



CAMBRIDGE RESEARCH SYSTEMS

# enhancement dynamic range

## Bits++ is a new tool for vision scientists.

It increases the dynamic range of your existing Windows or Macintosh system up to 64 times, which for the first time allows you to run very high resolution colour and contrast experiments using your current computer equipment.

### Not just another attenuator!

Bits++ is a high-speed, real-time Digital Video Processor, which allows you to use standard desktop Digital Visual Interface (DVI) video cards in completely new ways. Unlike other schemes, Bits++ uses a single high-performance 14 bit Digital to Analog Converter (DAC) system, not several 8 bit devices. The output is monotonic and completely free of the artefacts usually associated with simple attenuator networks, and full colour displays can be generated without compromise.

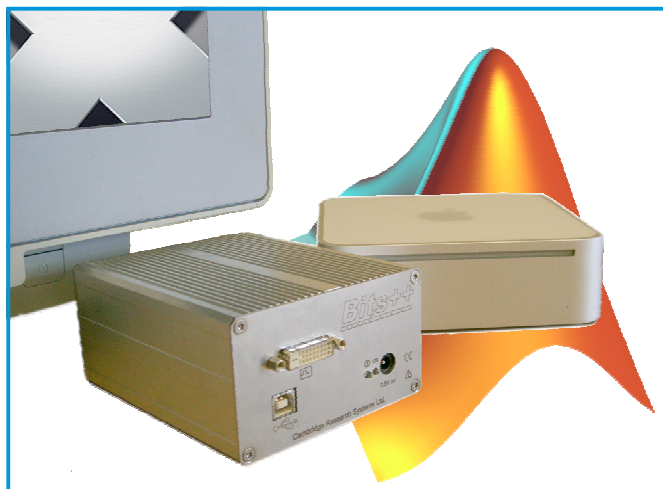
### 14 bit Video Modes

Three video modes are provided, which are optimised to support different types of visual displays. All three modes are available for both PC and Macintosh and can be easily used with the Psychtoolbox.

The basic palette mode remaps the standard 3x8 bit video signal into a 3x14 bit signal using individual RGB look-up tables (LUTs or CLUTs). This allows you to place the available bits where you need them, substantially increasing the usable luminance dynamic range. For example, displaying a low contrast/low spatial frequency luminance or chromatic grating without banding artefacts. In this mode, look-up tables can either be loaded using a USB computer interface, or our unique T-Lock frame-by-frame system. In this new technique, the actual LUTs are encoded in each displayed image. This provides high-speed LUT manipulation, which is guaranteed synchronous with the stimulus display.

Mono++ mode uses the 3x8 bit pixel information that usually specifies the individual RGB colours to form a 14 bit monochrome image with a palletised 8 bit colour overlay. This is ideal for psychophysical applications where only a luminance display is needed. The colour overlay is ideal for implementing fixation markers, masks etc.

Using our latest Pixel Doubling technology, the Color++ this mode gives a true 3x14 bit true colour output. By sacrificing horizontal resolution, adjacent pixels in the framebuffer are used to encode 14 bit true colour. This halves the horizontal resolution, but makes displaying wide dynamic range colour images a reality. Color++ is ideal for HDR Natural Scenes and colour psychophysics.



### Synchronisation

Bits++ includes an integrated digital I/O interface, which can be used to synchronise and control external equipment such as eye movement recorders and electrophysiological amplifiers. The digital, TTL-compatible output data can also be encoded with the stimulus to ensure that triggers are produced synchronous to the video display.

### Subject Responses & Reaction Timing

The digital interface is also compatible with the CRS range of wireless, small form-factor response boxes. The CB6 or CT6 response box can be connected to Bits++ to capture your subject's responses and measure their reaction times.

### Software

Bits++ is designed to work with your existing stimulus software, so typically no additional routines are necessary to make the special features of Bits++ available to your own experimental software.

A MEX file is provided to support MATLAB. This enables Bits++ to be easily integrated with the "Psychophysics Toolbox" extensions (Brainard, 1997; Pelli, 1997) on the Macintosh. PsychToolbox is a free software system for visual psychophysics, which provides an interface between MATLAB and the computer's video display system.

If you prefer using Python, the cross-platform PsychoPy software tool includes native support for the Bits++ system. PsychoPy is an open-source package for creating psychology stimuli. PsychoPy combines the graphical strengths of OpenGL with the easy Python syntax to give psychophysics a free and simple stimulus presentation and control package.

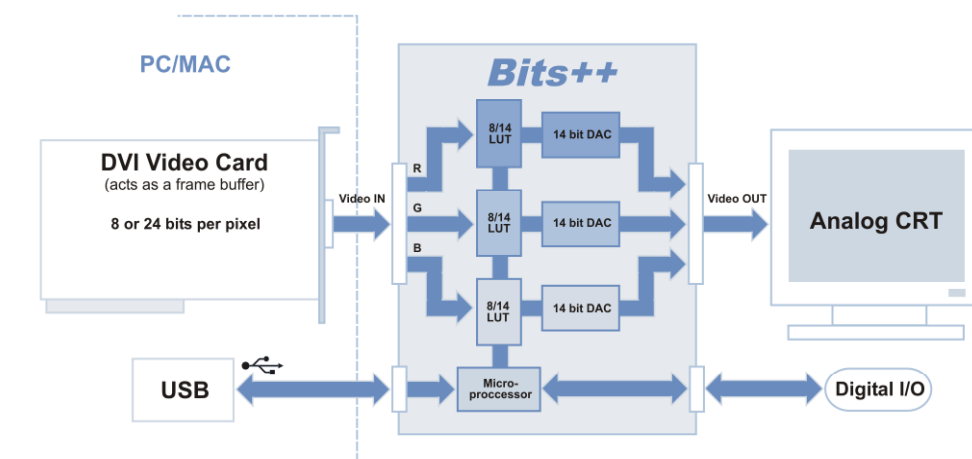
### Display Characterisation and Calibration

The ColorCAL colorimeter is a programmable, high performance colorimeter, which is specially made for CRS by Konica Minolta. If you are using Windows or the Mac OS 9 version of PsychToolbox, you can use ColorCAL to calibrate and characterise your stimulus display.



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# tools for vision science



**Bits++ digital video processor**

## Technical Specification

### Video

Single Link DVI-I input

RGB analog output, 14 bit resolution per colour

60 - 160 Hz frame rates

25 - 130 MHz pixel clocks

Note: monitor spatial and temporal resolutions are defined by the OS video & display drivers

### Control

USB 1.1 interface to host computer

### Intelligence

Analog Devices - ADSP-2189M microprocessor for look-up table processing and storage

### Digital I/O

10 bits in

10 bits out

### Hardware Reaction Timing

100  $\mu$ s resolution

Requires CB6 or CT6 response box

### Cables & Connectors

Single Link DVI-I input

13W3 Sun workstation video output connector,

1.5 m 4 BNC video cable

VGA adapter, provides HD15 video output connector

USB b input connector, 1.5 m USB cable

HD25 digital I/O connector

## System Requirements

### PC

DVI video card (for example: ATI Radeon 9800, NVIDIA GeForce 6, Matrox Parhelia, VillageTronic VTBook)

PC or notebook with USB (Windows 98 SE, Windows Me, Windows 2000 or Windows XP)

### Macintosh

DVI video card (for example: ATI Radeon 9800)

Macintosh or Powerbook with USB (G4 or later, Mac Mini. Mac OS 9 or Mac OS 10.3 or later)

MathWorks MATLAB 5 or later (for PsychToolbox on OS 9) or MATLAB 7 or later (for PsychToolbox on OS X)

## Software Notes

### The Psychophysics Toolbox

<http://www.psychtoolbox.org>

Brainard, D. H. (1997) *The Psychophysics Toolbox, Spatial Vision* 10:433-436.

Pelli, D. G. (1997) *The VideoToolbox software for visual psychophysics: Transforming numbers into movies, Spatial Vision* 10:437-442.

### Psychopy

<http://www.psychopy.org>

**Contact us for more information**

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