Packet-Master USB12 and USB480+ Bus Analysers

Packet-Master USB500 AG Bus Analyser / Generator

*The **Packet-Master USB12** is a Hardware USB Bus Analyser, intended for development of Low and Full Speed USB devices and hubs etc.*

*The **Packet-Master USB480+** adds High Speed capability together with On-The-Go analysis and Advanced Hardware Triggering.*

*The **Packet-Master USB500 AG** adds USB Generator Capability, and a V_{BUS} Monitor function.*

*All come complete with our Windows application **GraphicUSB** for capturing and displaying every detail of the data interactions on a USB link.*

Packet-Master USB12, USB480+ and USB500 AG

Take Control of your USB Development

Chapter 9 of the USB Specification details some seventeen Standard Device Requests which must be correctly implemented in any USB device, in order for the device to be successfully enumerated by the host controller.

When developing a USB-based device it is a major undertaking to implement the basic Chapter 9 Framework correctly as enumeration will simply fail for any number of reasons involving incorrect responses to the requests.

There is no substitute for a USB bus-analyser for revealing the smallest details of the packet transfer taking place on the bus. Software based analysers can only ever give you a partial picture of what is going on, usually not reporting at all the packets with the errors.

The Packet-Master Analyser connects passively between a host computer and the USB device, and captures all USB activity without influencing the link.

Packet-Master Analyser Benefits

Save Development Time

The Packet-Master analyser will provide you with exact information showing you at which point a device under development is failing. It will save you weeks of wasted development time. In many cases you will find that the error you are looking for is highlighted on the GraphicUSB display in a distinctive colour.

Simple Connection

The Packet-Master analyser connects passively between a host computer and the USB device, and captures all USB activity without influencing the link. So you can be sure that you are seeing exactly what really happens. All the important timings are displayed.

Understand USB

When it comes to the USB protocol, a picture is worth a thousand words. The graphical display of GraphicUSB immediately provides deeper understanding of the data transfers and their related timings. By examining a working device, you will learn more in a few minutes than from hours of reading the specifications. (Specifications are essential too, but easier to understand when you have a picture in your mind.)

Understand Host Command Sequences

There is no specification as to the sequence of commands which a device may expect from a host. Some command sequences can be very surprising to the starting-out developer. The Packet-Master analyser will allow you to examine the sequences for any Operating System / Host Controller combination of your choice. This will allow you to reveal any false assumptions you may be making that a particular enumeration sequence is standardised.

(As a device developer, just remember that the device should make no assumptions about enumeration sequences, but simply respond correctly to any request it receives.)

Examine Working Devices

A great benefit available from the Packet-Master analyser is that it allows you to examine exactly what transactions occur in a working device, perhaps manufactured by a third party. This may reveal your own bad assumptions about how a protocol works, or may show you how many devices on the market do not obey the rules.

Some operating systems have work-arounds for certain common protocol errors, and you may discover some of these first-hand.

Specifications often contain ambiguities. For example, without seeing it for yourself, you might not have realised that there have been two different ways of encoding the version number (bcdUSB) for USB 1.1. Operating systems appear to take the pragmatic approach of accepting either.

Fine-tune Performance

Much of the effort in developing a new device will go into achieving the throughput required. There is no substitute for seeing the transactions attempted by the host, together with the device's response to them. Armed with this valuable information you will be in the best position to be able to fine-tune your device's performance.

Packet-Master Generator Benefits

Emulate any host or device sequence

With a Packet-Master Generator, you no longer have to persuade your host computer to produce a rare situation for testing your device. Write a simple script and the generator will do the rest.

If you want to know what happens when a transaction occurs which your host never seems to send, simply write a script and find out!

Packet-Master USB12

The USB12 provides the most economical solution to Low Speed and Full Speed USB bus analysis. An ideal introduction to USB development, it is USB Bus Powered for convenience of use, via a High Speed USB (480 Mb/s) connection to a host PC.

Integral Capture Start and Stop buttons and Capture Indicator allow captures to be controlled from the unit, or from the GraphicUSB application.

The link under test connects passively through the front panel USB connectors.

A rear panel feature connector provides signals for oscilloscope or logic analyser.

Packet-Master USB480+

The USB480+ adds the capability of High Speed USB analysis. In addition a 64 MB FIFO prevents loss of data.

Advanced triggering capability allows captures to be automatically started by a selected set of precise conditions.

A pre-trigger buffer can capture up to 32MB of events before the trigger point

A BNC Trigger socket, on the rear panel, can be used as input or output in conjunction with the triggering, under software control

Packet-Master USB500 AG

In addition to the capabilities of the USB480+, the USB500 AG analyser can also be configured as a USB generator. In host mode, it provides the V_{BUS} supply, applies bus states, and sends packets and waits for responses, all under control of your script.

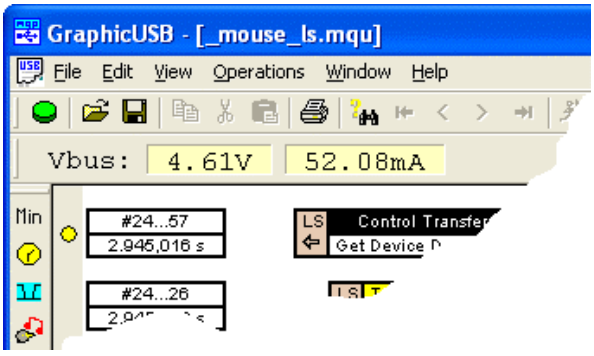
In device mode, it emulates plug-in, waits for the appropriate bus states and packets, and responds with the required data, all exactly as you specify.

To see the detailed interactions on the bus, use any USB analyser.

The advantage of using a Packet-Master unit for the analyser is that the powerful GraphicUSB application is able to control both the analyser and the generator simultaneously.

V_{BUS} Monitor

Whether configured as an analyser or as a generator, the USB500 AG continuously displays the V_{BUS} voltage and current.



Comparison Chart

Packet-Master Comparison Chart			
Feature	**USB12**	**USB480+**	**USB500 AG**
Analyser	✔	✔	✔
Generator			✔
V_{BUS} Monitor			✔
High Speed		✔	✔
Full Speed	✔	✔	✔
Low Speed	✔	✔	✔
Start/Stop Controllable From Unit	✔	✔	✔
Chirp Analysis		✔	✔
On-The-Go Analysis		✔	✔
FIFO Buffer		64 Mbyte	64 Mbyte
BNC Trigger		✔	✔
Advanced Triggering		✔	✔
Pre-Trigger Buffer		✔	✔
Class Analysis Options Available	✔	✔	✔
External Power Supply Provided			✔
RoHS Compliant	✔	✔	✔

Software Overview

The Packet-Master Analyser owes a large part of its functionality to the GraphicUSB application, supplied with the unit. A simple, yet information-rich display allows you to view every detail of a capture. The latest version is always available, free of charge, from our website.

This shows the organisation of the screen after a typical capture:

Event pane reveals every detail of data and timing, which occurs on the bus. You see exactly what happened in graphic detail.

Any selected event is thoroughly analysed in the details pane. Highlighting an item locates its data in the data pane below.

VBUS monitor display

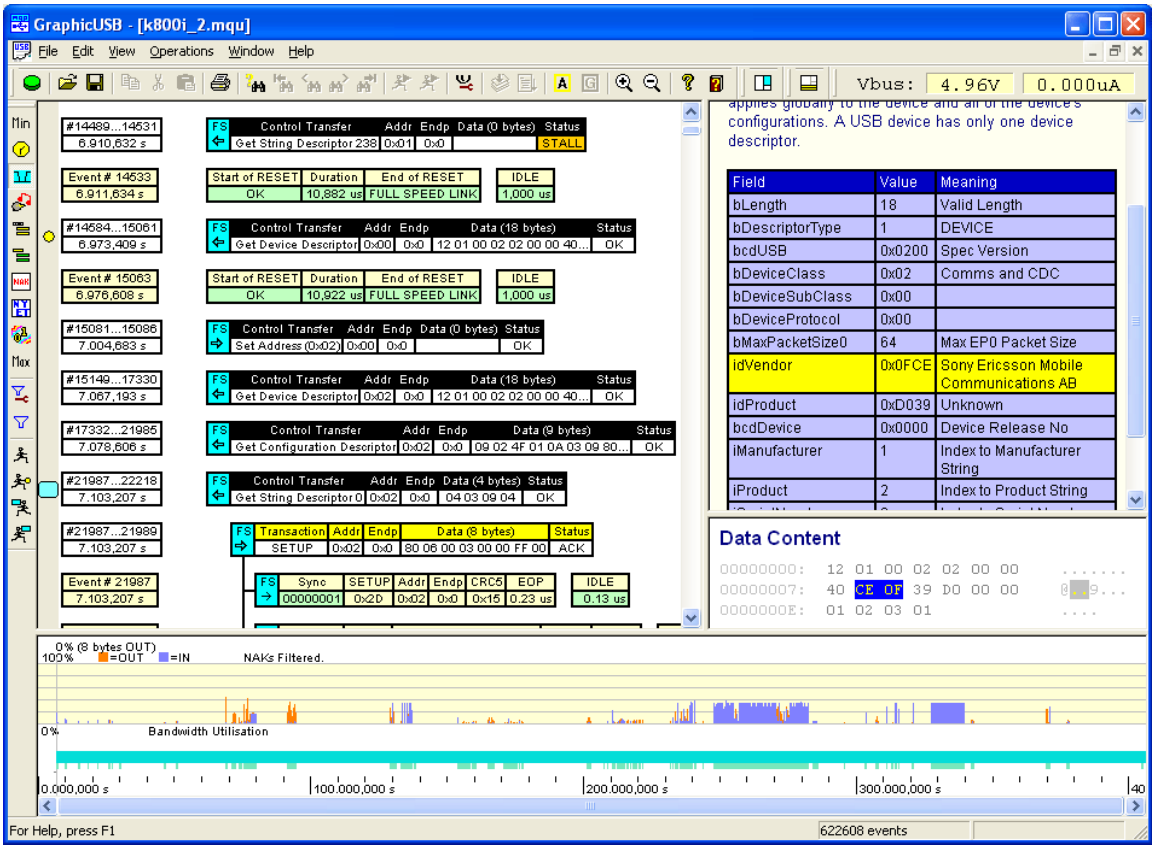
Filter out less significant events

Precise timing for every event

Custom filter

Bookmarks for fast event location

Bandwidth usage at any point in time

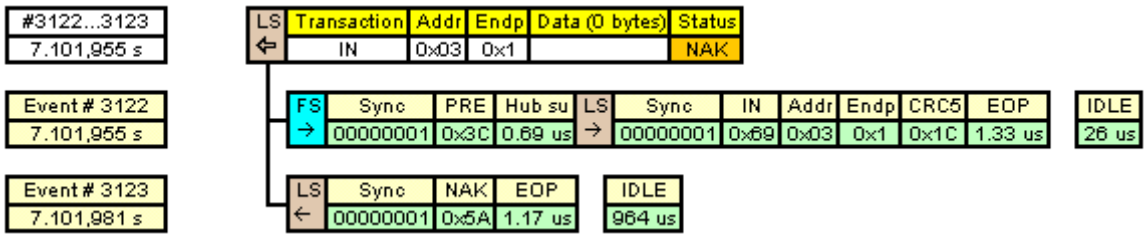


Timeline view: Zoom in to a single packet

Analyser Software Features

- Capture controlled from Packet-Master unit or from GraphicUSB screen.
- Triggering on user-definable event sequences, including BNC connector input (not USB12).
- Adjustable Pre-Trigger Buffer size allows capture of up to 32 Mbytes of event data prior to trigger point (not USB12).
- Captured document shows every detail of data transactions graphically for a fuller understanding of the USB protocol. This includes a detailed visual analysis of each packet.
- Transactions are grouped and summarised with a header row in the event pane. Transfers are summarised with a special header row.
- Filters allow less significant information to be removed from the display to allow you to concentrate on the critical data.
- Each event is analysed in detail, with any significant features explained, and possible errors or warnings highlighted.
- Data pane shows the data content of any packet.
- Detailed timeline and bus bandwidth usage pane.
- Bookmarks can be set on events of interest to allow them to be quickly located.
- Comprehensive search functions.
- Events display, detail analysis or data can be printed.
- Standard software and firmware up-grades are free of charge from our web site.
- Software can be freely used as a viewer in the absence of the Analyser Hardware.
- A multi-document interface allows comparison between captures.
- Capture size only limited by host computer RAM size.
- Export any range of events to text file, with a chosen level of filtering.
- Export all or chosen descriptors as annotated source code.
- Export data from a selected event, or a range of events.
- Custom event filter.
- Captures can be controlled from another application.
- Optional Class Analysis modules.

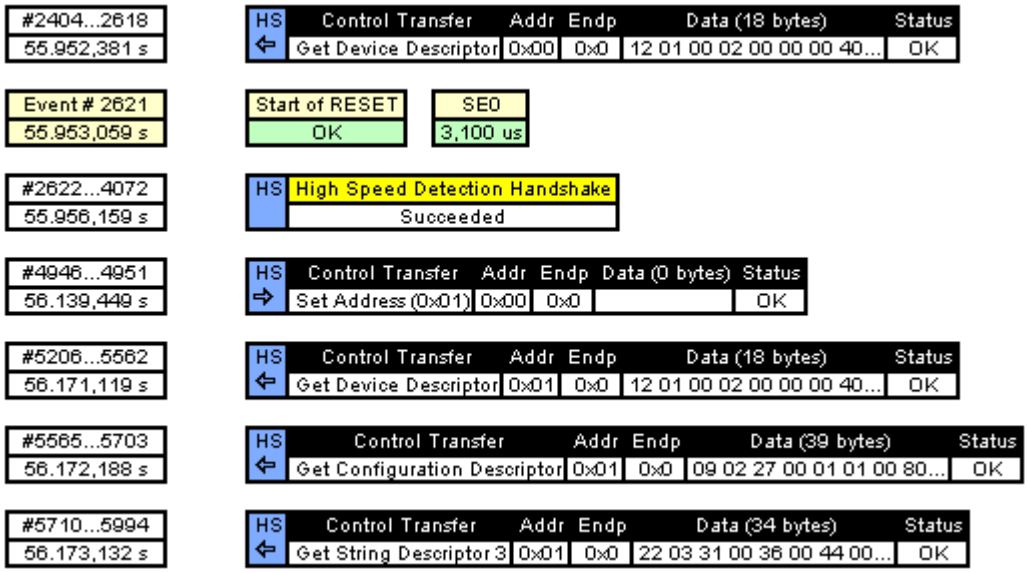
Mixed Speed On Single Link



This view of part of a screen-shot from Graphic USB shows a representation of data being transferred at two different speeds on the same link. Each packet is preceded by a coloured marker indicating Full Speed or Low Speed. This makes the function of the PREAMBLE packet very clear. Each Event has a precise timestamp (left). Notice also the detailed timing information for Hub Setup time, End Of Packet duration, and IDLE state time.

View By Control Transfers

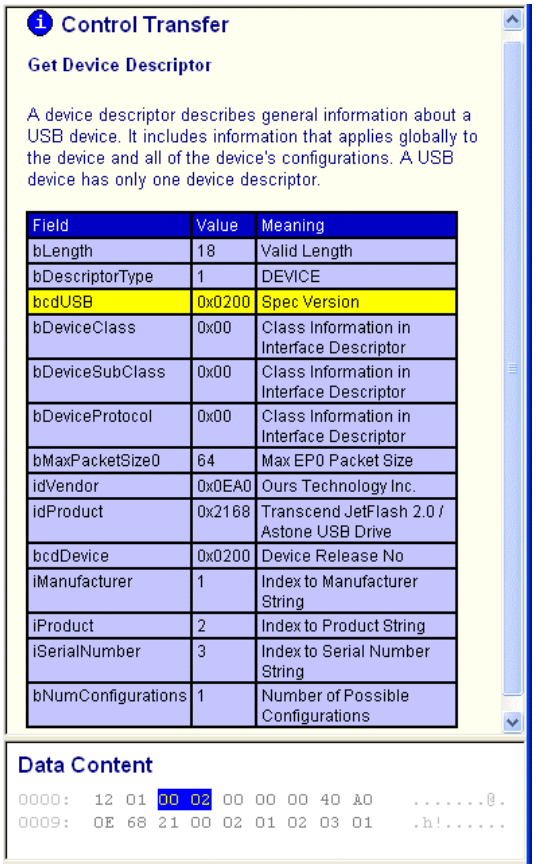
(less significant events filtered)



By clicking on the filter buttons for less significant events, the sequence of top-level control transfer header rows may be viewed in isolation. This ability to view information at an appropriate level of complexity makes GraphicUSB an invaluable tool for getting straight to the heart of the subject.

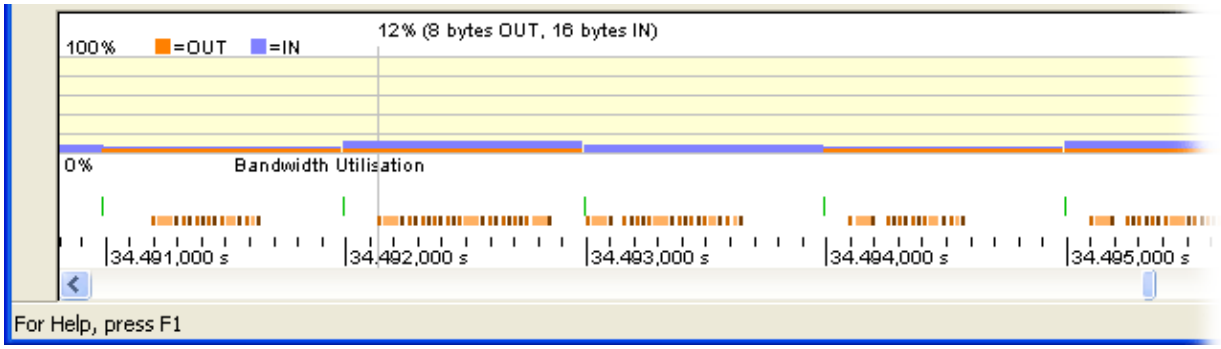
Full Analysis and Data Panes

By clicking on an event row in the event pane, a complete analysis of the event is displayed in the analysis pane, and the data content is shown in its entirety in the data pane. Where relevant, any information selected in the analysis pane is highlighted in the data pane for easy identification. All standard requests and descriptors are analysed in detail. Discrepancies are described.



Timeline and Bandwidth Pane

Timeline view zooms in to reveal individual packets within the frames. Bus usage is indicated by bandwidth utilisation histogram.



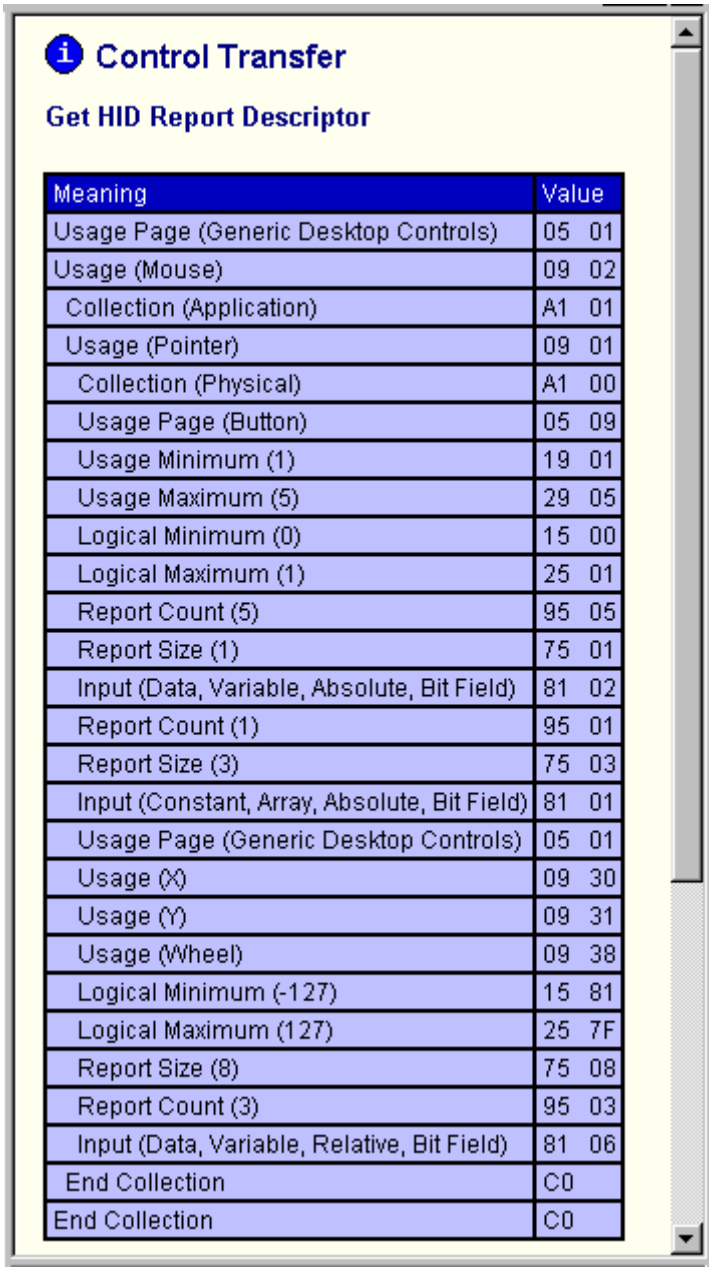
Optional Class Analysis Modules

A number of Class Analysis Options are available. These include

- Human Interface Devices (HID) Class
- Hub Class
- CDC and Comms Class
- Mass Storage Class
- Audio Class
- Image Class and Media Transfer Protocol (MTP)
- Printer Class
- Smart Card Class
- Video Class
- Test and Measurement Class
- Wireless Controller Class
- Vendor Class

Each option is available individually. Registering an option allows Graphic USB to display a full analysis of the specific Class transfer.

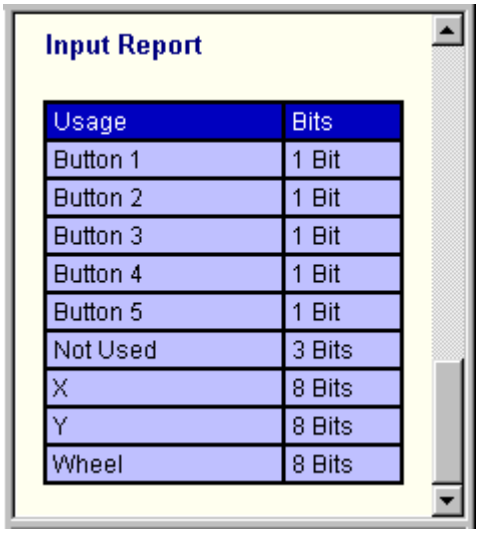
The screen shot to the right shows the analysis of a HID Report Descriptor.



Control Transfer

Get HID Report Descriptor

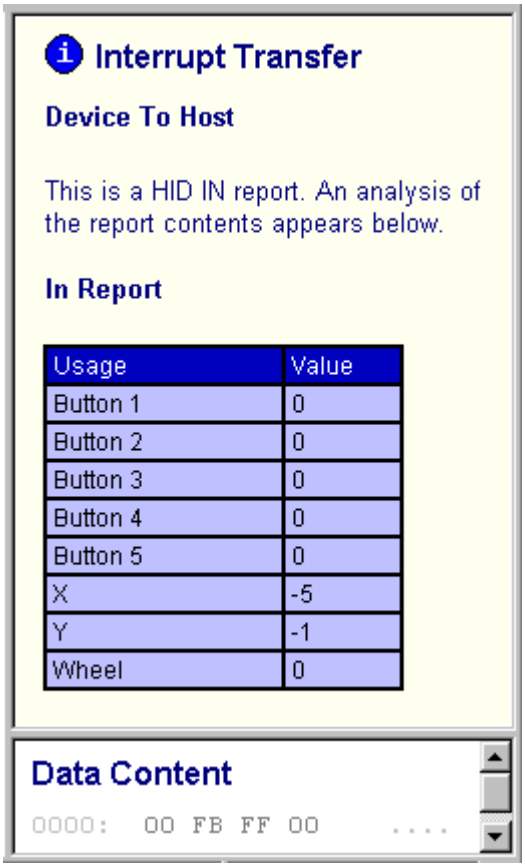
Meaning	Value
Usage Page (Generic Desktop Controls)	05 01
Usage (Mouse)	09 02
Collection (Application)	A1 01
Usage (Pointer)	09 01
Collection (Physical)	A1 00
Usage Page (Button)	05 09
Usage Minimum (1)	19 01
Usage Maximum (5)	29 05
Logical Minimum (0)	15 00
Logical Maximum (1)	25 01
Report Count (5)	95 05
Report Size (1)	75 01
Input (Data, Variable, Absolute, Bit Field)	81 02
Report Count (1)	95 01
Report Size (3)	75 03
Input (Constant, Array, Absolute, Bit Field)	81 01
Usage Page (Generic Desktop Controls)	05 01
Usage (X)	09 30
Usage (Y)	09 31
Usage (Wheel)	09 38
Logical Minimum (-127)	15 81
Logical Maximum (127)	25 7F
Report Size (8)	75 08
Report Count (3)	95 03
Input (Data, Variable, Relative, Bit Field)	81 06
End Collection	C0
End Collection	C0



The shot to the left shows the results of the built-in 'HID Report Descriptor' parser. Each report defined by the Report Descriptor is identified and displayed.

With the HID Class Analysis enabled, each HID report is identified, and the contents analysed.

Examining the analysis of existing devices is an excellent way to learn how a class works, and it has never been easier to reveal the building blocks, than with Graphic USB.



Class Analysis options currently supported by all Packet-Master Analysers

Audio Class V1.0

- Audio Control
- Audio Streaming
- MIDI Streaming
- Class Descriptors
- Class Requests
- Isochronous Streaming Data Transfers
- MIDI bulk transfers

Audio Class V2.0

- Audio Control
- Audio Streaming
- MIDI Streaming
- Class Descriptors
- Class Requests
- Isochronous Streaming Data Transfers
- MIDI bulk transfers
- Notification Interrupt Transfers

Comms and CDC

- CDC Data
- Direct Line Control Model
- Abstract Control Model
- Telephone Control Model
- Multi-channel Control Model
- CAPI Control Model
- Ethernet Networking Control Model
- ATM Networking Control Model
- Wireless Handset Control Model
- Device Management Model
- Mobile Direct Line Model
- OBEX Model
- Class Descriptors
- Class Requests
- Ethernet: Link Layer encapsulation, ARP, RARP, IP Datagrams, TCP, UDP and IGMP headers, etc
- Obex V1.3 protocol

Human Interface Device (HID) Class

- Class Descriptors (Report, Physical)
- Class Requests
- Report Interrupt Transfers

Hub Class

- Hub Class Descriptor
- Class Requests
- Notification Interrupt Transfers

Image Class and Media Transfer protocol (MTP)

- Class Requests
- Bulk Data Transfers
- PIMA 15740 Operation Interpretation
- PIMA 15740 Data Interpretation
- PIMA 15740 Response Interpretation
- MTP Extensions
- MTP Enhanced Extensions
- Event Interrupt Transfers

Mass Storage

- Class Requests
- Bulk Transport Only
- Control/Bulk/Interrupt (CBI) Transport
- RBC T10 Project 1240-D
- SFF-8020i, MMC-2 (ATAPI)
- QIC-157
- USB Floppy Interface (UFI)
- SFF-8070i
- SCSI transparent command set
- Bulk Data Transfers
- Notification Interrupt Transfers

Printer Class

- Class Requests
- Bulk Data Transfers

Vendor Class (user definable analysis)

- Class Requests
- Data Transfers

Test and Measurement Class

- USBTMC
- USB488
- Class Requests
- Bulk Data Transfers
- Notification Interrupt Transfers

Video Class V1.0

- Video Control
- Video Streaming
- Class Descriptors
- Class Requests
- Isochronous Streaming Data Transfers
- Bulk Streaming Data transfers
- Notification Interrupt Transfers

Video Class V1.1

- Video Control
- Video Streaming
- Class Descriptors
- Class Requests
- Isochronous Streaming Data Transfers
- Bulk Streaming Data transfers
- Notification Interrupt Transfers

Advanced Triggering

The Packet-Master USB480+ and USB500 AG are provided with an advanced trigger capability. Capturing can be triggered by a wide range of possible events, or sequences of events, as listed below.

The Pre-trigger Buffer can be set to a range of sizes up to 4Mbytes, and can capture events which occurred before the trigger point. This allows analysis of events, which lead up to a particular situation which needs to be investigated.

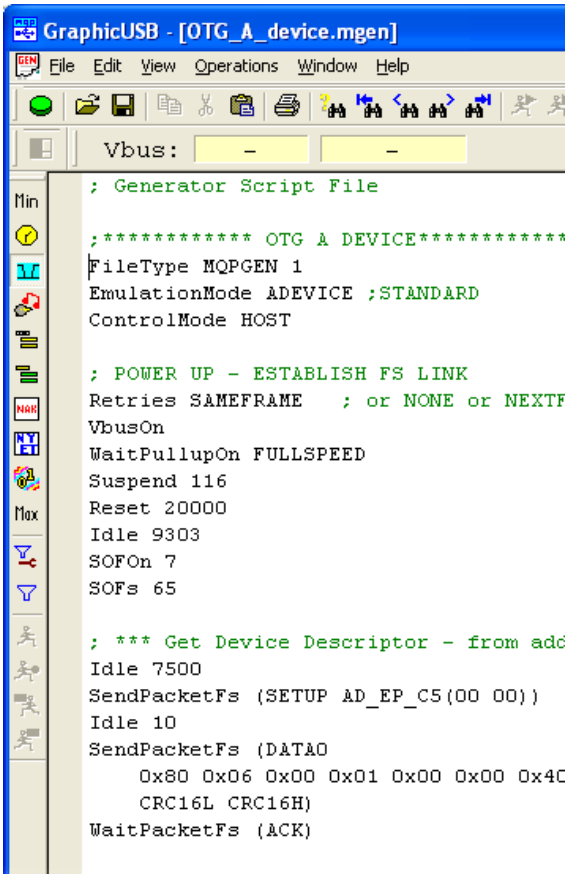
Events Available For Triggering

- Any Event
- Start Button (Manual)
- BNC Socket Input On Condition
- BNC Socket Input Off Condition
- Any of four specified Token Packets
- Any of four specified Data Packets
- Any of four specified Split Packets
- ACK Packet
- NAK Packet
- STALL Packet
- NYET Packet
- Not Handshake Packet (any event other than ACK, NAK, STALL or NYET packet)
- ERR Packet
- PRE Packet
- Specified SOF Packet
- Reserved PID Packet
- Bus Reset
- Suspend
- Resume
- HS Handshake OK
- HS Handshake Fail
- Chirp
- Keep Alive
- Data Line High
- Data Line Low
- Vbus On
- Vbus Off
- Specified Error Condition
- Any of four sequences of up to four of the above events occurring consecutively
- A counted quantity (up to of any of 65535) of any of the above
- A set of up to four of any of the above which occur in a particular order though not necessarily consecutively

Triggering Presets

In order to allow fast trigger setup, a number of presets are provided to cover common triggering requirements, to act as a starting point for more complex settings, or simply to demonstrate how typical triggering requirements can be set up.

- Triggering OFF
- Manual Triggering
- Trigger on any Transaction
- Trigger on any Data Packet
- Trigger on Bus Reset
- Trigger on Preamble with Setup Transaction
- Trigger on Isochronous In Transaction
- Trigger on Isochronous Out Transaction
- Trigger on In or Out Transaction
- Trigger on Ping Transaction
- Trigger on Split Setup Transaction
- Trigger on Split Bulk In or Out Transaction
- Trigger on Split Interrupt In or Out Transaction
- Trigger on Split Isochronous In or Out Transaction
- Trigger on Specified Data Pattern
- Trigger on Chirp
- Trigger on Suspend or Resume
- Trigger on Error Condition



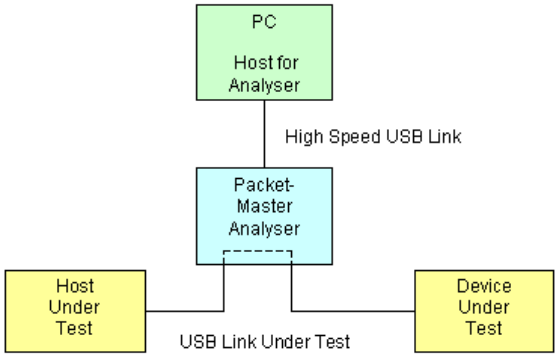
Generator Software Features

- Generator can emulate standard USB, or an On-the-Go A-device or B-device
- Generator can emulate a device or a host, and can switch between them for On-the-Go
- Generation controlled from Packet-Master unit or from GraphicUSB screen.
- Generator programs can be up to 64MB in size
- Generator Script language uses intuitive commands
- Generator scripts can be directly exported from any Packet-Master analyser capture file
- Pre-defined common script sequences can be directly inserted into script
- A single button click can save and compile the script, download it to the generator and start it running
- Intelligent transaction retry modes
- If you have a Packet-Master generator and a Packet-Master analyser, you can control them both from the same GraphicUSB screen
- Standard software and firmware up-grades are free of charge from our web site.
- A multi-document interface allows scripts and captures to be open at the same time

Test Set-up Connections

Analyser

To achieve a good capture rate it is important to provide a suitable test environment. The Packet-Master Analyser should be hosted by a good performance PC with a high speed USB connection. This USB host controller should not be shared by any other USB device while doing the testing.



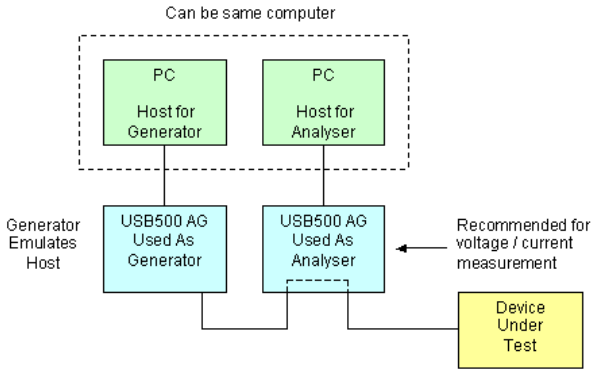
The Packet-Master USB12 will function correctly when connected to a Full Speed link but the capacity will be severely reduced and only low rates of USB traffic may be captured from the device under test.

In a similar fashion it is theoretically possible to use the same host computer for the Packet-Master Analyser, and for the Host Under Test. We do not recommend this, but if it is absolutely unavoidable, then you must at least use a separate USB host controller for the device under test. If your computer does not have two host controllers then you will need to buy a plug-in USB host controller card.

Packet-Master USB480+ and USB500 AG must be connected to a High Speed host.

Generator

The USB500 AG, when used as a generator, should be connected as shown below.



In this example a second USB500 AG is used as an analyser to capture the resulting traffic.

The device-under-test could be replaced by a host-under-test, with the generator emulating a device. It could also be replaced by an OTG A- or B-device.

Specifications

Minimum System Requirements (for Packet-Master Host)

- Pentium 3 - 600MHz
- PC with High Speed USB port should be dedicated to the capturing. (Actual target device should be connected to a different Host Computer to ensure reliable capture bandwidth)
- Windows Vista or XP (Service Pack 1 or better). 32-bit or 64-bit.
- CD ROM / DVD Drive
- 1GB RAM
- 100MB space on Hard Disk

Note: A good performance machine is recommended for good capture rate.

Physical Specification

	USB12	USB480+	USB500 AG
Weight:	155 g	360 g	400 g
Dim:	129 x 100 x 31 mm	190 x 140 x 32 mm	190 x 140 x 52 mm
Temp:	0°C - 40°C	0°C - 40°C	0°C - 40°C
Hum:	20% - 80% non condensing	20% - 80% non condensing	20% - 80% non condensing

Safety etc.

CE compliant.

Electrical Requirements

The Packet-Master analyser normally derives its power from the Host computer's USB connection.

Power (USB12)	150mA from USB host Optionally zero mA from USB if powered externally
Power (USB480)	225mA from USB host Optionally zero mA from USB if powered externally
Power (USB500 AG)	350mA from USB host Optionally zero mA from USB if powered externally. External powering mandatory when used as generator

Signals Available on Feature Connector

USB12	USB480+ USB500 AG
D+	D+
D-	D-
Decoded Data	RXVALID
Decoded Clock	RXACTIVE
Packet Sync Detected	60 MHz Clock

Standard Accessories

Packet-Master Analysers come complete with the following:

- GraphicUSB control software on CD
- USB 2.0 cable x 2
- Manual on CD
- External Power Supply (USB500 AG only)

Optional Accessories

- External Power Supply

Software Options

- Various class analysis options
- GraphicUSB DevKit

A comprehensive User Manual is available for download from our website. The GraphicUSB application, together with some sample captures, can also be downloaded.

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