

Photic Output control using BrainMaster Atlantis

Software version 3.5 (and later)

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Introduction

The Photic output of the BrainMaster Atlantis provides light feedback using photic glasses provided by BrainMaster, or the Comptronix David PAL type of glasses. With an adapter (Radio Shack 274-373), glasses can also be used from the Mind Gear or Roshi devices. This manual describes the functions in the 3.5 software used to control the photic feedback under EEG control.

Connecting a photic output device is as simple as plugging into the “Photic” connector on the left rear of the Atlantis device. Plug the device in securely, and place the Atlantis device in a convenient place, preferably behind the trainee, so that the connecting wires are not in the way, and so that the wires will not be disturbed during the training. Make sure the photic wires do not become tangled with the EEG leads.

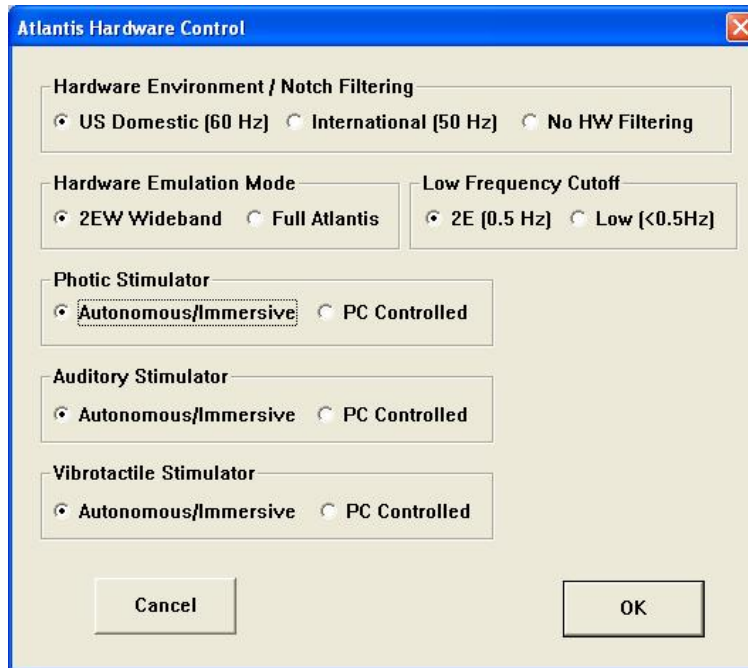
In order to use the Photic output during training, it is first necessary to make sure the basic settings are correct. This is a simple matter of making sure the controls are set correctly in the “Atlantis Hardware Control” panel, as follows.

To access the basic Photic controls from the Setup/Control Home Screen, use “View or Change Settings”, then press “Data Channels”. The Data Channels control panel is shown below. From this control panel, press “Atlantis Hardware Control.”

The screenshot shows the "Data Channels" control panel with the following settings:

- EEG Channels:** One (selected), nIR HEG, Two, Four, pIR HEG or TEMP.
- Sum-Channel Mode:** ON (selected), OFF.
- 4-channel Sum Method:** Split, Combine (selected).
- Save EEG to Disk:** ON (selected), OFF.
- Software Digital Filter Order:** 1 (selected), 2, 3, 4, 5, 6, 7, 8, 9, 10. Text below: "lower order is faster, higher order is more selective".
- Atlantis Hardware Control:** Button.
- Amplitude Scale:** Peak-to-Peak (selected), RMS.
- Artifact Threshold:** 255 microvolts.
- Software Notch Filters:** 60 Hz Notch Filter (checked), 50 Hz Notch Filter (checked).
- EEG Data Sampling Rate:** 120 sps, 256 sps (selected).
- COM Port Select:** Enter COM Port Number (1, 2, 3, ..., 32) with 4 entered in the text box.
- Buttons:** Cancel, Electrodes & Trainee Info, Search this PC for Available COM Ports, OK.

The Atlantis Hardware Control panel is shown below. From this, you can select one of the two currently available modes for the Photic Stimulator. The Photic Stimulator controls can be used in either of the two available Hardware Emulation Modes. In other words, either the “2EW Wideband” or “Full Atlantis” mode can be used, with the Photic Simulator in either of its selected modes.



The available modes for Photic output are (1) Autonomous/Immersive mode, and (2) PC Controlled mode. These are described below.

Note that the Autonomous/Immersive mode is available on all Atlantis devices, and has been implemented in all 3.0 and later versions of the software. The PC Controlled mode is only implemented in 3.5 and later software.

Note that while all users have access to Autonomous/Immersive mode, only users with the “StimFlash” passkey enabled have access to PC Controlled stimulation. To determine if you have this feature enabled, use the “Login” control panel, and press “OK” in this panel, to show your login options. Look for the entry “StimFlash is Enabled” to ensure that you have access to PC Controlled output. Contact BrainMaster Technologies, Inc. for information relating to this option and how to obtain it.

Also note that when testing protocols with photic output, the system must be in “training” mode set in the Session Control panel. **Protocols will not operate photic output control in “simulation” mode**, because no communication channel exists to the hardware, hence the hardware control of photic output cannot function. To test and operate photic output, the system must be communicating with live Atlantis hardware.

Autonomous/Immersive Mode

This mode is described in several prior publications, including “Atlantis Visual/Auditory/Tactile (VAT) Immersive Stimulators” published by BrainMaster Technologies, BrainMaster document # 535-087, dated 6/20/06, and published in **AVS Journal**, 5(2), 29–33. All Atlantis users have access to this mode.

The above cited article, and other helpful information, are posted on the BrainMaster Knowledge Base at:

<http://www.brainm.com/kb/entry/223/> and also at <http://www.brainm.com/kb/entry/276/>

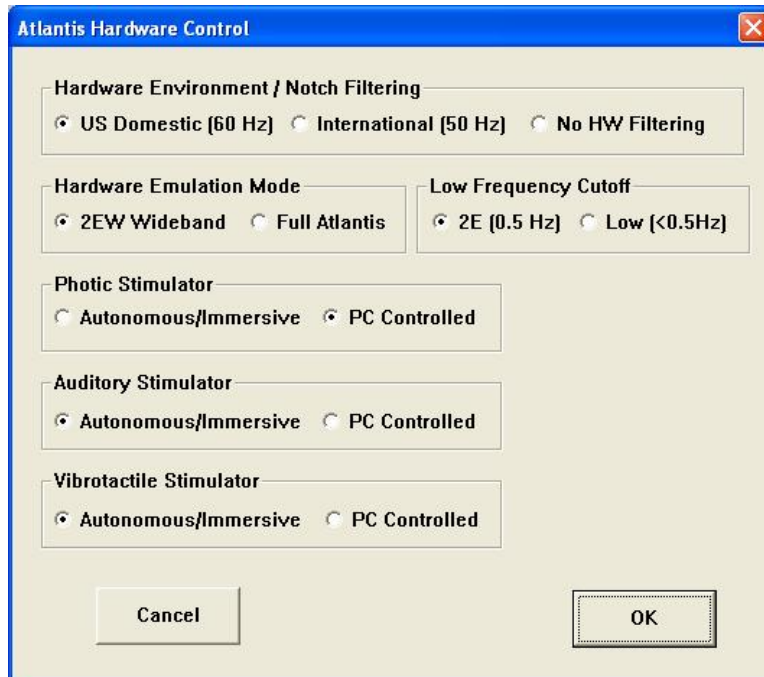
If you choose Autonomous/Immersive Mode, the photic output will operate in that mode.

The raw EEG signals will automatically be encoded into the LED output for channels 1 and 2, and activate the left and right eyes (or visual fields, if the glasses are hemi-field type) directly under EEG control. When using Autonomous/Immersive mode, no further changes to the protocol design are necessary. The Photic output will be continually enabled, and will flash under EEG control as long as the LED glasses are plugged into the Photic output, and as long as there are 2 channels of good EEG being monitored. This is the simplest way to achieve EEG controlled photic output using the Atlantis device, and is recommended as a general brain “brightening” or “disentrainment” approach. This should generally be used in combination with an EEG training protocol. The protocol will provide the direction and control, while the Autonomous/Immersive stimulation will provide a means for the brain to achieve change, and to break old patterns.

Again, when using Autonomous/Immersive mode, no additional protocol design elements are required. This mode can be used with any protocol, by simply selecting this mode, and by plugging in a photic output device. This is the simplest way to provide EEG-controlled photic output, without having to design a special protocol.

PC Controlled Mode

If you choose PC Controlled as shown below, then the photic outputs will be under PC control, as described below. The lights will only flash when the protocol directs them to flash. The commands to flash the lights under PC control are controlled by the Event Wizard and/or by the Session Wizard. Note that only users with the “StimFlash” option enabled will have access to PC Controlled functions.



Photic output control using the Event Wizard.

Having chosen “PC Controlled” mode, you can use the photic output either by loading in a preset trainee/study folder, as shown below, or by designing your own protocols. All controls in PC Controlled mode are done using either the Event Wizard or the Session Wizard. The photic output can be controlled using the following Event Wizard functions:

Event Wizard functions:

SetPhoticRate(rate)
(short form) SPR(rate)

In the SetPhoticRate function, the rate of photic output can be set to any frequency in Hz. Any value or variable can be used in this expression to set the photic rate, including values derived from EEG or other live data. The SetPhoticRate function is used in an equation, and when it is called by the Event Wizard, it sets the photic output rate based on the value used as an argument (the value in parenthesis) to the function. The argument may be a constant, or any type of expression that provides a number to be used as the photic output rate. For example, to set the photic output rate to 10 flashes per second, the following expression could appear in any enabled event:

“x=SetPhoticRate(10);”

To set the photic rate to the current peak EEG frequency, the following expression could be used: **“x=SetPhoticRate(Peakf(1, 0, 40));”** which would set the photic output rate to the peak EEG frequency on channel 1, in the range from 0 to 40 Hz. To set the photic rate to a value of 5 Hz above the current peak EEG frequency, the following expression could be used: **“x=SetPhoticRate(Peakf(1, 0, 40)+5);”**. The SetPhoticRate return value (the value that shows up as the x value) is the value that is calculated and used within the parentheses. This makes it possible to easily see the current photic rate in the Text Stats panel, alongside the event that uses this function.

Note: once you use SetPhoticRate, you must also use the event result **“Activate Photic Stim”** as an Event Wizard result, in order to produce photic output. This allows you to activate and de-activate the photic stim under control of any event. This provides the ability to do EEG controlled photic stimulation, or control the photic output with any other event condition. To keep the photic output on continuously, use an event that is always true, such as **“If (entered value) 1 Is Greater Than (entered value) 0 Then Activate Photic Stim”**. This event would turn on the photic output continuously.

Event Wizard Event Results:

In addition to the functions given above, it is possible to select the photic output in the following Event Wizard Event Results, which are selected in the Event Result area of the Event Wizard Designer.

Flash Photic Once

The Event Result “Flash Photic Once” will cause the photic output to emit a brief flash once, when the event condition is first met. Then, it will not flash again until the condition is not met, then met again. Thus, the photic output will flash once to signal each time that the event condition is newly met. This is useful to provide a single signal, indicating that a condition has become met, and will flash once each time that the condition becomes true. This is useful in discrete training paradigms in which the trainee is to be informed with a single flash, that a change in state has occurred.

Activate Photic Stim

The Event Result Activate Photic Stim will cause the photic output to begin flashing at the set rate, and to continue flashing as long as the event condition is met. This provides continuous photic output for the entire time that the condition is true.

The screenshot shows the 'Event Wizard Designer' window. At the top, 'Event Number' is set to 1, and 'This Event Is' is 'Enabled'. The 'Event Condition' section has 'IF: Channel 1: Alpha % Energy' and 'Constant: 100.0'. The 'RULE' is 'IS LESS THAN:'. The 'Event Result' section has 'THEN: Activate Photic Stim'. The 'Event Trend Graph' has 'Scale Factor: 20' and 'Offset: 0'. The 'Event Summary' shows 'EVENT 1 IS CURRENTLY: ENABLED'. The 'MIDI Sound Properties' section is on the right, with 'Starting Note: 37 A (440.0)', 'Instrument: 107 Koto', 'Playing Style: Sustained', 'Modulation: Pitch', 'Starting Loudness: Level: 80', 'Loudness Change Rate: 10', 'Note Change Rate: 2', 'Musical Scale (Mode): Chinese', 'Musical Key: A', and 'Play Note or Chord: 1 Note'. Buttons at the bottom include 'Enable All Events', 'Disable All Events', 'Data Dictionary', 'Clear All Events', 'Show All Events', 'Print All Events', 'Help', 'Copy Event', 'Paste Event', 'Cancel', 'Use Now', and 'OK'.

Event Wizard Designer

Event Number: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

This Event Is: ☒ Enabled ☐ Disabled

Visibility: ☒ Visible ☐ Hidden

Event Condition:

IF: Channel 1: Alpha % Energy Constant: 100.0 Damping Factor: 0

Check Equation: $x=0$

RULE: IS LESS THAN:

Use Entered Value: Lobeta Constant: 100.0 Damping Factor: 20

Check Equation: $x=E1A$

Note: You must press "Check Equation" to check and save any changes made to equations

Event Result:

THEN: Activate Photic Stim

☐ Obey Inhibits ("stops") ☐ Control MMP Player

Event Trend Graph

Scale Factor: 20 Offset: 0

Event Summary:

Summary for Event 1:
IF: Channel 1 Alpha % Energy IS LESS THAN Value: 100.0
THEN: Activate Photic Stim

EVENT 1 IS CURRENTLY: ENABLED

MIDI Sound Properties:

Starting Note: 37 A (440.0) 1 to 88
Instrument: 107 Koto 128 choices
Playing Style: Sustained Percus. or Sust.
Modulation: Pitch Ampl. or Pitch
Starting Loudness: Level: 80 0 to 128
Loudness Change Rate: 10 0 to 20
Note Change Rate: 2 0 to 20
Musical Scale (Mode): Chinese 15 choices
Musical Key: A C to B Flat
Play Note or Chord: 1 Note 1 to 8 Notes

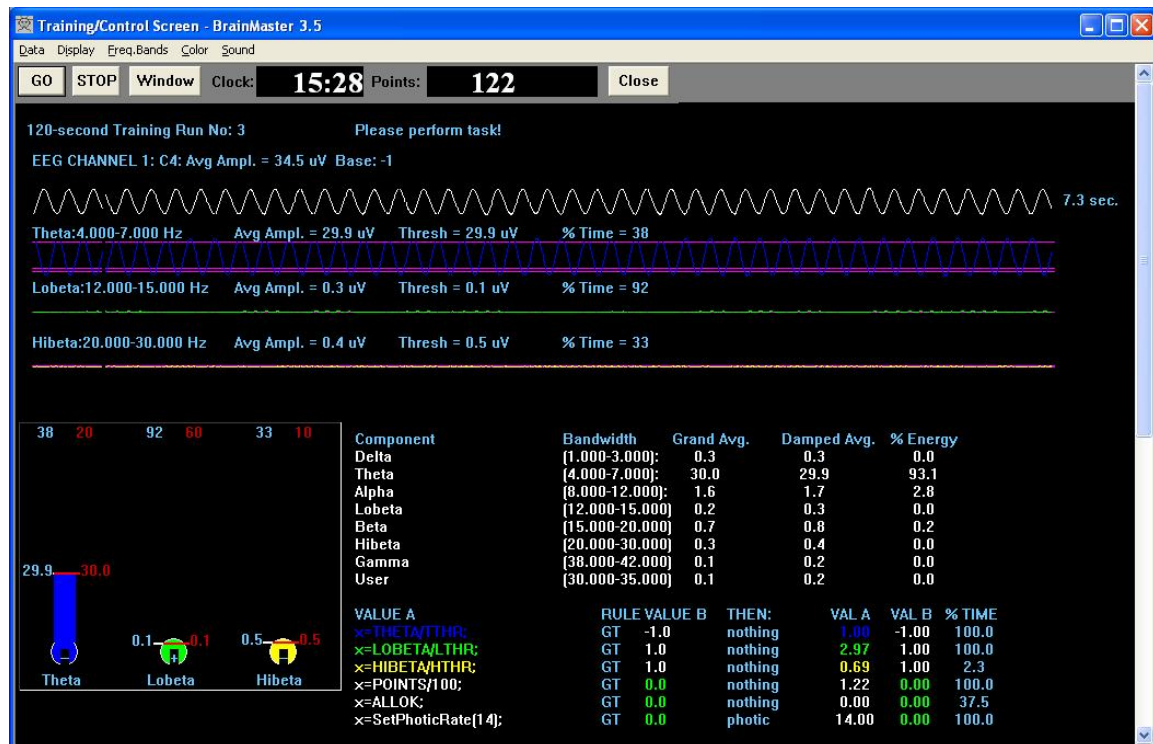
Enable All Events Disable All Events Data Dictionary
Clear All Events Show All Events Print All Events
Help Copy Event Paste Event
Cancel Use Now OK

Example Designs using the Event Wizard

The following example designs are available on the BrainMaster knowledge base and can be downloaded and tested per the following descriptions. It is possible using the Atlantis software, to use the photic output to emulate any of a wide range of photic systems, including fixed, variable, program controlled, or EEG other biofeedback-controlled methods.

Photic output (continuous) with a fixed rate

The example file “Photic Output Fixed Rate” allows the system to provide photic output at a fixed rate of 12 flashes per second, continuously. It also runs the complete “focus” protocol at the same time. Thus, the photic output becomes an “assist” to the conventional neurofeedback training. All feedback methods including sound, multimedia, DVD, CD, Flash Games, etc. operate with this design, in addition to the photic output. The design requires only one additional event, which uses a simple expression that sets the photic rate to the fixed frequency, and allows it to operate continuously. The photic rate can be changed by editing the entry for Event 6, and changing the value 14 to any desired frequency. It is also possible to have the photic output under EEG control, by using the event that controls the “Activate Photic Stim” result.



Below is the Event 6 added to the focus protocol, to add the continuous photic stimulation.

Photic Output control with Atlantis and BrainMaster 3.5 software

Event Wizard Designer

Event Number: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16

This Event Is: ☒ Enabled ☐ Disabled

Visibility: ☐ Visible ☒ Hidden

Event Condition:

IF: Use Equation: Delta Amplitude Constant: Damping Factor:

Check Equation: x=SetPhoticRate(14);

RULE: IS GREATER THAN:

Use Entered Value: Delta Constant: Damping Factor:

Check Equation: x=0;

Note: You must press "Check Equation" to check and save any changes made to equations

Event Result:

THEN: Activate Photic Stim

☐ Obey Inhibits ("stops") ☐ Control MMP Player

Event Trend Graph

Scale Factor: 100 Offset: 0

Event Summary:

Summary for Event 6: EVENT 6 IS CURRENTLY: ENABLED
IF: EQN: x=SetPhoticRate(30); IS GREATER THAN Value: 0.0
THEN: Activate Photic Stim

Sustained Reward Criterion
Condition must be met for: 0 milliseconds

Refractory Period
Time between rewards is: 0 milliseconds

MIDI Sound Properties:

Starting Note: 1 A (55.0) 1 to 88

Instrument: 0 Piano 1 128 choices

Playing Style: Sustained Percus. or Sust.

Modulation: Amplitude Ampl. or Pitch

Starting Loudness: Level: 0 0 to 128

Loudness Change Rate: 0 0 to 20

Note Change Rate: 0 0 to 20

Musical Scale (Mode): Chromatic 15 choices

Musical Key: A C to B Flat

Play Note or Chord: 1 Note 1 to 8 Notes

Enable All Events Disable All Events Data Dictionary

Clear All Events Show All Events Print All Events

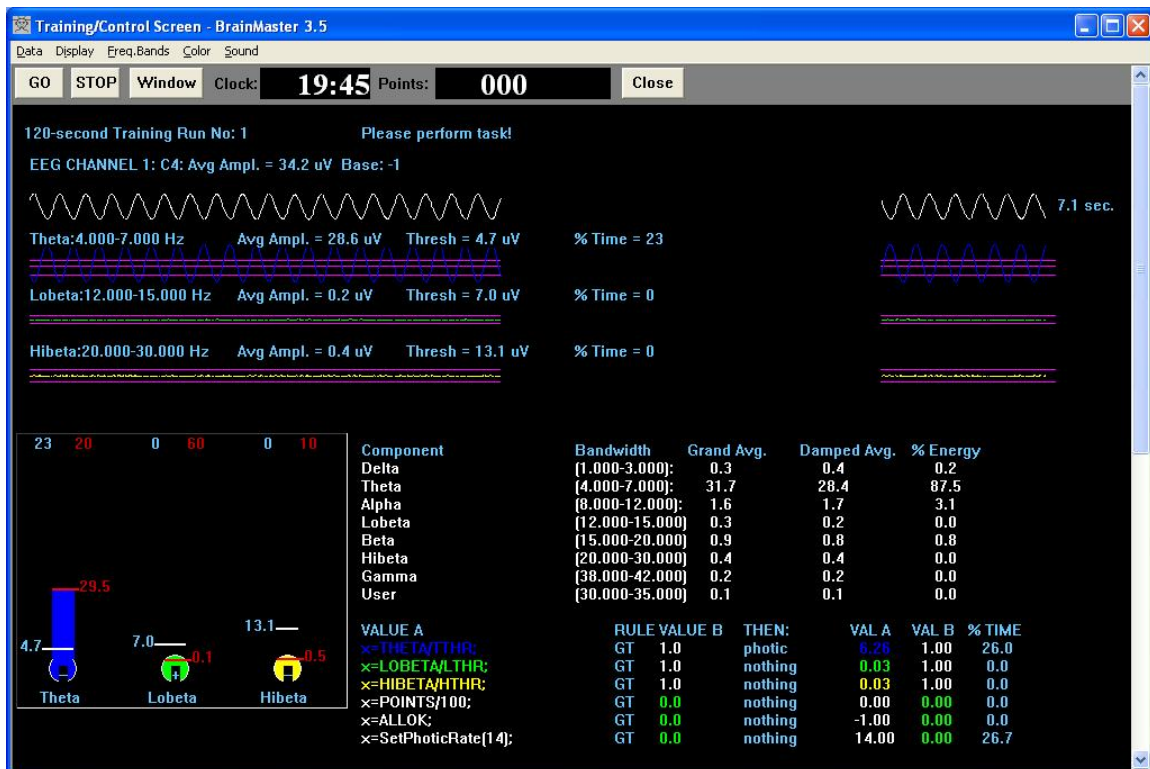
Help Copy Event Paste Event

Cancel Use Now OK

Photic output (EEG controlled) with a fixed rate

The example file “Photic Output EEG controlled fixed rate” provides EEG-controlled photic stimulation at a fixed rate. The photic stimulation is controlled by the EEG, so that it only occurs when theta is above threshold. This method has been used to reduce theta using EEG-controlled photic stimulation, in addition to the neurofeedback.

This is done with two small changes in the Event Wizard. Event 1 is set up to control the lights simply by selecting “Activate Photic Stim” as the result of theta being above threshold. Event 6 is the same as in the continuous example, except that the event result is set to “Do Nothing”. Event 6 sets the rate of stimulation, while Event 1 actually turns the photic output on and off in real time, under EEG control.



Photic Output control with Atlantis and BrainMaster 3.5 software

Event Wizard Designer

Event Number: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

This Event Is: ☒ Enabled ☐ Disabled

Visibility: ☒ Visible ☐ Hidden

Event Condition:

IF: Use Equation: Delta Amplitude Constant: Damping Factor: 5

Check Equation $x = \text{THETA} / \text{TTHR};$

RULE: IS GREATER THAN:

Use Entered Value: Delta Constant: Damping Factor: 1.0 0

Check Equation $x = 1;$

Note: You must press "Check Equation" to check and save any changes made to equations

Event Result:

THEN: Activate Photic Stim

☐ Obey Inhibits ("stops") ☐ Control MMP Player

Event Trend Graph

Scale Factor: 2 Offset: 0

Event Summary:

Summary for Event 1:
IF: EQN: $x = \text{THETA} / \text{TTHR};$ IS GREATER THAN Value: 1.0
THEN: Activate Photic Stim

EVENT 1 IS CURRENTLY: ENABLED

MIDI Sound Properties:

Starting Note: 1 A (55.0) 1 to 88
Instrument: 0 Piano 1 128 choices
Playing Style: Sustained Percus. or Sust.
Modulation: Amplitude Ampl. or Pitch
Starting Loudness: Level: 0 0 to 128
Loudness Change Rate: 0 0 to 20
Note Change Rate: 0 0 to 20
Musical Scale (Mode): Chromatic 15 choices
Musical Key: A C to B Flat
Play Note or Chord: 1 Note 1 to 8 Notes

Enable All Events Disable All Events Data Dictionary
Clear All Events Show All Events Print All Events
Help Copy Event Paste Event
Cancel Use Now OK

X

Event Wizard Designer

Event Number: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

This Event Is: ☒ Enabled ☐ Disabled

Visibility: ☐ Visible ☒ Hidden

Event Condition:

IF: Use Equation: Delta Amplitude Constant: Damping Factor: 0

Check Equation $x = \text{SetPhoticRate}(14);$

RULE: IS GREATER THAN:

Use Entered Value: Delta Constant: Damping Factor: 0.0 0

Check Equation $x = 0;$

Note: You must press "Check Equation" to check and save any changes made to equations

Event Result:

THEN: Do Nothing

☐ Obey Inhibits ("stops") ☐ Control MMP Player

Event Trend Graph

Scale Factor: 100 Offset: 0

Event Summary:

Summary for Event 6:
IF: EQN: $x = \text{SetPhoticRate}(14);$ IS GREATER THAN Value: 0.0
THEN: Do Nothing

EVENT 6 IS CURRENTLY: ENABLED

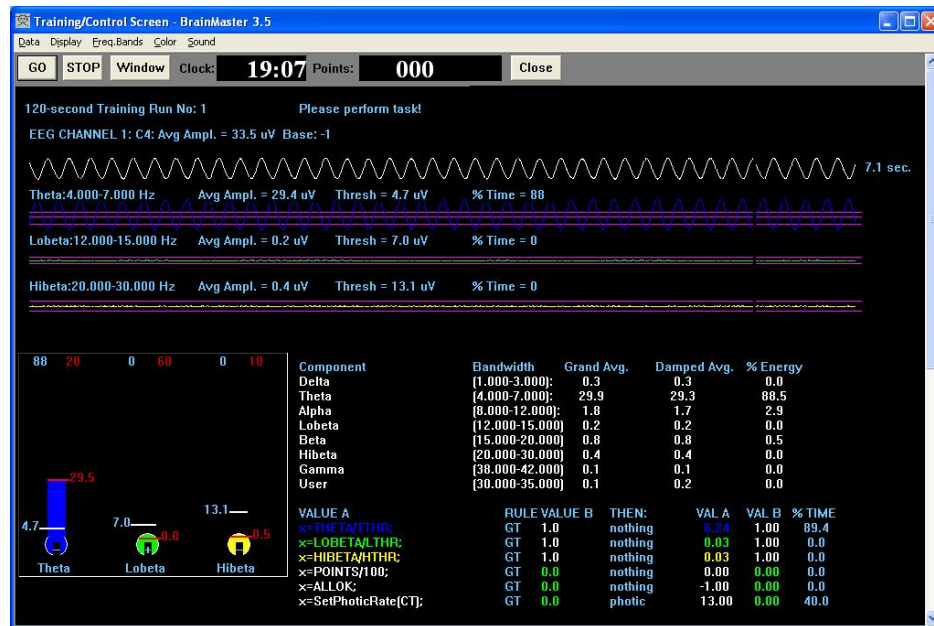
MIDI Sound Properties:

Starting Note: 1 A (55.0) 1 to 88
Instrument: 0 Piano 1 128 choices
Playing Style: Sustained Percus. or Sust.
Modulation: Amplitude Ampl. or Pitch
Starting Loudness: Level: 0 0 to 128
Loudness Change Rate: 0 0 to 20
Note Change Rate: 0 0 to 20
Musical Scale (Mode): Chromatic 15 choices
Musical Key: A C to B Flat
Play Note or Chord: 1 Note 1 to 8 Notes

Enable All Events Disable All Events Data Dictionary
Clear All Events Show All Events Print All Events
Help Copy Event Paste Event
Cancel Use Now OK

Photic output with a variable rate

The example file “Photic Output Variable Rate” allows the system to provide photic output at a variable rate, set using the “c” and “C” key. This design also simultaneously runs the “focus” protocol. The value of the current rate is visible in the Text Stats panel.



The Event Wizard setup for Event 6 is shown below. The event reads:
 “If (Use Equation) x=SetPhoticRate(CT) IS GREATER THAN 0.0 THEN Activate Photic Stim.”

Since the photic rate will always be greater than 0, the photic output will be continuously flashing.

Photic Output control with Atlantis and BrainMaster 3.5 software

Event Wizard Designer

Event Number: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

This Event Is: ☒ Enabled ☐ Disabled

Visibility: ☐ Visible ☒ Hidden

Event Condition:

IF:

Check Equation:

RULE:

Check Equation:

Note: You must press "Check Equation" to check and save any changes made to equations

Event Result:

THEN:

Event Trend Graph

Scale Factor: Offset:

Event Summary:

Summary for Event 6:
 IF: EQN: x=SetPhoticRate(CT); IS GREATER THAN Value: 0.0
 THEN: Activate Photic Stim

EVENT 6 IS CURRENTLY: ENABLED

Sustained Reward Criterion
 Condition must be met for: milliseconds

Refractory Period
 Time between rewards is: milliseconds

MIDI Sound Properties:

Starting Note: 1 to 88

Instrument: 128 choices

Playing Style: Percus. or Sust.

Modulation: Ampl. or Pitch

Starting Loudness: 0 to 128

Loudness Change Rate: 0 to 20

Note Change Rate: 0 to 20

Musical Scale (Mode): 15 choices

Musical Key: C to B Flat

Play Note or Chord: 1 to 8 Notes

Enable All Events Disable All Events Data Dictionary

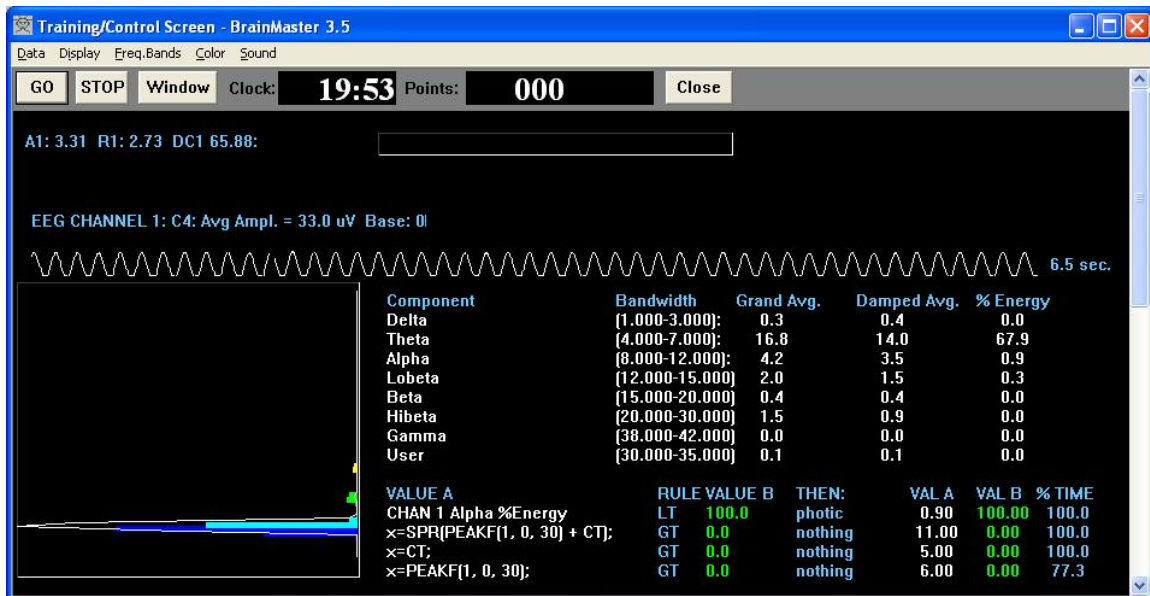
Clear All Events Show All Events Print All Events

Help Copy Event Paste Event

Cancel Use Now OK

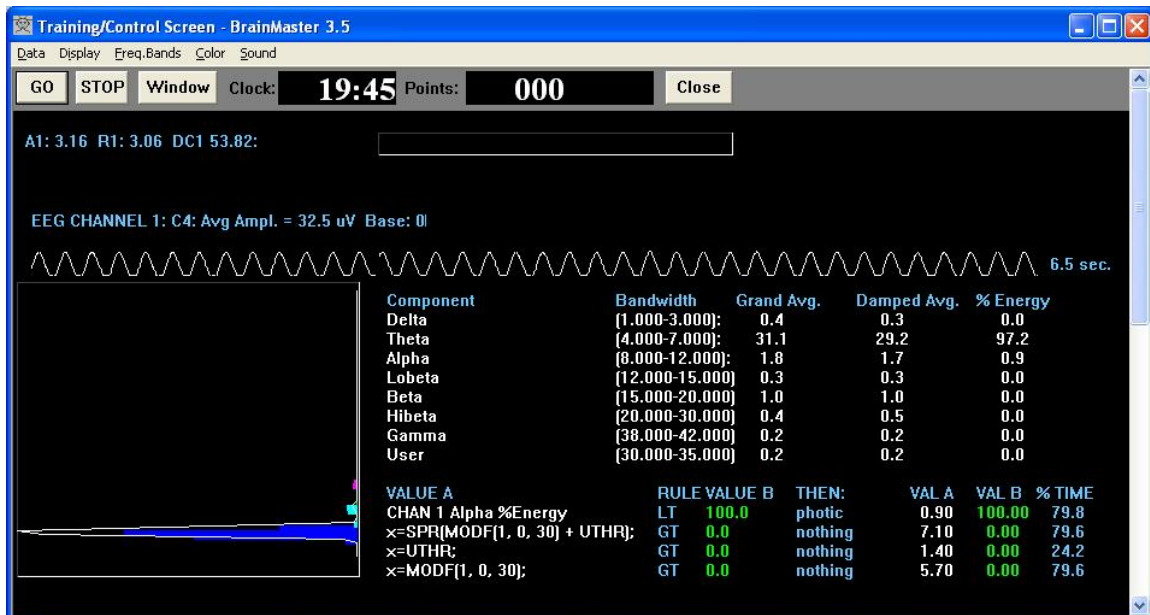
Photic Output with Peak Frequency and Offset

This example “Photic Output Peak Frequency and Offset” provides photic output at a frequency determined by the peak frequency in the EEG, with an added offset. It uses the peak frequency between a range of 0 and 30 Hz, adds an offset determined by the “CTHR” value, and sets the photic rate to that frequency continuously. Thus, the photic rate is continually updated with the desired frequency of stimulation, which is the current EEG peak frequency, plus the offset. In this approach, the peak frequency has a resolution of 1 Hz, and is wherever the maximum peak in the EEG occurs. This can be in any frequency band, and can be anywhere in the entire frequency range, for example, from 1 to 30 Hz. It will often jump quickly from one value to another. In this example, the peak frequency is 6 Hz, and the offset is 5, so the lights are flashing at $6 + 5 = 11$ Hz.



Photic Output with Modal Frequency and Offset

This example “Photic Output Modal Frequency and Offset” produces photic output at a frequency determined by the modal frequency in the EEG, with an added offset. This is the “center of energy” within a band, and has a resolution of 0.1 Hz. When this approach is used, the modal frequency is used as a precise indicator of the exact frequency of a rhythm, for example, whether the alpha rhythm is 10.1, 10.2, 10.3, etc. Hz. The modal frequency is usually taken within a band, and moves very slowly, always in the same general range of frequency. The offset is relatively small, for example, 0.5 Hz. This approach will present stimulation that is gently “nudging” the natural frequency a little higher or lower. In the illustration, the input frequency is 5.7 Hz and the offset is 1.4 Hz, so the lights are flashing at $5.7 + 1.4 = 7.1$ Hz.



The modal frequency is an accurate estimator of the “center of energy” of the EEG. It is defined as the second moment of the spectral energy, normalized to the first moment (total energy). This metric provides resolution of 0.1 Hz, and is very useful for tracking fine changes in the energy distribution of the EEG. When used with in a particular band, it provides a very precise indication of the location of the dominant EEG energy in that band, e.g. whether alpha is at 10.1, 10.2, or 10.3 Hz, etc.

The offset is again using UTHR as the offset value. This allows the user to set the offset with 0.1 Hz resolution, thus being able to lead or lag the EEG modal frequency by very small and adjustable frequency ranges. The control variable UTHR is controlled by the “u” and “U” keys, and changes 0.1 for each keypress. (increases with “u” and decreases with “U”)

Photic Output Random Rates

The example file “Photic Output Random Rates” produces photic output with the frequency of output changing randomly over time. This design uses the Event Wizard function “Rnd” to create random numbers, used to compute the changing flashing rate. It is possible to set this within a range of frequencies, using the equation and damping factor.

Photic Output On and Off

By using the Event Result “Activate Photic Stim”, it is possible to turn the photic output on and off under program control. The following example sets the photic output to a fixed rate of 14 flashes per second, then turns the output on only when the EEG theta amplitude is above a certain threshold.

This design incorporates the photic output into a standard “Focus” protocol. This protocol reinforces SMR (12-15 Hz) waves over the motor cortex, while inhibiting theta and high beta. As an additional training feature, the photic output is enabled at 14 flashes per second, whenever the theta exceeds threshold.

Photic Output control using the Session Wizard

The Session Wizard provides scripted control of the Photic Output. This can be used instead of, or in addition to, the Event Wizard controls. It is possible to use the Session Wizard for some things, and the Event Wizard for others. There will be commands used within the Session Wizard script, that will allow the protocol to control the Photic Output under script control. This will provide functionality similar to typical photic devices that provide built-in or user-customizable scripts. Contact BrainMaster Technologies for the latest information regarding use of the Session Wizard for photic output control.

Commands using the Session Wizard

The commands used in the Session Wizard are:

PHOTICRATE: rate

PHOTICRATE will specify the output rate of the photic output.

For example, to flash for 10 seconds at 10 Hz, then 10 seconds at 20 Hz, the following script would be used:

```
PHOTICRATE: 10  
PERIOD: 10  
PHOTICRATE: 20  
PERIOD: 10
```

PHOTICENABLE: code

PHOTICENABLE will use a “1” code to enable the output, and a “0” code to disable it.

For example, to flash at 10 Hz for 10 seconds followed by 10 seconds of rest, followed by 10 seconds at 12 Hz, the following script could be used:

```
PHOTICRATE: 10  
PHOTICENABLE: 1  
PERIOD: 10  
PHOTICENABLE: 0  
PERIOD: 10  
PHOTICRATE: 12  
PHOTICENABLE: 1  
PERIOD: 10
```

Example Files using Session Wizard to control Photic Output.

Photic Output Sequence I

See the example file “Photic Output Sequence I”

Photic Output Sequence II

See the example file “Photic Output Sequence II”

Photic Output Frequency Hopping

See the example file “Photic Output Frequency Hopping”