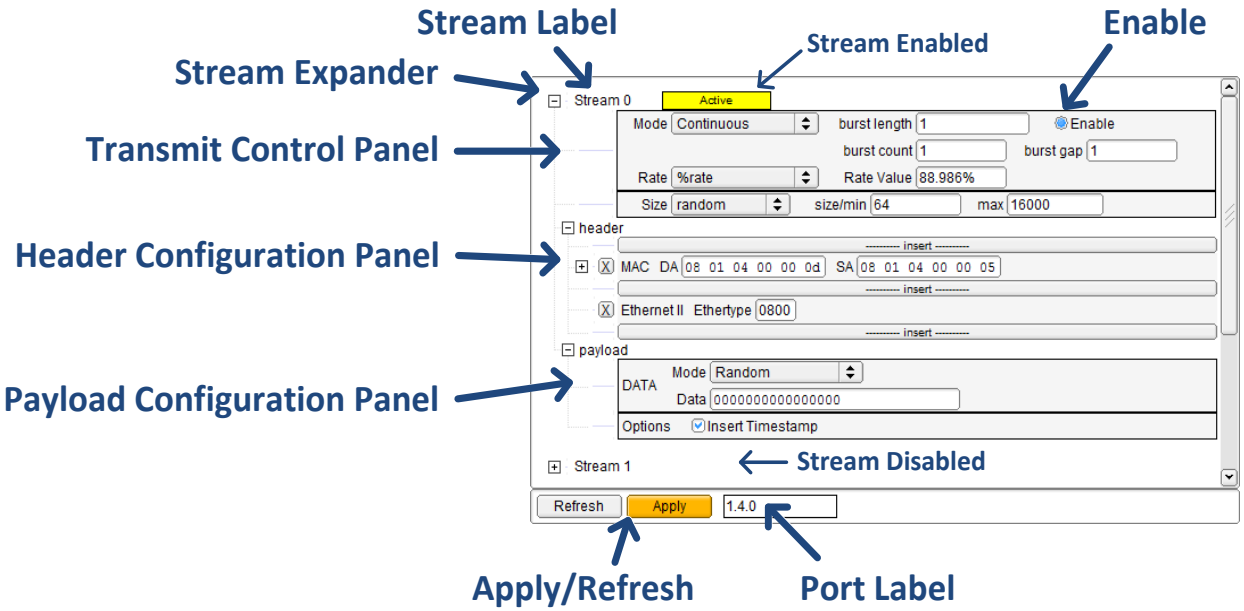
Option	Function
Serial Number	Serial number of the unit
Unit Status	**TEMP:** Temperature OK Temperature Warning – fan speed will increase Over-Temperature – front panel disabled
	FAN: Fan OK Fan is running faster than expected Fan is running at full speed
	SELF-TEST: Self-Test passed Self-Test running 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

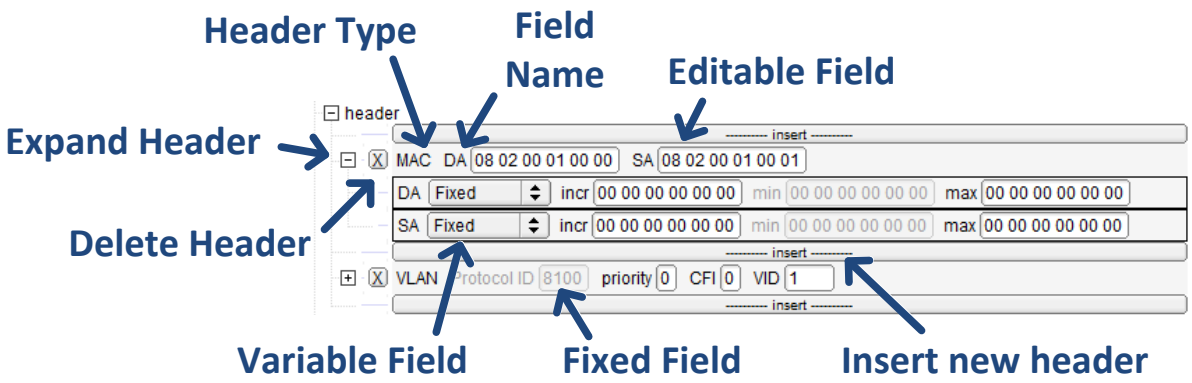
The stream transmit mode, rate and length are configured in the Transmit Control Panel.

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. 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.
SIZE MAX		Maximum packet length for variable **SIZE** modes. Not used if **SIZE** is FIXED. 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.

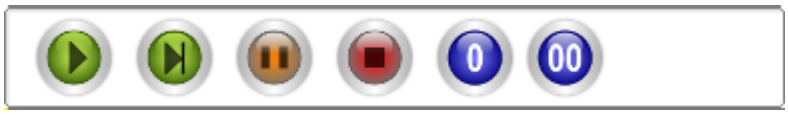
6.5.3 Payload Configuration

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 selected ports.
	STEP – Transmit a single packet on the selected ports
	PAUSE – Pause transmission on the selected 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 selected ports.
	CLEAR SELECTED COUNTERS – Clear counters on the selected ports only.
	CLEAR ALL COUNTERS

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 selected ports before starting transmission.

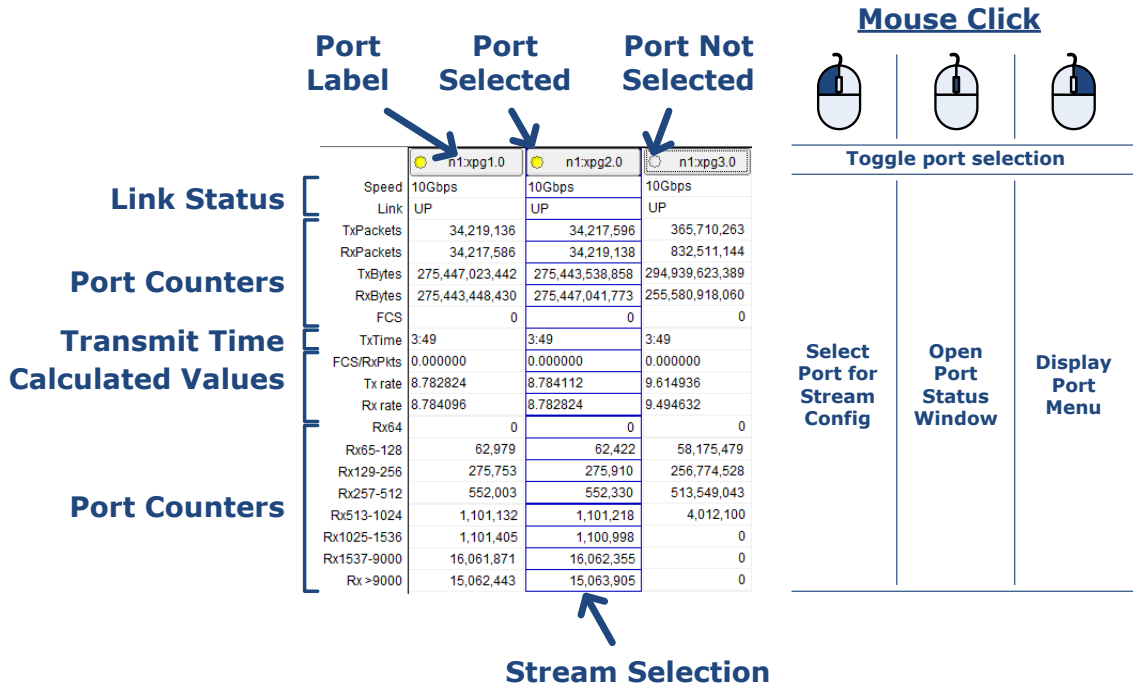
If the port is transmitting packets, the **STOP** button must be pressed before the **START** to load the stream configurations into the selected ports.

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

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'.



	n1:xpg1.0	n1:xpg2.0	n1:xpg3.0
Speed	10Gbps	10Gbps	10Gbps
Link	UP	UP	UP
TxPackets	34,219,136	34,217,596	365,710,263
RxPackets	34,217,586	34,219,138	832,511,144
TxBytes	275,447,023,442	275,443,538,858	294,939,623,389
RxBytes	275,443,448,430	275,447,041,773	255,580,918,060
FCS	0	0	0
TxTime	3:49	3:49	3:49
FCS/RxPkts	0.000000	0.000000	0.000000
Tx rate	8.782824	8.784112	9.614936
Rx rate	8.784096	8.782824	9.494632
Rx64	0	0	0
Rx65-128	62,979	62,422	58,175,479
Rx129-256	275,753	275,910	256,774,528
Rx257-512	552,003	552,330	513,549,043
Rx513-1024	1,101,132	1,101,218	4,012,100
Rx1025-1536	1,101,405	1,100,998	0
Rx1537-9000	16,061,871	16,062,355	0
Rx >9000	15,062,443	15,063,905	0

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		10Gbps or 40Gbps
Link Status		Link is UP or DOWN If TRANSMIT ENABLE (Section 6.8.1.1) is not set (ie module disabled), the Link Status is followed by **(txd)**
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 STATUS WINDOW

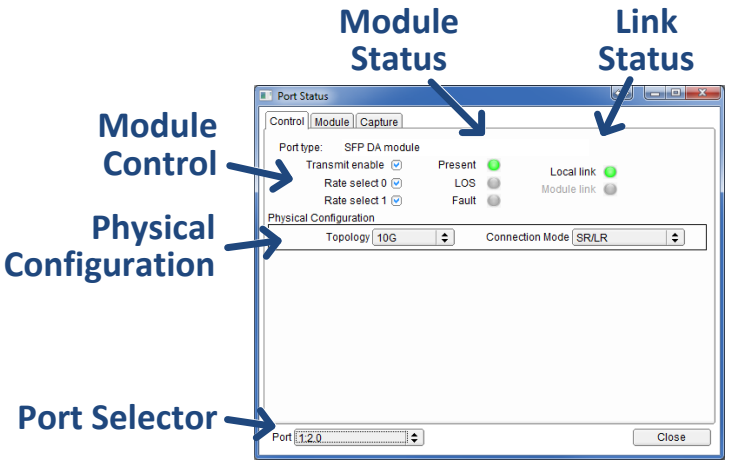
The Port Status window can be accessed in two ways:

- 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)

6.8.1 Control Tab



The contents of the Control Tab varies depending on the inserted module.

6.8.1.1 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:

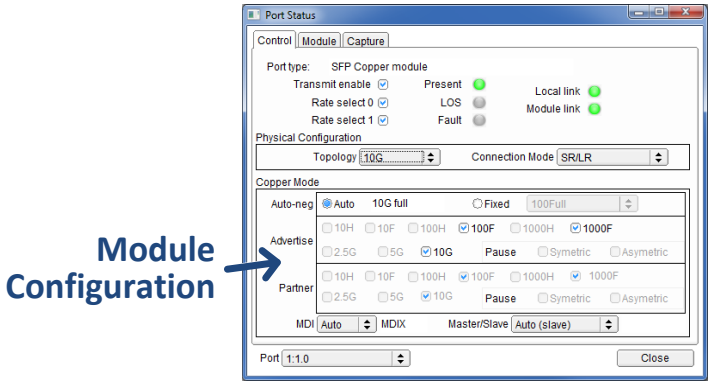
Status	Definition
Local Link	Displays the link status of the Packet Generator MAC to the link partner. For fibre optic and direct attach cables, this is the end-to-end link status. Where the module contains an additional active linking device, eg the 10GBase-T modules contain a PHY, the 'Local Link'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

6.8.1.2 Physical Configuration

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

6.8.1.3 Module Configuration (optional)

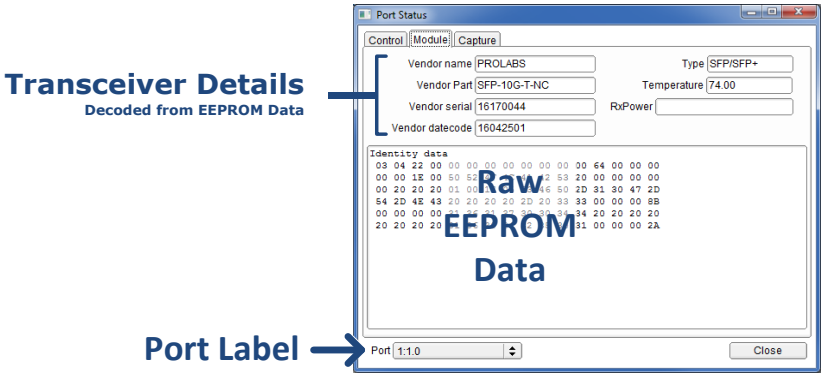
The Control Tab will display additional module configuration options if they are available, eg for the 10GBase-T modules:



The 10GBase-T Configuration comprises the Auto-Negotiation and Advertised Capabilities settings, the partner capabilities, and MDI/MDIX and Master/Slave configuration.

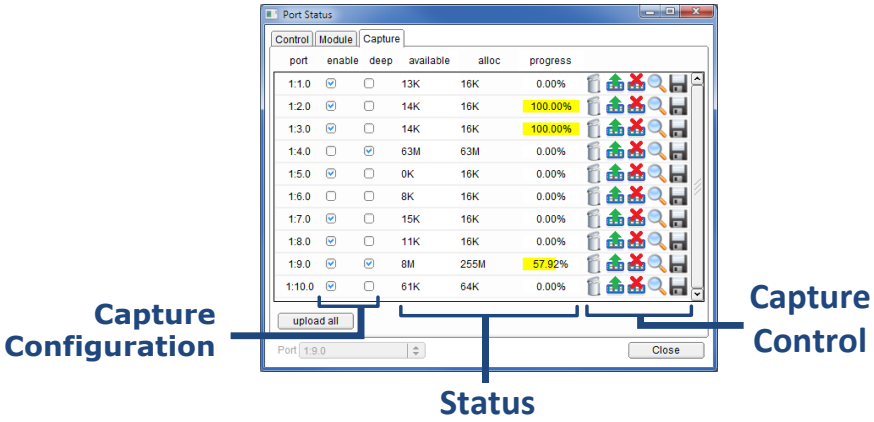
6.8.2 Module Tab

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



6.8.3 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.

Although Deep Capture can be selected on more than one port, it can only be enabled on one port in V2.1 Embedded Software.

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. Click the VIE(w) button to display the captured packets.
	Upload the Packet Data window with the latest captured data. 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 6.9)
	Save the captured port data to a PCAP file.
upload all	Uploads all captured port data.

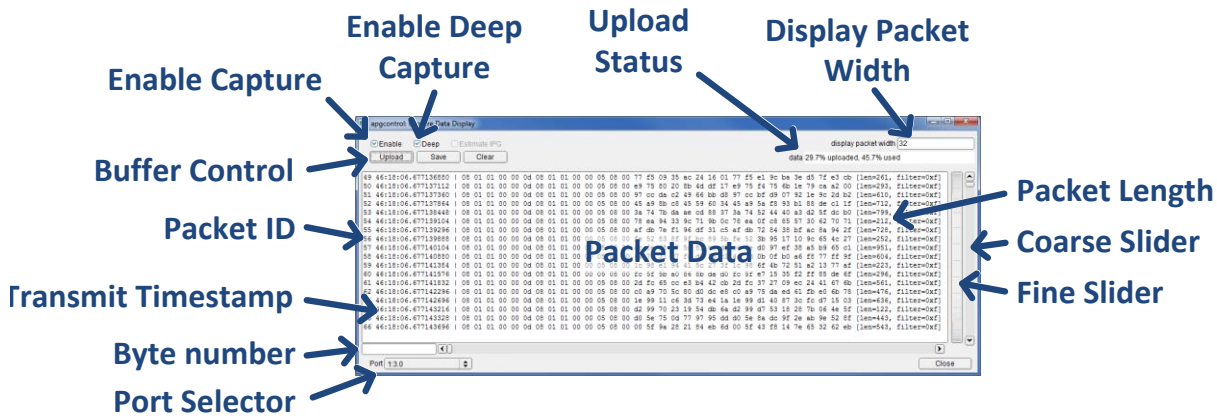
6.9 CAPTURE DATA DISPLAY

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.

Deep Capture can only be enabled on <u>one</u> port in V2.1 Embedded Software.



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. 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.

6.10 SLIDERS

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

Xentech Solutions Ltd
Suite 6 Stanta Business Centre
3 Soothouse Spring
St Albans
AL3 6PF
United Kingdom

Tel: +44 (0)1727 867795
Email: **support@axtrinet.com**