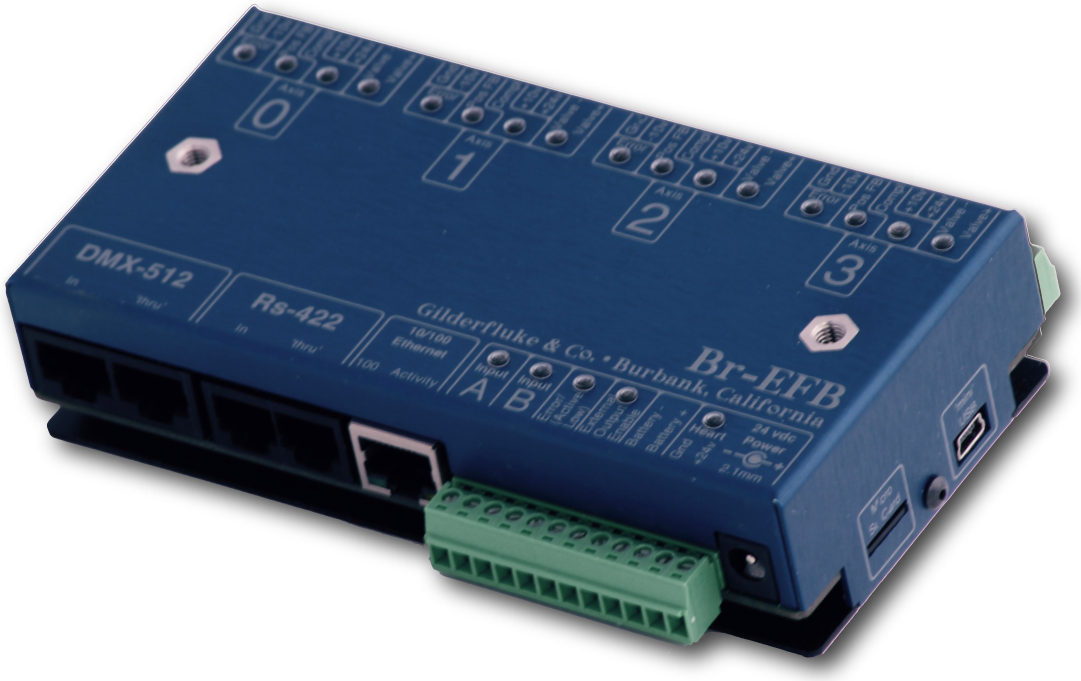
# Br-EFB

## Four Channel Electronic FeedBack Controller v3.1




An actuator is a mechanical device that moves something. It doesn't matter if the actuator is powered by hydraulics or compressed air, or directly from an electric motor. Analog closed loop control of actuators is used when you want to create truly lifelike animatronic effects. The actuator can be commanded to move slowly or quickly, and can stop repeatably at any point within its range of movement. If a force is applied to try to move the actuator, it will fight to return to the original position.

The Br-EFB is used to close up to four Position Feedback loops for four independent actuators. These can be used in animated shows, lighting, motion base simulators, pneumatic and hydraulic systems, special effects, signs, fountains, and more.

**Safety Disclaimer: Any electronic or mechanical system has a potential to fail. Certain applications using Gilderfluke & Company equipment may involve potential risks of death, personal injury, or severe property, or environmental damage ("Critical Application"). Gilderfluke & Company equipment is not designed, intended, authorized, or warranted to be suitable in life support applications, devices, or systems, or other critical applications. Inclusion of Gilderfluke & Company products in such applications is understood to be fully at the risk of the customer. In order to minimize risks associated with the customer's applications, adequate design and operating safeguards should be provided by the customer to minimize inherent or procedural hazards.**

**Gilderfluke & Company assumes no liability for applications assistance, customer produced design, software performance, or infringement of patents or copyrights. Nor does Gilderfluke & Company warrant or represent that any license, either express, or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of Gilderfluke & Company covering or relating to any combination, machine, or process in which Gilderfluke & Company products or services might be or are used.**

this page is not blank

# A note about this manual:

This manual covers the specifics of the **Br-EFB**. To program the **Br-EFB** you will also want to refer to the **PC•MACs** manual sections that cover the **PC•MACs** software.

The **Br-EFB** is typically programmed in 'Software-only' or 'Hardwareless RealTime' mode. If you are using the **USB-DMX** for programming your **Br-EFB** through the DMX-512 inputs, please refer to the **PC•MACs** 'Unlimited' mode.

The full **PC•MACs** manual can be downloaded from our web site at:

http://www.gilderfluke.com

# Br-EFB Overview

The Br-EFB is effectively the combination of a DAC-Quad and analog PID-quad board. Since it is an all-digital board, there are no potentiometers to adjust, and the PID loop is much more 'intelligent'. It is able to adjust itself, sense error conditions and compensate for changing loads.

Like most other GilderGear, the Br-EFB can be run as a stand-alone controller, or networked together with other GilderGear and third party gear as either a DMX-512 'Master' to control hundreds of other actuators, lighting and effects, or as a DMX-512 'slave' to be among the controlled.

The Br-EFB has separate terminals for a full 512 channel universe of DMX-512 in and 'thru' for daisy changing multiple Br-EFBs and other gear together using standard CAT5 (or better) ethernet cables. The pinout of these connectors follows the USITT standard. As with all GilderGear, checksums can be embedded in the DMX-512 data to keep the Br-EFB, (or the gear that it is controlling through the DMX-512 output), from updating on any DMX-512 packets that contain corrupted data.

For storing shows, the Br-EFB uses any micro Sd, micro SdHC or micro SdXC flash cards. These can potentially hold years worth of shows!

Shows can be started using the two 'trigger' inputs, the USB port, the ethernet port, or the RS-422 serial port. Shows can also be set to start playing when the Br-EFB is powered up.

The Br-EFB keeps log and configuration files on the $\mu$Sd card, so even if you don't need to store show date, you should always have a $\mu$Sd card inserted into the Br-EFB. If you ever need to replace a Br-EFB with a new one, transferring the $\mu$Sd card from the old unit to the new one will transfer all the shows and settings to the new Br-EFB. No additional configuration or adjustments should be needed.

For triggering shows and other actions, there are two optically isolated non-polarized 'trigger' inputs imaginatively labeled 'A' and 'B'. These will accept any DC voltage between 5 vdc and 24 vdc. Because they are non-polarized, you can't wire them backwards. Either way you apply the voltage, they will accept it. What you want these inputs to do is configured when you are saving the AutoDownload file that holds the show data. Different actions can be configured for the 'closing' edge (when a voltage is applied to the trigger input) or the 'opening' edge (when voltage stops flowing through the trigger input).

There is also third optically isolated 'External Output Enable' input. Until 5 vdc to 24 vdc is applied to this terminal, all four servo loops are disabled, and the 'valve' outputs are physically connected through electromechanical relays to the Br-EFB's 'battery'

terminals. If desired, a small voltage applied to the 'battery' terminals from an uninterruptible power supply can be used to bias the ServoValves/Motor Controllers (or VFDs) towards the 'home' positions. This allows the Br-EFB to safely return a motion base or other device to the load/unload position, even in a complete power failure. The 'Enable' input can also trigger a show, E-Stop, or anything else that the normal trigger inputs can do. This allows the Br-EFBs to call up a video or audio cue, ramp up the lights, or whatever you want it to do. In many applications, the 'Enable' input can be wired right into the E-Stop safety loop. Any 'opening' in the E-Stop loop (an E-Stop switch being hit, a wire break, etc.) will send the actuators for 'home, ramp u the lights, and play the appropriate Audio/Video files.

For each of the four ServoLoops, there is:

- One sixteen bit resolution +/-10vdc analog output for connecting the ServoValves/Motor Controllers These are updated at over 100 times each second.
- One sixteen bit resolution Analog input for the actuator position feedback. These are sampled at approximately 100,000 times each second.
- One sixteen bit resolution Analog input for an optional Compliance Feedback sensor Also sampled at approximately 100,000 times each second.
- One ground connection to supply power or a 'ground' reference to the ServoValves/Motor Controllers and sensors (if needed)
- One 24 vdc connection (PTC fused for 1.1 amp) to supply power to the ServoValves/Motor Controllers and sensors (if needed)
- One +10 vdc reference for use with potentiometer position feedback sensors. The potentiometer can be referenced either from the -10 vdc and the +10 vdc reference for a +/-10 vdc swing on the wiper (preferred), or between ground and the +10 vdc reference for a 0 to 10 vdc swing on the wiper.
- One -10 vdc reference for use with potentiometer position feedback sensors.

Both analog inputs can be individually set to accept +/10 volts, 0-10 volts, +/-5 volts or 0-5 volts. This can be set in the configuration to match whatever voltages your Position Feedback and Compliance Feedback sensors will be outputting. The analog inputs use sixteen bit resolution analog to digital converters (ADCs), and are oversampled at 100,000Hz to reduce noise in the Position Feedback signals.

To talk to a local or remote computer, you can use the Rs-422 serial port, mini USB port or Ethernet port.

The Rs-422 serial port has both a 'input' and 'thru' ports, to allow multiple Rs-422 port devices to be easily daisy chained together into a simple serial network using simple Rj-12 cables. Each individual device on the network is given a unique eight bit address, so you can have up to 256 devices on each network. This Rs-422 port is completely compatible with the Rs-422 ports found on the Br-Brain4, Br-ANA, Br-ZBR and other GilderGear.


The mini USB port can be used to plug a computer into the Br-EFB. If the computer has the appropriate drivers installed, its operating system will open the USB port and begin communicating with it. The Br-EFB will then appear as a 'COM' port to the PC, and can be accessed using GilderTerm or any other serial terminal software.

!!!! The ethernet port can be used to communicate with the Br-EFB using simple !!!! formatted text data, or by using the built-in web server and just about any web browser on your PC, tablet or smartphone.

The Br-EFBs are designed to be used as stand-alone show controllers, as a ‘master’ sending data to other devices that act as ‘slaves’ on a DMX-512 network, or as ‘slaves’ themselves, receiving DMX-512 data from a ‘master’ elsewhere on the DMX-512 network:

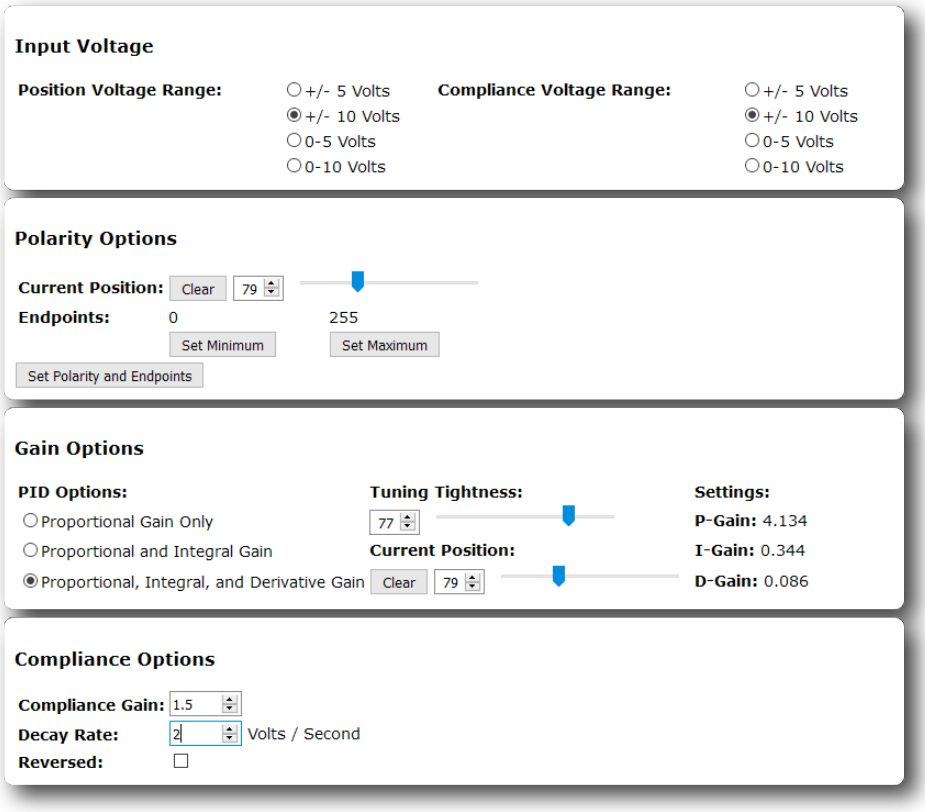
1) **Br-EFB running standalone or acting as a ‘Master’**: In this mode of operation, data for the outputs is stored in the standard micro Sd, SdHC or SdXc flash cards as Gilderfluke & Co. AutoDownload files.

   When being running as a standalone controller or as a ‘master’, an Br-EFB acts just like any other Gilderfluke & Co. Brick, playing animation data from the micro Sd card. The Br-EFB can be set to start and play a show at power up, or only play when triggered to do so. The start trigger can come through the two optically isolated trigger inputs, the Rs-422 serial port, the mini USB port, or the Ethernet port. The Br-EFB then uses the show data stored in the Flash Memory to update its outputs and the DMX-512 network at the appropriate frame rate.

   Multiple Br-EFBs (and other GilderGear) can be triggered simultaneously, but this is not generally recommended as a way to synchronize multiple units. The far better way of synchronizing is by sending data stored on

the designated ‘master’ to all the ‘slaves’ attached to a DMX-512 network.

2) **Br-EFB as a ‘Slave’**: In this mode the Br-EFB receives data from and external source and uses this data to update its outputs. Data can come from:




   a) RealTime serial updates from a Pc•MACs programming system through the serial port. Up to sixteen eight-bit wide channels of animation control data can be received through the serial port at 9600 baud. The Br-EFB can be addressed to use any address from 1 to 16 for RealTime serial data.

   b) DMX-512 data from a Pc•MACs programming system (or any other source of DMX-512). Up to 512 eight-bit wide channels of animation control data can be received through the DMX-512 port. The Br-EFB can be addressed to use any DMX-512 address from 1-512. The DMX-512 input allows the Br-EFB to be used as a permanent ‘slave’ as a part of a larger Control System. If the incoming DMX-512 contains Gilder-Checksums, the Br-EFB will automatically update only on valid data packets.

The animation sequence which is to be used on the Br-EFB is generated on a PC•MACs Animation Control System. During programming, the DMX-512 or serial port RealTime updates can be used so that you can see the animation sequence as it is programmed. Once programming is completed and your show(s) are saved to disk, the data is downloaded to the *µ*Sd/*µ*SdHC/*µ*SdXc flash card onboard the Br-EFB. It is generally much faster and easier to save the completed shows’ AutoDownload file to your computer’s hard drive, then drag-n-drop the AutoDownload file onto the *µ*Sd/*µ*SdHC/*µ*SdXc flash card which is then plugged into the Br-EFB. You may choose to also include the .SET, .SHO, .STE and other files on the flash card as well, but the only file the Br-EFB actually reads is the AutoDownload (.A00) file.

The Br-EFB supports position resolutions commands of eight, twelve, sixteen, twenty-four or thirty-two bits of resolution. Internally, the ADCs and DACs in the Br-EFB use 16 bits of resolution, so going beyond sixteen bits of resolution in your show data can be done, but it won't actually benefit the resolution of the movement.

!!!! The analog and PCM outputs of the Br-EFB are oversampled for ultra-smooth outputs, typically to ??? times the current frame rate. This means that even with eight bit resolution data arriving at 30 FPS, the outputs will have four sub-frame outputs at 16 bit resolution at 120 Hz between each full frame of data that arrives.

All 512 channels of data are transmitted through the DMX-512 output on an Br-EFB. The DMX-512 output can be used to control other GilderGear, light dimmers, automated spotlights, color changers, fog and wind machines, or any other pieces of equipment which will accept standard DMX-512. If there are less than 512 channels of data in the shows, channels past the last channel are sent as ‘zeros’.

If you are transmitting DMX-512 data with GilderChecksums, you will want to avoid addressing dimmers and other devices to the same addresses that are used for the checksums (257, 258, 511 and 512). If you must use the addresses occupied by one pair of checksums, the other can still be used. It is best to reuse the lower pair so that you still retain protection across the whole universe. The lower pair of checksums will not protect against data errors in DMX-512 channels 257 through 512, whereas the upper checksums will protect the entire universe from data errors.

The Br-EFB can be mounted on standard 2-¾” Augat snap track, on DIN rails (using a pair of the DIN-Adapt blocks), using screws through the provided mounting holes, or simply velcro’d to whatever they are controlling. Rack mounting is normally accomplished using a DIN rail mounted to a 2U (3.5”) tall ‘top hat’ plate, and then using the DIN-Adapt blocks on the backs of the units.

The power requirements for Br-EFBs is 24 VDC. This is needed to allow some ‘head room’ for the analog circuitry to output the 0-10 volt levels. The actual current requirements are determined by the loads attached to the unit (up to 50 ma. per output). The Br-EFB itself draws just xx ma..

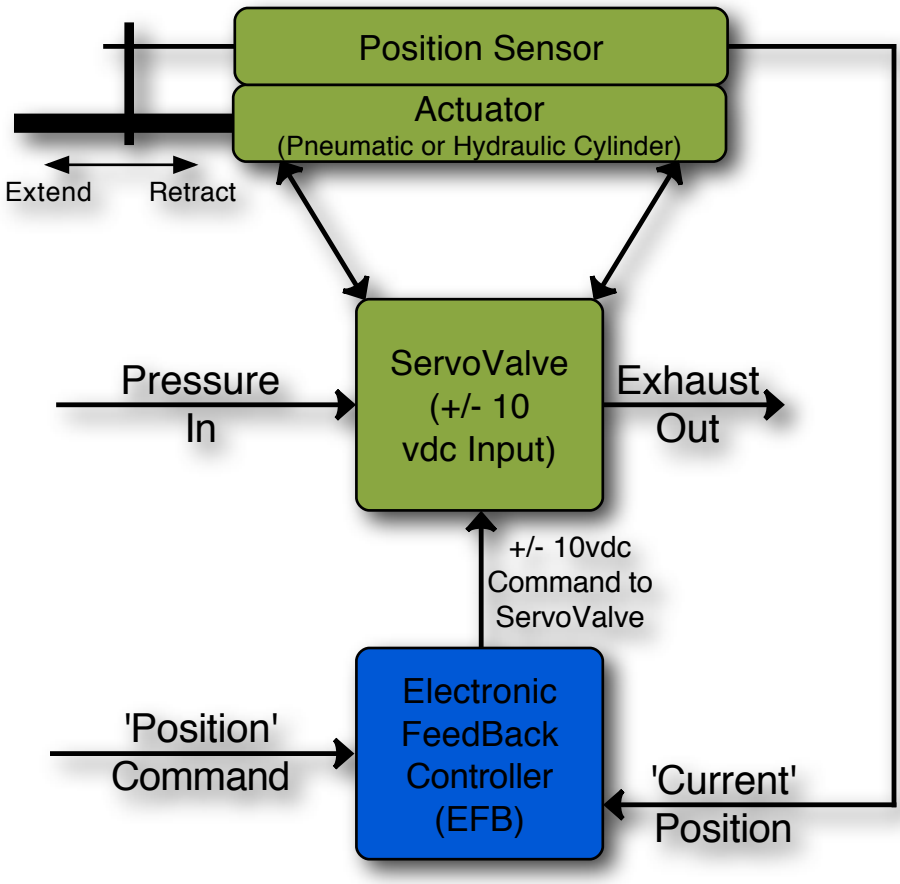
Customized front panel artwork is available on all GilderGear, including the Br-EFB. These can be custom branded, or labeled for specific installation names. Please contact the Gilderfluke & Company factory for details on generating custom Br-EFB labels.

# Closing the Servo Loop

Closed loop analog control of an actuator requires:

- An 'Electronic FeedBack Controller' (EFB) is used for closing a ServoLoop. The Br-EFB will simultaneously close four ServoLoops.
- An analog ServoValve must be used for pneumatic or hydraulic actuators. For electronic actuators, a Brushless DC (BLDC) driver (for small three phase DC motors) or Variable Frequency Drive (VFD) (for larger 3 phase AC motors) is used in place of the ServoValve. In either case, it must be capable of bidirectional control of the actuator/motor. The most common command signal for these is +/-10 VDC. The positive or negative polarity controls the direction or the movement, and the further away from zero, the more the ServoValve/Motor Controller opens.
- A Position Feedback sensor. This can be a simple potentiometer or a more complex electronic device like (the unfortunately named) 'Sick' sensors. The position sensor can be built into the actuator, or mounted on its outside.

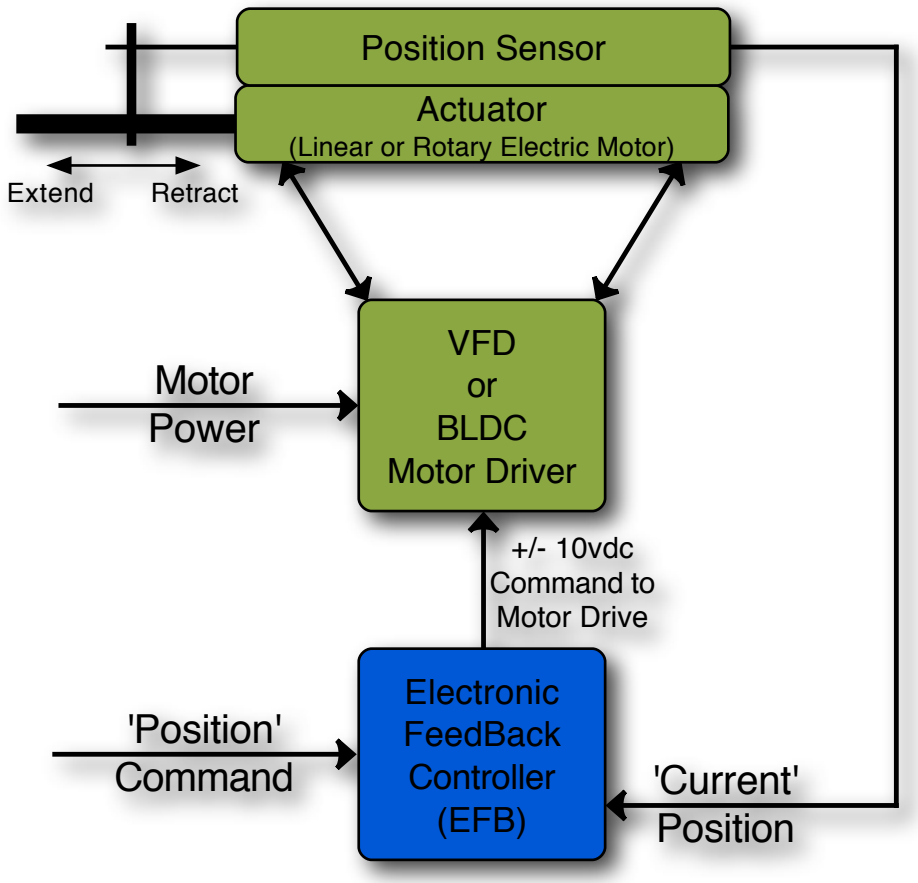
The EFB controller's main job is to compare the requested actuator position (from an external show control system, or from the Auto-Download file on the Br-EFB's $\mu$Sd flash card) with the actual position of the actuator (as measured by the position sensor). The EFB Controller will then open or close the ServoValve/Motor Controller a little or a lot (as needed) to send the actuator towards the requested position.




One of the unique features of the Br-EFB is that it can adjust itself in many applications. Once it has done the initial adjustments for an actuator, the Br-EFB can divide the stroke of the actuator into many small segments, and then continuously adjust the settings for each of these

segments individually. This allows the Br-EFB to control uneven loads, or unbalanced loads that go over fulcrum. Even if the load changes over time (the actuator bore gets smoother, the hydraulic fluid gets thinner as it gets hotter, or the motion base is loaded with a bunch of 300 pound football players), the Br-EFB can compensate for this.

The Br-EFB can be set up over ethernet using its built in web server and just about any browser on any tablet, smart-phone or computer. You can also use its textual menu and GilderTerm, either through an TCP connection over ethernet, or through the networkable Rs-422 serial port.




You can configure the Br-EFB using the PID Setup Wizard or manually. The first thing you need to tell the Br-EFB is the range of voltage expected on the position and Compliance Feedback inputs for the axis. Set these to match the expected outputs from your position and Compliance Feedback sensors. If you are using potentiometers, you will probably be using the Br-EFB's +/10 vdc reference outputs, and will set the inputs to match.

The next step is to tell the Br-EFB where the ends of the actuator's travel are located. If the actuator can safely be moved to both its mechanical stops, then the Br-EFB can find the endpoints for you. The Br-EFB will then back off slightly to set the normal range of movement to just short of the ends of the actuator. Otherwise, you can use the web menu to ‘Jog’ the actuator to where you want to place each end of the actuator's stroke, and then lock them in. Once the endpoints have been set, the Br-EFB will do its best to keep the actuator within this range of movement.

As you are setting the endpoints, the Br-EFB is detecting the 'phase' of the actuator and Position Feedback hardware, and automatically correcting for any phase-flipped wires or hoses.

At this point, you can manually set the 'Positional' ('P'), Integral ('I') and 'Derivative (D)' ('D') gains for the axis, or let the Br-EFB do this for you.

If you opt for the automatic tuning, the Br-EFB will move the actuator to roughly mid-stroke, and perform a series of short movements at gradually increasing speeds. If it was successful, the Br-EFB will set the P, I and D to the optimal settings for the actuator. Since you don't always want the axis too stiff, a slider lets you select between a soft and hard tune for the actuator.

If the Br-EFB is unsuccessful in automatically setting the PID, you will need to manually adjust these settings as needed.

The next step is to enable the continuous automatic tuning, if desired. This also uses the setting for the tuning 'tightness', so it doesn't over tune the actuator over time.

If Compliance Feedback is to be used, it is enabled and adjusted 'to taste'. Each axis has a 'Gain' and 'Decay' setting. These set how much of an effect the Compliance Feedback has on the actuator, and how long this effect lasts.

The plumbing for a closed loop actuator is not complicated. Air or hydraulic pressure comes into the ServoValve and two hoses connect the ServoValve to the actuator. The position feedback and command input go into the EFB controller. After comparing the Command and Actuator positions, the EFB controller sends the command voltages that are used to open and close the ServoValve as needed (typically +/-10 vdc).

The speed of an electric actuator is set by the voltage for the actuator's motor (if the actuator runs from DC current), or frequency of the current (if the actuator runs from AC current).

A Brushless DC (BLDC) controller or Variable Frequency Drive (VFD) can be used to control the speed and direction of motors by controlling the frequency of the current the motor receives. BLDC motors are typically used to control motors from a DC power source (they are what make electric cars go), while VFDs are used to run motors from an AC 'mains' source (they are what make elevators go up and down).

To control an electric actuator, the ServoValve is simply replaced by a VFD or BLDC controller. that accepts the +/-10 vdc as the speed and direction command.

# Compliance

Compliance Feedback is a technique that was first proposed in several scientific papers as a way to make pneumatic actuators 'stiffer' (more like hydraulic actuators), and to make hydraulic actuators 'spongier' (more like pneumatic actuators).

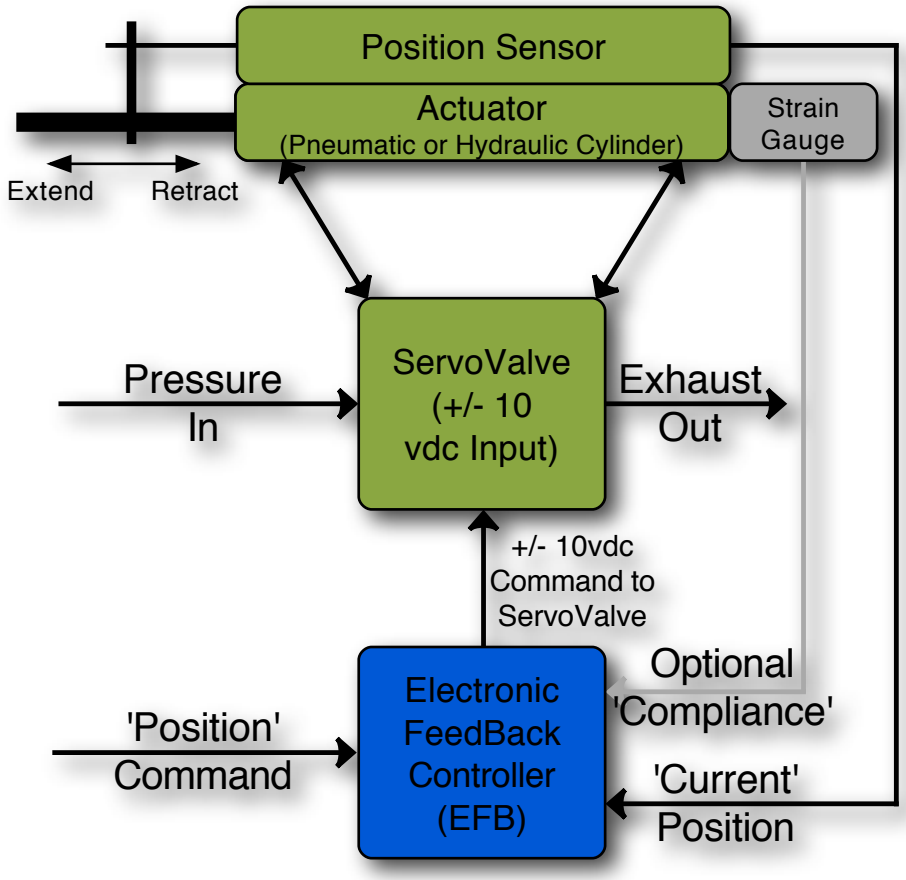
It was first seen in experimental animatronics that were built for Disney by the late Dr. Stephen Jacobsen of The University of Utah and Sarcos. These later evolved into the S-100 series of animatronics at Disney.

The Gilderfluke & Co. Br-EFB controller has been designed with Compliance Feedback inputs available on all four of its axis.

Compliance Feedback has the unusual effect of making an analog movement both 'softer' and 'stiffer' at the same time.

To accomplish these two seemingly contradictory effects, a compliant actuator needs a strain gauge or differential pressure sensor to 'feel' the force being applied by the actuator.

A strain gauge works best, but must be built into the figure. A differential pressure sensor will have a slight 'lag', but is far less expensive and is easily mounted on or near the ServoValve.

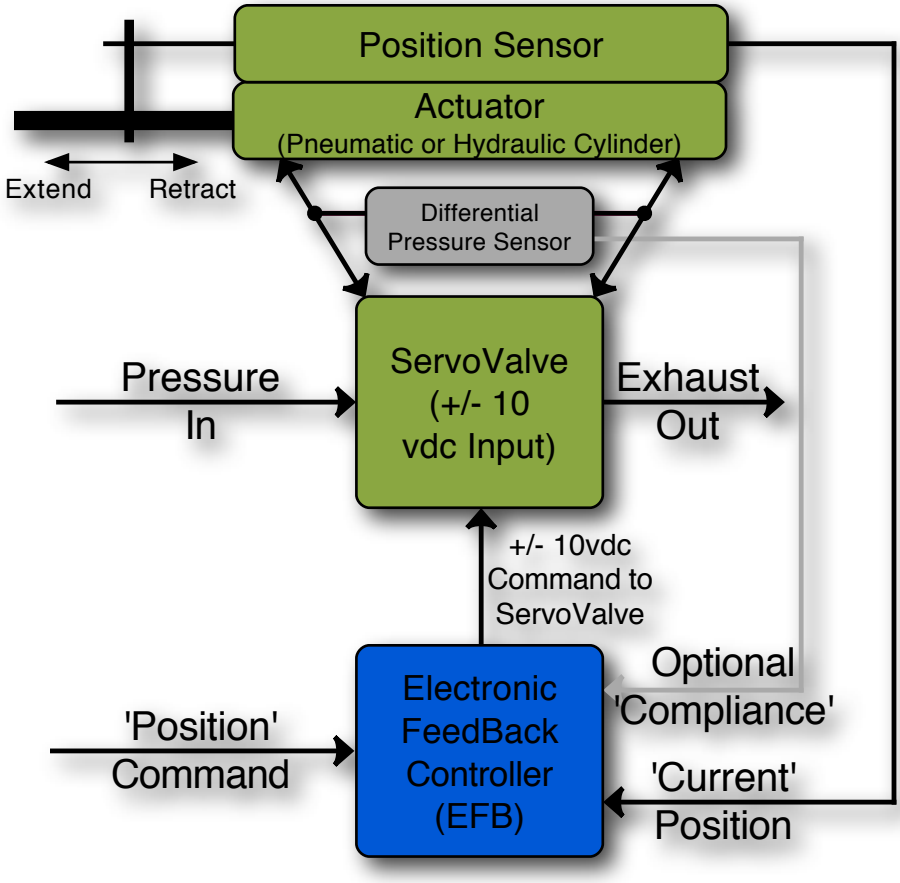



Other than the addition of a differential pressure sensor or strain gauge, a compliant actuator is plumbed just like any other closed-loop actuator.

Even if it is strong enough to throw you across the room, as you push on a compliant actuator, the force on the cylinder will be sensed by the differential pressure sensor or strain gauge. The EFB controller will open the ServoValve/Motor Controller to move the actuator out of your way. This makes it seem like the movement is 'softer', but the effect is only temporary. If you continue holding

the actuator in a displaced position, it will soon begin to fight you to move the actuator back to the original position using all its strength.

If any actuator in a compliant figure is moved, the other actuators will feel the changes in their loads and move in sympathy. This makes for a much more 'life-like' animatronic.



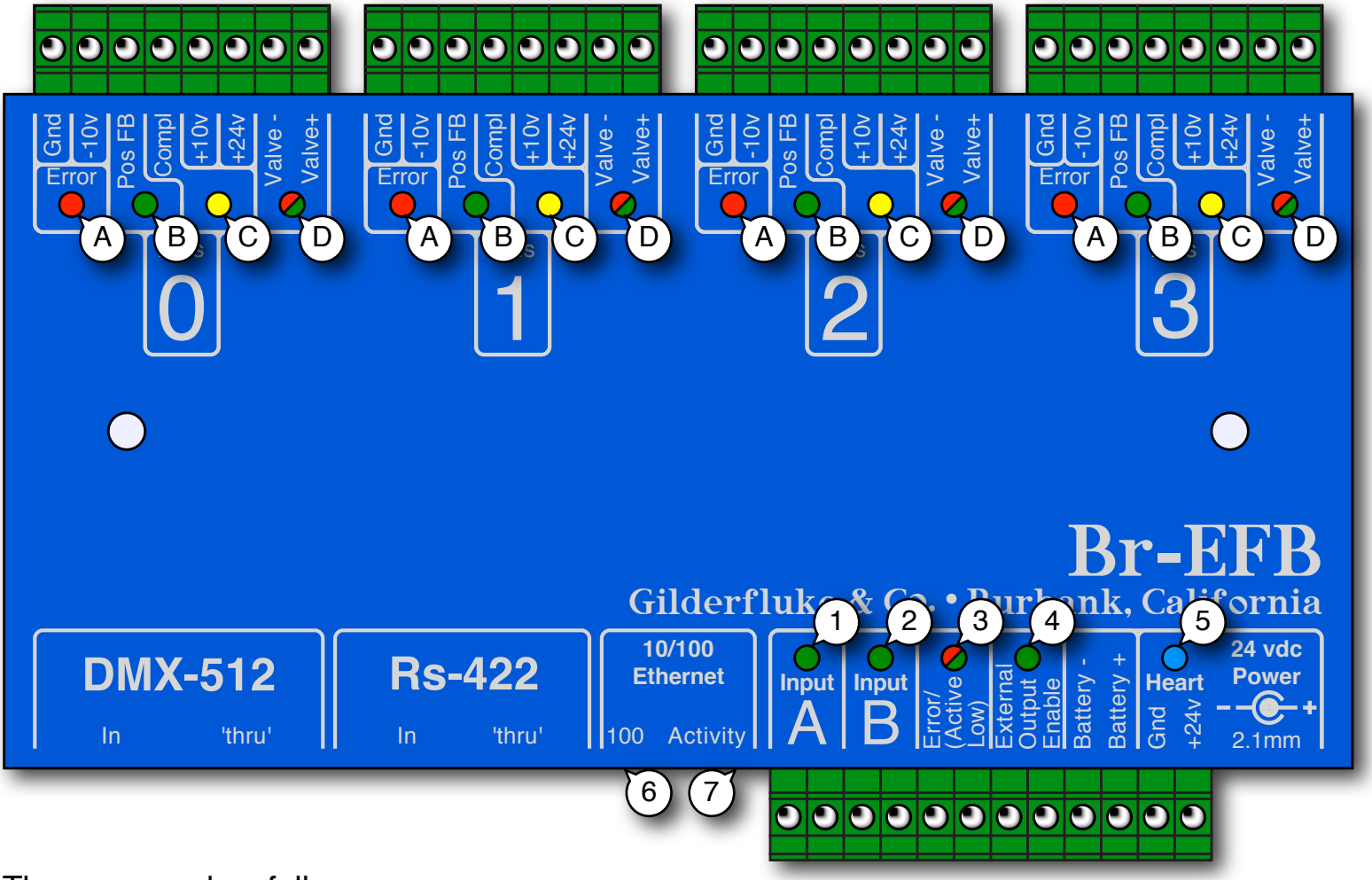

If you tell a compliant actuator to start moving sharply, the acceleration inertia of the actuator will be sensed, and the EFB controller will open the ServoValve/Motor Controller more than just the positional error would have caused. This accelerates the actuator more quickly.

Conversely, when the actuator is stopped abruptly, the deceleration inertia is sensed, and this can cause the ServoValve/Motor Controller to close, or even open the ServoValve/Motor Controller in the reverse direction to provide active braking to the actuator.

The net result is that the actuator will move when you push on it, making it seem 'softer', but can accelerate and decelerate more quickly than a non-compliant actuator making it seem 'stiffer'.

# Br-EFB Indicator LEDs

There are twenty-three LED indicators on the Br-EFB.




They are used as follows:

### W) 'A' Trigger Input LED

*(One Green LEDs)*

This LEDs indicate the status of the optically isolated 'A' trigger input on the Br-EFB. This LED is on the isolated side of the optoisolator. If it is not on when you send a trigger to the 'A' input, then there is an external wiring problem or the optoisolator has been damaged.

During AutoDownloads of show data to the Br-EFB, this LED will flash alternately with 'B' Trigger input LED to show that a AutoDownload is in process.

## X) 'B' Trigger Input LED

*(One Green LEDs)*

This LEDs indicate the status of the optically isolated 'B' trigger input on the Br-EFB. This LED is on the isolated side of the optoisolator. If it is not on when you send a trigger to the 'B' input, then there is an external wiring problem or the optoisolator has been damaged.

During AutoDownloads of show data to the Br-EFB, this LED will flash alternately with 'A' Trigger input LED to show that a AutoDownload is in process.

## Y) Error/Status LED

*(One Red/Green LED)*

This LED serves several functions on the Br-EFB...

1. This LED will be lit solid GREEN if:
   a) The Br-EFB is powered up
   b) The 'External Output Enable' input has a voltage applied to it to enable the Br-EFB's ServoValve/Motor Controller outputs
   c) All enabled axis are following the position command within following error limits
   d) An internal show is not running and no external show control data is being received and processed by the Br-EFB

2. This LED will be flashing GREEN at the current frame rate if:
   a) The Br-EFB is powered up
   b) The 'External Output Enable' input has a voltage applied to it to enable the Br-EFB's ServoValve/Motor Controller outputs
   c) All enabled axis are following the position command within following error limits
   d) Either:
      a) an internal show is running

b) external show control data is being received through the DMX-512, serial or ethernet ports and processed by the Br-EFB

3. This LED will be lit solid RED if:
   a) The Br-EFB is powered up
   b) The 'External Output Enable' input does NOT have a voltage to enable the Br-EFB's ServoValve/Motor Controller outputs
   c) An internal show is not running and no external show control data is being received and processed by the Br-EFB

4. This LED will be flashing RED at the normal heartbeat flash rate if:
   a) The Br-EFB is powered up
   b) The 'External Output Enable' input has a voltage applied to it to enable the Br-EFB's ServoValve/Motor Controller outputs
   c) There is an error condition reported on one or more of the servo channels. The Axis that are in error will have their individual error LEDs flashing to identify the source and type of error.
   d) An internal show is not running and no external show control data is being received and processed by the Br-EFB

5. This LED will be flashing RED at the current frame rate if:
   a) The Br-EFB is powered up
   b) The 'External Output Enable' input has a voltage applied to it to enable the Br-EFB's ServoValve/Motor Controller outputs
   c) There is an error condition reported on one or more of the servo channels. The Axis that are in error will have their individual error LEDs flashing to identify the source and type of error.
   d) Either:

a) an internal show is running

b) external show control data is being received through the DMX-512, serial or ethernet ports and processed by the Br-EFB

**Z) External Output Enable LED**

*(One Green LED)*

This LED will be lit when the 'External Output Enable' input has a voltage applied to it to enable the Br-EFB's ServoValve/Motor Controller outputs.

**AA) Heartbeat LED**

*(One Green LED)*

LED Flashes continuously while the CPU is running. If it ever stops for more than a fraction of a second, the 'Deadman' circuit in the Br-EFB will automatically reset the CPU. While performing an Ease-In, the heart flash rate will double.

**BB) Ethernet '100' LED**

*(One Green LED located on Ethernet Connector)*

This LED indicates that the Br-EFB has established a 100Mb/second Ethernet connection. If this LED is off, then the connection is 10Mb/second.

**CC) Ethernet 'Link Activity' LED**

*(One Amber LED located on Ethernet Connector)*

This indicates that the Br-EFB has established an Ethernet connection, and something is coming through on it. It blinks on all activity that passes through the Ethernet Connection.

## Indicator LEDs for each ServoLoop Axis

Each of the four Servo Loop axis has four LEDs. They are used as follows….

## W) ServoLoop Error LEDs

*(One Red LED per axis for Four Red LEDs in total)*

These four red LEDs light to show errors in each of the ServoLoops. You can identify which ServoChannel is having a problem and the type of error by counting the 'blink code' on these LEDs:

1) One blink = Following Error. The servo loop isn't able to follow the position commanded by the Show Control System within the allowable tolerances or time.
2) Two blinks = Position Feedback voltage below allowable limit. You set the allowable range of travel as you are doing the initial ServoLoop setup. If it goes outside of this range, it is an indication that there is something wrong with the Position Feedback sensor or wiring to it. This could indicate a break in one of the Position Feedback wires (typically the positive reference, it using a three terminal potentiometer).
3) Three blinks = Position Feedback voltage above allowable limit. You set the allowable range of travel as you are doing the initial ServoLoop setup. If it goes outside of this range, it is an indication that there is something wrong with the Position Feedback sensor or wiring to it. This could indicate a break in one of the Position Feedback wires (typically the negative reference, it using a three terminal potentiometer).

## X) ServoLoop Position Feedback LEDs

*(One Green LED per axis for Four Green LEDs in total)*

These four Green LEDs show the scaled input level on all four of the voltage inputs from the position feedback sensors. This should also be a fairy accurate representation of the position commands from the Show Control System. You will see these LEDs fade in and out as the signals on the inputs change. These LEDs are not directly connected to the analog outputs. They are scaled to reflect the ‘minimum’ and ‘maximum’ endpoint settings. If the command from the Show Control System calls for the output at 0%, the LED will be off. If it asks for 100%, it will be fully on.

## Y) ServoLoop Compliance Feedback LEDs

*(One Yellow LED per axis for Four Yellow LEDs in total)*

These four Yellow LEDs show the output level on all four of the Compliance Feedback inputs. As you push on a compliant axis, you will see these LEDs turn on sharply and fade out as the Compliance Feedback effect fades away. These LEDs are not directly connected to the analog Compliance Feedback inputs.

## Z) ServoValve Output Indicators

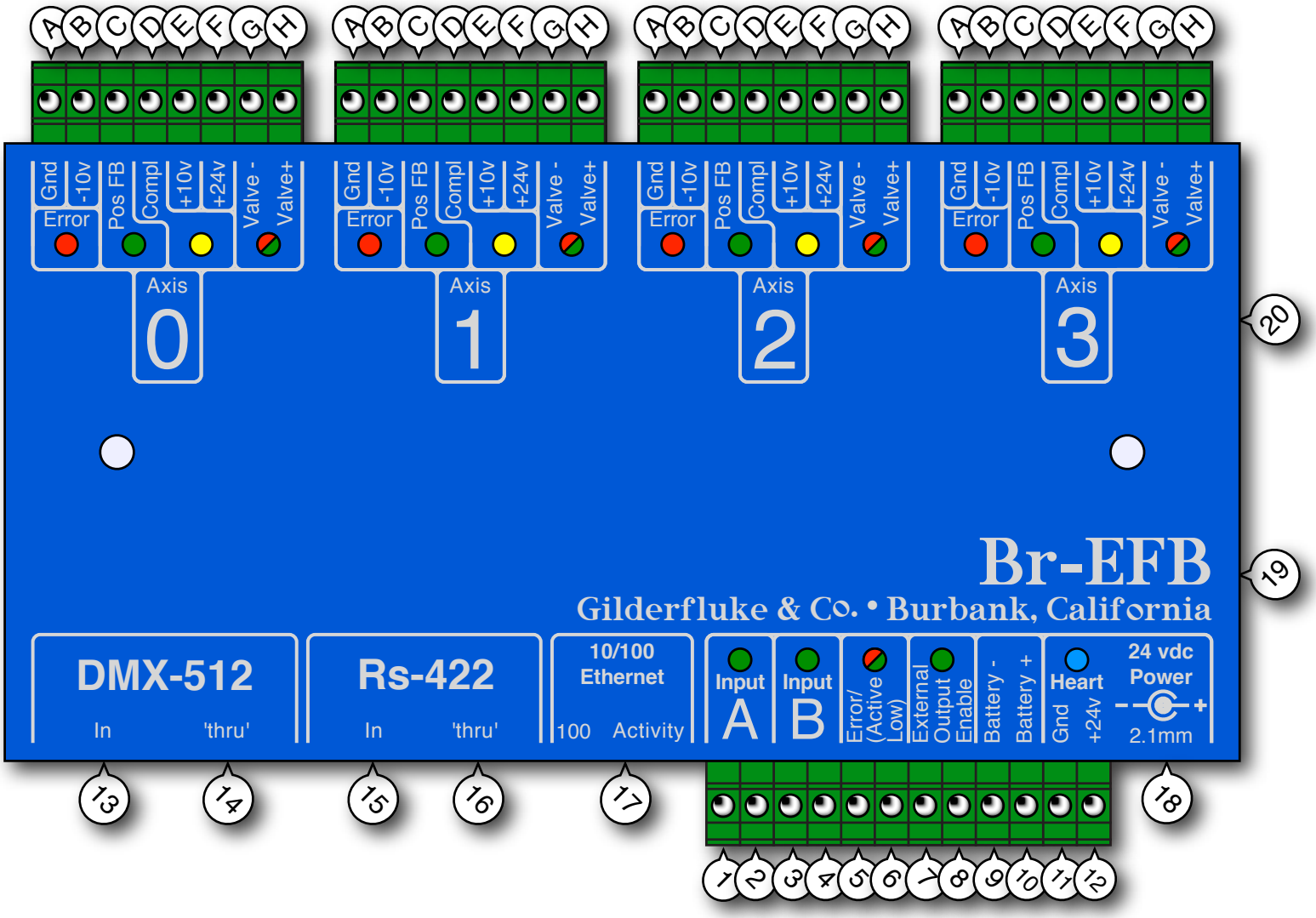
*(One Red/Green LED per axis for Four Red/Green LEDs in total)*

These four Red/Green LEDs show the output level on all four of the +/-10vdc ServoValve/Motor Controller outputs. You will see these LEDs fade in and out as the signals are sent to the ServoValves/Motor Controllers. When the voltage sent to a ServoValve/Motor Controller output is below zero, the LED lights Red. For voltage sent to a ServoValve/Motor Controller output is above zero, the LED lights Green. The further away from zero that the ServoValve/Motor Controller voltage is, the brighter the LEDs will glow.

Note that when the External Output Enable Input is not enabled (no voltage applied), the voltage from the 'battery' terminals are connected through electromechanical relays to all four of the ServoValve/Motor Controller outputs. Since the entire Br-EFB is bypassed when in this mode, the ServoValve/Motor Controller Output Indicator LEDs will not light to show the battery voltage.

# Br-EFB Connectors

The Br-EFB has connectors on three of its four sides. All the screw terminals are removable, to make swap-out and maintenance easy.



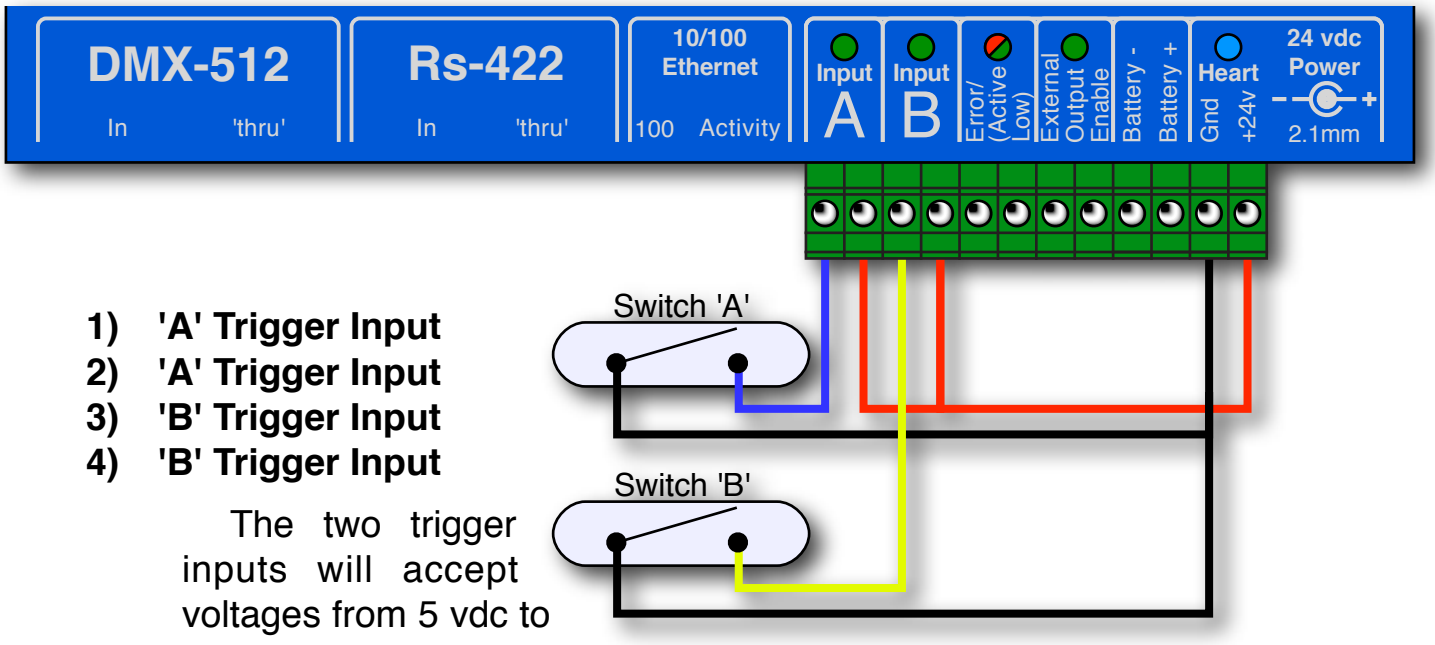

## Input Connector

*(12 Position Pluggable Screw Terminal)*

The Input connections use a twelve position, pluggable screw terminal.

The screw terminals are 'cage clamp' style, which don't require crimps or ferrels on the ends of the wires (although you can use them, if you like). They will accept wire sizes between 14-30 AWG (0.14mm$^2$-1.5mm$^2$). All of the connections to the Br-EFB are low current, so most wiring will use 20 AWG (0.812mm$^2$) or smaller wires.

| Terminal # | wire function |
|---|---|
| 1 | ‘A’ Optoisolated Trigger |
| 2 | |
| 3 | ‘B’ Optoisolated Trigger |
| 4 | |
| 5 | Error/Status Output |
| 6 | |
| 7 | External Output Enable |
| 8 | |
| 9 | 'Battery' input |
| 10 | |
| 11 | Power Supply Ground |
| 12 | Power Supply Positive (24 VDC) |




1) **'A' Trigger Input**
2) **'A' Trigger Input**
3) **'B' Trigger Input**
4) **'B' Trigger Input**

The two trigger inputs will accept voltages from 5 vdc to 24 vdc. The inputs are optically isolated from the rest of the Br-EFB's circuitry and non-polarized. It doesn't matter which terminal is wired to the negative or positive lead. You can't wire it backwards, because it will work either way.

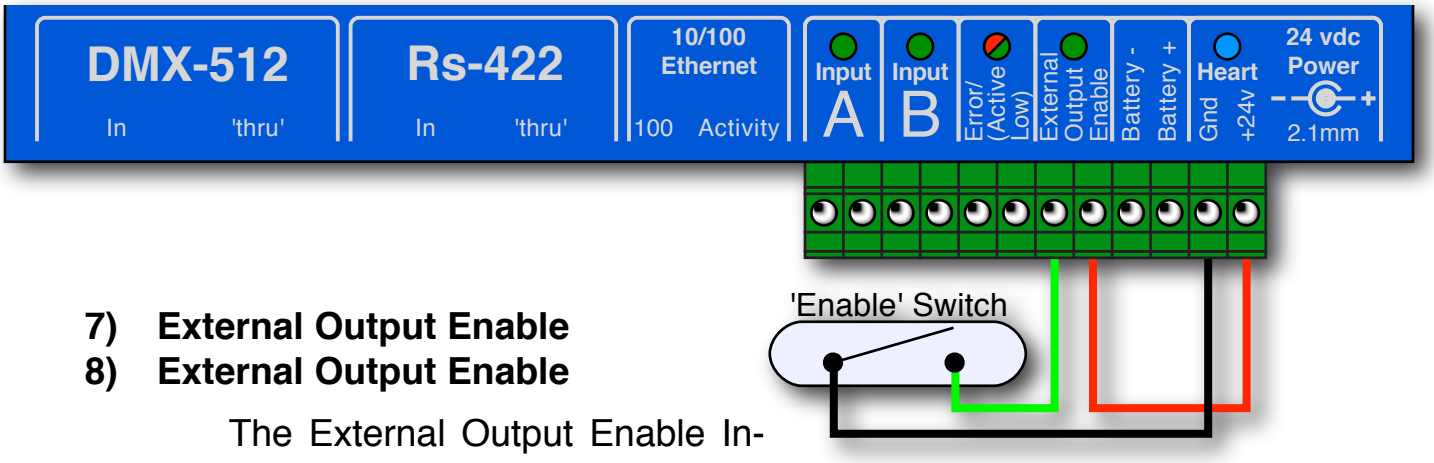
It is preferable (but not required) to provide an voltage from an external, isolated power supply. If you aren't using an isolated supply for these trigger inputs, you can borrow some power from the Br-EFB to power them, as shown in the illustration.

There are two green LEDs that indicate the inputs are active. They are on the isolated side of the optoisolators. If they are not on when you send a trigger to the Br-EFB, then there is an external wiring problem or the optoisolator has been damaged.

**5) Error/Status Output**
**6) Error/Status Output**

The Error/Status output is a solid state relay. This output is rated for switching a load of up to 100ma, and voltages up to 24vdc. It is protected by a 30 volt ESD diode.

This output is typically used to tell an external monitoring system that the Br-EFB needs some attention. This is a fail-safe output. The 'inactive' state is when the relay is 'closed' and conducting current. When the relay 'opens' and stops conducting, it is indicating a problem. In this way, even a simple wire break or power failure will show up as an 'error'. The level of internal error that triggers this output to stop conducting can be set in the Br-EFB's configuration.




**7) External Output Enable**
**8) External Output Enable**

The External Output Enable Input will accept voltages from 5 vdc to 24 vdc. The input is optically isolated from all other circuitry in the Br-EFB. It is non-polarized, so it doesn't matter which lead is wired to the negative or positive terminal. You can't wire it backwards, because it will work either way.

It is preferable (but not required) to provide an voltage from an external, isolated power supply. If you aren't using an isolated supply for this enable input, you can borrow some power from the Br-EFB to power them, as shown above.

Until a 5-24 vdc voltage is applied to these terminals, the ServoValve/ Motor Controller Output terminals are attached through electromechanical relays directly to 'Battery' terminals. The positive (+) 'battery' terminal is connected to all four positive (+) 'ServoValve'/'Motor Controller' terminals. The negative (-) 'battery' terminal is connected to all four negative (-) 'ServoValve'/'Motor Controller' terminals.

In some applications, the enable may not be needed. It still needs a voltage applied to enable the Br-EFB to allow it to run. In this case, just jumper power from any source (like the power terminals on positions #11 and #12 of this terminal block) to these inputs.

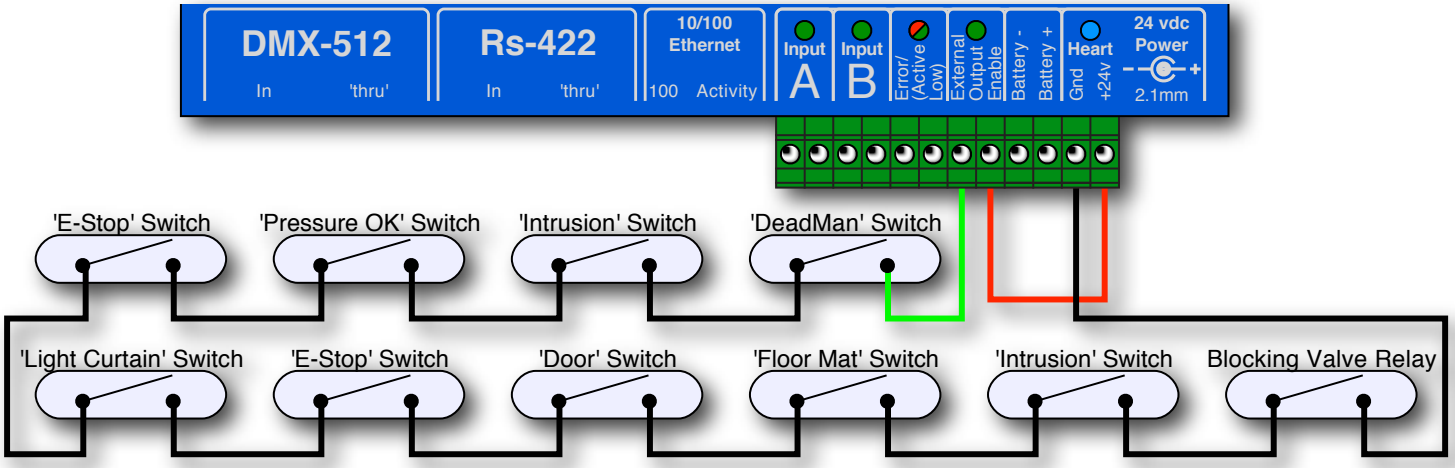
The 'Enable' switch shown above could be any type of switch:

1. A simple switch closure, used by the operators or maintenance personnel to enable or disable movement of the actuators.
2. A 'pressure OK' switch, which closes only when the air or hydraulic pressure has reached a level where the actuators will operate properly.
3. An E-Stop button, where the movement can be disabled and (optionally) the actuators return to a known position. There are often several of these located at different points around an attraction. In motion bases, there is normally one or more of these inside the cabin, normally referred to as a 'chicken switch'.
4. An 'intrusion' switch that disables the Br-EFB if someone gets too close to the mechanism. Examples of this could be:
   a) A light curtain that senses if guests try to reach into the motion envelope of an animatronic figure
   b) A switch on a door that is used to access the area under a motion base.
   c) A 'dead man' switch on the operators' chair or pressure mat that disables the attraction if the operator leaves their work station.
   d) A pressure mat that covers the floor in an area where peo-

ple shouldn't be walking while the attraction is in operation.

5. 'Blocking Valve Output': This is a digital output from the show control system that tells the Br-EFB when it should enable the actuators. It is often found on motion base attractions, where the motion base typically has the actuators adjusted so that they never reach the mechanical end of travel. The 'blocking Valve' is used to physically disable the Br-EFB during passenger load and unload operations. This prevents the motion base from moving during load/unload cycles. With the ‘battery’ input providing a small voltage bias, it also assures that the motion base settles down onto its hard stops at the end of the actuators so that the loading/unloading ramps will perfectly match the floor level of the motion base cabin.

In application where more than one of these 'Enable' functions is needed, they can simply be wired in series, or combined within a simple PLC so that each switch can be monitored individually.




When the External Output Enable is asserted, the Br-EFB will do a long EaseIn on all enabled axis to keep the actuators from jumping. The Br-EFB will not signal an 'out of range' or 'following' error if the actuators are outside of their normal range of movement when the outputs are disabled, or during this initial EaseIn.

When you configure your shows' AutoDownload file, you can choose what happens on the opening or closing of the External Output Enable input, just as you can for the 'A' and 'B' Trigger inputs. The shows that are started can be used to turn on or off lights, begin an audio or video announcement, or anything else you may like to do. If you choose the 'E-Stop' option, this will need to be cleared by 'E-Clear' transition on this or

one of the trigger inputs before the Br-EFB will be able to resume normal operations.

When the External Output is not enabled (no voltage applied), all other functions of the Br-EFB are still active. If it is a standalone system, DMX-512 'slave' or the DMX-512 'master', it can run shows normally, and all the functions the Br-EFB controls will work normally. The Br-EFB just won't be able to control the ServoValve/Motor Controller outputs.

A small voltage from an uninterruptible power supply attached to the 'Battery' terminals can be used to bias the ServoValves/Motor Controllers back to a 'parked' position whenever there isn't a voltage applied to the External Output Enable Input terminals. This can be used to safely 'park' the actuators back to a predictable position, even during a power failure.

Because you don't want to actuators to park too quickly, the 'battery' voltage is typically going to below a volt or two. With a standard +/-10 volt valve, one volt would open the valve to approximately 10% of full operating speed.

**9) - 'Battery' Input**
**10) + 'Battery' Input**

These terminals have no connections to the Br-EFB and ServoValve/Motor Controller terminals when the External Output Enable is enabled (5-24 vdc applied).

When the External Output Enable is not enabled (no voltage applied), electromechanical relays connect the positive (+) 'battery' terminal to all four positive (+) 'ServoValve'/'Motor Controller' output terminals and the negative (-) 'battery' terminal to all four negative (-) 'ServoValve'/'Motor Controller' output terminals. A small voltage from an uninterruptible power supply attached to the 'Battery' terminals can be used to bias the ServoValve/Motor Controller outputs to move the actuators towards a predictable 'parked' position, even during a power failure. This feature is normally used in motion base applications.

Because you don't want to actuators to park too quickly, the 'battery' voltage is typically going to be under one volt (this depends on your valves).

The 'battery' power supply needs to be adjustable in the 0-5 volt range, so you can set the speed you would like your actuators to move at. With a standard +/-10 volt valve, one volt would open the valve to approximately

10% of full operating speed. The 'battery' power supply must provide enough current to drive all of your ServoValves/Motor Controllers simultaneously.

A small industrial or bench power supply can be used, if you simply plug it into an uninterruptible Power Supply.

If your application is likely to be powered down for extended periods, you may need to provide instructions for disabling the UPS to keep the batteries from being drained while the system is powered down.

If you don't need to bias the ServoValves/Motor Controllers or drive them 'home', you can run a wire between these two terminals to assure that the speed and direction command voltage to the ServoValves/Motor Controllers is zero when the Br-EFB's outputs are disabled. You can also tie these terminals to the 'ground' terminal (or any other voltage), if needed.

**11) Power Supply Ground**
**12) Power Supply Positive (24vdc)**

The Br-EFB is designed to run from 24vdc. The power supply connections are diode protected against reversed polarity and ElectroStatic Discharge by a 30 volt ESD diode.

The Power Supply Ground and Positive screw terminals are wired in parallel with the Power Supply 5.5mm O.D. x 2.1mm I.D. barrel connector. They can be used interchangeably.

An idle Br-EFB draws only about !!!!?? milliamperes. The Position Feedback and Compliance Feedback sensors, as well as the ServoValves and/or Motor Controllers which the Br-EFB is controlling will usually draw far more current than the Br-EFB itself.

**13) DMX-512 Input**
**14) DMX-512 'Thru'**

This pair of RJ-45 connectors are used to receive and/or transmit DMX-512. These two jacks can be used interchangeably.

You will need to make sure the DMX-512 transmission is enabled in the configuration of the Br-EFB if you need it to act as the DMX-512 'Master', transmitting DMX-512 to all the other show control gear.

If the Br-EFB is NOT going the be used as the DMX-512 'Master', then you need to make sure that he DMX-512 transmission is disabled in the Br-EFB's configuration. There can only be one DMX-512 'Master' in the same DMX-512 network at one time.

The DMX-512 standard was developed by the United States Institute for Theatrical Technology (USITT) for a high speed (250 KBaud) asynchronous serial data link. Although it was originally designed for controlling light dimmers, it is now supported by thousands of suppliers throughout the world for controlling all kinds of theatrical equipment.

The DMX-512 connections to the Br-EFB follow the USITT standards for running DMX-512 through standard CAT-5 ethernet-style cables.

| Br-EFB, Sd-25 w/DMX, Pb-DMX or Brightsign Video Player with v-Hd-to-DMX | | | | |
|---|---|---|---|---|
| **Pair** | **Wire #** | **Color** | **Function** | **5 or 3 pin XLR** |
| Pair 2 | 1 | White / Orange | Data 1+ | #3 |
| | 2 | Orange | Data 1- | #2 |
| Pair 3 | 3 | White / Green | no connection | no connection |
| | 6 | Green | | |
| Pair 1 | 4 | Blue | | |
| | 5 | White / Blue | | |
| Pair 4 | 7 | White / Brown | Signal Common | #1 |
| | 8 | Brown | | |

You can use standard CAT5 (or better) ethernet cables and patch cords to attach together Br-EFBs, Sd-25s w/DMX, BrightSign players with the v-Hd-to-DMX adapters, and any other piece of GilderGear or third party gear that uses RJ-45 connectors for DMX-512.

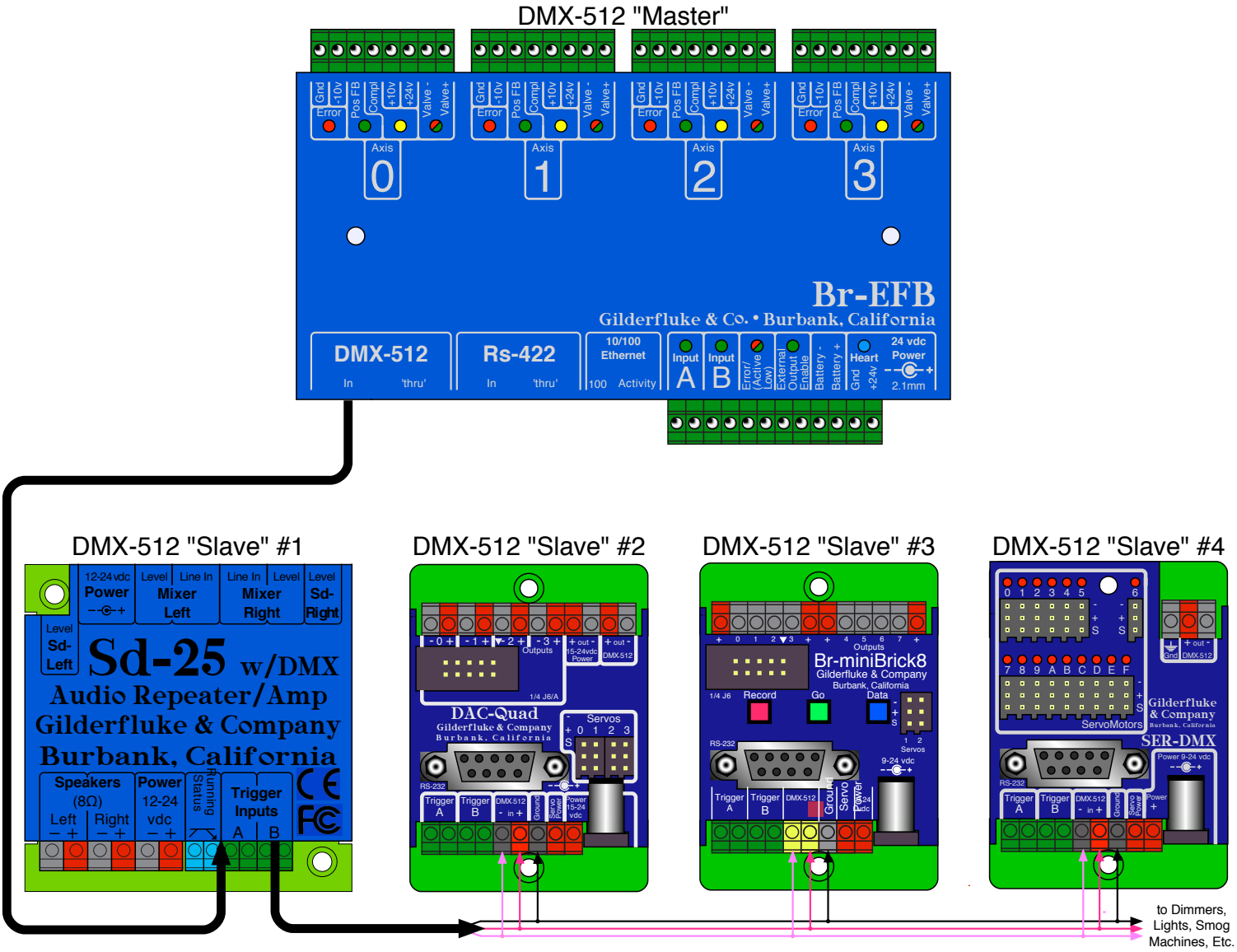
To connect to the three or five pin XLR connectors used on most DMX-512 equipment, just follow the pin numbers shown in the far right column. Commercially made adapters for this are also available.

Addresses 257, 258, 511 and 512 are optionally used in GilderGear for transmitting checksums. The Br-EFB will automatically use these to verify that the data received has no transmission errors in it. If you address a light dimmer or other DMX-512 device to addresses 257, 258, 511 or 512, you will see this verification data displayed as a flickering pattern. Most

GilderGear will automatically start requiring GilderChecksums after receiving DMX-512 that has GilderChecksums in it. Once it starts requiring GilderChecksums, the only way to get the Br-EFB to stop requiring it is to cycle power on it.

Note that at higher frame rates (above about 40 FPS), not all 512 channels can be transmitted through DMX-512.

The DMX-512 standard calls out a 5 pin XLR connector or screw terminals for all connections. Many less expensive DMX-512 devices use three pin XLR connectors. More devices are starting to use RJ-45 connectors so that you can use standard CAT-5 (or better) ethernet cables for carrying DMX-512. The Br-EFB provides interchangeable RJ-45 'in' and 'thru' connections for the DMX-512.



This illustration shows using a single Br-EFB as the ‘DMX-512 ‘Master’, and a Sd-25 w/DMX, DAC-Quad, Br-miniBrick8 and a SER-DMX as DMX-512 ‘Slaves’.

Almost any other piece of GilderGear, or any intelligent lights, dimmers, strobes, smog machines or other pieces of DMX-512 compatible equipment can be used as the ‘slaves’ [1].

The first link uses a standard CAT-5 (or better) ethernet cable to connect the Br-EFB to the Sd-25 w/DMX. The Ethernet cable has RJ-45 connectors on both ends. The DMX-512 connectors on the Br-EFB are interchangeable, so the DMX-512 can come from either of the DMX-512 connectors.

Like the Br-EFB, the Sd-25 w/DMX has interchangeable 'DMX-512 in' and 'DMX-512 thru' connections. The DAC-Quad, Br-miniBrick8 and a SER-DMX have the DMX-512 inputs on their screw terminals. In this example, the cable that connects from the Sd-25 has an RJ-45 on one end, and bare wires on the other to connect to the DAC-Quad. A shielded twisted pair of wires is used for connecting the remaining controllers.

The downstream 'dimmers, lights, Smog Machines, etc.' will most likely use either three or five pin XLR connectors, so the appropriate connectors would be added to the end of the cable to connect to them.

If you are connecting multiple DAC-Quad, Br-miniBrick8 and a SER-DMX (or other GilderGear) as ‘Slaves’, you will want to use the DMX-512 ‘input’ for connecting the downstream units as well. This is because the they will receive and verify each frame of data completely before retransmitting it out the DMX-512 output pins. This delays the retransmission slightly, which can become noticeable if running through several units.

All the equipment on the DMX-512 network can be in one cabinet or control room, but are more commonly distributed throughout the installation. This allows the individual controllers to be prewired to whatever they are controlling and completely pretested before the installation even starts. During installation, instead of running hundreds (or thousands) of wires to each control point, a single DMX-512 network is daisy-chained through each local controller.

1 Most modern DMX-512 equipment will allow you to attach up to 256 ‘Slaves’ to a network. Some older gear limited you to 32 or 64 ‘Slaves’ on a DMX-512 line. You can use a isolated DMX-512 buffer or DMX-512 splitter to allow you to attach any number of DMX-512 ‘Slaves’ to a system, until you have used up all 512 channels of the data that can be sent down one DMX-512 network.

A DMX-512 network can be as long as a mile, or as short as a few inches. The DMX-512 network needs to be one long line, with no long side branches. If the network is longer than a few feet, you may need to provide a terminating resistor at the two far ends of the network (120Ω, ½ Watt is typically used). The resistors suppress ‘echoes’ on the DMX-512 wires.

If the network runs throughout a facility, it is prudent to use a some isolated splitters. These will keep an electrostatic zap or lightning hit on the network from damaging the entire network. An isolated splitter also allows you to run side branches on the network, since each isolated branch is treated as a separate DMX-512 network. DMX is daisy chained from the output of the isolated splitter to the first ‘slave’, then from ‘Slave’ to ‘Slave’. It can be run up to a mile, and may need its own termination resistors.

Addresses 256, 257, 511 and 512 are optionally used in GilderGear for a checksum. The Br-EFB will automatically use this to verify that the data received through DMX-512 has no transmission errors in it. If you address a light dimmer or other DMX-512 device to addresses 256, 257, 511 or 512, you will see this verification data displayed as a flickering pattern. Most GilderGear will automatically start requiring GilderChecksums after receiving DMX-512 that has GilderChecksums in it. Once it starts requiring GilderChecksums, the only way to get the Br-EFB to stop requiring it is to cycle power on it.

Note that at higher frame rates, not all 512 channels can be transmitted through DMX-512.

The typical wires used for carrying a DMX-512 network are a single shielded twisted pair or wires. For short runs, just about any 'microphone cable' can be used. For longer runs, a low capacitance twisted pair is recommended. Recommended wires include:

| Manufacturer | Part # | Gauge | Wire Stranding |
|---|---|---|---|
| Belden | 3105A | 22 AWG | 7 x 30 |
| Belden | 3106A | 22 AWG | 7 x 30 |
| Belden | 9841 | 24 AWG | 7 x 32 |
| Belden | 7200A | 24 AWG | 41 x 40 (high flexibility) |
| Proplex | PC222P | 22 AWG | 19 x 34 |
| Dataplex | WDP222TBK | 22 AWG | 16 x 0.2mm |

Recent revisions of the DMX-512 standards have included specifications for running raw DMX-512 signals through standard Cat-5 (or better) ethernet cables.

**15) RS-422 Input**
**16) RS-422 'Thru'**

This pair of RJ-12 connectors are used to receive and/or transmit serial data. They two jacks can be used interchangeably.

This is used for configuration, uploading and downloading configurations, status enquiries, AutoDownloading show data to Flash memory, and serial port RealTime updates. It is compatible with all the RS-422 Serial Ports and protocols used on Gilderfluke & Company products.

The RS-422 serial data signals from the Br-EFB are brought out on two six position RJ-12 female connectors. This uses the Gilderfluke & Co. standard pinout:

| POSITION | WIRE # | COLOR | SIGNAL NAME: |
|---|---|---|---|
| LEFT | 1 | white | Signal Ground |
| | 2 | black | - Serial data out from Br-EFB |
| | 3 | red | + Serial data out from Br-EFB |
| | 4 | green | - Serial data in to Br-EFB |
| | 5 | yellow | + Serial data in to Br-EFB |
| RIGHT | 6 | blue | Ground |

Computers don't normally come with serial ports on them anymore. Instead, you use a USB-to-Serial (USB-RS232/422) adapter, or Ethernet-to-Serial (Modem-Internet) adapter. For the Br-EFB you will need one that provides the less common RS-422. These are available from a number of different sources, including Gilderfluke & Company. Our part number USB-RS232/422 provides both RS-232 and RS-422 connections.

The Br-EFB expects to see the serial data in the following format:

**ONE START BIT**
**EIGHT DATA BITS**
**ONE STOP BIT**

Br-EFB responds appropriately to all commands which are used by other Gilderfluke & Co. serially controlled devices. These are used for configuration, uploading and downloading configurations, status enquiries, AutoDownloading show data to Flash memory, and serial port RealTime updates. It will ignore all commands which are not addressed to it, or not appropriate for it to respond to.

If you have hooked up the Br-EFB to your computer and it still doesn't seem to respond to the keyboard, the first thing to check is that you are attached to the right serial port. The easiest way to do this is with 'The Paperclip Test'. Disconnect the Br-EFB and short between the Tx data and Rx data pins on your USB-to-Serial converter. For a RS-422 port, this means temporarily shorting between pins #2 and #4 and #3 and #5.

While still running the modem program, anything you type should be shown on the screen while the paper clip is in place, while nothing will ap-

pear when you remove the paper clip. If your computer passes this test, then you are using the right serial port and the problem is most likely the baud rate setting or in your wiring to the Br-EFB. If you get characters on the screen even with the jumpers removed from the serial port, it means you probably need to set the 'echo' mode to 'none' or 'full duplex' and try this test again.

### 17) Ethernet

This is a standard 10/100 Ethernet jack. Integrated into the jack are LED indicators for connection activity and connection speed.

By default, the Br-EFB is set to use DHCP addressing on this port. Your local DHCP server will assign it an IP address as soon as it is plugged into your network.

Before you can talk to the Br-EFB through the ethernet port, you will need to know what its assigned IP address is. If you don't have access to the DHCP Server, the easiest way to do this is to plug into the USB or RS-422 serial port and bring up the text-based menu using GilderTerm.

The IP address is displayed on the header of every menu page.

Enter this IP address into your browser's address bar, and when you hit <Return>, the web based menus should appear in your browser.

The Br-EFB has a built in web page with several tabs. You can use this web-based interface as a user-friendly alternative to the text-based menus for configuring the Br-EFB.

Using either the text-based or web-based user interface, you can disable the DHCP, set the IP address and other ethernet settings manually.

### 18) Power Supply 2.1mm Barrel connector (24vdc)

The Br-EFB is designed to run from 24vdc. The power supply connections are diode protected against reversed polarity and ElectroStatic Discharge by a 30 volt ESD diode.

The 5.5mm O.D. x 2.1mm I.D. barrel connector is wired in parallel with the Power Supply Ground and Positive screw terminals. They can be used interchangeably.

An idle Br-EFB draws only about !!!!?? milliamperes. The Position Feedback and Compliance Feedback sensors, as well as the ServoValves

and/or Motor Controllers which the Br-EFB is controlling will usually draw far more current than the Br-EFB itself.

### 19) µSd/µSdHC/µSdXc Flash Memory Card Slot

*(One µSd/µSdHC/µSdXC compatible socket)*

This socket is compatible with both standard Micro Sd flash cards, Micro SdHC and Micro SdXC flash cards. It will support µSd flash cards of 64 GBytes and larger.

The Br-EFB stores configuration and log data on the µSd card. You must always run the Br-EFB with a µSd flash card in this socket. The Br-EFB stores all its configuration data on the µSd flash card, as well as show data in AutoDownload files, and logs that are regularly updated by the Br-EFB.

The Br-EFB writes a new log entry for each major event that happens to it. This includes starting shows, enabling/disabling the valve outputs, following errors, and more. So that the Log files don't grow and take over the µSd flash card, the Br-EFB caps the size of each of them. After a log file reaches this cap, it begins a new Log file. After a ten Log files have been created, the Br-EFB deletes the oldest Log file when it creates a new one.

### 20) Mini USB

*(One Mini USB compatible socket)*

This is used to connect the Br-EFB to your computer for configuration and programming. if you have the appropriate drivers installed on your PC, the Br-EFB will appear as a standard COM port to your computer. Once this connection has been established, you can use this port just as you would the RS-422 ports, using GilderTerm, Pc•MACs, or other software running on your PC.

Before you can use the USB port, you will need to load a driver on your PC. This driver, from STMicroelectronics, allows your computer to use the serial port on the Br-EFB, just like any other USB to serial adapter.

### W) ServoLoop Error LEDs

*(One Red LED per axis for Four Red LEDs in total)*

These four red LEDs light to show errors in each of the ServoLoops. You can identify which ServoChannel is having a problem and the type of error by counting the 'blink code' on these LEDs:

## Output Connectors for each ServoLoop Axis

*(8 Position Pluggable Screw Terminal)*

The Input connections use four eight position, pluggable screw terminals.

The screw terminals are 'cage clamp' style, which don't require crimps or ferrels on the ends of the wires (although you can use them, if you like). They will accept wire sizes between 14-30 AWG (0.14mm$^2$-1.5mm$^2$). All the connections to the Br-EFB are relatively low current, so most wiring will use 20 AWG (0.812mm$^2$) or smaller wires.

| Terminal # | wire function |
|---|---|
| A / #1 | Power Supply Ground |
| B / #2 | Negative (-) 10 Volt reference |
| C / #3 | Position Feedback (+/-10v, +/-5v, 0-10v or 0-5v) |
| D / #4 | Compliance Feedback (+/-10v, +/-5v, 0-10v to 0-5v) |
| E / #5 | Positive (+) 10 Volt Reference |
| F / #6 | +24 vdc Supply Out |
| G / #7 | - ServoValve/Motor Controller Output |
| H / #8 | + ServoValve/Motor Controller Output |

### A) #1: Power Supply Ground

*(One Screw Terminal per axis for Four Screw Terminals in total)*

This screw terminal (Position #1) is connected directly through the ground plane of the Br-EFB's printed circuit board to the ground connection on the twelve position 'input' screw terminal block (Position #11) and the ground connection on the Power Supply 2.1mm Barrel connector.

If you will be using 24vdc for powering your position sensor or Compliance Feedback sensor or ServoValve, you will typically connect these devices' 'ground' wires to this terminal.

If you are using 0-10 volts or 0-5 volts for your position or Compliance Feedback sensors, this terminal would be used to connect the ground pin of your sensor.

### B) #2: Negative (-) 10 Volt Reference

*(One Screw Terminal per axis for Four Screw Terminals in total)*

This screw terminal (Position #2) is is the output the negative 10 volt reference. This is where you will normally connect the 'retract' end of a position sensing potentiometer. The other end of the potentiometer will normally be connected to the positive 10 volt terminal (Position #5) and the potentiometer wiper to position feedback input (terminal #3)

This output is meant only to provide enough current to power an external device. It can only be used as an -10 vdc reference to a potentiometer or similar resistive load.

The OpAmp that drives the positive and negative reference output pins for each Servo axis is socketed for easy replacement incase it gets damaged by a miswire during installation.

### C) #3: Position FeedBack Input

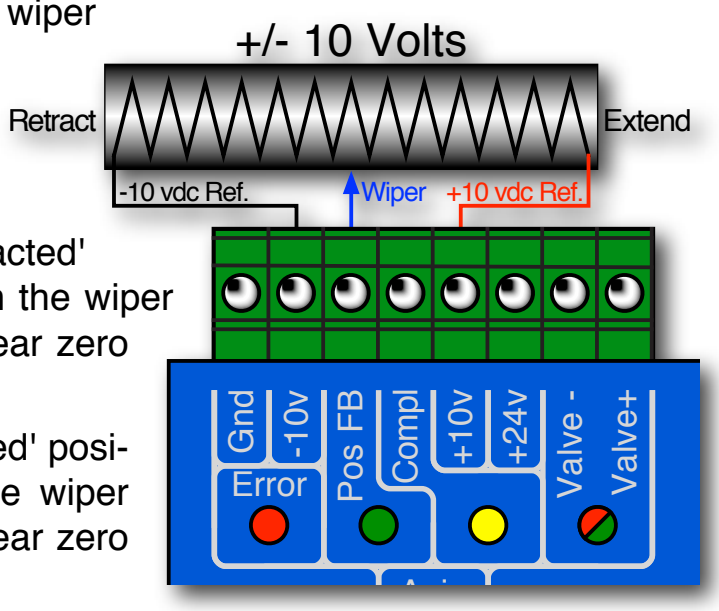
*(One Screw Terminal per axis for Four Screw Terminals in total)*

This screw terminal (Position #3) is connected to the Br-EFB's sixteen bit resolution Analog to Digital converter (ADC). This input is sampled at approximately 100KHz.

All potentiometers have three wire leads. The first of these connects to the 'retract' end of the resistive sensing element (which is usually a piece of conductive plastic). The second wire connects to the 'extend' end of the resistive element. The third wire is connected to the 'wiper', which moves up and down the resistive element.

If you measure between the 'retract' and 'extend' leads, the resistance will not change as you move the wiper. The resistance should be close to the value you specified for the resistance of this potentiometer (typically 10K ohms).

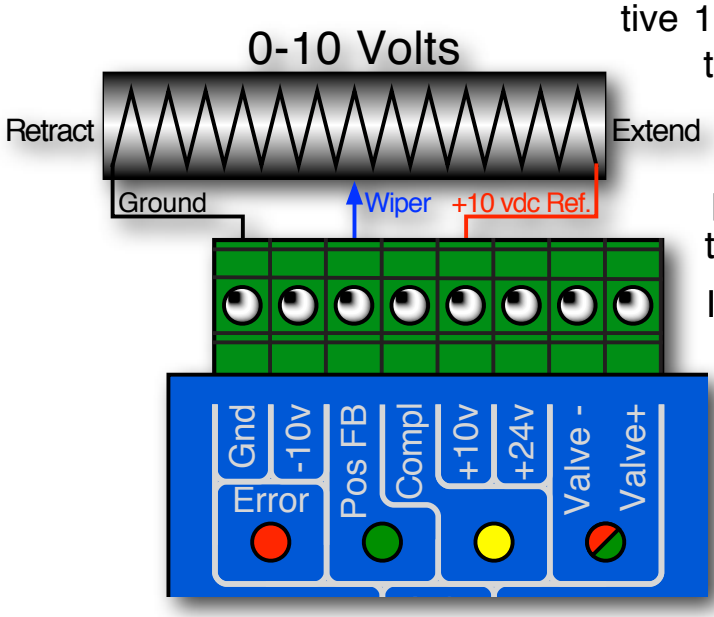
If you measure between the wiper lead and the 'retract' or 'extend' leads, the measurement will now change as you move the wiper.




With the wiper in the 'retracted' position, the resistance between the wiper and 'retract' lead will be at or near zero ohms.

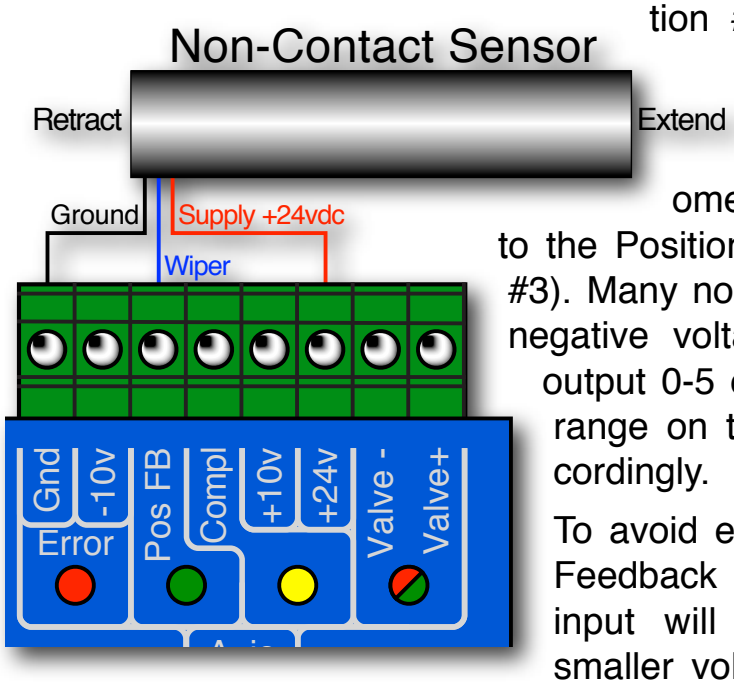
With the wiper in the 'extended' position, the resistance between the wiper and 'extend' lead will be at or near zero ohms.

The Position Feedback Input (screw terminal position #3) is where you will normally connect the 'wiper' from a position sensing potentiometer. The retract end of the potentiometer would normally be connected to the negative 10 volt reference terminal (Position #2), while the other end of the potentiometer will normally be connected to the positive 10 volt terminal (Position #5).




If you want to use a potentiometer with a 0-10 volt range, connect the 'retract' end of the potentiometer to the Ground terminal (position #1) instead of the negative 10 volt reference terminal (Position #2).

With no moving parts to wear out, non-contact position sensors have a far longer service life than any potentiometer. They generally don't need to connect to either the negative or positive references on the Br-EFB. Instead they have a connection to the Ground (screw terminal position #1) and 24vdc (screw terminal posi-




tion #6) to provide power for the sensor[2]. The third 'signal' wire takes the place of the 'wiper' terminal on a potentiometer, and should be connected to the Position Feedback Terminal (position #3). Many non-contact sensors can't output negative voltages. Instead, they will only output 0-5 or 0-10 vdc signals. The input range on the Br-EFB should be set accordingly.

To avoid electrical noise on the Position Feedback inputs, a higher voltage span input will always be 'quieter' than a smaller voltage span. If you can, use a position feedback sensor that uses +/-10 vdc. This is a 'span' of 20 volts.

With a potentiometer connected between the -10 volt and +10 volt references, the normal voltage range for this input would be set to +/-10 vdc.

With a potentiometer connected between the ground and +10 volt references, the normal voltage range for this input would be set to 0-10 volts.

If you find that the range of motion of your actuator is such that the voltage range never exceeds a lower input range supported by the Br-EFB, you can set the input to a lower range.

This is not uncommon with rotary actuators when using a rotary potentiometer. If the actuator only moves about 90º, and the potentiometer has a 270º range of motion (this is standard with most rotary potentiometers), the voltage range will only be 6.66 volts, you can set the input for +/-5 vdc. If you have a potentiometer with a 360º rotation and 90º of actuator motion, the voltage range will only be about 4 volts, you can set the input range for 0-5 volts. In either case, you will need to physically rotate the potentiometer so that the voltage on input stays within the selected range.

### D) #4: Compliance FeedBack Input

*(One Screw Terminal per axis for Four Screw Terminals in total)*

[2] Be sure to check the specifications on your Non-Contact Position sensor to confirm it is able to run at 24 vdc before you connect it to the Br-EFB's 24 volt output terminals.

This screw terminal (Position #4) is connected to the Br-EFB's sixteen bit resolution Analog to Digital converter (ADC). This input is sampled at approximately 100KHz.

This is where you will normally connect the output from an amplified strain gauge or differential pressure sensor. Whether you are using a differential pressure sensor or a strain gauge, it must be bi-directional.

Many differential pressure sensors and strain gauges are not bidirectional, and will only work in one direction. Unless you want the Compliance Feedback to work in only one direction, these are not suitable.

A Bi-Directional differential pressure sensor or strain gauge will have an output voltage that sits at the mid-point of its output range when there is no force applied (for a strain gauge) or the pressure is equal on both ports (for a differential pressure sensor.

Physical force (or pressure) applied on one side will cause the voltage to drop. Physical force (or pressure) applied on the other side will cause the output voltage to rise. If your sensor doesn't do this, then it is not bi-directional.

The signal output from a non-amplified strain gauge or differential pressure sensor is only a few millivolts. The Analog to Digital converter is looking for a +/-10 vdc, 0-10 vdc, +/-5 vdc pr 0-5 volt DC signal, so your pressure sensor or strain gauge needs to be amplified to get the signal to a level where the can easily be measured by the Br-EFB.

### E) #5: Positive (+) 10 Volt Reference

*(One Screw Terminal per axis for Four Screw Terminals in total)*

This screw terminal (Position #5) is the output from the positive 10 volt reference. This is where you will normally connect the 'extended' end of a position sensing potentiometer. The other end of the potentiometer will normally be connected to the negative 10 volt terminal (Position #2) and the potentiometer wiper to position feedback input (terminal #3).

This output is meant only to provide enough current to power an external device. It can only be used as a +10 vdc reference to a potentiometer or similar resistive load.

The OpAmp that drives the positive and negative reference output pins for each Servo axis is socketed for easy replacement incase it gets damaged by a miswire during installation.

### F) #6: 24 vdc Supply Output

*(One Screw Terminal per axis for Four Screw Terminals in total)*

This screw terminal (Position #6) is protected by a diode and a solid state circuit breaker (PTC Fuse) rated for 1 amp. The PTC fuse acts as an extremely slow blow fuse, that resets itself after whatever caused the too much current to be drawn has been removed. You should treat each Servo Channel as an individual, and not cross the outputs or power output lines from one Servo Channel to the lines from another. Doing this won't cause any damage, but can reduce the protection for the outputs that the circuit breakers normally provide.

Use this terminal to provide power for your ServoValve and position and Compliance Feedback sensors, if needed.

### G) #7: Negative (-) ServoValve/Motor Controller Output
### H) #8: Positive (+) ServoValve/Motor Controller Output

*(Two Screw Terminal per axis for Eight Screw Terminals in total)*

The ServoMotor/Motor Controller output is actually a pair of complimentary 0-10 volt outputs.

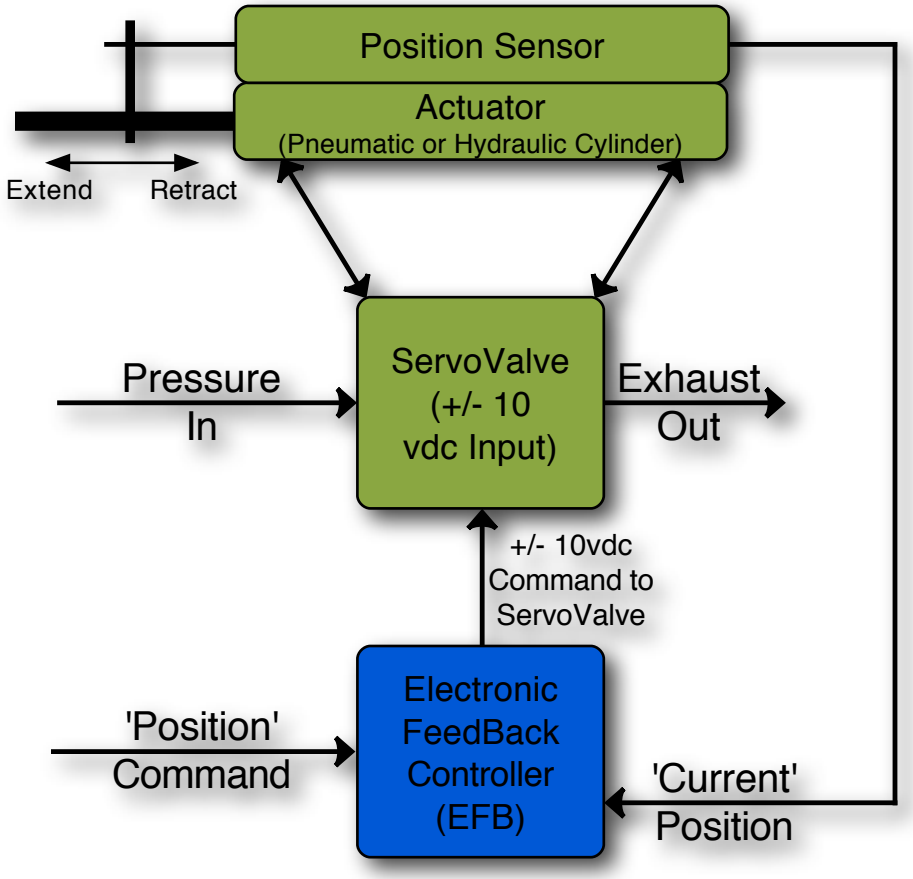
If you measure the voltage across these two terminals, you will see a swing of plus and minus 10 volts DC going to the ServoValve/Motor Controller.

If you measure between the ground terminal (position #1) and either of the outputs, each will be a 0-10 volt signal. When one output is at zero volts, the other will be at ten volts.

If you measure when the the actuator is not moving, you will find that both of the outputs (measured from ground) are at five volts DC. Measuring between the positive and negative terminals, you will see that the voltage is measured at zero volts, as is needed to have the actuator stopped.

Typical ServoValves have a single coil with a 500Ω resistance (some ServoValves have two coils with 250Ω each, but these are normally wired in series to act like a single 500Ω coil). At plus or minus ten volts, these will draw plus or minus 20 milliamps. The complimentary outputs can drive 'normal' ServoValves/Motor Controllers that want to see a +/-10vdc command input with a current of up to 50ma.

Standard ServoValves are connected as shown:



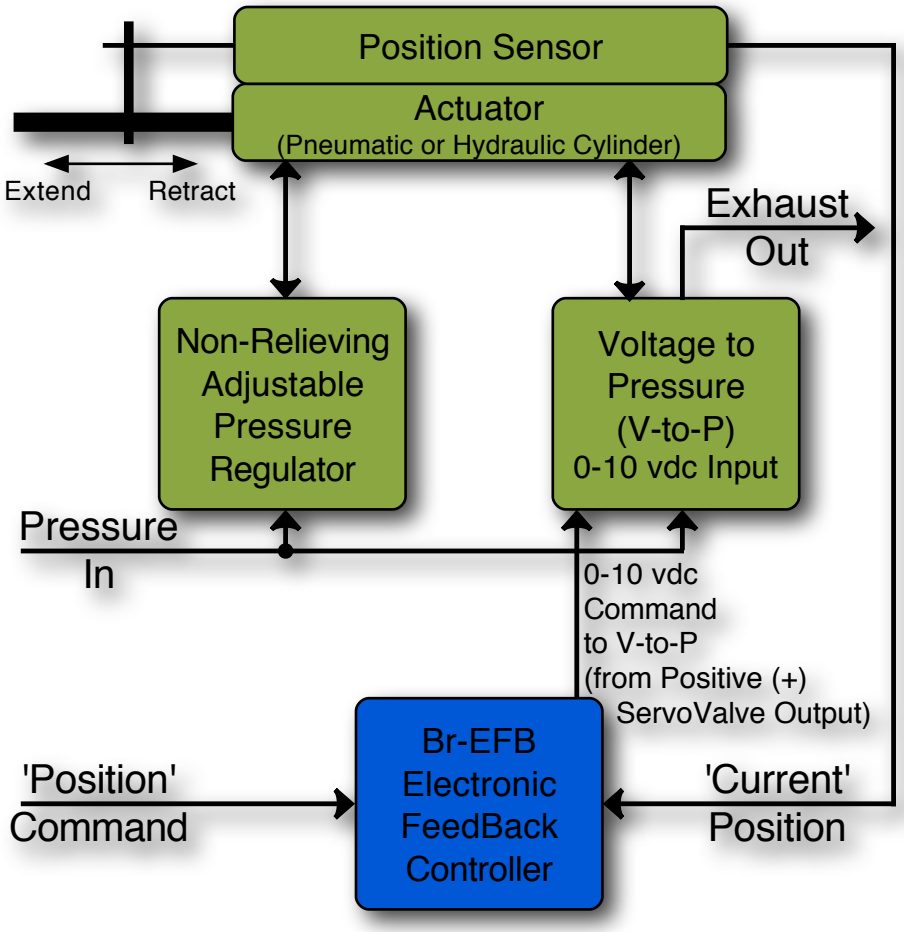

The complimentary outputs allows the Br-EFB to also work with non traditional ServoValves that want to see a unipolar outputs where five volts is 'stopped'. Voltages below five volts move the actuator in one direction, and voltages above five volts move the actuator in the other direction.

An example of this would be using one relieving fast acting pneumatic Voltage to Pressure (VtoP) transducer working against a non-relieving adjustable pressure regulator to move an actuator. The input to the single V-to-P is attached to the ground screw terminal (position #1) and the Positive (+) ServoValve output on the Br-EFB. If the V-to-P needs 24 vdc to run (it probably does), connect this lead to the 24 vdc Supply Output Screw Terminal (position #6).

Since the actuator is working against a fixed regulator set to 50% of the pressure that the V-to-P can source, this method looses 50% of the potential strength of the actuator.

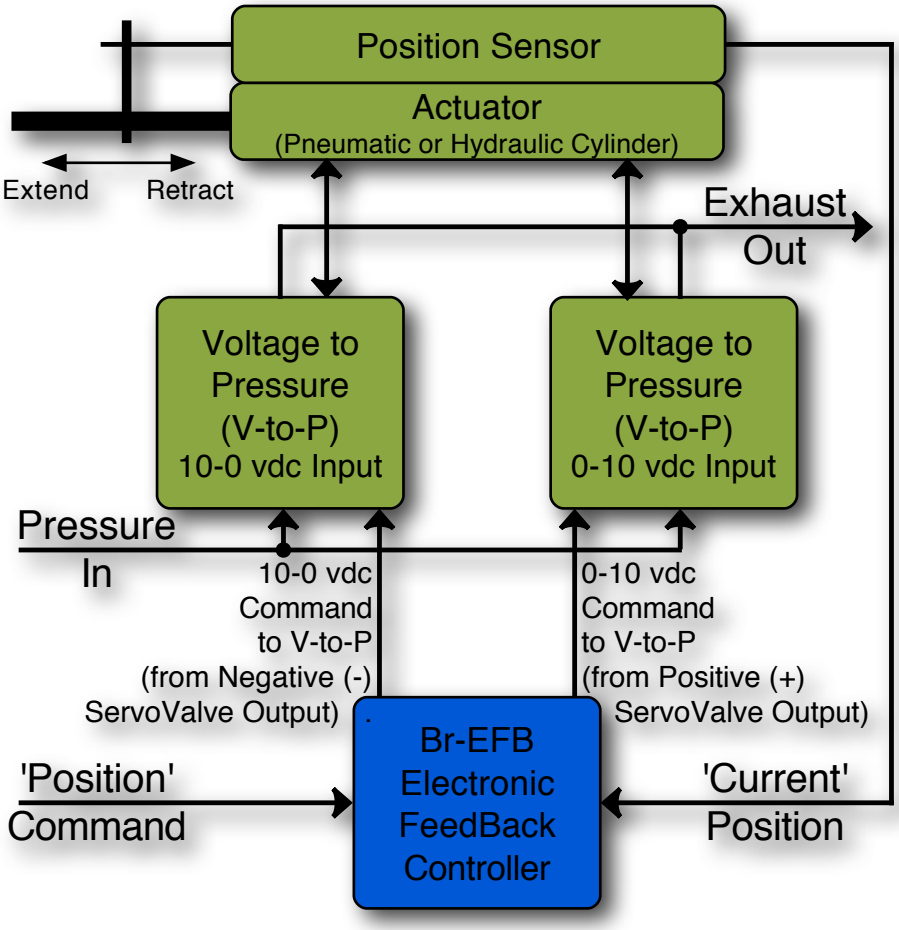
To calibrate the adjustable regulator, apply a 5 vdc to the V-to-P regulator and adjust the other regulator to minimize movement of the actuator.

Don't worry about getting it absolutely still. This is what the Br-EFB will do once the servo loop is closed.




Two fast acting relieving Voltage to Pressure (VtoP) transducers working against each other can also be used to move a pneumatic actuator. The ground inputs to both V-to-Ps are attached to the ground screw terminal (position #1). The Negative (-) ServoValve output on the Br-EFB (position #7) is attached to the command input on the first V-to-P. The Positive (+) ServoValve output on the Br-EFB (position #8) is attached to the command input on the other V-to-P. If the V-to-Ps need 24 vdc to run (they probably do), connect these leads to the 24 vdc Supply Output Screw Terminal (position #6).

This method provides the full force of the actuator for maximum strength and accuracy.

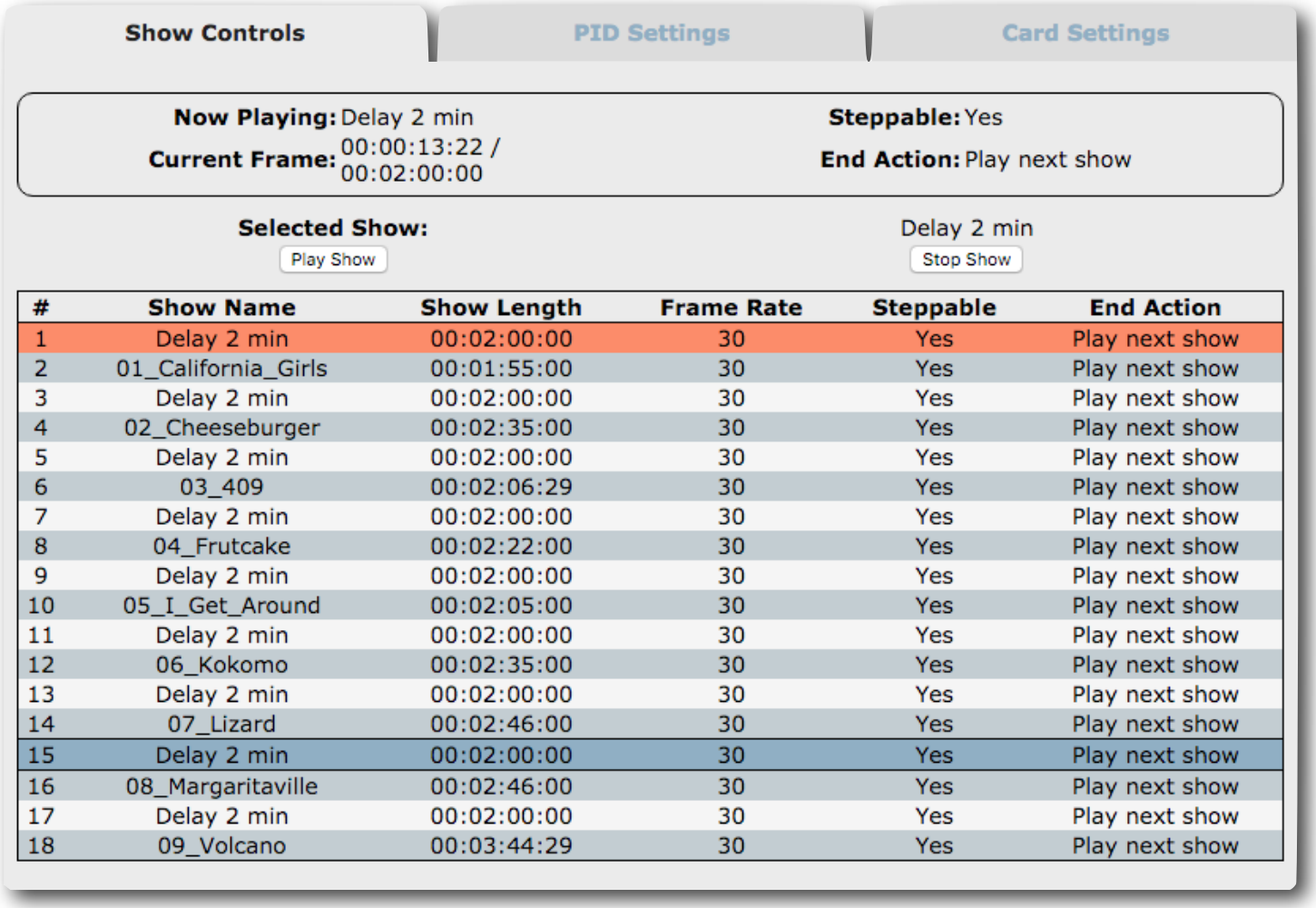



The OpAmp that drives the positive and negative ServoValve/Motor Controller output pins for each Servo axis is socketed for easy replacement incase it gets damaged by a miswire during installation.

# Web-Based Configuration

For accessing the Br-EFB through the Ethernet port, you can use any computer tablet or smart phone running just about any web browser. The Br-EFB uses JSON (JavaScript Object Notation) for asynchronous browser/server communication. If your web page screens don't update variables (like the frame number of a show that is running) the Br-EFB's screens in near-RealTime, then your browser may not have JSON messaging supported or enabled.

To establish initial contact with the Br-EFB's built-in web page, you will need to know the IP address of the Br-EFB. By default, the Br-EFB is set to DHCP. It will accept an address assigned to it by to your network's DHCP server.




| # | Show Name | Show Length | Frame Rate | Steppable | End Action |
|---|---|---|---|---|---|
| 1 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 2 | 01_California_Girls | 00:01:55:00 | 30 | Yes | Play next show |
| 3 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 4 | 02_Cheeseburger | 00:02:35:00 | 30 | Yes | Play next show |
| 5 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 6 | 03_409 | 00:02:06:29 | 30 | Yes | Play next show |
| 7 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 8 | 04_Frutcake | 00:02:22:00 | 30 | Yes | Play next show |
| 9 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 10 | 05_I_Get_Around | 00:02:05:00 | 30 | Yes | Play next show |
| 11 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 12 | 06_Kokomo | 00:02:35:00 | 30 | Yes | Play next show |
| 13 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 14 | 07_Lizard | 00:02:46:00 | 30 | Yes | Play next show |
| 15 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 16 | 08_Margaritaville | 00:02:46:00 | 30 | Yes | Play next show |
| 17 | Delay 2 min | 00:02:00:00 | 30 | Yes | Play next show |
| 18 | 09_Volcano | 00:03:44:29 | 30 | Yes | Play next show |

**Main Web Page**

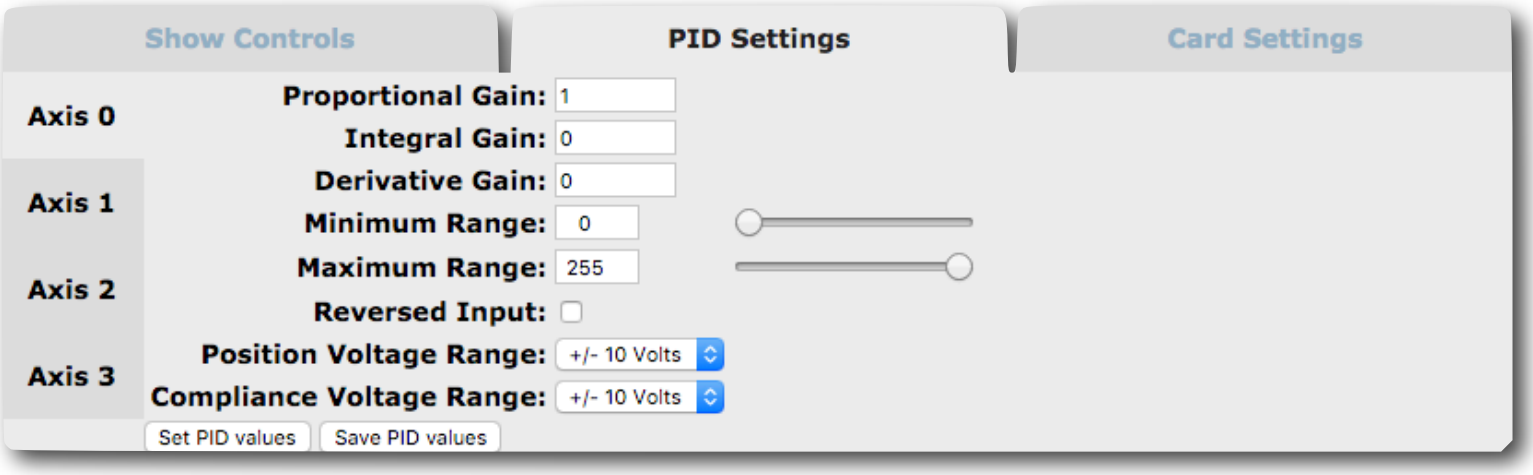
If you don't know what the IP address of your Br-EFB is, and can't access the DHCP server to find the assigned address, you can temporarily plug the Br-EFB to your computer via the USB or Rs-422 serial port. Once connected, you can use Gil-

derTerm to open the text-based menus. You can see the current IP address in the header of every page, and alter the settings if desired.

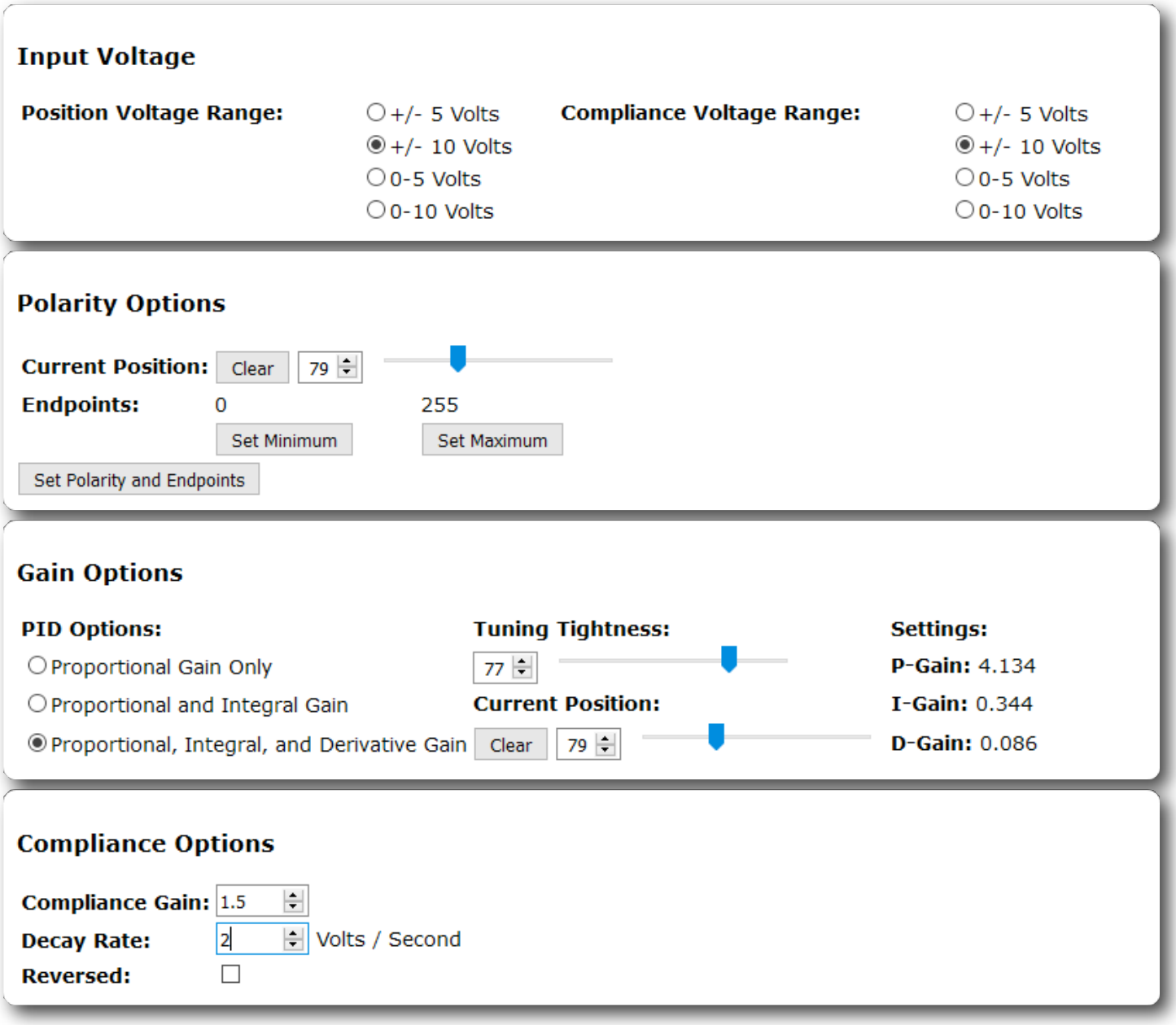
The first tab on the Br-EFB's web page displays al the shows in the AutoDownload file. The show which is playing, its length, and the frame it is on is displayed at the top of the window. This show is also highlighted in the list of shows. You can stop this show using the 'Stop Show' button, or select another show from the list and tell it to 'play'.

# Web-Based PID Configuration Tab

This is where you set up, test and adjust the PID loops. There is one tab for each axis of the Br-EFB.




**PID Settings Web Tab**




**PID Settings Web Tab**

## A) Minimum Scale (numeric value & slider)

This sets the end of travel for the actuator when a 0% command voltage is applied to this axis.

If the 'Auto Jog While Setting Min/Max' checkbox is on, when moving this slider or the numeric entry will cause the 'Jog' Checkbox to turn ON, and the 'Jog' Slider and Numeric value to ramp at the EaseIn rate to the 0% position.

Even while it is doing the EaseIn, the user can grab the jog slider and move it as desired.

If the 'Auto Jog While Setting Min/Max' checkbox is still on, then next time the user changes the Minimum or Maximum scale sliders or numeric value, will try to ramp the 'Jog' position to 0% or 100%.

**B) Maximum Scale (numeric value & slider)**

This sets the end of travel for the actuator when a 100% command voltage is applied to this axis.

If the 'Auto Jog While Setting Min/Max' checkbox is on, when moving this slider or the numeric entry will cause the 'Jog' Checkbox to turn ON, and the 'Jog' Slider and Numeric value to ramp at the EaseIn rate to the 100% position.

Even while it is doing the EaseIn, the user can grab the jog slider and move it as desired.

If the 'Auto Jog While Setting Min/Max' checkbox is still on, then any time the user changes the Minimum or Maximum scale sliders or numeric values, the 'Jog' position will ramp to 0% or 100%, as needed.

**C) Proportional (P) Gain (numeric value, slider & output voltage display)**

This command is used to manually set the 'P' gain used by the currently selected axis controlled by this Br-EFB.

The 'P', or 'Positional' gain is the main factor used in any closed loop system. It compares the position the actuator is commanded to be positioned to with the actual measured position as sensed by the sensor attached to the actuator. The direction and how far the desired and actual positions are from each other controls the voltage sent to the valve output, which sets how quickly the actuator moves towards the desired position.

The range of setting for the Proportional (P) Gain is from 0.001 to 8.000. The default is 1.000, which gives you a One-to-One gain.

You can see this by disconnecting the valve outputs and manually positioning your actuator (or at least the Position Feedback device) to the fully retraced position. With the gain set to 1.000, when you send a command to the Br-EFB for this axis to move to the 0% position, the 'valve' light will be off showing that zero volts are being sent to the valve outputs. If you have the 'following error' features enabled, the axis' 'Error' led for the axis will also turn off (If the board 'Error' relay output has been triggered, you may need to cycle power or the 'Valve Enable' input to reset the 'Hard Error Timeout' condition before the valve output will be enabled). If you move either the actuator (or at least the Position Feedback

device) to the fully extended position. The valve output LED will glow either red or green (depending on if the outputs are reversed) and 10 volts will be sent to the valve output.

After a delay set by the 'Soft Error Timeout', the 'Error' LED for the axis will turn on, indicating the actuator has not followed the commanded position closely enough. After the delay set by the 'Hard Error Timeout', the output 'Status' LED will go red, and the axis will be disabled.

If you move both the actuator and command to the fully extended position, then the valve LED will again extinguish, showing that zero volts are being sent to the valve output. (You may need to reset the 'Hard Error Timeout' before the valve output will be enabled again.)

Moving both the actuator and command to the 50% position the valve LED will be extinguished, because the Position Feedback loop thinks the actuator is at the commanded position. Now if you move either the Position Feedback or commanded position, the valve will output a +/-5 volt signal as the Br-EFB tries to command the actuator to follow the commanded position. If you increased the gain to 2.000, the valve output would again reach +/-10 volts. Increasing the gain even further will narrow how far apart the command and position sensor need to be to reach the full +/-10 volt valve output. This is known as 'narrowing the 'V'', because as the gain is raised, it increases how tightly the actuator will try to follow the position commands.

### D) Integral (I) Gain (numeric value, slider, checkbox & output voltage display)

This Numeric Value box and slider is used to manually set the 'I' gain used by the currently selected axis controlled by this Br-EFB. If you don't want to use Integral (I) Gain at all, just uncheck the checkbox.

The 'I', or 'Integral' gain is used in a PID ServoLoop to nudge the actuator that last little bit to get it to the commanded position.

When an actuator is very near the position it is being commanded to move towards, the difference between the current position (as measured by the Position Feedback element on the actuator) and the commanded position are too close for the positional ('P') gain to output a sufficient voltage to move the actuator the last little bit.

The 'I' gain will give a steadily rising voltage to the valve output until it rises high enough to 'nudge' the actuator the last little bit to get to the commanded position.

If the 'I' gain is turned up too high, then the movement will constantly seek the desired position, overshoot, and seek again. Unlike the oscillation that occurs when the 'P' is set too high, the 'I' oscillation occurs at a low speed. Although mildly amusing, it is rarely destructive. If the 'I' is adjusted too low, then the 'dead band' around the desired position will be slightly wider.

**E) Derivative (D) Gain (numeric value, slider, checkbox & output voltage display)**

This Numeric Value box and slider used to manually set the 'D' gain used by the currently selected axis. If you don't want to use Derivative (D) Gain, just uncheck the checkbox.

The 'D', or 'Derivative' gain is used in a PID ServoLoop to accelerate and decelerate the actuator quickly to try to follow quickly changing command positions more closely.

You can think of the 'D' gain as an accelerator pump in an automobile carburetor. If you thrump on the accelerator pedal, the carburetor's accelerator pump will send an extra bolus of gasoline down the throat of the carburetor to help accelerate the car quickly.

The 'D' gain works in exactly the same way in a servo loop. You can see its effect most clearly when performing a 'step' test, where you send commands to the servo loop that step sharply between command values. The 'D' gain helps the actuator accelerate more quickly at the beginning of a step.

With slightly slower steps, if the 'D' is set too high, then the movement will start too quickly, overshoot the commanded position, and then slow down as the 'P' error takes over.

**F) Tightness (numeric value & slider)**

*Available only after running the PID Wizard.*

In industrial controls, you generally want the actuator to move as quickly and accurately as possible. In entertainment applications, you may want the movements to be slower and softer, or faster and stiffer, depending on your application.

The 'Tightness' setting defaults to 50%. If you want the movement to be fast and sharp, you can increase the 'Tightness'. If you want the movement to be slower and 'softer', you can decrease the 'tightness' as needed. As the 'Tight-

ness' is increased and decreased, the 'P', 'I' & 'D' Gains will be scaled as needed.

**G) Compliance Feedback Gain (numeric value, slider, checkbox & output voltage display)**

The gain sets the 'depth' of the Compliance Feedback input. If you push against a compliant actuator, it should move away from you, requiring far less pressure than it would take with the Compliance Feedback turned off. How far it moves with the initial push is controlled by the Compliance Feedback Gain.

**H) Compliance Feedback Decay Rate (numeric value & slider)**

This controls the 'decay' rate for a Compliance Feedback signal. As you push on the compliant axis and it moves out of your way, this time delay sets how long this effect lasts. As it decays, the compliant axis will fight its way back to its original position with increasing strength.

**I) Jog (numeric value, slider & checkbox)**

This command will allow the current Br-EFB axis being adjusted to be manually controlled. If the checkbox is OFF, then the slider/numeric value will follow the analog command being sent to this axis. Manually changing the slider position or the numeric value will automatically check the checkbox so that the slider/numeric value will now provide the command position for this axis.

The jog control will remain in effect until the checkbox is unchecked. At that instant, there will be an EaseIn to smoothly ramp the control of the axis from the Jog slider/numeric entry back to normal Show Control. The Jog slider/numeric entry will reflect this EaseIn as and return to following the command position for this axis.

**J) Position Feedback Phase Reversed (checkbox)**

The phasing in the feedback loop needed to be reversed. This can be set manually, or by the Polarity Wizard.

**K) Compliance Feedback Input Reversed (checkbox)**

If you press on a compliant axis and instead of moving out your way, it moves towards you, then it needs to be reversed.

### L) Auto Jog While Setting Min/Max (checkbox)

If the this checkbox is on, altering either the Minimum or Maximum Endpoint settings will cause the 'Jog' Checkbox to turn ON, and the 'Jog' Slider and Numeric value to ramp at the EaseIn rate to the 0% or 100% position, as needed.

### M) Position Feedback A/D Voltage Range (DropDown)

This DropDown allows you to select the voltage input range for this input. The possible input range settings are: +/-10 volts, +/-5 volts, 0-10 Volts and 0-5 volts. The default for the position feedback inputs is +/-10 vdc.

### N) Compliance Feedback A/D Voltage Range (DropDown)

This DropDown allows you to select the voltage input range for this input. The possible input range settings are: +/-10 volts, +/-5 volts, 0-10 Volts and 0-5 volts. The default for the compliance input is ‘disabled’.

### O) Polarity Wizard (Button)

This command sets a Setpoint voltage that is near the current Position Feedback voltage. The Br-EFB will then slowly raise the gain. When the gain reaches a level where the actuator starts to move, the Br-EFB will try to move the actuator towards the Setpoint. If it is successful, the Br-EFB will have determined the 'phase' of the servo Position Feedback loop, and corrected it if necessary.

### P) PID Wizard (Button)

The PID Wizard is used to automatically set the Proportional ('P'), Integral ('I') and Derivative ('D') gains for the Feedback Loop.

The Br-EFB does this by moving the actuator to mid-stroke and then making a series of small steps as the Proportional ('P') gain is raised until it is high enough to put the actuator into a sustainable oscillation. The period of the oscillation is measured, and from this the Br-EFB mathematically derives the proper settings for the Proportional ('P'), Integral ('I') and Derivative ('D') gains.

Because the this function will potentially cause the actuator to move faster than it would under normal circumstances, the following warning is presented before any movement begins:

```
Automatic tuning involves finding a steady oscillation point in order to derive
an optimal PID tune. If what is being tuned is delicate under oscillation or is
attached to anything delicate or not secured down, Automatic Tuning may damage
the mechanism.

                Not all actuators can be automatically tuned.

                    Do you wish to continue? Y/N-
```

**PID Wizard Warning**

Actuator movement will not start until you type a 'Y' for the answer 'yes'.

```
                Finding ultimate Proportional (P) Gain- 0.000

                    press ANY key to abort test-
```

**PID Wizard in Progress**

If you need to abort the PID Wizard while it is in process, you can hit any key on the keyboard, or remove the enabling voltage from the Valve Enable input.

```
            Ultimate Gain- 11.512, Ultimate Period- 273.37 ms
```

**PID Wizard Completed**

Once the has successfully completed, the PID Wizard will have determined the 'Ultimate Gain' and Ultimate Period'. It will use these to calculate the Proportional (P), Derivative (D) and Integral (I) Gains. The Web interface will return to the PID Settings Web Tab.

Not all actuators will be able to work with the PID Wizard. If the PID Wizard doesn't arrive with a good 'Ultimate Gain' and Ultimate Period', you can try re-running the PID Wizard a few times to see if you get different results.

If your actuator can't reach a speed high enough that it will sustain an oscillation, then the PID Wizard will not be able to measure the oscillation period. This can be caused by an undersized valve for a pneumatic or hydraulic cylinder, or limiting the valve output voltage from the Br-EFB, which can also limit the flow through the valve.

### Q) Valve Voltage

Display only- Not user modifiable.

This is the sum of the Proportional (P) Gain output voltage display, Integral (I) Gain output voltage display, Derivative (D) Gain output voltage display and Compliance Feedback voltage display.

### R) Ultimate Gain

*Available only after running the PID Wizard.*

Display only- Not user modifiable.

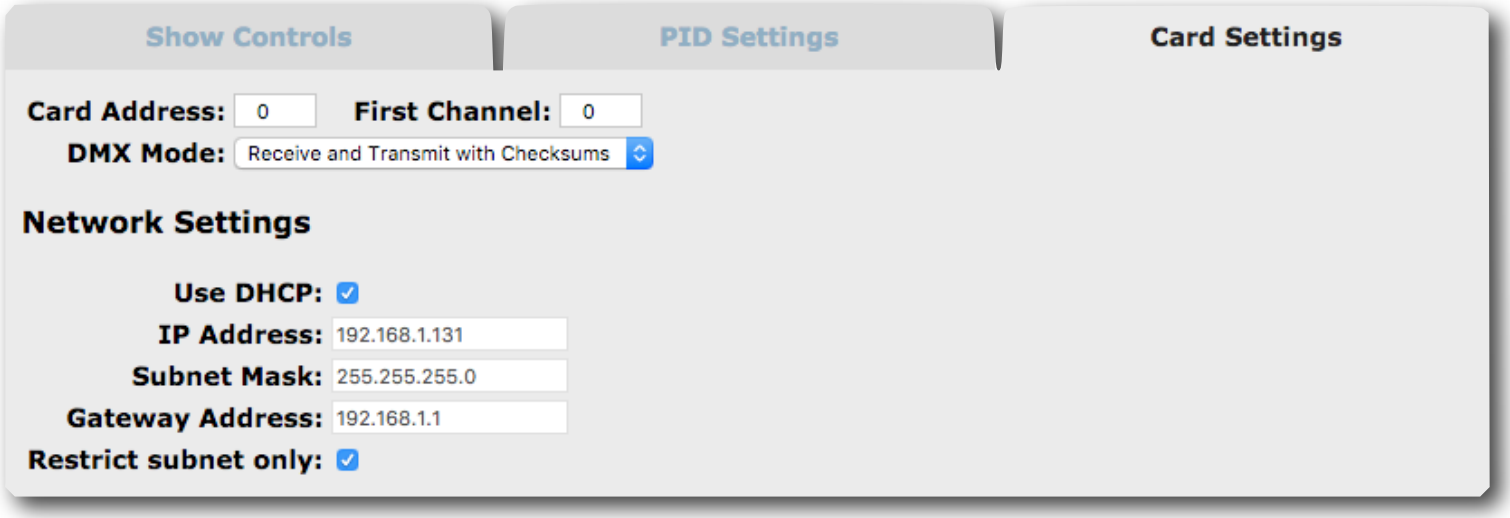
### S) Ultimate Period

*Available only after running the PID Wizard.*

Display only- Not user modifiable.

# Web-Based Card Settings Tab

This is where you set up, test and adjust the PID loops. There is one tab for each axis of the Br-EFB.




**Card Settings Web Tab**

## A) First DMX-512 Address

This toggle selects whether the outputs' DMX-512 address is set from:

- First analog DMX-512 Address stored in the AutoDownload file. Any digital channels will be ignored. If you save AutoDownload files with a non-zero starting number for the number of channels to go into the AutoDownload file. This is the Default.
- Addressed at a location you specify. You simply enter the DMX-512 address for each Br-EFB and fixture on the DMX-512 network.
- Use default of DMX-512 address zero.

If you choose the first option, but no AutoDownload has been found it will report 'Default Until AutoDownload', to tell you that it wants to get the address from the AutoDownload file, but the AutoDownload file has yet to be loaded. If it has found and loaded from an AutoDownload file, but the AutoDownload file is then later removed, it will report 'Addressed by AutoDownload, but no AutoDownload'.

If resolutions of 12 bits or higher, some addresses will be skipped. You can see this in the sample screen above.

### B) Serial Address

*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

All devices on an Rs-422 network need to have a unique address assigned to them. This is usually set by the AutoDownload file on the Sd card. If there isn't a AutoDownload file loaded, you can manually set the serial address. Valid values are anywhere between 0 to 255. In Pc•MACs, it is set on the Device Dialog for the AutoDownload target device.

### C) Sequencer Enabled x

*To help keep this from being switched inadvertently, this command will ask you 'Are you sure?' before being applied.*

This toggle enables and disables the Br-EFB's ability to use the Animation Data from the *µ*Sd/*µ*SdHC/*µ*SdXc flash card. When it is OFF, nothing will be output from the AutoDownload file on the *µ*Sd/*µ*SdHC/*µ*SdXc flash card. Any output data must come from either the DMX-512 or Serial Port inputs. If it is ON, then the data from the *µ*Sd/*µ*SdHC/*µ*SdXc flash card will be sent out normally.

### D) DMX-512 mode

*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

This command is a toggle which can be used to enable and disable the DMX-512 reception and transmission, as well as the GilderChecksums.

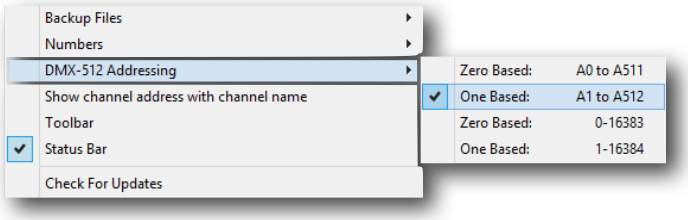
The GilderChecksums allow GilderGear to recognize errors in DMX-512 data. With GilderChecksums, the outputs won't be updated when a bad data packet is received. GilderChecksums should be left ON whenever sending DMX-512 to other GilderGear.

The Br-EFB, and most other GilderGear will automatically sense when it is receiving GilderCheckSums. Once it does this, the GilderGear will have to be reset before it will accept DMX-512 data without GilderCheckSums.

### E) DMX-512 Zero-Based or One-Based x

*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

It is set in Pc•MACs by the Preferences Menu's 'DMX Addressing' command:




Whatever you have selected at the time you build your AutoDownload file will be what is used on the AutoDownload target device. If there isn't a v1.1 Auto-Download file being used, this command is a toggle between displaying DMX-512 addresses as zero-based 0-511 numbers, or as one-based 1-512 numbers. The default is one-based, since virtually all lighting equipment is now One-Based.

## F) EaseIn Speed x

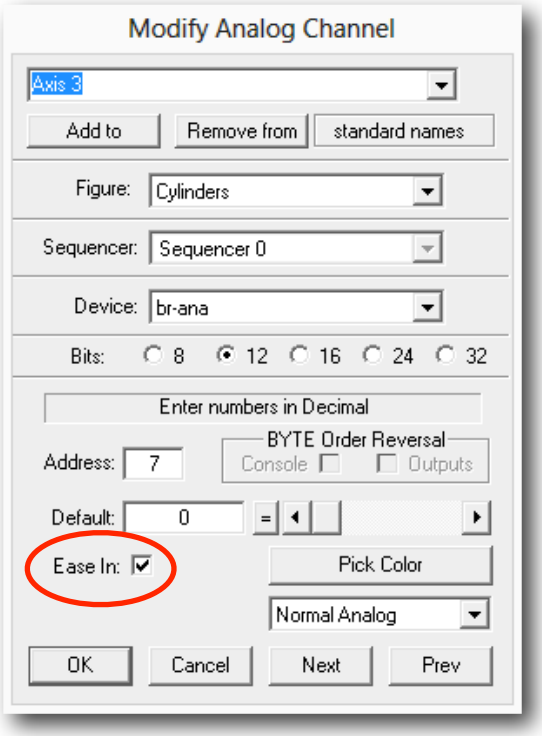
*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

When enabled, EaseIns will keep all the selected channels from jumping at a high rate of speed if:

1) The DMX-512 data starts being received.
2) The DMX-512 signal drops (after a delay of ten seconds).
3) An output is 'Jogged' to a specific value.
4) One or more outputs are put into or taken out of the internal test mode.
5) At boot up as the outputs assume their starting values.
6) The frame number jumps more than the 'EaseIn Threshold' while playing a show
7) The show number being played changes while it is playing a show.
8) A show has been stopped mid-show, the Br-EFB will do an EaseIn when the next show is started. Note that when a show reaches its normal end, starting the next show will not trigger an EaseIn.

When the Br-EFB does an EaseIn, these EaseIns will include all analog channels that have the EaseIn function enabled. If the Br-EFB is being used as the DMX-512 'Master' on a DMX-512 network, the EaseIn includes both the local Br-EFB outputs, and all EaseIn enabled analog channels that are controlled by the DMX-512 network.

The exception to this is the EaseIn that is generated when the Output Enable input on the Br-EFB is activated. This EasesIn only the Br-EFB's local outputs.



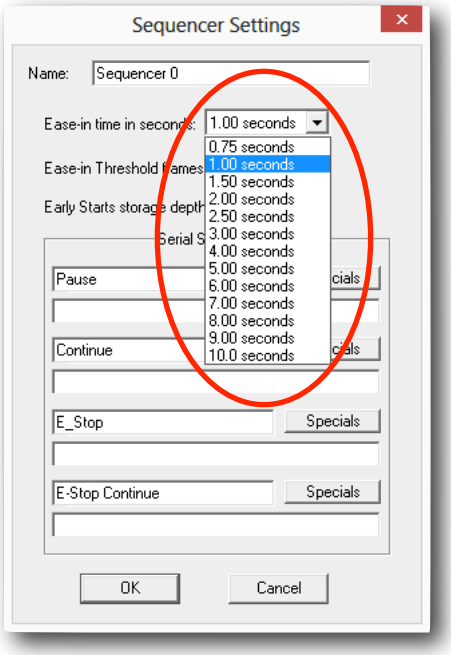

Individual analog output channels can have the EaseIn enabled or disabled on the Analog Channel Dialogs in Pc•MACs. By default, the EaseIn is enabled on most analogs output channels as they are added to Pc•MACs. You will typically want to disable EaseIns to control channels for Intelligent lights, strobes, and similar control channels.

This command allows you to select the amount of time any output will take to ramp from one extreme to the other. The range of time available is:

1) Ease-In is disabled
2) 0.25 seconds
3) 0.50 seconds
4) 0.75 seconds
5) 1.00 seconds
6) 1.50 seconds
7) 2.00 seconds
8) 2.50 seconds
9) 3.00 seconds
10) 4.00 seconds
11) 5.00 seconds
12) 6.00 seconds
13) 7.00 seconds
14) 8.00 seconds
15) 9.00 seconds
16) 10.0 seconds

You can tell when an Ease-In is being performed by the Heartbeat flashing to twice normal speed. Once all outputs have dropped out of Ease-In mode, the heartbeat will return to its regular rate.

The EaseIn speeds for the Br-EFB are set under the Sequencer's Setup dialog. These can be accessed from the Channels List while viewing 'by Sequencers', or from the AutoDownload dialog.




## G) Output to Test & Adjust x

This command is used to set the output address that will be used by the 'Test One' and 'Jog' commands.

If there is a AutoDownload file open, then the range of DMX-512 addresses that can be selected is limited to the range of channels in the AutoDownload file. If no AutoDownload is loaded, then any address in the DMX-512 universe (between 0 and 511 (or 1-512)) can be chosen.

The Br-EFB will assume that all channels are analogs if output resolution data is unavailable (v1.0 AutoDownload or no AutoDownload file is found).

If the AutoDownload file is a v1.1 or later, the FigureName and OutputName will be displayed adjacent to the ‘Test Output’ command.

## H) Test One x

A single output selected by the 'Output to Test & Adjust' command will be ramped up and down. This can be a DMX-512 address that is for one of the Br-EFB's onboard outputs, or if the Br-EFB is sending out DMX-512, an axis that is off-board and controlled through the DMX-512 network. If an v1.1 AutoDownload file is loaded, then the Br-EFB will know what resolution to use for ramping the off-board outputs. Digital functions are turned on and off. Analog functions are ramped up and down.

The default ramp time is about 5 seconds. The default time the output dwells at each extreme is about one second. These can be changed by holding down the <Control> key when invoke this command. You will be prompted to enter the time for the ramp and dwell.

### I) Test All x

This command will begin to ‘Test All Outputs’. This test is limited to the on-board outputs, so the address selected by the 'Output to Test & Adjust' command will be ignored. The outputs will be ramped between their two extremes, one at a time. Any axis that is disabled will be skipped.

The default ramp time is about 5 seconds. The default time the output dwells at each extreme is about one second. These can be changed by holding down the <Control> key when invoke this command. You will be prompted to enter the time for the ramp and dwell.

### J) Jog Output x

This command will allow a single analog or digital output selected by the 'Output to Test & Adjust' command to be manually controlled. The output can be on-board or off-board. An on-screen slider is used for analog functions. An on-screen button is used for digital functions.

### K) Set Power-On Defaults x

The Power On defaults are used by the Br-EFB only if there is no AutoDownload file found or DMX-512/Serial RealTime data being received. If there is a AutoDownload file on the *µ*Sd/*µ*SdHC/*µ*SdXc flash card in the Br-EFB, the first frame of the first show will automatically be loaded at power up. The power On defaults will have no effect.

This command allows you to set the value that will be output on any one of the 512 possible output addresses. This value will be sent out when the Br-EFB is first powered up. This command gives you the option of:

1) Entering a value as the default value for the currently selected output.
2) Capturing the current values as the default for the currently selected output.
3) Capturing the current value as the default that will be applied to all the channels in the DMX-512 universe.
4) Entering a single value, that will be applied to all the channels in the DMX-512 universe.

The PowerOn value for all outputs is displayed in the 'PowerOn Default' column on the display.

### L) Use DHCP

If enabled, the local DHCP server will provide the IP address to the Br-EFB. If disabled, you will need to manually address the IP address, NetMask and Gateway.

### M) Restrict Subnet Only

!!!!.

### N) IP Address

The current IP address will be displayed here. If manually addressing the Br-EFB, you will enter the IP address here.

### O) NetMask

The current NetMask will be displayed here. If manually addressing the Br-EFB, you will enter the NetMask here.

### P) Gateway Server

The IP address of the current Gateway Server will be displayed here. If manually addressing the Br-EFB, you can enter the address of the Gateway Server here.

# JSON messages

The Br-EFB uses JSON (JavaScript Object Notation) for asynchronous browser/server communication.

JSON messages allow you to easily write code to access and control the Br-EFB through the ethernet connection.

### GET /current.php

Returns a JSON object with basic info about the current state of the card. This includes uptime in seconds, the current play status as a string, the current show, the current frame, and 16 bit data about each axis.

#### Example:

```json
{
  "uptime": 47,
  "play_status": "stopped",
  "current_show": 0,
  "current_frame": 0,
  "axis": [
    {
      "input": -32454,
      "compliance": 0,
      "setpoint": -32768,
      "output": -51
    },
    {
      "input": 31718,
      "compliance": 0,
      "setpoint": -32768,
```

```
        "output": -10511
      },
      {
        "input": 3003,
        "compliance": 0,
        "setpoint": -32768,
        "output": -5830
      },
      {
        "input": 31781,
        "compliance": 0,
        "setpoint": -32768,
        "output": -10521
      }
    ]
  }
```

# GET /settings.php

Returns an object with basic card settings such as the serial address and first DMX channel along with PID settings for each axis.

#### Example:

```json
{
  "card_address": 0,
  "first_channel": 0,
```

```
"dmx_mode": 6,
"echo_mode": false,
"subnet_only": true,
"dhcp": true,
"ip_address": "192.168.1.131",
"netmask": "255.255.255.0",
"gateway": "192.168.1.1",
"axis": [
  {
    "proportional_gain": 1,
    "integral_gain": 0,
    "derivative_gain": 0,
    "reversed": false,
    "scaled_min": 0,
    "scaled_max": 255
  },
  {
    "proportional_gain": 1,
    "integral_gain": 0,
    "derivative_gain": 0,
    "reversed": false,
    "scaled_min": 0,
    "scaled_max": 255
  },
  {
    "proportional_gain": 1,
    "integral_gain": 0,
    "derivative_gain": 0,
```

```
        "reversed": false,
        "scaled_min": 0,
        "scaled_max": 255
      },
      {
        "proportional_gain": 1,
        "integral_gain": 0,
        "derivative_gain": 0,
        "reversed": false,
        "scaled_min": 0,
        "scaled_max": 255
      }
    ]
  }
  ```

  # GET /shows.php

  Returns an array of objects with basic details of each of the shows in a loaded ADL. Each object has the show name, length in frames, frame rate, whether it is steppable, and the end action.

  #### Example:
  ```json
  [
    {
      "name": "Jai Ho",
      "length": 60,
```

```
      "frame_rate": 1,
      "steppable": "Yes",
      "end_action": "Play show 1"
    },
    {
      "name": "Blue Danube",
      "length": 1800,
      "frame_rate": 30,
      "steppable": "Yes",
      "end_action": "Play show 2"
    },
    {
      "name": "Dueling Banjos",
      "length": 6000,
      "frame_rate": 100,
      "steppable": "Yes",
      "end_action": "Play show 3"
    }
  ]
  ```


  # POST /command.php

  Receives a JSON object with a `command` variable of what to do and an optional `value` variable depending on the command.


  ### `command` (string):

  - `"play"` will immediately play whatever show index is set in `value`.

- `"stop"` will immediately stop the currently playing show.

- `"set_pid"` will load an array of PID settings from `value` that is in the same format as what is received from GET /settings.php

- `"save_pid"` will load an array of PID settings from `value` that is in the same format as what is received from GET /settings.php and save it to the SD card if it exists.

#### Example:

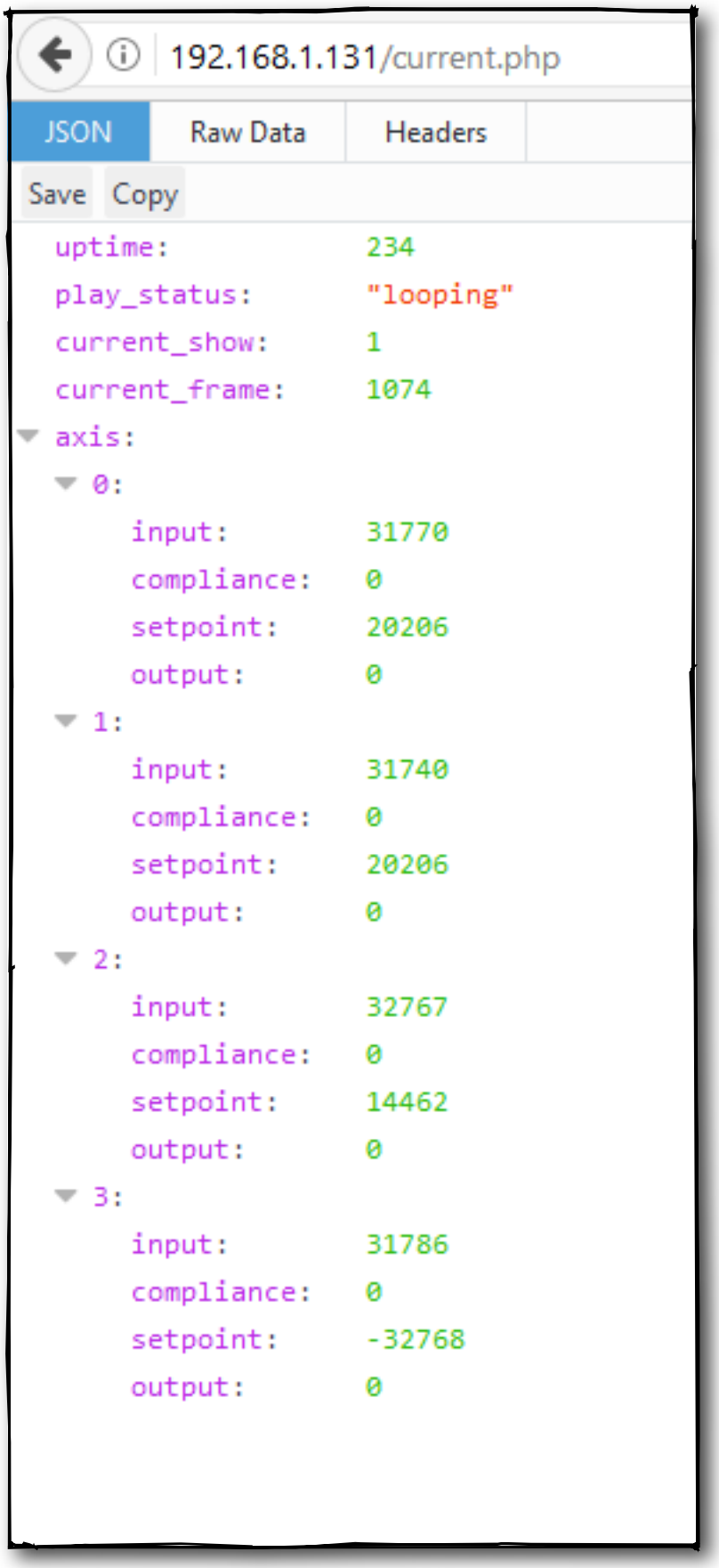
```json
{
  "command":"play",
  "value":1
}
```

### Response:

The response is an object with a boolean `success` variable and if success is a false an `error` string.

#### Example:

```json
{
  "success": false,
  "error": "no shows loaded"
}
```


192.168.1.131/current.php
JSON
Raw Data
Headers
Save
Copy
uptime: 234
play_status: "looping"
current_show: 1
current_frame: 1074
axis:
0:
input: 31770
compliance: 0
setpoint: 20206
output: 0
1:
input: 31740
compliance: 0
setpoint: 20206
output: 0
2:
input: 32767
compliance: 0
setpoint: 14462
output: 0
3:
input: 31786
compliance: 0
setpoint: -32768
output: 0

# Br-EFB Text-Based Configuration

For accessing the Br-EFB through the USB or Rs-422 serial port, you can use any computer running just about any serial terminal program.

We provide a free stand-alone terminal program called GilderTerm that makes working with GilderGear through the serial port a little easier. There is also a version of GilderTerm built into the Pc•MACs program.

Most Gilderfluke & Co products can be controlled through their RS-232 or RS-422 Serial ports. The Br-EFB has a single Rs-422 serial port on it. You can attach operator panels to access and control the Br-EFB, or you can use a WiFi or Ethernet modem so that it can be accessed from around the block or around the world.

GilderTerm is available free from Gilderfluke & Co. for use with all of our products. It can be downloaded from our web page, and is included on all of our CD-ROMs. GilderTerm has been optimized for use with all Gilderfluke & Company equipment. All the commands are built in, and it will even let you use your mouse to select commands by clicking on the menus.

If you are using GilderTerm, all the settings are fixed at the appropriate settings. All you will need to do is select the appropriate 'COM' port. To talk to the Br-EFB, just configure your terminal program for 9600 baud, no parity, eight data bits, one stop bit and no flow control handshaking.

Computers don't normally come with serial ports on them anymore. Instead, you use a USB-to-Serial (USB-RS232/422 or C-USB-RS232) adapter, BlueTooth-to-Serial (Bt-Rs232Rx and Bt-USBTx), Ethernet-to-Serial (Modem-Internet) adapter, or WiFi-to-Serial (Modem-Wi-Fly) adapter. For the Br-EFB you will need one that provides the more common RS-232. These are available from a number of different sources, including Gilderfluke & Company. Our part number is USB-RS232/422 provides both RS-232 and RS-422 connections. Our lower cost C-USB-RS232 provides just a single RS-232 serial connection, so it won't help with the Br-EFB.

To enter the configuration mode you need to press the 'configure' button on GilderTerm, or type the following. The (address) is replaced by the two digit HEXadecimal address of the Br-EFB you are talking to.

**m5AA5(address)**

If any other card is in configuration mode (or even if it just thinks another card is in configuration), the Br-EFB won't be able to enter configuration mode. To exit any other card from configuration type 'XN'. You can then try entering configuration again.

For a v1.1 AutoDownload file, the menu will appear as follows. Decimal values have been selected for the numbers. At the top of the screen the information about the AutoDownload file and show that is loaded (if any) is shown. With a v1.1 AutoDownload file, the Br-EFB will skip channels that are assigned as digital functions, can mix and match between different resolution outputs, and will display the last lines as blank if it runs out of analog channels to display.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                             DeviceName Main Menu
a) 1st Addr: 123 [from ADL]      +---------+-------+-------+-------+-------+----
b) serial address: 123           | DMX_512 |  Min. |  Max. | 'Jog' | Power |Axis
c) sequencer enabled: yes        | Address | Scale | Scale |  Pos. |  Def. |Rez.
d) DMX: Rx/Tx w/CS, g) 1-based   +---------+-------+-------+-------+-------+----
e) EaseIn speed: 1.00 sec.    -> | OutputName / FigureName |       |       |
                              -> | 123 [0] |    0  |  255  |  n/a  |    0  |  8
q) jog output to a value         +---------+-------+-------+-------+-------+----
t) set Power-On defaults         | OutputName / FigureName |       |       |
u) min/max/jog w/keypad          | 125 [1] |    0  |  255  |  n/a  |    0  | 12
w) set analog endpoints          +---------+-------+-------+-------+-------+----
                                 | OutputName / FigureName |       |       |
j) address to test: 123          | 128 [2] |    0  |  255  |  n/a  |    0  | 16
k) testing: none                 +---------+-------+-------+-------+-------+----
r) resolution: 8 Bits            | OutputName / FigureName |       |       |
figure: FigureName               | 130 [3] |    0  |  255  |  n/a  |    0  | 24
output: OutputName               +---------+-------+-------+-------+-------+----
m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                   Command-
```

**Br-EFB Main Menu**

This is the first serial menu that opens on the Br-EFB when using the Rs-422 serial interface and GilderTerm. To redraw any screen at any time, just press the <ESC>ape key or <SPACE> bar.

To select any menu item, you can:

1) Type the number or letter that appears to the left of the command. For example, 'a' is the first command, and is used to set the DMX-512 address for the first output on the Br-EFB.

2) If you are using GilderTerm, and GilderTerm's Option menu's 'Mouse Selection' option is checked, you can simply left mouse click on the on screen text, and GilderTerm will type the command for you.

Some commands are 'toggles'. They will change each time to type/click on them. Others will want you to enter a numeric value or answer further questions.

All numeric values are entered in using decimal numbers (0 through 9). If more characters have been entered than are allowed, then the characters already entered will scroll to the left to make room for the new entries. Once they have been typed, characters can be erased one-by-one by using the <DELETE> key (<BACKSPACE> on some keyboards). An entire entry can be erased by hitting the <ESC>ape key. A command can be canceled altogether by hitting the <ESC>ape key once (if no additional characters have been typed) or twice (the fist hit deletes any characters you have already typed, and the second cancels the command).

Once you have configured an Br-EFB, you can 'lock' the configuration by moving the 'Write Protect' switch to the 'Write Protected' position from the 'Write Enabled' position. This should protect your configuration from anything short of a lightning hit. The menu will change to show that the Flash Memory has been protected and warn you that you can no longer make any changes. Configuration changes can be re-enabled at any time by moving the switch back to the 'Enabled' position.

If you want to keep a hard copy printout of the current configuration of the Br-EFB, you should use the <ESC>ape key to redraw the screen while 'saving to file' in the modem program running on your computer. This file can be printed out at any time, or spliced into the documentation package for your project.

### A) First DMX-512 Address

This toggle selects whether the outputs' DMX-512 address is set from:

- First analog DMX-512 Address stored in the AutoDownload file. Any digital channels will be ignored. If you save AutoDownload files with a non-zero starting number for the number of channels to go into the AutoDownload file. This is the Default.
- Addressed at a location you specify. You simply enter the DMX-512 address for each Br-EFB and fixture on the DMX-512 network.
- Use default of DMX-512 address zero.

If you choose the first option, but no AutoDownload has been found it will report 'Default Until AutoDownload', to tell you that it wants to get the address from the AutoDownload file, but the AutoDownload file has yet to be loaded. If it has

found and loaded from an AutoDownload file, but the AutoDownload file is then later removed, it will report 'Addressed by AutoDownload, but no AutoDownload'.

If resolutions of 12 bits or higher, some addresses will be skipped. You can see this in the sample screen above.

### B) Serial Address

All devices on an Rs-422 network need to have a unique address assigned to them. This is usually set by the AutoDownload file on the Sd card. If there isn't a AutoDownload file loaded, you can manually set the serial address. Valid values are anywhere between 0 to 255. In Pc•MACs, it is set on the Device Dialog for the AutoDownload target device.

### C) Sequencer Enabled

*To help keep this from being switched inadvertently, this command will ask you 'Are you sure?' before being applied.*

This toggle enables and disables the Br-EFB's ability to use the Animation Data from the *µ*Sd/*µ*SdHC/*µ*SdXc flash card. When it is OFF, nothing will be output from the AutoDownload file on the *µ*Sd/*µ*SdHC/*µ*SdXc flash card. Any output data must come from either the DMX-512 or Serial Port inputs. If it is ON, then the data from the *µ*Sd/*µ*SdHC/*µ*SdXc flash card will be sent out normally.

### D) DMX-512 mode

*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

If there isn't a v1.1 AutoDownload file being used, this command is a toggle which can be used to enable and disable the DMX-512 reception and transmission, as well as the GilderChecksums.

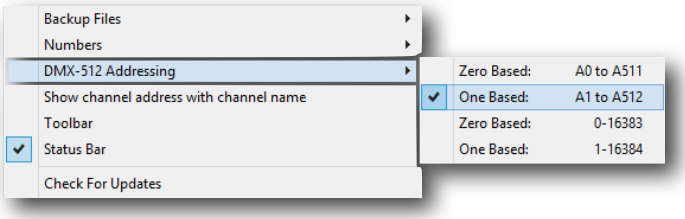
The GilderChecksums allow GilderGear to recognize errors in DMX-512 data. With GilderChecksums, the outputs won't be updated when a bad data packet is received. GilderChecksums should be left ON whenever sending DMX-512 to other GilderGear.

The Br-EFB, and most other GilderGear will automatically sense when it is receiving GilderCheckSums. Once it does this, the GilderGear will have to be reset before it will accept DMX-512 data without GilderCheckSums.

## G) DMX-512 Zero-Based or One-Based

*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

It is set in Pc•MACs by the Preferences Menu's 'DMX Addressing' command:




Whatever you have selected when you build your AutoDownload file will be what is used on the AutoDownload target device. If there isn't a v1.1 AutoDownload file being used, this command is a toggle between displaying DMX-512 addresses as 0-511 numbers, or as 1-512 numbers.

## E) EaseIn Speed

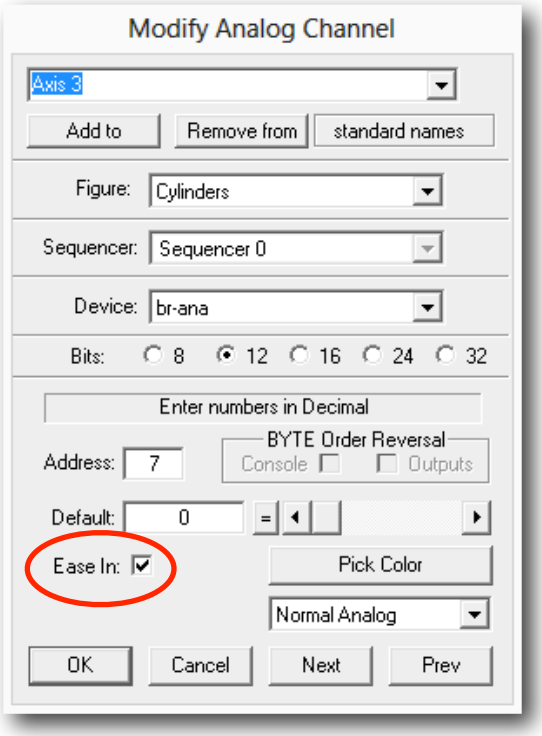
*If using a v1.1 AutoDownload file, this will be set automatically for you in the AutoDownload file. If you try to change it, the Br-EFB will tell you that: 'This is set in your AutoDownload file'.*

When enabled, EaseIns will keep all the selected channels from jumping at a high rate of speed if:

1) The DMX-512 data starts being received.
2) The DMX-512 signal drops (after a delay of ten seconds).
3) An output is 'Jogged' to a specific value.
4) One or more outputs are put into or taken out of the internal test mode.
5) At boot up as the outputs assume their starting values.
6) The frame number jumps more than the 'EaseIn Threshold' while playing a show
7) The show number being played changes while it is playing a show.
8) A show has been stopped mid-show, the Br-EFB will do an EaseIn when the next show is started. Note that when a show reaches its normal end, starting the next show will not trigger an EaseIn.

When the Br-EFB does an EaseIn, these EaseIns will include all analog channels that have the EaseIn function enabled. If the Br-EFB is being used as the DMX-512 'Master' on a DMX-512 network, the EaseIn includes both the local Br-EFB outputs, and all EaseIn enabled analog channels that are controlled by the DMX-512 network.

The exception to this is the EaseIn that is generated when the Output Enable input on the Br-EFB is activated. This EasesIn only the Br-EFB's local outputs.



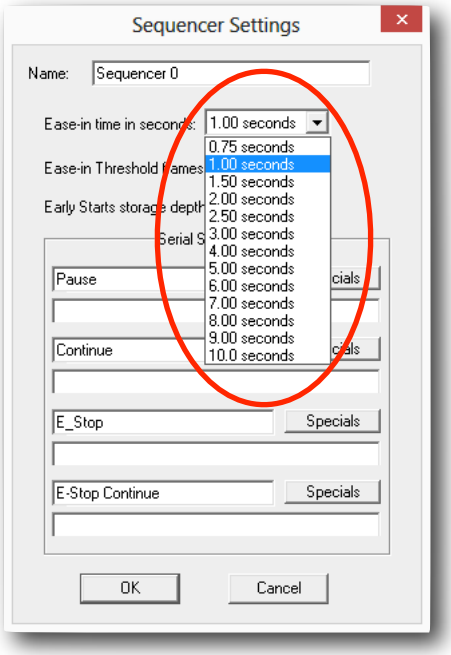

Individual analog output channels can have the EaseIn enabled or disabled on the Analog Channel Dialogs in Pc•MACs. By default, the EaseIn is enabled on most analogs output channels as they are added to Pc•MACs. You will typically want to disable EaseIns to control channels for Intelligent lights, strobes, and similar control channels.

This command allows you to select the amount of time any output will take to ramp from one extreme to the other. The range of time available is:

1) Ease-In is disabled
2) 0.25 seconds
3) 0.50 seconds
4) 0.75 seconds
5) 1.00 seconds
6) 1.50 seconds
7) 2.00 seconds
8) 2.50 seconds
9) 3.00 seconds
10) 4.00 seconds
11) 5.00 seconds
12) 6.00 seconds
13) 7.00 seconds
14) 8.00 seconds
15) 9.00 seconds
16) 10.0 seconds

You can tell when an Ease-In is being performed by the Heartbeat flashing to twice normal speed. Once all outputs have dropped out of Ease-In mode, the heartbeat will return to its regular rate.

The EaseIn speeds for the Br-EFB are set under the Sequencer's Setup dialog. These can be accessed from the Channels List while viewing 'by Sequencers', or from the AutoDownload dialog.




## J) Output to Test & Adjust

*Many of the adjustment commands are only for the on-board outputs. If you invoke one of these commands and the currently selected channel is pointing to an off-board address, you will be prompted to enter an on-board address before you can make the adjustment.*

This command is used to set the output address that will be used by the 'Test Output', 'Set Analog Endpoints', 'Force output to a Value', ‘set Min/Max/’Jog’ using keypad’, 'set PowerOn Defaults', etcetera, commands.

If there is a AutoDownload file open, then the range of DMX-512 addresses that can be selected is limited to the range of channels in the AutoDownload file. If no AutoDownload is loaded, then any address in the DMX-512 universe (between 0 and 511 (or 1-512)) can be chosen.

The Br-EFB will assume that all channels are analogs if output resolution data is unavailable (v1.0 AutoDownload or no AutoDownload file is found).

If the output address selected is one of the four on the Br-EFB, then an arrow will appear to the left of it on the screen. In the example screen above you can see this arrow pointing to output at DMX-512 address ‘123’.

Off-Board addresses are only transmitted through the DMX-512 outputs. Their addresses can be anywhere between 0 and 511 (or 1-512).

If the AutoDownload file is a v1.1 or later, the FigureName and OutputName will be displayed just below the ‘Test Output’ command.

On any menu that has ‘for axis n’ in in the fifth line of the menu, if the 'address to test' is off-board, you will will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' will all be limited to the four on-board addresses.

## K) Test Output

Although the display changes immediately, the tests that are started by this command are delayed by half a second. This is to allow you to tap twice to go straight to the 'Test All' without first going through the 'Test One' mode, or to exit 'Test One' mode by taping twice without without starting the 'Test All' mode.

A half a second after being toggled to ‘Test One Output’, a single output selected by the 'Output to Test & Adjust' command will be ramped up and down. This can be a DMX-512 address that is for one of the Br-EFB's onboard axis, or if the Br-EFB is sending out DMX-512, an axis that is off-board and controlled through DMX. If an v1.1 AutoDownload file is loaded, then the Br-EFB will know what resolution to use for ramping the off-board outputs. Digital functions are turned on and off. Analog functions are ramped up and down.

When pressed a second time, a half second later this command will begin to ‘Test All Outputs’. The on-board outputs will be ramped between their two extremes, one at a time. Any axis that is disabled will be skipped.

The default ramp time is about 5 seconds. The default time the output dwells at each extreme is about one second. These can be changed by holding down the <Control>+K. You will be prompted to enter the time for the ramp and dwell.

## Q) ‘Jog’ Outputs to a Value

This command is used to force an output to any value. This value can be written into EEprom Memory so that the output will never leave this value, even after the Br-EFB is reset. It can be used to 'lock down' a movement that has malfunctioned or needs to be positioned for servicing or adjustment. Any outputs which have been ‘Jogged’ will be displayed in the ‘Jog’ output column on the display.

## T) Set Power-On Defaults

The Power On defaults are used by the Br-EFB only if there is no AutoDownload file found or DMX-512/Serial RealTime data being received. If there is a AutoDownload file on the *µ*Sd/*µ*SdHC/*µ*SdXc flash card in the Br-EFB, the first frame of the first show will automatically be loaded at power up. The power On defaults will have no effect.

This command allows you to set the value that will be output on any one of the 512 possible output addresses. This value will be sent out when the Br-EFB is first powered up. This command gives you the option of:

1) Entering a value as the default value for the currently selected

output.

2) Capturing the current values as the default for the currently selected output.
3) Capturing the current value as the default that will be applied to all the channels in the DMX-512 universe.
4) Entering a single value, that will be applied to all the channels in the DMX-512 universe.

The PowerOn value for all outputs is displayed in the 'PowerOn Default' column on the display.

## U) Set Minimum, Maximum and 'Jog' using Keypad

This is the text-based menus' easiest way to adjust the endpoints of the analog outputs to prevent a actuator movement from over traveling. If your analog movement is hitting the ends of travel, you can reduce this range until it doesn't hit the mechanical ends of travel.

Selecting this command redraws the screen. The menu shows a representation of the numeric keypad found on most full-sized keyboards. The 'arrow' points to the output which has been selected. You can select a different output by pressing the 'N) Next' or 'L) Last' commands.

This menu is accessed by selecting the 'm) more' selection from any other menu, or the direct links to it found on the Main, PID, Wizards, Polarity Wizard, PID Wizard or compliance menus. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) use the 'm) More...' command to save changes and go to any other menu.
2) hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.
4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
          minimum maximum  'Jog'                    Endpoint Adjustment Menu
adjust-->  scale   scale  position           +---------+-------+-------+-------
         |-----------------------|           | DMX_512 |  Min. |  Max. | 'Jog'
  Up --> |   7   |   8   |   9   |           | Address | Scale | Scale |  Pos.
         |-----------------------|           +---------+-------+-------+-------
 50% --> |   4   |   5   |   6   |         -> | OutputName / FigureName |
         |-----------------------|         -> | 123 [0] |    0  |  255  |  n/a
Down --> |   1   |   2   |   3   |           +---------+-------+-------+-------
         |-----------------------|           | OutputName / FigureName |
a) toggle Auto-'Jog' to 0% or 100%           | 125 [1] |    0  |  255  |  n/a
1, 4, 7, - sets 'Jog' to 0%, '-' 2x clears   +---------+-------+-------+-------
2, 5, 8, + sets 'Jog' to 100%                | OutputName / FigureName |
                                             | 128 [2] |    0  |  255  |  n/a
j) address to test: 123, 8 Bits              +---------+-------+-------+-------
k) testing: none                             | OutputName / FigureName |
figure: FigureName                           | 130 [3] |    0  |  255  |  n/a
output: OutputName                           +---------+-------+-------+-------
n) Next channel, l) Last channel, <CR> to save, <Esc> or eXit bails out, x) eXit

                                    Command-
```

**Set Minimum, Maximum and 'Jog' using Keypad**

Use the '1', '4' and '7' keys to adjust the 'minimum' position the for the selected analog output. This sets the voltage that will be sent out from the Br-EFB when you give it a 'zero' position command through the DMX-512 or AutoDownload file. The default analog output (when set to 0/0h) is 0 vdc. This will automatically force the output to the 'zero' position [3]. For cylinders and electric actuators, this is usually the fully retracted position. You can adjust the analog output to anywhere between 0 and 10 volts. If you adjust the 'minimum' to a voltage that is higher than the 'maximum', this is perfectly acceptable, and is the easiest way to reverse the motion of an actuator.

The keys are used as follows:

1) Decrements the 'minimum' position value

[3] This 'forcing' feature can be toggled on and off using the command 'a) toggle Auto force to 0% or 100%', or if you entered this mode while holding down the <control> key while you pressed the 'u' key.

4) Sets the ‘minimum’ position value to 128 (50%)

7) Increments the ‘minimum’ position value

Use the ‘2’, ‘5’ and ‘8’ keys to adjust the ‘maximum’ position the for the selected analog output. This sets the voltage that will be sent out from the Br-EFB when you give it a ‘100%’ position command through the DMX-512 or Auto-Download file. The default analog output (when set to 255/0FFh) is 10 vdc. This will automatically force the output to the ‘100%’ position [4]. For cylinders and electric actuators, this is usually the fully extended position. You can adjust the analog output to anywhere between 0 and 10 volts. If you adjust the ‘maximum’ to a voltage that is lower than the ‘minimum’, this is perfectly acceptable, and is the easiest way to reverse the motion of an actuator.

The keys are used as follows:

2) Decrements the ‘maximum’ position value

5) Sets the ‘maximum’ position value to 128 (50%)

8) Increments the ‘maximum’ position value

You can then use the ‘-’, ‘+’, ‘3’, ‘6’ and ‘9’ keys to move the analog output over the full range of output (the full range is set by the values in the ‘minimum’ and ‘maximum’ columns). You can use these keys to test your adjustments. The Br-EFB does this by using these keys to adjust the ‘Jog’ value. When you are done adjusting this output, you will want to make sure you clear the ‘Jog’ value, or the analog output will remain locked at the last value set in the ‘Jog’ column. You can do this by hitting the ‘-’ key twice, or hitting the ‘3’ (decrement ‘Jog’ value) one more time after it is already at zero.

If you have console or other way of moving the channel you are adjusting, you will probably not use this feature and use the console instead.

The keys are used as follows:

‘-’) Sets the ‘Jog’ position value to zero (a 2nd time clears ‘Jog’)

‘+’ or ‘=’)sets the ‘Jog’ position value to 100%

2) Decrements the ‘Jog’ position value

5) Sets the ‘Jog’ position value to 128 (50%)

8) Increments the ‘Jog’ position value

[4] This ‘forcing’ feature can be toggled on and off using the command ‘a) toggle Auto force to 0% or 100%’, or if you entered this mode while holding down the <control> key while you pressed the ‘u’ key.

When you are satisfied with your adjustments, just hit the <Carriage Return>. If you don't want to save your settings, hit the <ESC>ape key to restore the original values.

### W) Set Analog Endpoints

*The endpoints can only be set for the on-board 0-10 volt analog outputs. A new output address will be requested if the currently selected 'Output to Test & Adjust' is not one of the on-board ones.*

This command is used to adjust the endpoints of the sixteen analog outputs. Unless you already know the numeric values you want to set the endpoints to, the 'Set Min/Max/'Jog' using Keypad' is a much easier way of setting these. Use it if you can.

The analog outputs normally sweep between 0 and 10 Volts DC. By using these commands you can set either endpoint to anywhere between 0 and 10 volts for a reduced or reversed analog output swing. If you want to invert the voltage swing of any output, all you need to do is set the lower limit to a higher level than the upper limit. The endpoints for all sixteen outputs is displayed in the 'Minimum Scale'/'Maximum Scale' columns on the display.

As an example of the use of the analog endpoint adjustments, if you wanted to set the voltages on a channel to sweep from approximately 25% to 75% of full scale. From the chart you would see that the values that would be entered are 64 and 192.

To set the endpoints, first clear the endpoints to the two extremes (0%/0/00h). Then use a Togglodyte, Programming Console, or the 'Force Output to a Value' command to find what values set the proper endpoints for the output. You can then enter these numbers into the endpoints for this output.

### N) Next

This moves the 'Output to test & Adjust' arrow down by one line. This command limits you to channels stored in the AutoDownload file. After the Br-EFB's last channel, it will jump back up to the first. If there is no AutoDownload file loaded, then it assumes that all channels are 8 bit resolution analogs, and limits you to the DMX-512 universe.

If there have been changes made in the settings for the selected channel, they will be saved before the Br-EFB steps to the 'next' channel.

On any menu that has ‘for axis n’ in in the fifth line of the menu, if the 'address to test' is off-board, you will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' will all be limited to the four on-board addresses.

**L) Last**

This moves the ‘Output to test & Adjust’ arrow up by one line. This command limits you to channels stored in the AutoDownload file. After the Br-EFB’s first channel, it will jump back up to the last. If there is no AutoDownload file loaded, then it assumes that all channels are 8 bit resolution analogs, and limits you to the DMX-512 universe.

If there have been changes made in the settings for the selected channel, they will be saved before the Br-EFB steps to the 'previous' channel.

On any menu that has ‘for axis n’ in in the fifth line of the menu, if the 'address to test' is off-board, you will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' will all be limited to the four on-board addresses.

**M) More….**

This command displays a list of all nine menus, and allows you to jump directly to any menu with just a single keypress or mouse click.

**I) Info….**

This command displays information on the currently loaded AutoDownload file:

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
        Uptime: 0:00:20:45, Serial Address: 0, IP Address: 192.168.1.131
             ADL File: Lorenzo (2015-12-25 0744) with 503 channels
                   Show #4 Night Mode 4 looping @ 00:20:44.25

Input A now Open
Input B now Open
Valve Enable now Open

Filename: Lorenzo (2015-12-25 0744)
  For CardName: Br-EFB
  v1.1 format file for 1 sequencers
  File created: 07:44:48 December 25, 2015
  512 channel universe starts at: a

Sequencer Names & Settings:
  Sequencer A: Sequencer 0
  On PowerUp: Play Show 4
  EaseIn Speed: none
  EaseIn Threshold: 30 frames
  Early starts stored up to 0 deep

+-----+-------------------------+-------------+-----+----------------+-------+
| #   |        Show Name        |   Length    | FPS |   End Action   | Plays |
+-----+-------------------------+-------------+-----+----------------+-------+
|   1 | Walking Test 1          | 00:09:04.00 |  30 |    Play Show 1 |     0 |
+-----+-------------------------+-------------+-----+----------------+-------+
|   2 | Start Background Loop 2 | 00:00:31.00 |  30 |    Play Show 2 |     0 |
+-----+-------------------------+-------------+-----+----------------+-------+
|   3 | Start a Random Show 3   | 00:01:00.00 |  30 |    Play Show 3 |     0 |
+-----+-------------------------+-------------+-----+----------------+-------+
|   4 | Night Mode 4            | 01:00:00.00 |  30 |    Play Show 4 |     1 |
+-----+-------------------------+-------------+-----+----------------+-------+
|   5 | Armando's Rhumba        | 00:05:17.00 |  30 |    Play Show 2 |     0 |
+-----+-------------------------+-------------+-----+----------------+-------+
|   6 | Barcelona Nights        | 00:04:03.00 |  30 |    Play Show 2 |     0 |
+-----+-------------------------+-------------+-----+----------------+-------+
```

**'Get Info' Response**

a) Input Status on the three optically isolated inputs. FileName of this AutoDownload file (this is set during the AutoDownload process when you save the file to disk)

b) Name of the Br-EFB that this AutoDownload is intended for. The name is set on the 'Device Settings' dialog. The 'Device Settings' dialog is accessed either by:
   1) Opening the Channels List, changing the 'Show by' to 'Show by Devices', and double clicking on the Br-EFB you will be downloading to
   2) Clicking on the 'Device Settings' button at the top of the AutoDownload dialog (next to where you select the target device)

c) AutoDownload file version number (as of this writing, this will be 'v1.1')

d) The number of sequencers in this AutoDownload file. the Br-EFB supports only one sequencer at a time. The 'Device Settings' dialog is accessed either by:
   1) Opening the Channels List, changing the 'Show by' to 'Show by Devices', and double clicking on the Br-EFB you will be downloading to
   2) Clicking on the 'Device Settings' button at the top of the AutoDownload dialog (next to where you select the target device)

e) The date and time when this AutoDownload file was created

f) Number of DMX-512 channels per universe. This will normally be 512, unless the frame rate is set above 32 frames per second. Above about 44 frames per second, there is not enough time to send out all 512 channels. Higher speeds are not recommended for large shows on the Br-EFB without consulting Gilderfluke & Co. first.

g) Range of DMX-512 channels in the AutoDownload file. This will normally start with the first channel in universe 'a', unless the 'first channel' on the AutoDownload has been offset to begin after this.

h) The name of each sequencer, along with the show that each loads at startup and if it waits or plays the show. This is set for each sequencer during the AutoDownload

i) The EaseIn Speed and EaseIn Threshold for each sequencer. These are set on the 'Sequencer Settings' dialog. The 'Sequencer Settings' dialog is accessed by:
   1) Opening the Channels List, changing the 'Show by' to 'Show by Sequencers', and double clicking on the sequencer you want to change
   2) Selecting the sequencer you would like to modify and clicking on the 'Sequencer Settings' button on the AutoDownload dialog (next to where you select the sequencer for the startup and input actions)

3) Opening the ‘Device Settings’ dialog and pressing the ‘Sequencer Settings’ buttons

j) If there is an attempt to start a show while another show which is un-steppable[5] is already running, these ‘early’ starts can be ‘banked’. This setting shows how deeply stored starts can be ‘banked’. These are set on the ‘Sequencer Settings’ dialog. The ‘Sequencer Settings’ dialog is accessed by:

1) Opening the Channels List, changing the ‘Show by’ to ‘Show by Sequencers’, and double clicking on the sequencer you want to change

2) Selecting the sequencer you would like to modify and clicking on the ‘Sequencer Settings’ button on the AutoDownload dialog (next to where you select the sequencer for the startup and input actions)

3) Opening the ‘Device Settings’ dialog and pressing the ‘Sequencer Settings’ buttons

k) Show Names. This displays both the ‘short’ (DOS 8.3) names and the longer names saved in the v1.1 AutoDownload extended header

l) v1.0 AutoDownload file header

m) Each of the shows including:

1) Show’s numeric position in the AutoDownload file

2) Show’s ‘short’ (DOS 8.3) name

3) Offset to the ‘start’ of the show

4) Length of the show (in frames)

5) Under the ‘S’, whether the show is

1) ‘Steppable’ (interruptible if a new show request arrives while this show is playing) is shown by a ‘Y’

2) ‘non-Steppable’ (uninterruptible if a new show request arrives while this show is playing) is shown by a ‘N’

6) Under the ‘L’, whether the show is

1) ‘Loopable’ (Plays to the end of the show, then performs the ‘at end’ actions as set on the AutoDownload dialog) is shown by a ‘Y’

[5] Uninterruptible if a new show request arrives while this show is playing

2) 'non-Loopable' (Plays to the end of the show, and stops and waits for the next start command) is shown by a 'N'

7) The frame rate for the show

8) The 'next' show defined for the show during the AutoDownload

n) the current output level of each ServoMotor output

**O) Reload Defaults**

This command sets all the settings of the Br-EFB back to factory defaults. It asks you an extra time if you are really sure you want to do this before it does.

**P) Play/Loop**

This allows you to select and play a show. If there is only one show loaded, just selecting this command will play that show without asking 'which' show you want to play. If There is more than one show loaded, you can select which show you want to play.

**H) Halt**

This will stop the currently playing show. The word 'stopped' will be displayed as 'STOPPED' on line #04 of the menus. When you start your next show, the Br-EFB will do an EaseIn on all channels. When the Br-EFB does an EaseIn, it will EaseIn all analog channels that have the EaseIn function enabled. If the Br-EFB is being used as the DMX-512 'Master' on a DMX-512 network, the EaseIn includes both the local Br-EFB outputs, and analog channels that are controlled by the DMX-512 network

**V) Verify**

This command verifies the data stored in the Br-EFB's AutoDownload file. This will take anywhere from a few seconds to several minutes, depending of the size of the AutoDownload file that must be tested.

**X) eXit**

This exits the configuration mode and returns the Br-EFB to the command mode. When exiting you must enter a 'y' or 'n', to preserve compatibility with some other Gilderfluke & Company cards.

# Br-EFB Text-Based PID Configuration

This menu is used to manually configure the PI & D settings for a feedback loop. You can also access the Wizards to determine the 'phasing' of the servoloop and use the PID wizard if you want the Br-EFB to set up the PID settings for you.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                           DeviceName PID Settings
1) axis 0: Enabled           +---------+--------+--------+--------+-------+-----
2) proportional (P) gain     | DMX_512 |  Prop. |  Int.  |  Der.  |Voltage| Rev
3) integral (I) gain         | Address |  Gain  |  Gain  |  Gain  | Limit | Out
4) derivative (D) gain       +---------+--------+--------+--------+-------+-----
5) limit valve voltage    -> | OutputName / FigureName   |        |       |
6) reverse axis output    -> | 123 [0] |  1.000 |  0.000 |  0.000 | 10.00 |  No
7) compliance settings       +---------+--------+--------+--------+-------+-----
8) following errors          | OutputName / FigureName   |        |       |
9) A/D Range: +/-10 volts    | 125 [1] |  1.000 |  0.000 |  0.000 | 10.00 |  No
0) PID adjustment wizards    +---------+--------+--------+--------+-------+-----
u) min/max/jog w/keypad      | OutputName / FigureName   |        |       |
j) address to test: 123      | 128 [2] |  1.000 |  0.000 |  0.000 | 10.00 | Yes
k) testing: none             +---------+--------+--------+--------+-------+-----
resolution: 8 Bits           | OutputName / FigureName   |        |       |
figure: FigureName           | 130 [3] |  1.000 |  0.000 |  0.000 | 10.00 |  No
output: OutputName           +---------+--------+--------+--------+-------+-----
m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

**Br-EFB PID Menu**

This menu is accessed by selecting the 'm) more' selection from any other menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be re-

turned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

### 1) Axis Enabled

This command lets you enable/disable the currently selected axis on this Br-EFB. When an axis is disabled, the P, I and D are all temporarily set to zero values. You will typically enable all the axis you are using, and disable the ones that are not being used. This prevents unused axis from going into 'error' modes and opening the relay on the 'Status' output.

### 2) Proportional (P) Gain

This command lets you manually set the 'P' gain used by the currently selected axis controlled by this Br-EFB. The 'P', or 'Positional' gain is the main factor used in any closed loop system. It compares the position the actuator is commanded to be positioned to with the actual measured position as sensed by the sensor attached to the actuator. The direction and how far the desired and actual positions are from each other controls the voltage sent to the valve output, which sets how quickly the actuator moves towards the desired position.

The range of setting for the Proportional (P) Gain is from 0.001 to 8.000. The default is 1.000, which gives you a One-to-One gain.

You can see this by disconnecting the valve outputs and manually positioning your actuator (or at least the Position Feedback device) to the fully retraced position. With the gain set to 1.000, when you send a command to the Br-EFB for this axis to move to the 0% position, the 'valve' light will be off showing that zero volts are being sent to the valve outputs. If you have the 'following error' features enabled, the axis' 'Error' led for the axis will also turn off (If the board 'Error' relay output has been triggered, you may need to cycle power or the 'Valve Enable' input to reset the 'Hard Error Timeout' condition before the valve output will be enabled). If you move either the actuator (or at least the Position Feedback device) to the fully extended position. The valve output LED will glow either red or green (depending on if the outputs are reversed) and 10 volts will be sent to the valve output.

After a delay set by the 'Soft Error Timeout', the 'Error' LED for the axis will turn on, indicating the actuator has not followed the commanded position closely enough. After the delay set by the 'Hard Error Timeout', the output 'Status' LED will go red, and the axis will be disabled.

If you move both the actuator and command to the fully extended position, then the valve LED will again extinguish, showing that zero volts are being sent to the valve output. (You may need to reset the 'Hard Error Timeout' before the valve output will be enabled again.)

Moving both the actuator and command to the 50% position the valve LED will be extinguished, because the Position Feedback loop thinks the actuator is at the commanded position. Now if you move either the Position Feedback or commanded position, the valve will output a +/-5 volt signal as the Br-EFB tries to command the actuator to follow the commanded position. If you increased the gain to 2.000, the valve output would again reach +/-10 volts. Increasing the gain even further will narrow how far apart the command and position sensor need to be to reach the full +/-10 volt valve output. This is known as 'narrowing the 'V'', because as the gain is raised, it increases how tightly the actuator will try to follow the position commands.

### 3) Set Integral (I) Gain

This command lets you manually set the 'I' gain used by the currently selected axis controlled by this Br-EFB. The 'I', or 'Integral' gain is used in a PID ServoLoop to nudge the actuator that last little bit to get it to the commanded position.

When an actuator is very near the position it is being commanded to move towards, the difference between the current position (as measured by the Position Feedback element on the actuator) and the commanded position are too close for the positional ('P') gain to output a sufficient voltage to move the actuator the last little bit.

The 'I' gain will give a steadily rising voltage to the valve output until it rises high enough to 'nudge' the actuator the last little bit to get to the commanded position.

If the 'I' gain is turned up too high, then the movement will constantly seek the desired position, overshoot, and seek again. Unlike the oscillation that occurs when the 'P' is set too high, the 'I' oscillation occurs at a low speed. Although entertaining, it is rarely destructive. If the 'I' is adjusted too low, then the 'dead band' around the desired position will be slightly wider.

### 4) Set Derivative (D) Gain

This command lets you manually set the 'D' gain used by the currently selected axis controlled by this Br-EFB. The 'D', or 'Derivative' gain is used in a PID

ServoLoop to accelerate and decelerate quickly to try to follow quickly changing command positions more closely.

You can think of the 'D' gain as an accelerator pump in an automobile carburetor. If you thrump on the accelerator pedal, the accelerator pump will send an extra bolus of gasoline down the throat of the carburetor to help accelerate the car quickly.

The 'D' gain works in exactly the same way in a servo loop. You can see its effect most clearly when performing a 'step' test, where you send commands to the servo loop that step sharply between command values. The 'D' gain helps the actuator accelerate more quickly at the beginning of a step, and decelerate more quickly to minimize overshoot at the end of the step.

With slightly slower steps, if the 'D' is set too high, then the movement will start too quickly, overshoot the commanded position, and then slow down as the 'P' error takes over.

### 5) Limit Valve Voltage

This command lets you manually limit the voltage sent to the valve output. By default, the output voltage range is +/-10 vdc. This is the standard voltage for running most servo valves and VFDs. You may want to lower the valve output voltage if:

A) Your actuator or valve requires a lower voltage than +/-10 volts. We have rarely come across servo valves that need lower voltages, some as low as +/-5 or +/-2.5 volts.

B) You want to limit the speed of your actuator. If your +/-10 volt actuator is moving twice as fast as you would like it to move, limiting the voltage to +/-5 volts will cut the maximum speed of the actuator by 50%.

### 6) Reverse Axis Output

When you are wiring/plumbing a servo loop, you have a 50%/50% chance of getting something the servo loop backwards. This is known as a 'phase reversal'.

If when the Proportional (P) Gain is first turned up the movement tends to slam to one end or the other, then there is probably a phase reversal problem. This can be corrected in the wiring by either reversing the two wires that lead to the valve, or swapping the wires that runs to the ends of the Position Feedback

pot. It can also be corrected in the plumbing by swapping the two hoses that run to the actuator.

This easiest way to correct a phase reversal is to let the Br-EFB do it for you. If you are using the Br-EFB's wizard to set the endpoints for the actuator, it will first automatically detect and correct for a phase reversed servo loop.

This second easiest way to correct a phase reversal is to use this command to manually reverse the phase.

**7) Compliance Settings**

This opens the menu where you can adjust the Compliance settings for the currently selected axis.

**8) Error Options**

This opens the sub menu where you can PID Adjustment Wizards to let the Br-EFB automatically adjust the PID servo loop for each axis.

**9) A/D Input Range**

This sets the range of voltage for the position feedback sensor input. The possible input range settings are: +/-10 volts, +/-5 volts, 0-10 Volts or 0-5 volts. On each press of this command, the Br-EFB steps to the next possible setting. The default input range for the position feedback inputs is +/-10 vdc.

**10) PID Adjustment Wizards**

This opens the sub menu where you can PID Adjustment Wizards to let the Br-EFB automatically adjust the PID servo loop for each axis.

**M) More...**
**J) Output to Test & Adjust**
**K) Test Output**
**N) Next**
**L) Last**
**I) Info….**
**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**

**V) Verify**
**X) eXit**

These commands are described on the Main Menu.

# Br-EFB Text-Based PID Wizards

This menu is used when you want to let the Br-EFB to do most of the work of adjusting the PID loop for you.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                          DeviceName Wizards for Axis 1

1) Feedback A/D input range: +/-10 volts
2) polarity wizard
3) PID Wizard
4) set min/max/jog w/keypad


j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName



m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

### PID Adjustment Wizard

This menu is accessed by selecting the 'm) more' selection from any other menu, or the '0) PID adjustment wizards' on the PID Menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

Go through steps 1 through 4 on each axis of the Br-EFB to set up all four PID servo loops.

**1) Set Input Voltages**

This sets the range of voltage for the position feedback sensor input. The possible input range settings are: +/-10 volts, +/-5 volts, 0-10 Volts or 0-5 volts. On each press of this command, the Br-EFB steps to the next possible setting. The default input range for the position feedback inputs is +/-10 vdc. On each press, the selected input is rotated through the possible input range settings: +/-10 volts, +/-5 volts, 0-10 Volts, 0-5 volts or disabled.

**2) Polarity Wizard**

This command sets a Setpoint voltage that is near the current Position Feedback voltage. The Br-EFB will then slowly raise the gain. When the gain reaches a level where the actuator starts to move, the Br-EFB will try to move the actuator towards the Setpoint. If it is successful, the Br-EFB will have determined the 'phase' of the servo Position Feedback loop, and corrected it if necessary.

**3) PID Wizard**

This opens the PID Wizard page. The PID Wizard will be able to adjust the setting that control the feedback loop in many actuators.

**4) Set Min/Max/Jog w/keypad**

After you have adjusted the PID loop, but before you run any show data through an axis, you should set the final ends of travel. More details on this command can be found on the Main Menu.

You can use this same command to prior to adjusting the PID loop to set your preliminary endpoints, but assuming the loop is ‘tighter’ after you have adjusted it, the endpoint settings will be more accurate if run after tuning.

**M) More...**
**J) Output to Test & Adjust**
**K) Test Output**

**N) Next**
**L) Last**
**I) Info….**
**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**
**V) Verify**
**X) eXit**

These commands are described on the Main Menu.

# Br-EFB Text-Based Polarity Wizard

This menu is used to determine the phasing of the servoloop. This must be done before attempting to adjust the PID settings or endpoints.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
           DeviceName Polarity Wizard looking for Polarity for axis x

Current gain:  0.050              The Br-EFB is moving the actuator until the
Axis Reversed: No                 Feedback voltage matches the Setpoint Voltage.
Setpoint voltage:  2.000 Volts
Feedback voltage:  3.026 Volts    If the actuator moves, but the Feedback
                                  voltage does not change, then there may be
                                  a problem with your feedback sensor.

j) address to test: 123           If a different actuator moves, we may be
k) testing: none                  adjusting the wrong axis, or there is a
resolution: 8 Bits                wiring problem.
figure: FigureName
output: OutputName                If there is no actuator movement, check that
                                  the actuator has power, and the correct axis
r) Run polarity wizard            is selected.

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                  Press any key to abort the Polarity Wizard-
```

**Polarity Wizard During Test**

This menu is accessed by selecting the 'm) more' selection from any other menu, or the '2) polarity wizard' on the Wizards menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

Unlike the PID wizard, the movements in the actuator are slight when running the Polarity Wizard. Before starting the Polarity Wizard, you should make sure that your actuator is powered up, that the correct axis has been chosen, and that the actuator movements, though slight, will not damage anything.

The Polarity Wizard sets a Setpoint for a movement that is not far from the current Position Feedback voltage. The Polarity Wizard then slowly raises the gain by small steps until the actuator begins to move. If the initial movement is towards the Setpoint, then the 'phase' is OK. If the initial movement is away from the Setpoint, the Polarity Wizard will reverses the phase of the movement and try again. Once the Polarity Wizard is satisfied, it will end the test.

If you need to abort the Polarity Wizard, you can hit any key on the keyboard, or remove the enabling voltage from the Valve Enable input.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                  DeviceName Polarity Wizard failed for axis x

Current gain:  0.050
Axis Reversed: No
Setpoint voltage:  2.000 Volts    The Br-EFB was unable to sense any movement
Feedback voltage:  3.026 Volts    on this Axis.

                                  Check that the correct Br-EFB axis is selected

j) address to test: 123           Check that actuator has power applied
k) testing: none
resolution: 8 Bits                Check your wiring
figure: FigureName
output: OutputName                Manually move the actuator and see if the
                                  Feedback voltage follows
r) Run polarity wizard

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

**Polarity Wizard After Test Failure**

The usual cause of a Polarity Wizard failure is a lack of movement in the actuator, or the failure to pick up the movement in the Position Feedback voltage.

The most common reasons for the actuator not moving are:

1) The wrong axis has been selected for adjustment
2) There is no voltage applied to the Valve Enable input
3) The axis is disabled
4) There is not pneumatic or hydraulic pressure (or voltage for an electric actuator) applied to the actuator.
5) There is a wiring problem with the valve outputs.

If the actuator moves, but the movement is not registered on the Position Feedback Voltage, there is likely a problem in the Position Feedback circuit. The common problems are:

1) Wiring problems. Either the actuator or Position Feedback is wired to the wrong axis on the Br-EFB.
2) The voltage input is set too low, and the Analog converter is getting a voltage that is too high or too low for the currently selected range.

If you can manually move the actuator (or at least the Position Feedback sensor), you should be able to see the movement registered on the Position Feedback Voltage displayed on the menu. If there is no change on the Position Feedback voltage, then there is definitely a problem in the Position Feedback wiring.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
              DeviceName Polarity Wizard found Polarity for axis x

Current gain:  0.050
Axis Reversed: No
Setpoint voltage:  2.000 Volts
Feedback voltage:  3.026 Volts



j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName

r) Run polarity wizard

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

**Polarity Wizard After Test Success**

If an axis passes the polarity test, congratulations! This means that your wiring and plumbing has now been verified. At this point you can continue with the other Wizards, or manually configure the axis.

**R) Run Polarity Wizard**

This command is used to run or rerun the Polarity Wizard.

**M) More...**
**J) Output to Test & Adjust**
**K) Test Output**
**N) Next**
**L) Last**
**I) Info….**

**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**
**V) Verify**
**X) eXit**

These commands are described on the Main Menu.

# Br-EFB Text-Based PID Wizard

This menu is used to automatically set the Proportional ('P'), Integral ('I') and Derivative ('D') gains.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                         DeviceName PID Wizard for axis x

Automatic tuning involves finding a steady oscillation point in order to derive
an optimal PID tune. If what is being tuned is delicate under oscillation or is
attached to anything delicate or not secured down, this routine may damage the
mechanism.

                  Not all actuators can be automatically tuned.

j) Addr. to test- 123
k) test Output- none
Resolution- 8 Bits
figure- FigureName
output- OutputName

t) Try again

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                           Do you wish to continue? Y/N-
```

### PID Wizard Warning

This menu is accessed by selecting the 'm) more' selection from any other menu or the '3) Pid Wizard' command on the Wizards menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

The Br-EFB does this by moving the actuator to mid-stroke and then making a series of small steps as the Proportional ('P') gain is raised until it is high enough to put the actuator into a sustainable oscillation. The period of the oscillation is measured, and from this the Br-EFB mathematically derives the proper settings for the Proportional ('P'), Integral ('I') and Derivative ('D') gains.

Because the this function will potentially cause the actuator to move faster than it would under normal circumstances, the previous warning is presented. Actuator movement will not start until you type a 'Y' for the answer 'yes'.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
           DeviceName PID Wizard looking for Gain & Period for axis x

               Ultimate Gain: 11.512, Ultimate Period: 273.37 ms

1) Proportional (P) gain:  3.799; Use P only
2) Integral (I) gain:      0.137; Use P and I
3) Derivative (D) gain:    0.091; Use P, I and D
+) Tighter tune, -) Looser tune, Tightness: 50

j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName

r) Run PID Wizard

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                     Press any key to abort the PID Wizard-
```

**PID Wizard in Progress**

If you need to abort the PID Wizard while it is in process, you can hit any key on the keyboard, or remove the enabling voltage from the Valve Enable input.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
             DeviceName PID Wizard found Gain and Period for axis x

               Ultimate Gain: 11.512, Ultimate Period: 273.37 ms

1) Proportional (P) gain:  3.799; Use P only
2) Integral (I) gain:      0.137; Use P and I
3) Derivative (D) gain:    0.091; Use P, I and D
+) Tighter tune, -) Looser tune, Tightness: 50

j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName

r) Run PID Wizard

m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

**PID Wizard Completed**

Once the has completed, it will have determined the 'Ultimate Gain' and Ultimate Period'. It will use these to calculate the Proportional (P), Derivative (D) and Integral (I) Gains.

Not all actuators will be able to work with the PID Wizard. If the PID Wizard doesn't arrive with a good 'Ultimate Gain' and Ultimate Period', you can try rerunning the PID Wizard a few times to see if you get different results.

If your actuator can't reach a speed high enough that it will sustain an oscillation, then the PID Wizard will not be able to measure the oscillation period. This can be caused by an undersized valve for a pneumatic or hydraulic cylinder, or limiting the valve output voltage from the Br-EFB, which can also limit the flow through the valve.

1) **'P' Gain only**
2) **'P' & 'I' Gains**

**3) 'P', 'I' & 'D' Gains**

These commands let you choose whether this axis will use 1) only the Proportional (P) Gain, 2) both the Proportional (P) and Integral (I) Gains, or 3) all three Proportional (P), Integral (I) and 'Derivative (D)' Gains.

**+ Increase 'Tightness'**
**- Reduce 'Tightness'**

In industrial controls, you generally want the actuator to move as quickly and accurately as possible. In entertainment applications, you may want the movements to be slower and softer, or faster and stiffer, depending on your application.

The 'Tightness' setting defaults to 50%. If you want the movement to be fast and sharp, you can increase the 'Tightness'. If you want the movement to be slower and 'softer', you can decrease the 'tightness' as needed. As the 'Tightness' is increased and decreased, the 'P', 'I' & 'D' Gains will be scaled as needed.

**R) Run PID Wizard**

This command is used to run or rerun the PID Wizard.

**M) More...**
**J) Output to Test & Adjust**
**K) Test Output**
**N) Next**
**L) Last**
**I) Info….**
**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**
**V) Verify**
**X) eXit**

These commands are described on the Main Menu.

# Br-EFB Text-Based Compliance Settings

This menu is used to manually configure the Compliance settings on each axis. Compliance, if used, must be configured manually using this menu.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                   DeviceName Compliance Settings for axis 1


1) compliance gain: 0.123
2) compliance decay rate: 2.35 Volts/Second
3) compliance input: reversed
4) compliance input range: +/-10 volts


j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName



m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

### Compliance Feedback Settings

This menu is accessed by selecting the 'm) more' selection from any other menu or the '7) Compliance Settings' command on the Manual PID Config. menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be re-

turned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

**1) Compliance Feedback Gain**

The gain sets the 'depth' of the Compliance Feedback input. If you push against a compliant actuator, it should move away from you, requiring far less pressure than it would take with the Compliance Feedback turned off. How far it moves with the initial push is controlled by the Compliance Feedback Gain.

**2) Compliance Decay Rate**

This controls the 'decay' rate for a Compliance Feedback signal. As you push on the compliant axis and it moves out of your way, this time delay sets how long this effect lasts. As it decays, the compliant axis will fight its way back to its original position with increasing strength.

**3) Compliance Feedback Input Reversed**

If you press on a compliant axis and instead of moving out your way, it moves towards you with greater force, then it needs to be reversed.

**4) Compliance Input Range**

This sets the voltage range of the Compliance Feedback Input.

On each press of this command, the Br-EFB steps to the next possible setting.

The possible input range settings are: +/-10 volts, +/-5 volts, 0-10 Volts or 0-5 volts. The default input range for the position feedback inputs is +/-10 vdc. On each press, the selected input is rotated through the possible input range settings: +/-10 volts, +/-5 volts, 0-10 Volts, 0-5 volts or disabled.

**M) More...**
**J) Output to Test & Adjust**
**K) Test Output**
**N) Next**
**L) Last**
**I) Info….**

**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**
**V) Verify**
**X) eXit**

These commands are described on the Main Menu.

# Br-EFB Text-Based Following Error Settings

This menu is used to manually configure the Following Error settings for each axis.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                 DeviceName Following Error Config. for Axis 1


1) Following Error threshold: 5%
2) Soft Error Timeout: 1.00 second(s)
3) Hard Error Timeout: 5.00 second(s)

u) min/max/jog w/keypad

j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName



m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

### Following Error Configuration

This menu is accessed by selecting the 'm) more' selection from any other menu or the '8) Following Error' command on the Manual PID Config.' menu. If the 'address to test' is off-board, the user will be prompted for an on-board address. The 'n) Next', 'l) Last)' and 'j) address to test' are all limited to the four on-board addresses. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.

4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

During normal operations, the actuator will keep as close as possible the position it is commanded to follow. Any deviation between the command position and the actuator's actual position is called the 'Following Error'.

In applications where the actuator moves very slowly and smoothly, there may be almost no following error. In applications where the actuator is asked to move fast, and possibly faster than the actuator is physically capable of moving, there may be regular, albeit short, following errors.

The Br-EFB allows you to set the percentage of following error that constitutes an error that demands attention. The default for this is 5%. Since momentary errors are not unusual, there are two timers that allow the Br-EFB to ignore transient errors.

If a following error persists for longer than the Soft Error Time, the 'Error' LED for the axis will turn on until the following error again falls below the following error threshold.

The errors you really want to catch are the ones that persist. If a hose pops off a cylinder, the fuse on an electric actuator blows or the compressor or HPU shuts down. Any of these will cause a Following Error that lasts far longer than the transient errors. If a Following Error persists for longer than the Hard Error Time, the Br-EFB will disable the axis. The 'Status' LED till turn Red, and the Status relay will open to indicate to a supervisory system that there is an axis that has faulted out. The status Output Relay can also be wired in series with the Valve Enable Input of this and other Br-EFBs to automatically disable them if any one axis faults out.

To clear the error condition on this axis, you will need to either cycle power on the Br-EFB, or remove the voltage from the Valve Enable input and then reapply it.

### 1) Following Error Threshold

This sets how far the deviation measured between the Position Feedback Voltage and the Command Position must be before it constitutes a 'Following Error'.

### 2) Soft Error Timeout

If the Following Error persists longer than the Soft Error Timeout, the red Error LED for this axis will light. When the Following Error no longer persists, the red LED will turn off.

**3) Hard Error Timeout**

If the Following Error persists longer than the Hard Error Timeout, the axis will be disabled. The Status Relay output will open and the Status LED will turn Red.

To clear the error condition on this axis, you will need to either cycle power on the Br-EFB, or remove the voltage from the Valve Enable input and then reapply it.

**M) More...**
**N) Output to Test & Adjust**
**K) Test Output**
**N) Next**
**L) Last**
**I) Info….**
**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**
**V) Verify**
**X) eXit**

These command are described on the Main Menu.

# Br-EFB Text-Based Network Config

This menu is used to manually configure the Network settings on the Br-EFB.

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
          Uptime: 99:23:59:59, Serial Address: 123, IP: 192.168.2.113
           ADL: Lorenzo (2015-12-25 0744) w/503 channels @ 12 Offset
               Show #4 (of 210) Night Mode looping @ 00:19:49.22
                          DeviceName Network Settings

1) DHCP enabled: yes
2) Restrict Subnet Only: No
3) IP addr: 192.168.1.131
4) Netmask: 255.255.255.1
5) Gateway: 192.168.1.1
6) Time Server: 129.6.15.28

j) address to test: 123
k) testing: none
resolution: 8 Bits
figure: FigureName
output: OutputName



m) More, n) Next, l) Last, i) Info, o) def, p) Play, h) Halt, v) Verify, x) eXit

                                    Command-
```

**Network Configuration Menu**

This menu is accessed by selecting the 'm) more' selection from any other menu. To exit this menu:

1) Use the 'm) More...' command to save changes and go to any other menu.
2) Hit the <ESCape> key. Changed values will be discarded, and you will be returned to the previous menu.
3) Hit the <RETURN> key. Changed values will be saved, and you will be returned to the previous menu.
4) Use the 'x) eXit' command. Changed values will be saved, and the Br-EFB will exit configuration mode.

**1) DHCP enabled**

If enabled, the local DHCP server will provide the IP address to the Br-EFB. If disabled, you will need to manually address the IP address, NetMask and Gateway.

**2) Restrict Subnet Only**

!!!!.

**3) IP Address**

The current IP address will be displayed here. If manually addressing the Br-EFB, you will enter the IP address here.

**4) NetMask**

The current NetMask will be displayed here. If manually addressing the Br-EFB, you will enter the NetMask here.

**5) Gateway Server**

The IP address of the current Gateway Server will be displayed here. If manually addressing the Br-EFB, you can enter the address of the Gateway Server here.

**6) Time Server**

This allows the Br-EFB to set its internal clock using a networked time server. Without this, the times in the logs are all relative to the last reboot, rather than an accurate date and time.

**G) Output to Test & Adjust**
**K) Test Output**
**M) More...**
**N) Next**
**L) Last**
**I) Info….**
**O) Reload Defaults**
**P) Play/Loop**
**H) Halt**

**V) Verify**
**X) eXit**

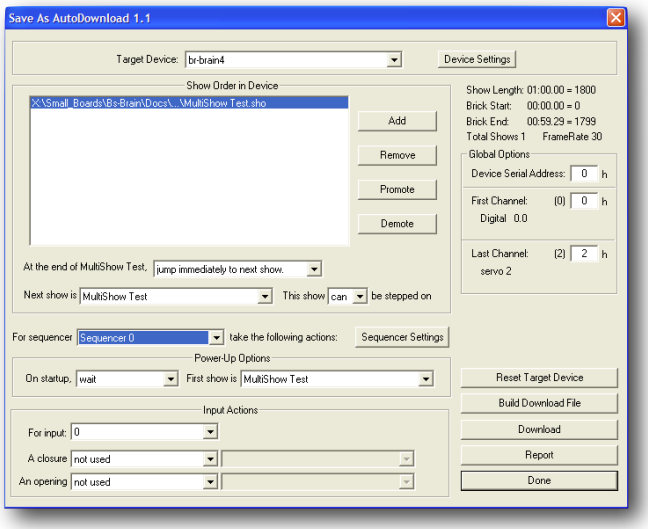
These command are described on the Main Menu.

# Optically Isolated Trigger Input Actions

The following Input Actions are used to start, stop, and generally control the Br-EFB through its two optically isolated trigger inputs. The optically isolated trigger inputs can be used as the sole method to control the Br-EFB, or as an adjunct to the Br-EFB's Rs-422, USB and Ethernet ports.

You set what each of the Trigger Inputs will do on the AutoDownload dialog, (usually) after you have finished programming all of your shows and are ready to send them to the Br-EFB.

The Br-EFB has two Trigger Inputs. You can set different Input Actions for the 'closing Edge' [6] on the input and the 'opening Edge' [7].This allows you to do things like 'pause' a show on a closure of an input, and then 'continue' it on the opening of the same input.




Pc•MACs uses the 'Target Device' to know what options are available for the Trigger Inputs, number of sequencers available, and even the size of the AutoDownload memory available. It looks this up from the GilderGearList each time you do an AutoDownload, so if new features have been added to the Br-EFB since your last AutoDownload, you will be able to access them.

Some of the Input Actions require you to enter a second or third value from the drop downs just to their right. Typically these will be a show, or range of shows for the Input Action to use.

---

[6] The 'closing edge' is when current starts flowing through the optically isolated input, which is usually when an attached switch 'closes'. The status of all the Trigger Inputs can be seen on the Br-EFB's 'status' command and 'main' menu.

[7] The 'opening edge' is when current stops flowing through the optically isolated input, which is usually when an attached switch 'opens'. The status of all the Trigger Inputs can be seen on the Br-EFB's 'status' command and 'main' menu.

**A) not used**

This is the default setting for all inputs. Leave any unused inputs as 'not used'

**B) Start Show**

This is the most commonly used trigger input command. It tells the Br-EFB to start the selected show with the 'looping' flag set. On the Br-EFB's menus, the show status will be shown as 'looping', to indicate that the show will check the 'at end' actions that have been set for the show when it completes playing.

Use the drop down to the right of the Input Action to select whether this Input Action will start playing 'whatever is next' in the AutoDownload list of shows, or a specific show. All the shows in the AutoDownload list will be shown in the drop down, and you can select the specific one you would like to start.

**C) Stop Show**

This tells the Br-EFB to stop playing a show immediately. The show is frozen at the current frame, as are the analog, ServoMotor and DMX-512 outputs. On the Br-EFB's menus, the show status will be shown as 'STOPPED', to indicate that the show was not allowed to play to completion. On starting another show, all the analogs will be EasedIn to the new show.

**D) Stop At End**

This is the Input Action you use when you want to stop a show which is playing, but allow it to play through to its natural end. On the Br-EFB's menus, the show status will be shown as 'playing', to indicate that the show will NOT check the 'at end' actions that have been set for the show.

**E) Pause Show**

This pauses the show playing immediately. The analog, ServoMotor and DMX-512 outputs are frozen at their current states. On the Br-EFB's menus, the show status will be shown as 'paused'.

### F) Continue Show

The opposite of the 'Pause' Input Action, this will allow a paused show to return to playing. On the Br-EFB's menus, the show status will be shown as 'looping' or 'playing', depending on what its status was before the 'pause'.

### G) E-stop Show

This stops an Br-EFB playing immediately, and prevents the Br-EFB from being restarted until the 'Clear E-Stop' input action is received, or the Br-EFB is reset.

Use the drop down to the right of the Input Action to select whether this Input Action will freeze the outputs at the 'Current Frame' or outputs the first frame of a specific show (Analog outputs will be EasedIn so they don't jump). All the shows in the AutoDownload list will be shown in the drop down, and you can select the specific one you would like to use for E-Stops.

Freezing at the current frame is used when additional movements on the analog outputs is more hazardous than leaving them right where they are (which is often the case on motion bases).

Jumping to the first frame of a specified show allows you to define the E-Stop output levels for all analogs and digitals. Use this to turn on emergency lighting, open doors, and return all outputs to a safe 'home' position.

The E-Stop Input Action is most commonly used on the 'opening' edge input. This is so a wire break or other fault between the Br-EFB and an E-Stop button will 'fail safe' on the Br-EFB.

On the Br-EFB's menus, the show status will be shown as 'E-Stop', to indicate that the Br-EFB has been locked up and will not be allowed to start any other shows until the E-Stop is E-Cleared.

### H) Clear E-stop

This just clears the lock that the E-Stop puts on an Br-EFB. This lock prevents it from starting any other shows until it has been cleared.

The 'Clear E-Stop' Input Action is most commonly used on the closing edge of the same input that triggers the E-Stop. This is so that pulling the E-Stop mushroom switch back to it's 'ready' position will also clear the E-Stop lockout.

## I) Sequential From List

This input action can only be selected for the 'Closing' edge on an input. It allows you to define a range of shows that will be played when the input closes. The range can be as short as two shows up to all the shows that are loaded on the Br-EFB.

Use both of the drop downs to the right of the Input Action to select the 'first' and 'last' show to play from this Input [8]. On the first activation of this input, the Br-EFB will play the 'first' show you selected. On subsequent activations it will select and play the shows until it plays the 'last' show you selected. On the next activation, it will start over by playing the 'first' show again.

It is possible to use the 'Sequential from List' and 'Random from List' Input Actions with overlapping ranges for multiple inputs. This is all legal to do, but there is only one 'already played' flag for each show. If one input has already played a show that is in a range that overlaps with another input, that other input will consider that show as 'already played' too.

You can tell the Br-EFB to reshuffle this list at any time by using the 'Reshuffle List' input action.

## J) Random From List

This input action can only be selected for the 'Closing' edge on an input. It allows you to define a range of shows that will be played when the input closes. The range can be as short as two shows up to all the shows that are loaded on the Br-EFB.

Use both of the drop downs to the right of the Input Action to select the 'first' and 'last' show to play from this Input [9]. On each activation of this input, the Br-EFB will pick at random a show that falls between the shows you defined as 'first' and 'last' and play it. When it has played all the shows in this range (including the 'first' and 'last'), it will 'reshuffle' the list. On the next activation it will pick and play any show *except* the most recently played show.

It is possible to use the 'Sequential from List' and 'Random from List' Input Actions with overlapping ranges for multiple inputs. This is all legal to do, but there is only one 'already played' flag for each show. If one input

[8] The range of shows shown on the drop downs will change to limit your selection to 'legal' ranges of shows.

[9] The range of shows shown on the drop downs will change to limit your selection to 'legal' ranges of shows.

has already played a show that is in a range that overlaps with another input, that other input will consider that show as ‘already played’ too.

You can tell the Br-EFB to reshuffle this list at any time by using the ‘Reshuffle List’ input action.

## K) Reshuffle List

This input action can only be selected for the ‘Closing’ edge on an input. It is used in conjunction with the ‘Sequential from List’ and ‘Random from List’ Input Actions to reset the ‘already played’ flags for a range of shows. The range can be as short as two shows up to all the shows that are loaded on the Br-EFB. The two drop downs to the right of the Input Action are used to select the ‘first’ and ‘last’ show have their ‘already played’ flags reset.

## L) Analog Limit

Normally the analog outputs will follow the complete range of motion you programmed in your shows, only limited by the analog endpoints you set on the Br-EFB ‘minimum’ and ‘maximum’ settings.

This feature can be used if you want to scale the analog outputs to limit them to a lower level when a switch is thrown. This is most commonly used to connect the switched ‘threshold’ outputs of anemometers used with fountain shows, or to 'gentle' motion base attractions for younger riders.

In a fountain application, if the wind level gets to the preset ‘threshold’, the anemometer ‘closes’ this input. This tells the Br-EFB to scale the analog outputs, and thereby the height that the fountain will squirt the water. When the wind level drops below the ‘threshold, the anemometer opens this output and a ‘Analog Limit’ action on the ‘opening’ edge of the same input tells the Br-EFB to scale the outputs to 100%, and return the fountain to normal operation.

In a motion base attraction, a simple switch closure can 'scale' motion base's movement for an extremely young (or old) load of passengers.

Use the drop down to the right of the Input Action to select the desired scaling value to use. A ‘zero’ value sets all of the outputs to the voltage set in the ‘minimum’ endpoint column. A value of 100% returns the Br-EFB to normal operation.

## M) Binary Bit

This Input Action allows you to use as many as two of the trigger inputs to select and play shows using a binary pattern of bits. This allows you to select and play up to 3 shows through the Optically Isolated Trigger Inputs.

You can define any of the inputs to any of the binary bits zero through seven. Each of the binary bits should only be used once.

When any of the inputs that are assigned as a binary bit changes, the entire binary byte is scanned. If the result is non-zero, the binary value is used to select and play a show. Care must be taken that all the binary bits are switched simultaneously. Some PLCs have an output update rate which is slower than the Br-EFB's input scan rate, which can result in un-expected shows being selected and played.

# Ethernet & Serial Port Commands

The following commands are used to start, stop, and generally control the Br-EFB through its Rs-422, USB, or Ethernet ports. The serial port commands can be used as the sole method to control the Br-EFB, or as an adjunct to the Br-EFB's two optically isolated trigger inputs.

The Br-EFB's serial port can be accessed from any computer running just about any modem or terminal program. The computer you are using doesn't even need to have any PC•MACs software installed on it.

One of the easiest and most flexible types of operator interfaces for accessing the serial port are the many touch screen operator panels. These can be a part of an existing PLC or room automation system (including AMX, Crestron, etc.). Stand-alone touch screen operator panels with serial port outputs are available from a number of different suppliers (Maple Systems and QSI Corp., etc.). These will easily attach directly to the Br-EFB's (and other GilderGear's) Rs-422 serial port. Most of touch screens are sold with a Windows program that will allow you to 'draw' buttons and user interface icons on their screens, attach ASCII strings to these 'buttons', and then download the final configuration to the operator panel. They need no PC or other hardware once they are programmed.

GilderTerm is available free from Gilderfluke & Co. for use with all of our products. It can be downloaded from our web page, and is included on all of our CD-ROMs. GilderTerm has been optimized for use with all Gilderfluke & Company equipment. All the commands are built in, and it will even let you use your mouse to select commands.

To use the Br-EFB with a terminal program, just configure it for 9600 baud, no parity, eight data bits, one stop bit and no handshaking. If you are using GilderTerm, all the settings are preset. All you will need to do is select the appropriate 'COM' port.

In all the following commands, the command (shown in "quotes") is the ASCII command. You can type these from your keyboard. The commands are all UPPER/lower case sensitive.

The "(card address)" is the serial address of the single card that the will respond to the command. In the Br-EFB, the serial address can be set to any Hexadecimal address from '00' to 'FFh. This allows up to 256 other GilderDevices to be connected to the same RS-422 serial bus and accessed individually.

The "(show #)" is the desired show's position in the AutoDownload list when the AutoDownload file is saved. The '(show #)' represents a two digit ASCII hexadecimal number for the desired show. Valid characters are "0" through "9", and "A" through "F".

The chart on the back page of this manual will help you translate decimal show numbers into hexadecimal show numbers.

## A) Echo Commands:

***"a"(card address)*** ***Echo On:***
***"b"*** ***Echo Off:***

The 'Echo ON' command will turn on a special mode that will cause all the other serial port commands to echo on the selected card. This used when you are setting up serial commands so you can verify all the commands you are issuing are being received correctly. In the following examples, the 'echo' responses are shown in bold italics:

If you send "a00", on the card addressed at 00h the echo mode will be turned ON:

"*card __0, echo mode*"

If you send "*03A" to request a specific show on all cards:

"*card __0, requested show __3 ShowName3*"

If you send "t00A" to start the requested show playing on a specific card:

"*card __0, starting show __3 ShowName3*"

If you send "!00A" to start a show looping on a specific card:

"*card __0, looping show __4 ShowName4*"

If you send "uA" to stop all shows playing on all cards:

"*card __0, stopped show __5 ShowName5*"

Error messages will be returned whenever you ask the card to do something that it cannot do at the current time.

The 'Echo OFF' command turn off the echo mode on all the cards in the system. It does not echo anything.

## B) Card Reset:

***"j5AA5" (card address)***

This command will erase the AutoDownload file on the Sd Flash Card on the Br-EFB. Needless to say, this command is only rarely used in a completed installation.

## C) Card Status:

### *"i" (card address)*

The status screen is a snapshot image of the current status of the Br-EFB. If you want to update the status information displayed, you must hit the 'Card Status' command again.

When the Br-EFB receives this command, it will respond with the following:

```
- Gilderfluke & Co. - Electronic Feedback Card - version 1.00 - copyright 2017 -
        Uptime: 0:00:22:37, Serial Address: 0, IP Address: 192.168.1.131
             ADL File: Lorenzo (2015-12-25 0744) with 503 channels
                   Show #4 Night Mode 4 looping @ 00:22:37.08

+---------+-----+-----+-----+--------+
| DMX-512 | Pos | Com | Set | Output |
|  Addr   | FB  | FB  | Pnt | Volt.  |
+---------+-----+-----+-----+--------+
|   0 (0) | 161 |   0 |   0 |   0.00 |
+---------+-----+-----+-----+--------+
|   1 (1) | 160 |   0 |   0 |   0.00 |
+---------+-----+-----+-----+--------+
|   2 (2) | 160 |   0 |   0 |   0.00 |
+---------+-----+-----+-----+--------+
|   3 (3) | 160 |   0 |   0 |   0.00 |
+---------+-----+-----+-----+--------+
```

**Card Status**

The Status Dump shows:

a) number of shows in the AutoDownload file
b) number of channels in the AutoDownload file
c) address offset of the first channel in the AutoDownload file
d) name of the AutoDownload file
e) name of the AutoDownload target device
f) serial address of the AutoDownload target device
g) for the show which is loaded:
    a) show number the Br-EFB is playing
    b) name of the show

c) playing status (looping, playing, stopped, paused, E-Stopped, etc.)

d) frame number into the current show

h) Status of both of the optically isolated trigger inputs

## D) Start Commands:

***"t" (card address)*** ***Start Track:***
***"u"*** ***Start Global:***

Instead of the 'start' commands, the 'loop' commands are generally a better choice. The difference between the 'start' and 'loop' commands are that at the end of a show which is started with a 'loop', it will check to see if any actions were set for the end of the show. A show that is started with the 'start' command will play to the end and then just stop and wait for the next command.

These commands start the animation playing on the Br-EFB(s) addressed by the command. The shows will always start from the beginning (frame zero). If an addressed Br-EFB is looping shows, it will have the 'LOOPING SHOWS' flag reset.

If the Br-EFB receives a start command after it has received a request for a specific show, it will play that show. Otherwise it will play the show that has been set as the 'next' show for the show which is currently playing (or most recently played show if it is not currently playing). If this is the first show played after an Br-EFB is reset, it will play the show which has been set as the 'first' show during the AutoDownload. Requests for specific shows can come only from the serial port.

When shows are downloaded to the Br-EFB, they can be set to ignore additional start commands while they are playing. This allows individual shows to be 'stepped' upon or not. If the Br-EFB is already playing a show which has this option set, it will ignore this command.

## E) Stop Commands:

***"x" (card address)*** ***Stop Track:***
***"y"*** ***Stop Global:***

These commands stop the selected Br-EFB(s) unconditionally. The stop takes place at the current frame being played.

## F) Loop Commands:

***"!" (card address)*** ***Loop Track:***
***" " "*** ***Loop Global:***

Instead of using the 'start' commands, the 'loop' commands are generally a better choice. The difference between the 'start' and 'loop' commands are that at the end of a show which is started with a 'loop', it will check to see if any actions were set for the end of the show. A show that is started with the 'start' command will play to the end and then just stop and wait for the next command.

These command acts much like the START commands, except that they also set the 'LOOPING SHOWS' flag. With the this flag set, it is possible to set a sequence of shows playing in any order. Since the 'next' show can be any show you ask for, one show can be played over and over again, or you can set up a sequence of shows which will be repeated until the Br-EFB is told to stop.

## G) Stop at End Commands:

***"%" (card address)*** ***Stop at End Track:***
***"&"*** ***Stop at End Global:***

These commands reset the 'LOOPING SHOWS' flag in the selected Br-EFB(s). What this does is to stop them playing when the end of the current show is reached. These commands are used when you want the shows to finish gracefully, instead of stopping in the middle. The STOP commands are used when you want to stop a show immediately.

## H) Select Show Commands:

***")" (card address) (show#)*** ***Select Show Track:***
***"*" (show#)*** ***Select Show Global:***

Up to two hundred fifty-five different animated shows can be stored on a single Br-EFB. These commands can be used to select an individual show on the selected Br-EFB(s). Individual shows can be requested with a range of 01 to FFH. Once a show is selected, it will be played on the next serial port START or LOOP command.

If a show selection has been made inadvertently, it can be cleared by sending a request for show number 00.

## l) Show Pause Commands:

***"<" (card address)*** ***Pause Show:***
***">" (card address)*** ***Continue Show:***

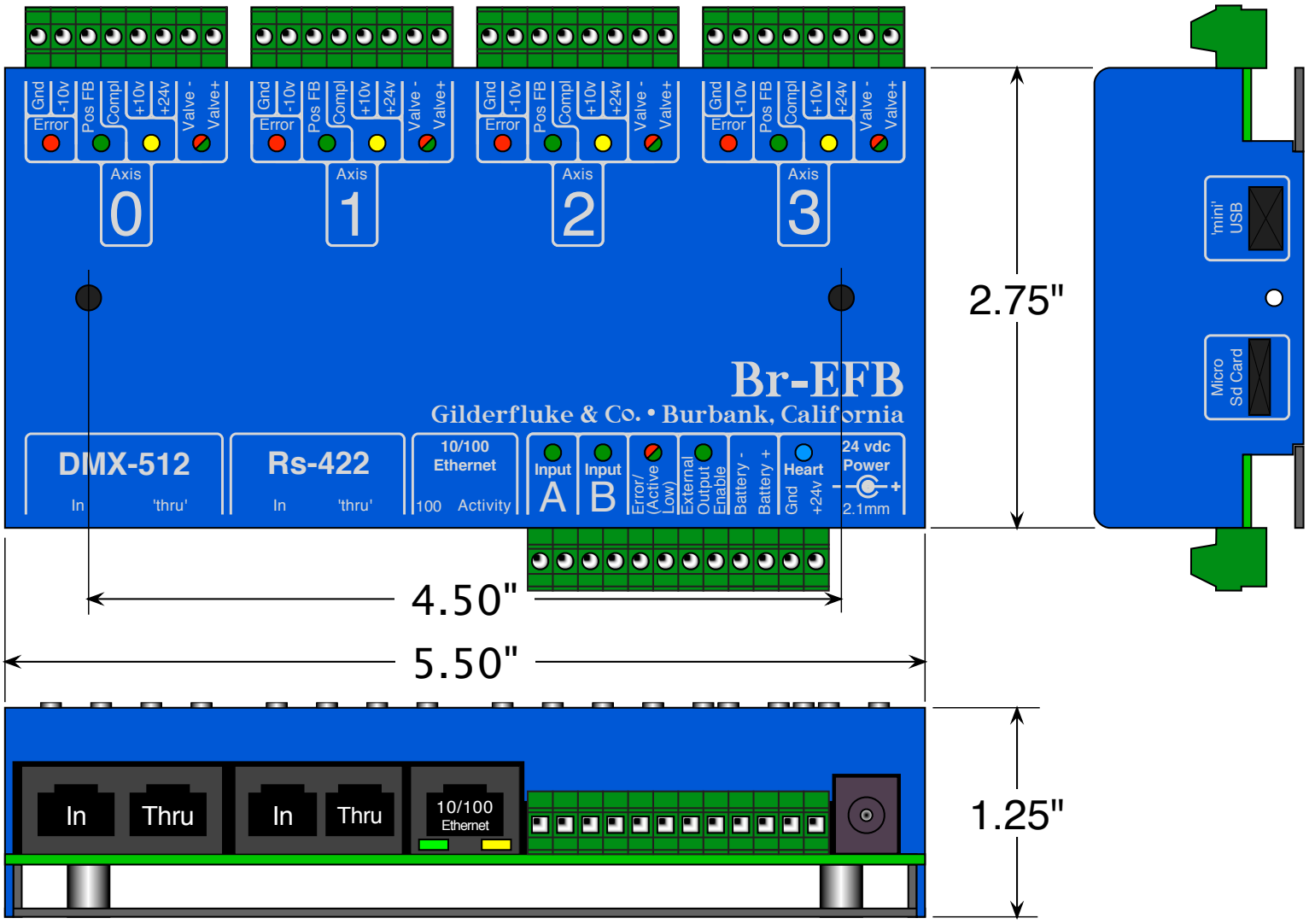
Any show can be paused at any point during its playback. The outputs are frozen at the 'levels they were at the instant the PAUSE command is received.

The CONTINUE command will resume any show playing which has previously been PAUSED.

# Br-EFB Dimensions & Mounting

The Br-EFB can easily be mounted in one of several ways:

1) Most GilderGear can easily be mounted in 2-¾" Snap-Track. This includes the Br-EFB.
2) A pair of DIN Adapters can be snapped onto the back of the Br-EFB. Once snapped into place, you'll have a devil of a time getting them off again. They allow the Br-EFB to attach to standard DIN rail.
3) There are two 10-32 threaded holes for mounting the Br-EFB to a panel from the back. They are on 4.50" centers. You can also use two 6-32 screws through the same holes in the Br-EFB from the front to hold it to a panel.
4) It is not uncommon to simply attach self-adhesive Velcro to the back of an Br-EFB and stick it to your control panel.



this page is not blank

# !!!! Br-EFB Firmware Updates

The firmware in an Br-EFB can easily be upgraded at any time. To update the firmware:

1) Download the Br-EFBv3.FRM file from the Gilderfluke & Co. website
2) Unzip the file (if needed)
3) Place the Br-EFBv3.FRM file onto a formatted μSd/μSdHC/μSdXc flash card
4) Power down (or disable) whatever the Br-EFB is controlling. You don't want your show to do anything unexpected during the update
5) While the Br-EFB is running, remove the μSd/μSdHC/μSdXc flash card it is using
6) Replace it with the μSd/μSdHC/μSdXc flash card that holds the Br-EFBv3.FRM file
7) The Br-EFB will update itself
8) Once the firmware update has completed, remove the μSd/μSdHC/μSdXc flash card that has the Br-EFBv3.FRM file on it
9) Insert the the μSd/μSdHC/μSdXc flash card with your shows on it
10) Power back up (or enable) whatever the Br-EFB is controlling.

During firmware updates, the Read LED and Busy LED flash back and forth.

The first stage is comparing the Br-EFBv3.FRM file on the Sd card. It then flashes a little slower as it reads the Br-EFBv3.FRM file in from the Sd card. It then flashes back and forth much more quickly as it reprograms the microcontroller in the Br-EFB.

Under no circumstances remove power from the Br-EFB while firmware is being updated. A partial firmware update may 'brick' the Br-EFB, and then it will need to be returned to the factory for reprogramming.

# HEXadecimal to Decimal to Percentage

The following chart shows decimal, HEXadecimal, and a few percentage equivalents to aid you when you need to convert between numbering bases:

| decimal | HEX | ASCII | % | decimal | HEX | ASCII | % | decimal | HEX | ASCII | % | decimal | HEX | ASCII | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00 | 00 | null | 0 | 64 | 40 | @ | 25% | 128 | 80 | (null) | 50% | 192 | C0 | (@) | 75% |
| 1 | 01 | soh/^A | | 65 | 41 | A | | 129 | 81 | (soh) | | 193 | C1 | (A) | |
| 2 | 02 | stx/^B | | 66 | 42 | B | | 130 | 82 | (stx) | | 194 | C2 | (B) | |
| 3 | 03 | etx/^C | | 67 | 43 | C | | 131 | 83 | (etx/) | | 195 | C3 | (C) | |
| 4 | 04 | eot/^D | | 68 | 44 | D | | 132 | 84 | (eot) | | 196 | C4 | (D) | |
| 5 | 05 | eng/^E | | 69 | 45 | E | | 133 | 85 | (eng) | | 197 | C5 | (E) | |
| 6 | 06 | ack/^F | | 70 | 46 | F | | 134 | 86 | (ack) | | 198 | C6 | (F) | |
| 7 | 07 | bell/^G | | 71 | 47 | G | | 135 | 87 | (bell) | | 199 | C7 | (G) | |
| 8 | 08 | bs/^H | | 72 | 48 | H | | 136 | 88 | (bs) | | 200 | C8 | (H) | |
| 9 | 09 | ht/^I | | 73 | 49 | I | | 137 | 89 | (ht) | | 201 | C9 | (I) | |
| 10 | 0A | lf/^J | | 74 | 4A | J | | 138 | 8A | (lf) | | 202 | CA | (J) | |
| 11 | 0B | vt/^K | | 75 | 4B | K | | 139 | 8B | (vt) | | 203 | CB | (K) | |
| 12 | 0C | ff/^L | | 76 | 4C | L | | 140 | 8C | (ff) | | 204 | CC | (L) | |
| 13 | 0D | cr/^M | | 77 | 4D | M | | 141 | 8D | (cr) | | 205 | CD | (M) | |
| 14 | 0E | so/^N | | 78 | 4E | N | | 142 | 8E | (so) | | 206 | CE | (N) | |
| 15 | 0F | si/^O | | 79 | 4F | O | | 143 | 8F | (si) | | 207 | CF | (O) | |
| 16 | 10 | dle/^P | | 80 | 50 | P | | 144 | 90 | (dls) | | 208 | D0 | (P) | |
| 17 | 11 | dc1/^Q | | 81 | 51 | Q | | 145 | 91 | (dc1) | | 209 | D1 | (Q) | |
| 18 | 12 | dc2/^R | | 82 | 52 | R | | 146 | 92 | (dc2) | | 210 | D2 | (R) | |
| 19 | 13 | dc3/^S | | 83 | 53 | S | | 147 | 93 | (dc3) | | 211 | D3 | (S) | |
| 20 | 14 | dc4/^T | | 84 | 54 | T | | 148 | 94 | (dc4) | | 212 | D4 | (T) | |
| 21 | 15 | nak/^U | | 85 | 55 | U | | 149 | 95 | (nak) | | 213 | D5 | (U) | |
| 22 | 16 | syn/^V | | 86 | 56 | V | | 150 | 96 | (syn) | | 214 | D6 | (V) | |
| 23 | 17 | etb/^W | | 87 | 57 | W | | 151 | 97 | (etb) | | 215 | D7 | (W) | |
| 24 | 18 | can/^X | | 88 | 58 | X | | 152 | 98 | (can) | | 216 | D8 | (X) | |
| 25 | 19 | em/^Y | | 89 | 59 | Y | | 153 | 99 | (em) | | 217 | D9 | (Y) | |
| 26 | 1A | sub/^Z | | 90 | 5A | Z | | 154 | 9A | (sub) | | 218 | DA | (Z) | |
| 27 | 1B | ESC | | 91 | 5B | [ | | 155 | 9B | (ESC) | | 219 | DB | ([) | |
| 28 | 1C | FS | | 92 | 5C | \ | | 156 | 9C | (FS) | | 220 | DC | (\) | |
| 29 | 1D | GS | | 93 | 5D | ] | | 157 | 9D | (GS) | | 221 | DD | (]) | |
| 30 | 1E | RS | | 94 | 5E | ^ | | 158 | 9E | (RS) | | 222 | DE | (^) | |
| 31 | 1F | VS | | 95 | 5F | | | 159 | 9F | (VS) | | 223 | DF | ( ) | |
| 32 | 20 | SP | 12.5% | 96 | 60 | ` | 37.5% | 160 | A0 | (SP) | 62.5% | 224 | E0 | (`) | 87.5% |
| 33 | 21 | ! | | 97 | 61 | a | | 161 | A1 | (!) | | 225 | E1 | (a) | |
| 34 | 22 | “ | | 98 | 62 | b | | 162 | A2 | (“) | | 226 | E2 | (b) | |
| 35 | 23 | # | | 99 | 63 | c | | 163 | A3 | (#) | | 227 | E3 | (c) | |
| 36 | 24 | $ | | 100 | 64 | d | | 164 | A4 | ($) | | 228 | E4 | (d) | |
| 37 | 25 | % | | 101 | 65 | e | | 165 | A5 | (%) | | 229 | E5 | (e) | |
| 38 | 26 | & | | 102 | 66 | f | | 166 | A6 | (&) | | 230 | E6 | (f) | |
| 39 | 27 | ‘ | | 103 | 67 | g | | 167 | A7 | (‘) | | 231 | E7 | (g) | |
| 40 | 28 | ( | | 104 | 68 | h | | 168 | A8 | (() | | 232 | E8 | (h) | |
| 41 | 29 | ) | | 105 | 69 | i | | 169 | A9 | ()) | | 233 | E9 | (i) | |
| 42 | 2A | * | | 106 | 6A | j | | 170 | AA | (*) | | 234 | EA | (j) | |
| 43 | 2B | + | | 107 | 6B | k | | 171 | AB | (+) | | 235 | EB | (k) | |
| 44 | 2C | ‘ | | 108 | 6C | l | | 172 | AC | (‘) | | 236 | EC | (l) | |
| 45 | 2D | - | | 109 | 6D | m | | 173 | AD | (-) | | 237 | ED | (m) | |
| 46 | 2E | • | | 110 | 6E | n | | 174 | AE | (•) | | 238 | EE | (n) | |
| 47 | 2F | / | | 111 | 6F | o | | 175 | AF | (/) | | 239 | EF | (o) | |
| 48 | 30 | 0 | | 112 | 70 | p | | 176 | B0 | (0) | | 240 | F0 | (p) | |
| 49 | 31 | 1 | | 113 | 71 | q | | 177 | B1 | (1) | | 241 | F1 | (q) | |
| 50 | 32 | 2 | | 114 | 72 | r | | 178 | B2 | (2) | | 242 | F2 | (r) | |
| 51 | 33 | 3 | | 115 | 73 | s | | 179 | B3 | (3) | | 243 | F3 | (s) | |
| 52 | 34 | 4 | | 116 | 74 | t | | 180 | B4 | (4) | | 244 | F4 | (t) | |
| 53 | 35 | 5 | | 117 | 75 | u | | 181 | B5 | (5) | | 245 | F5 | (u) | |
| 54 | 36 | 6 | | 118 | 76 | v | | 182 | B6 | (6) | | 246 | F6 | (v) | |
| 55 | 37 | 7 | | 119 | 77 | w | | 183 | B7 | (7) | | 247 | F7 | (w) | |
| 56 | 38 | 8 | | 120 | 78 | x | | 184 | B8 | (8) | | 248 | F8 | (x) | |
| 57 | 39 | 9 | | 121 | 79 | y | | 185 | B9 | (9) | | 249 | F9 | (y) | |
| 58 | 3A | : | | 122 | 7A | z | | 186 | BA | (:) | | 250 | FA | (z) | |
| 59 | 3B | ; | | 123 | 7B | | | 187 | BB | (;) | | 251 | FB | ( ) | |
| 60 | 3C | < | | 124 | 7C | | | 188 | BC | (<) | | 252 | FC | ( ) | |
| 61 | 3D | = | | 125 | 7D | l | | 189 | BD | (=) | | 253 | FD | (l) | |
| 62 | 3E | > | | 126 | 7E | ~ | | 190 | BE | (>) | | 254 | FE | (~) | |
| 63 | 3F | ? | | 127 | 7F | del | | 191 | BF | (/) | | 255 | FF | (del) | 100% |