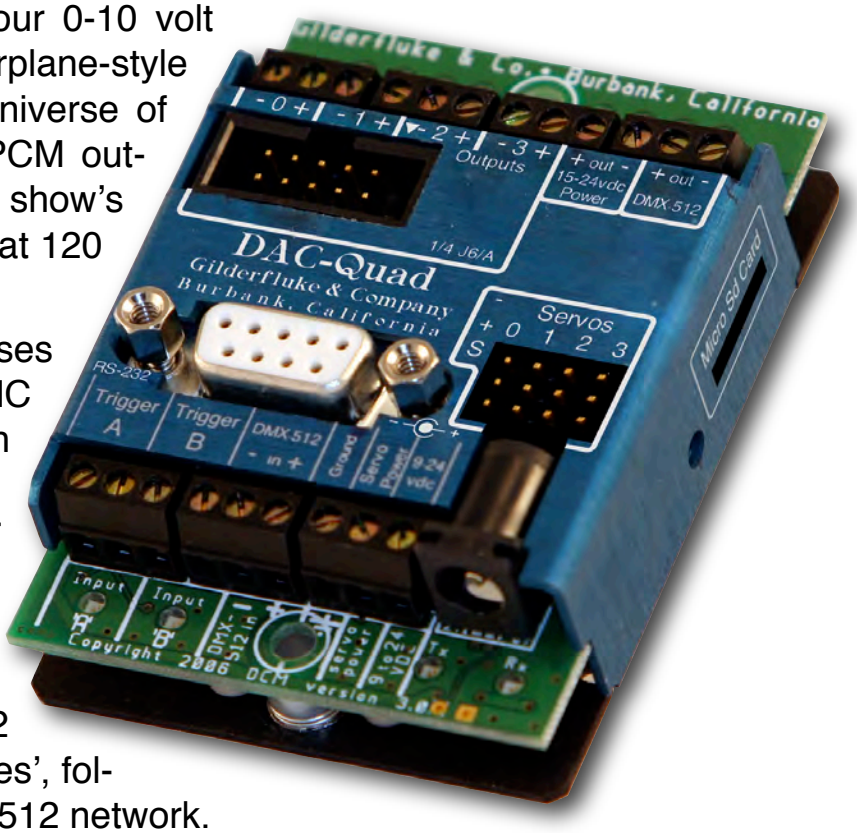
DAC-Quad

Four Output Analog Card v3.nn

The DAC-Quad is used when you need to control anything that needs a 0-10 vdc analog control voltage. These include animated shows, lighting, motion base simulators, pneumatic and hydraulic systems, special effects, signs, fountains, and more.

A Digital device is either on or off, like a light switch. An Analog device is on, off, or at any point between, like a light dimmer. The speed of the change is set by how fast you turn the knob. In animation, analog movements give the fluid, lifelike movements needed to bring an animated figure to life. They can move fast, slow or in between.

The DAC-quad is a controller with four 0-10 volt analog outputs, four mirrored model airplane-style PCM outputs, and a full 512 channel universe of DMX-512 in and out. The analog and PCM outputs are oversampled at four times the show's frame rate, so they are typically updated at 120 Hz for ultra smooth analog outputs.



For storing shows, the DAC-Quad uses any standard micro Sd or micro SdHC flash cards. These can hold months worth of shows! For triggering those shows, there are two optically isolated inputs, or the RS-232 serial port can be used.

DAC-Quads can be used as standalone show controllers, as a 'master', controlling slaves attached to a DMX-512 network, or they themselves can be 'slaves', following data sent to them through a DMX-512 network.

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 **DAC-Quad**. To program the **DAC-Quad** you will also want to refer to the **PC•MACs** manual sections that cover the **PC•MACs** software.

The **DAC-Quad** is typically programmed in 'Software-only' or 'Hardwareless RealTime' mode. If you are using the **USB-DMX** for programming your **DAC-Quad** 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

DAC-Quad Overview

The DAC-Quad is a smaller version of the Br-ANA, with four 0-10 volt analog outputs and four mirrored PCM ServoMotor outputs. The DAC-Quad comes in the popular ‘miniBrick’ form factor and is typically mounted right on whatever it is controlling. The DAC-Quad uses the smaller micro Sd or micro SdHC flash cards for storing shows. The shows stored on the DAC-Quad can be triggered using the two optically isolated inputs, or through the standard nine pin RS-232 serial port. To talk to a local or remote computer, you can use a WiFi-to-Serial (Modem-Wi-Fly), Ethernet-to-Serial (Modem-Internet). USB-to-Serial (USB-RS232/422 or C-USB-RS232), or BlueTooth-to-Serial (Bt-Rs232Rx and Bt-USBTx) adapter to connect your computer to this serial port.

The outputs on the DAC-Quad can be set to use either eight or twelve bits of resolution. The DAC-Quads 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) **DAC-Quad running standalone or acting as a ‘Master’**: In this mode of operation, data for the outputs is stored in the standard micro Sd or micro SdHC flash cards.

   When being running as a standalone controller or as a ‘master’, a DAC-Quad act just like any other 'Dumb' Brick playing animation data from the micro Sd or micro SdHC Flash card. The DAC-Quad 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 or the RS-232 serial port. The DAC-Quad 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 DAC-Quads (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) **DAC-Quad as a ‘Slave’**: In this mode the DAC-Quad 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 DAC-Quad can be addressed to use any address from 0 to 15 for Real-Time 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 DAC-Quad can be addressed to use any DMX-512 address from 0 to 511 (or 1-512 if using one-based DMX-512 addressing). The DMX-512 input allows the DAC-Quad to be used as a permanent 'slave' as a part of a larger Control System. If the incoming DMX-512 contains GilderChecksums, the DAC-Quad will automatically update only on valid data packets.

The animation sequence which is to be used on the DAC-Quad 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 Micro Sd/SdHC flash card onboard the DAC-Quad. 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 Micro Sd/SdHC flash card which is then plugged into the DAC-Quad. You may choose to also include the .SET, .SHO, .STE and other files on the flash card as well, but the only file the DAC-Quad actually reads is the AutoDownload (.A00) file.

On the DAC-Quad, four channels of data are converted to the individual 0-10 volt analog outputs. If twelve bit resolution has been selected for the outputs, then six channels of DMX-512 data are converted to individual 0-10 volt analog values. The same data is also converted to PCM signals and sent out the ServoMotor connectors.

The analog and PCM outputs of the DAC-Quad are oversampled for ultra-smooth outputs, typically to four 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.

The analog and PCM outputs' range can be scaled or even reversed without affecting the resolution of the outputs. For the analog outputs, this means that each end of the analog output can be limited to anywhere between zero and ten volts. For the PCM outputs, this means that the outputs can be adjusted for anywhere between 0.5 ms and 2.5 ms. endpoints (typical 90º servo travel range uses a 1.0 ms to 2.0 ms. pulse width). This allows you to limit the range of travel of an analog movement, usually without losing any resolution on the output.

All 512 channels of data is transmitted through the DMX-512 output on a DAC-Quad. 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 inputs. 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 and 258).

The DAC-Quad 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.

Power requirements for DAC-Quads are 15 to 24 VDC. This is needed to allow some 'head room' for the 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 DAC-Quad itself draws just xx ma..

The revision 3.nn DAC-Quad is a complete redesign from all earlier version of the earlier DAC-Quads. The chief differences are:

1) The earlier DAC-quads took thirty-two digital outputs from a Z-Brick, Sd-50/40, or other controller and converted all those digital signals into four 8 bit resolution analog signals and four eight bit resolution PCM ServoMotor signals. The v3.0+ DAC-Quad does not need any other controller to run. They have their own trigger inputs, DMX-512 inputs and outputs and micro Sd and micro SdHC flash card show storage.
2) The earlier DAC-Quads were a 2-¾" x 4.0" PCB with no case. The v3.0+ DAC-Quads come in a aluminum case, and measure only 2-¾" x 2.0", just like a Br-miniBrick8.
3) The earlier DAC-Quads used trimpots to adjust the analog endpoints. These are adjusted through the serial port on the 3.0+ DAC-Quads.

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

this page is not blank

DAC-Quad Panel Indicators

There are eight LED indicators on the DAC-Quad. They are used as follows:

A) Output Level Indicators

(Four Red LEDs)

These four red LEDs show the output level on all four of the 0-10 volt outputs. You will see these LEDs fade in and out as the signals on the outputs change. Unlike the LEDs on the Br-ANA, these LEDs are not directly connected to the analog outputs. They do not reflect the 'minimum' and 'maximum' endpoint settings. If the command from the show file in the AutoDownload or through the DMX-512 calls for the output at 0%, the LED will be off. If it asks for 100%, it will be fully on.

B) Trigger Input LEDs

(Two Green LEDs)

These LEDs indicate the status of the two optically isolated trigger inputs on the DAC-Quad. They are on the isolated side of the optoisolators. If they are not on when you send a trigger to the DAC-Quad, then there is an external wiring problem or the optoisolator has been damaged.

C) Running LED

(One Green LED)

This LED will be lit when the DAC-Quad is running a show from its internal clock and Flash memory.

During AutoDownloads of show data to the DAC-Quad, this LED will flash alternately with the DMX-512 LED to show that a AutoDownload is in process.

D) Heartbeat LED

(One Amber LED)

a) This 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 DAC-Quad will automatically reset the CPU. While performing an Ease-In, the heart rate will double.

this page is not blank

DAC-Quad Connectors

A) Micro Sd/SdHC Flash Memory Card Slot

(One Micro Sd/SdHC compatible socket)

This socket is compatible with both standard Micro Sd flash cards and Micro SdHC flash cards. It will support flash cards up to 32 GBytes in size. It will not currently support SdXC cards (64 GBytes and larger), which require licensing payments from Microsoft.

B) Input Connector

(9 Position Pluggable Screw Terminal)

The Input connections are through a nine position, pluggable screw terminal.

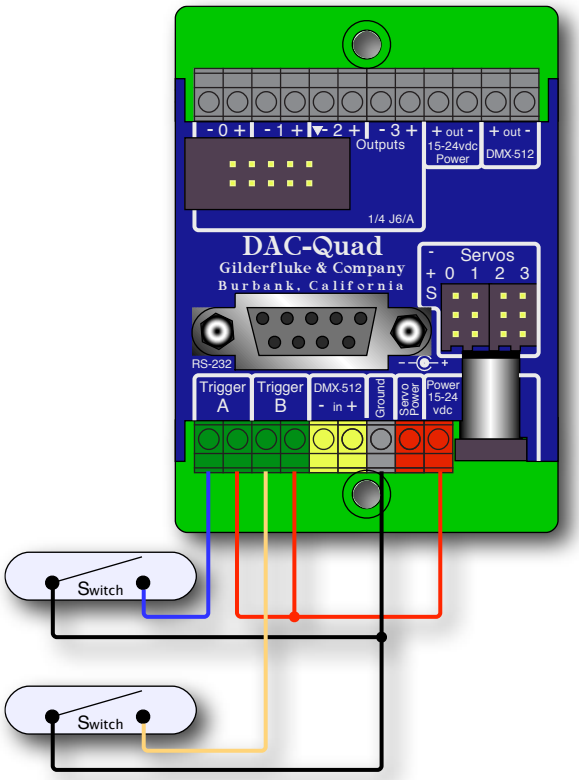
Terminal #	wire function
1	'A' Optoisolated Trigger Input
2	
3	'B' Optoisolated Trigger Input
4	
5	- DMX-512 Input
6	+ DMX-512 Input
7	Power Supply Ground/DMX Shield
8	Servo Motor Power Input (0-24 VDC)
9	Power Supply Positive (15-24 VDC)

Terminals one through four are used for the two optically isolated Trigger Inputs. These inputs are non polarized, so you can't possibly hook them up backwards.

1) Trigger Inputs

(Terminals #1, #2, #3, #4)

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 DAC-Quad, then there is an external wiring problem or the optoisolator has been damaged.



The trigger inputs will accept any voltage from 5 to 24 volts. You can provide an external voltage, or you can borrow some power from the DAC-Quad to power them, as shown here:

2) DMX-512 Input

(Terminals #5, #6)

Screw terminal positions five and six are used for the DMX-512 input. Terminal five is The negative, and terminal six is The positive. The DMX-512 shield should be connected to the ground terminal (number seven). The DAC-Quad will stop all shows and follow any valid DMX-512 data it hears whenever there is a DMX-512 signal present on this input.

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 hundreds of suppliers throughout the world for controlling all kinds of theatrical equipment.

Addresses 256 and 257 are optionally used in GilderGear for transmitting a checksum. The DAC-Quad will automatically use this to verify that the data received from PC•MACs has no transmission errors in it. If you address a light dimmer or other DMX-512 device to addresses 256 or 257,

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 DAC-Quad 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.

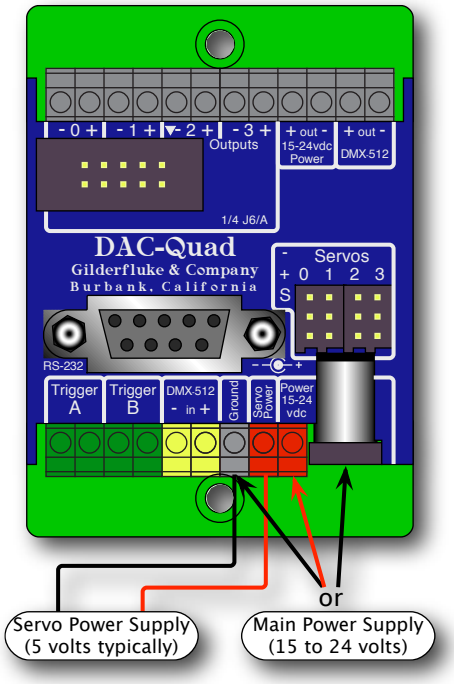
The DMX-512 standard calls out a 5 pin XLR connector or screw terminals for all connections. Many less expensive DMX-512 devices use three pin XLR connectors. More devices are starting to use CAT-5 (or better) ethernet cables for carrying DMX-512. The DAC-Quad provides screw terminals for attaching the DMX-512 input and output.

3) Power Input

(Terminals #7, #8, #9)

The last three positions of thee screw terminals are used to provide power to the DAC-Quad and any ServoMotors that are attached to it. If you are not using the servo motor outputs, you do not need to attach any power to the servo power terminal.

The power input is protected from reversed polarity. An idle DAC-Quad draws only about ?? milliamperes. The loads which the DAC-Quad is controlling will usually draw far more current than the DAC-Quad itself.



The DAC-Quad is rated for operation from 15 to 24 vdc. ServoMotors typically run on voltages between 4 and 7.2 volts (check the ServoMotors you plan to use to see what their optimal voltage level is). Some larger ServoMotors run their motors at 12 or 24 vdc, but these typically have connections for feeding this supply voltage to the motors or their controllers.

If you are not using the analog outputs of the DAC-Quad, it can be run from a 5 vdc supply. This is in the same voltage range as most ServoMotors want to run from. You may be able to use the same lower voltage power supply as the ServoMotors for running the DAC-Quad. Just make sure that your ServoMotor power supply has enough capacity that it won't 'dip' below 5 vdc when the ServoMotors are running under a heavy load.

C) Power Jack

(2.1 mm Power Jack)

This is a standard 2.1mm i.d., 5.5 mm o.d power jack. It is wired in parallel with the main power supply terminals. The screw terminals are typically used for permanent installations.

The power input is protected from reversed polarity. An idle DAC-Quad draws only about ?? milliamperes. The loads which the DAC-Quad is controlling will usually draw far more current than the DAC-Quad itself.

D) Servo Motor PCM Outputs

(Four 3 pin Male Headers)

Typical model airplane-style PCM ServoMotors use a three pin female connector. These can be plugged into the matching three pin headers on the DAC-Quad. The ground wire (typically black or brown on most ServoMotors) go to pin #1, which are at the end closest to the label for these connectors. If your ServoMotor's connector has a polarizing ridge on one side of the connector, you will find that the case is made to make it difficult to plug these in backwards

E) ¼ J6 Output

(10 Position Header)

In all the animation systems made by Gilderfluke & Company, all Analog input and output cabling is through what we call 'J6/A' standard output ribbon cables [1]. These are forty wire ribbon cables which are made up of four identical four channel wide cables of ten wire each. These split individual cables called ¼ J6/A. Each ¼ J6/A also includes a common power supply and ground wire which allow it to provide power for analog output accessories like Electronic FeedBack (EFB) controllers (these cards require a power supply of 18 volts be used for the DAC-Quad).

To simplify wiring to any MACs Animation Control System, the connectors used on the J6/A cables are what are called 'insulation displacement connectors'. These simply snap on to an entire cable, automatically 'displacing' the insulation and making contact with the wires within. This means that an entire forty wire cable can be terminated in seconds. All connectors are polarized, to keep them from being plugged in backwards.

The pinout for the DAC-Quad's ¼ J6/A connector is:

Terminal #		wire function
1	brown	circuit ground
2	red	+ power output (PTC protected to 1 amp)
3	orange	Output 3 (03h) Positive Analog Output
4	yellow	Output 3 (03h) Negative Reference
5	green	Output 2 (02h) Positive Analog Output
6	blue	Output 2 (02h) Negative Reference
7	violet	Output 1 (01h) Positive Analog Output
8	gray	Output 1 (01h) Negative Reference
9	white	Output 0 (00h) Positive Analog Output
10	black	Output 0 (00h) Negative Reference

The outputs from the ¼ J6/A connector are also available for discrete wire connections on the adjacent screw terminals.

Analog loads are connected between each of the Positive outputs and its associated Negative reference. The output capacity of each output is 50 ma. The output voltage range can be adjusted from the DAC-Quad to anywhere between 0 and 10 volts.

[1] Please note that the pinout of a J6 Digital output cable and a J6/A Analog output cable is completely different. Do not cross connect any analog and digital cables. Damage can (and probably will) result.

The negative reference on the DAC-Quad is attached directly to the circuit ground. The negative references are all connected on the DAC-Quad, but not to ground. On versions of the BS-ANA prior to 3.0, there could be no direct connections made between any of the negative references and the circuit grounds anywhere in the animation system. Starting with version 3.0 of the Br-ANA, connecting ground to the negative references was OK. The DAC-Quad extends this by simply attaching them the the circuit ground. This makes them incompatible with our older EFB-Quads and PID-Quads. The current versions of these boards are made with their negative reference pins attached to circuit ground too, so they will work perfectly with the DAC-Quad.

The '+ unregulated power output' for each 1/4 J6/A is protected by a solid state circuit breaker (PTC Fuse) rated for 1 amp. You should treat each 1/4 J6/A as an individual, and not cross the outputs or power output lines from one 1/4 J6/A 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.

F) Output Connector

(12 Position Pluggable Screw Terminal)

The pinout for this connector is as follows:

Terminal #	wire function
1	Output 0 (00h) Negative Reference
2	Output 0 (00h) Positive Analog Output
3	Output 1 (01h) Negative Reference
4	Output 1 (01h) Positive Analog Output
5	Output 2 (02h) Negative Reference
6	Output 2 (02h) Positive Analog Output
7	Output 3 (03h) Negative Reference
8	Output 3 (03h) Positive Analog Output
9	+ power output (PTC protected to 1 amp)
10	circuit ground
11	- DMX-512 Output
12	+ DMX-512 Output

1) ¼ J6/A on Screw Terminals

(Terminals #1 through #10)

The first ten of these screw terminals mirror the ¼ J6 outputs described above (although in reverse numeric order):

Analog loads are connected between each of the Positive outputs and its associated Negative reference. The output capacity of each output is 50 ma. The output voltage range can be adjusted from the DAC-Quad to anywhere between 0 and 10 volts.

The negative reference on the DAC-Quad is attached directly to the circuit ground. On versions of the BS-ANA prior to 3.0, there could be no direct connections made between any of the negative references and the circuit grounds anywhere in the animation system. Starting with version 3.0 of the Br-ANA, connecting ground and the negative references was OK. The DAC-Quad are all built this way. This makes them incompatible with our older, unmodified EFB-Quads and PID-Quads. The current versions of these boards are made with their negative reference pins attached to circuit ground too, so they will work perfectly with the DAC-Quad.

The '+ unregulated power output' for each 1/4 J6/A is protected by a solid state circuit breaker (PTC Fuse) rated for 1 amp. You should treat each 1/4 J6/A as an individual, and not cross the outputs or power output lines from one 1/4 J6/A 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.

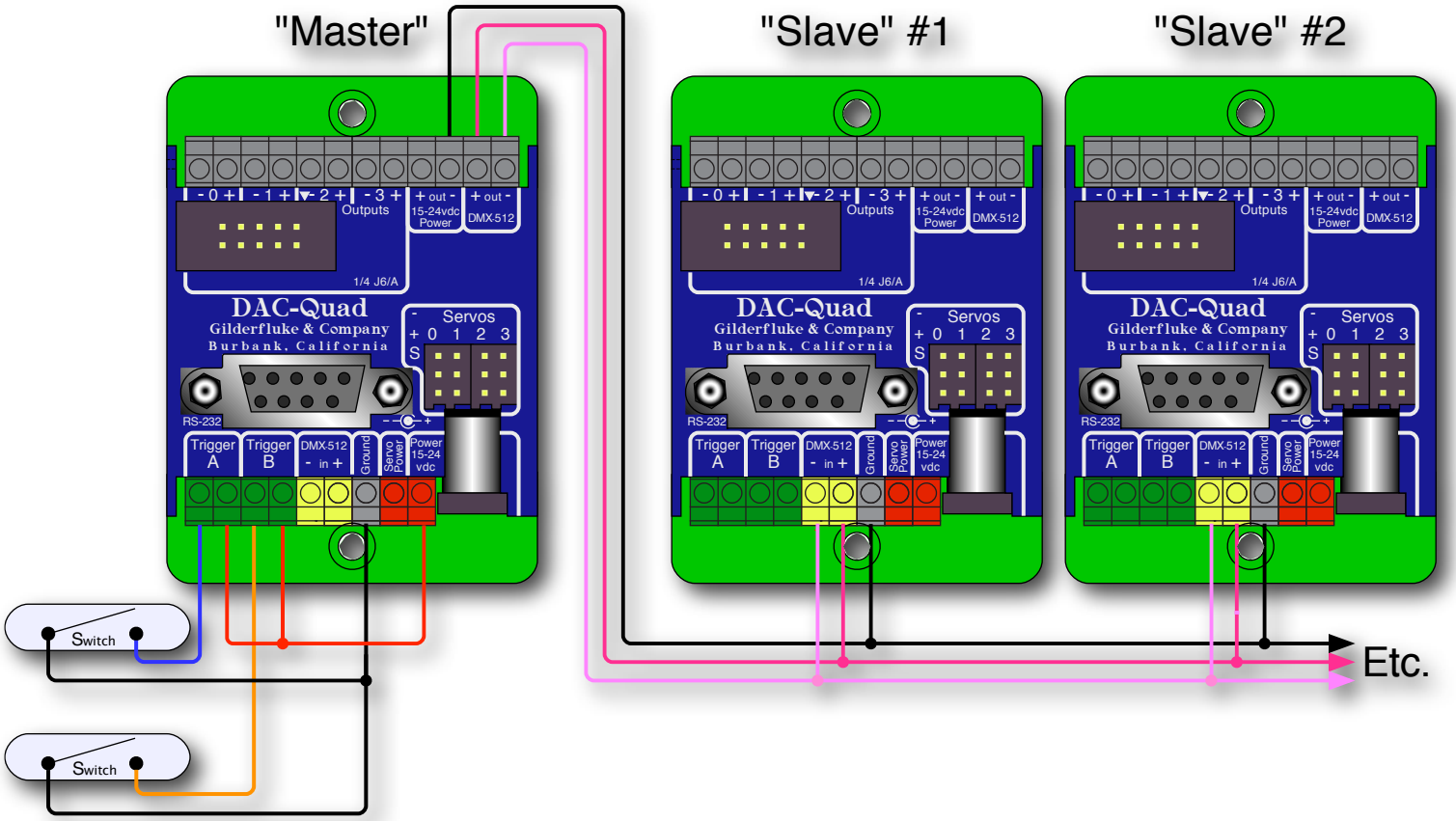
2) DMX-512 Output

(Terminals #11 & #12)

The last two terminals of the output screw terminals are used for the DMX-512 output from the DAC-Quad.

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 hundreds of suppliers throughout the world for controlling all kinds of theatrical equipment. The DMX-512 standard calls out a 5 pin XLR connector, screw terminals or a Rj-45 for all connections. The DAC-Quad provides screw terminals.

The following illustration shows using a single DAC-Quad as the 'DMX-512 'Master', and two more DAC-Quads 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 can be used as the 'slaves' [2].



All of 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.

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

2 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 terminating resistor at the two far ends of the network (120Ω, ½ Watt is typically used). The resistors suppress 'echos' 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 (daisy chained from DMX-512 'Slave' to 'Slave', it can be run up to a mile, and may need its own termination resistors).

Addresses 256 and 257 are optionally used in GilderGear for transmitting a checksum. The DAC-Quad will automatically use this to verify that the data received from PC•MACs has no transmission errors in it. If you address a light dimmer or other DMX-512 device to addresses 256 or 257, 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 DAC-Quad 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.

If you are connecting multiple DAC-Quads (or other GilderGear) as 'Slaves', you will want to use the DMX-512 'input' screw terminals for connecting the downstream units as well. This is because the DAC-Quad 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.

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. The recommended pinout is as follows:

Pair	Wire #	Color	Function	DMX-512 Pin
Pair 2	1	White / Orange	Data 1+	DMX-512 Pin 3
	2	Orange	Data 1-	DMX-512 Pin 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	DMX-512 Pin 1
	8	Brown		
Shield		Drain		

G) RS-232 Serial Port

(Nine Position DE-09 Female)

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-232 Serial Ports and protocols used on Gilderfluke & Company products.

The serial data signals from the DAC-Quad are brought out on a nine position DE-09 female connector. This uses the industry standard pinout:

WIRE #	SIGNAL NAME:
1	n/c
2	RS-232 Serial Tx Out
3	RS-232 Serial Rx In
4	n/c
5	Ground
6	n/c
7	n/c
8	n/c
9	n/c

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 DAC-Quad 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.

The DAC-Quad expects to see the serial data in the following format:

ONE START BIT
EIGHT DATA BITS
ONE STOP BIT

DAC-Quad 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. On the DAC-Quad, the serial address is permanently set to '00'.

If you have hooked up the DAC-Quad 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 DAC-Quad and short between the Tx

data and Rx data pins on your USB-to-Serial converter. For a RS-232 port, this means temporarily shorting between pins #2 and #3.

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 appear 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 DAC-Quad. 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.

DAC-Quad Software Configuration

The DAC-Quad can be accessed through the serial port from any computer running just about any modem or terminal program. We provide a free terminal program called GilderTerm that makes working with GilderGear through the serial port a little easier. The computer you are using doesn't even need to have any PC•MACs software installed on it.

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

If you don't have access to GilderTerm, typical modem programs you can use are Terminal.exe (which came with Windows 3.1) and HyperTerm.exe (which comes with later versions of Windows). The terminal program must support VT-52 commands to position the cursor and clear the screen.

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 DAC-Quad, 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 DAC-Quad 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.

If not using GilderTerm, your terminal emulation program must support VT-52 terminal emulation to do cursor positioning, clearing the screen, and a handful of other functions. You should set your program NOT to insert an extra LineFeed (LF) character after each Carriage Return (CR) it receives. You should also tell it NOT to scroll automatically after the eightieth column is filled. If either of these are on, the screen

will be displayed 'double spaced'. This won't cause any problem, but will make it hard to see the whole screen at one time.

To enter the configuration mode you need to press the ‘configure’ button on GilderTerm, or type the following if you are not using GilderTerm. The (address) is replaced by ’00’ on a DAC-Quad:

m5AA5(address)

If any other card is in configuration mode (or even if it just thinks another card is in configuration), the DAC-Quad 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 DAC-Quad 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. The DAC-Quad will display a bit of text about the range of movement you can expect from a typical model airplane-style ServoMotor.

```
- Gilderfluke & Co. - DAC-Quad Analog Card - version 3.17 - copyright 2013 DCM -
               Shows: 8, Ch: 123 @___0, ADL: AutoDownload_Filename
                                 Serial Address- __0
                __1 Show_FileName.sho looping @ frame ____1363
inputs: a/green:    | b/red:       DMX-512    E minimum maximum "forced" PowerOn
                                   address    I  scale   scale  position default
a) 1st addr: __0 (addr. from ADL)   0__4 (0) |Y|____0__|__255__|________|_____0_
b) twelve bit resolution- xxx       0__5 (1) |Y|____0__|__255__|________|_____0_
c) sequencer enabled- yes         ->0__7 (2) |Y|____0__|__255__|________|_____0_
d) DMX: Tx only w/CS,  g) 0-based   0__8 (3) |Y|____0__|__255__|________|_____0_
e) auto EaseIn- 5.00 seconds
f) numbering- decimal
                                       The normal 90 range of travel for a
j) addr. to test- __7 [12bit Rez] ]  servomotor uses a 1.000ms to 2.000ms wide
k) test output- none                 pulse. The DAC-Quad will allow you to set
figure: MiniBase                     the endpoints as low as 0.500ms to as high
output: Axis 3                          as 2.500ms. Not all ServoMotors will
                                     support 0.500ms to 2.500ms command ranges.
u) set min/max/force using keypad
q) force output to a value
t) set PowerOn defaults
w) set analog endpoints
n) Next, l) Last, i) info, o) def., p) looP, h) Halt, r) save, v) Verify, x) Xit
                                  Command-
```

To redraw the screen at any time, just press the <ESC>ape key or <SPACE> bar.

If you select ‘milliseconds’ for displaying the endpoints, the screen will print as follows:

```
- Gilderfluke & Co. - DAC-Quad Analog Card - version 3.17 - copyright 2013 DCM -
               Shows: 8, Ch: 123 @___0, ADL: AutoDownload_Filename
                                Serial Address- __0
                __1 Show_FileName.sho looping @ frame ____1363
inputs: a/green:    | b/red:       DMX-512    E minimum maximum "forced" PowerOn
                                   address    I  scale   scale  position default
a) 1st addr: __0 (addr. from ADL)    __4 (0) |Y|0.500ms|2.500ms|________|_____0_
b) twelve bit resolution- xxx       @__5 (1) |Y|0.500ms|2.500ms|________|_____0_
c) sequencer enabled- yes            __7 (2) |Y|0.500ms|2.500ms|________|_____0_
d) DMX: Tx only w/CS,  g) 0-based    __8 (3) |Y|0.500ms|2.500ms|________|_____0_
e) auto EaseIn- 5.00 seconds
f) numbering- decimal/millisecond
                                       The normal 90 range of travel for a
j) addr. to test- __2.7 [Digitals]   servomotor uses a 1.000ms to 2.000ms wide
k) test output- none                 pulse. The DAC-Quad will allow you to set
figure: Controls                     the endpoints as low as 0.500ms to as high
output: Cycle Counter                   as 2.500ms. Not all ServoMotors will
                                     support 0.500ms to 2.500ms command ranges.
u) set min/max/force using keypad
q) force output to a value
t) set PowerOn defaults
w) set analog endpoints
n) Next, l) Last, i) info, o) def., p) looP, h) Halt, r) save, v) Verify, x) Xit
                                   Command-
```

All numeric values are entered in HEXadecimal (0 through 9 and A through F) or Decimal numbers (0 through 9), as selected on the menu. Each number consist of one or more ASCII characters followed by a <RETURN> (<ENTER> on some keyboards). If more characters have been entered before the <RETURN> than are allowed, then the characters already entered will scroll to the left to make room for the new entries. Once a command has been invoked, 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 <RETURN> key (<ENTER> on some keyboards) or <ESC>ape key after all the characters have been erased or before any have been entered.

Once you have configured a DAC-Quad, 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 DAC-Quad, 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 Address

Because the DAC-Quad has a RS-232 serial port on it, it has a fixed serial address of 00. This toggle selects whether the outputs' address is set from:

1) Address stored in the AutoDownload file. This is the Default.

2) Addressed at a location you specify.

If twelve bit resolution has been selected, then any 'illegal'[3] twelve bit address will be skipped.

B) Twelve Bit Resolution

If using a v1.1 AutoDownload file generated with Pc•MACs version 2.02.212.xxx or later, this will be set automatically for you from data in the AutoDownload file.

When toggled ON, the output resolution will be twelve bits. This works out to a resolution of one part in 4096. With a 0-10 volt output, each step will be .00244 volts. If you are using 12 bit resolution analogs, you must carefully account for the locations and number of output channels you are using. Each 12 bit resolution input takes 1-1/2 eight bit channels. The DAC-Quad won't let you set the first address for a 12 bit analog channel to any address that can be evenly divided by three (0, 3, 6, 9, etc.). This is because it uses these bytes for storing the least significant four bits of the next two 12 bit resolution channels. Any 12 bit resolution channel that is addressed at an address that can be divided evenly by three plus one (addresses 1, 4, 7, 10, etc.) will need to have the previous address sent (or burnt into the Flash Memory) so that its lowest four bit nibble isn't lobbed off. Any 12 bit resolution channel that is addressed at an address that can be divided evenly by three plus two (addresses 2, 5, 8, 11, etc.) will need

[3] A twelve bit value cannot be addressed at any address that can evenly be divided by three (0, 3, 6, etc.).

to have the previous two addresses sent (or burnt into the Flash Memory) so that its lowest four bit nibble isn't lobbed off.

C) Sequencer Enabled

This toggle enables and disables the DAC-Quad to use the Animation Data Flash Memory. When it is OFF, nothing will be output from the Auto-Download file on the micro Sd/SdHC 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 micro Sd/SdHC flash card will be sent out.

D) DMX-512 mode

If using a v1.1 AutoDownload file generated with Pc•MACs version 2.02.212.xxx or later, this will be set automatically for you from data in the 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 DAC-Quad, 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 Gilder-CheckSums.

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

If using a v1.1 AutoDownload file generated with Pc•MACs version 2.02.212.xxx or later, this will be set automatically for you from data in the AutoDownload file.

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) Auto Ease-In

If using a v1.1 AutoDownload file generated with Pc•MACs version

2.02.212.xxx or later, this will be set automatically for you from data in the AutoDownload file.

When enabled, this feature 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 out for more than ten seconds.
3) An output is forced 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 default values.

This command allows you to select the amount of time any output will take to ramp from one extreme to the other and which outputs will be using the Ease-In feature. The range of time available is:

1) Ease-In is disabled
2) ¼ second
3) ½ second
4) ¾ second
5) 1 second
6) 1-½ seconds
7) 2 seconds
8) 2-½ seconds
9) 3 seconds
10) 4 seconds
11) 5 seconds
12) 6 seconds
13) 7 seconds
14) 8 seconds
15) 9 seconds
16) 10 seconds

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

Which outputs have been set to use the Ease-In Feature is shown under the column labeled ‘EI’. Outputs which will be Eased In are shown by the letter ‘Y’. All other channels will be unaffected by the Ease-In.

The Ease-In only affects the sixteen on-board analog outputs from the DAC-Quad. All the data output on DMX-512 or Z-Buss port to the Z-Bricks are unaffected.

F) Numbering System

This toggle is used to select between HEXadecimal, Decimal, percentage or milliseconds numbering systems for display and entries. The ‘milliseconds setting is used when working with ServoMotors, where the pulse widths are normally measured in milliseconds. When the DAC-Quad prompts you for a numeric entry, you will need to enter a HEXadecimal or Decimal number, depending on this setting.

J) Output to Test & Adjust

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/forced using keypad’, and 'set PowerOn Defaults' commands. If the output address selected is one of the sixteen on the DAC-Quad, then an arrow will appear to the left of it on the screen. In the eight bit resolution example screen above you can see this arrow pointing to output at address ‘1’. Since some of the adjustments can affect channels that are only transmitted through the DMX-512 and Z-Brick outputs, the address can be set to 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.

K) Test Output

When toggled to ‘Test One Output’, the single output selected by the 'Output to Test & Adjust' command will be ramped up and down. The ramp time is about 5 seconds. The time the output dwells at each extreme is about one second.

When pressed a second time, this command will toggle to ‘Test All Outputs’. All the outputs will be ramped between their two extremes. The ramp time is still about 5 seconds. The time the output dwells at each extreme is about one second.

U) Set Minimum, Maximum and Forced using Keypad

This is the easiest way to adjust the endpoints of the analog outputs to prevent a mechanical movement from over traveling. The normal range of the outputs is 0 to 10 volts DC. 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 his command redraws the left side of the screen. The drawing shows 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.

```
- Gilderfluke & Co. - DAC-Quad Analog Card - version 3.17 - copyright 2013 DCM -
               Shows: 8, Ch: 123 @___0, ADL: AutoDownload_Filename
                                Serial Address- __0
                __1 Show_FileName.sho looping @ frame ____1363
inputs: a/green:    | b/red:       DMX-512    E minimum maximum "forced" PowerOn
                                   address    I  scale   scale  position default
          minimum maximum "forced"  0__4 (0) |Y|____0__|__255__|________|_____0_
adjust-->  scale   scale  position  0__5 (1) |Y|____0__|__255__|________|_____0_
         |-----------------------|->0__7 (2) |Y|____0__|__255__|________|_____0_
    Up-> |   7   |   8   |   9   |  0__8 (3) |Y|____0__|__255__|________|_____0_
         |-----------------------|
middle-> |   4   |   5   |   6   |
         |-----------------------|      The normal 90 range of travel for a
  Down-> |   1   |   2   |   3   |]  servomotor uses a 1.000ms to 2.000ms wide
         |-----------------------|   pulse. The DAC-Quad will allow you to set
j) addr. to test- __7 [12bit Rez]    the endpoints as low as 0.500ms to as high
figure: MiniBase                        as 2.500ms. Not all ServoMotors will
output: Axis 3                       support 0.500ms to 2.500ms command ranges.
a) toggle Auto-force to 0% or 100%
1, 4, 7, -) sets "forced" to 0%
2, 5, 8, +) sets "forced" to 100%
Hit <CR> to save, <Esc> bails out
n) Next, l) Last, i) info, o) def., p) looP, h) Halt, r) save, v) Verify, x) Xit
                                    Command-
```

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 DAC-Quad 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 [4]. For cyl-

[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.

inders 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

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 DAC-Quad when you give it a '100%' position command through the DMX-512 or AutoDownload file. The default analog output (when set to 255/0FFh) is 10 vdc. This will automatically force the output to the '100%' position [5]. 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 DAC-Quad does this by using these keys to adjust the 'forced' value. When you are done adjusting this output, you will want to make sure you clear the 'forced' value, or the analog output will remain locked at the last value set in the 'forced' column. You can do this by hitting the '-' key twice, or hitting the '3' (decrement forced value) one more time after it is already at zero.

[5] 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.

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 'forced' position value to zero (a 2nd time clears 'forced')

'+' or '=')sets the 'forced' position value to 100%

2) decrements the 'forced' position value

5) sets the 'forced' position value to 128 (50%)

8) increments the 'forced' position value

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.

Q) Force 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 DAC-Quad 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 forced will be displayed in the 'Forced Output' column on the display.

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

T) Power On Defaults

The Power On defaults are used by the DAC-Quad only if there is no AutoDownload file found. If there is a AutoDownload file on the Micro Sd/SdHC flash card in the DAC-Quad, 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 DAC-Quad is first powered up. This command gives you the option of:

a) Capturing the current value as the default value for the currently selected output.

b) Capturing the current values as the default value for all outputs.

c) Entering a value as the default value for the currently selected output.

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

W)Set Analog Endpoints

This command is used to adjust the endpoints of the sixteen analog outputs. The ‘Set Min/Max/Forced using Keypad’ is a much easier way of setting these values. 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 2.5 volts to 7.5 volts: Looking at the chart at the end of this manual, you can see that this would be from approximately 25% to 75% of full scale. From the chart you would see that the values that should be entered would be 64 (40h) and 192 (C0h).

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.

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.

N) Next

This moves the ‘Output to test & Adjust’ arrow down by one line.

L) Last

This moves the ‘Output to test & Adjust’ arrow up by one line.

l) Card Status

This command displays information on the currently loaded AutoDownload file:

a) FileName of this AutoDownload file (this is set during the AutoDownload process when you save the file to disk)

b) Name of the DAC-Quad card that this AutoDownload is intended for. This 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 DAC-Quad 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 (this is set on the ' Device Settings' dialog, where between one and eight sequencers can be assigned to a single DAC-Quad. 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 DAC-Quad 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 DAC-Quad without consulting Gilderfluke & Co. first.

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

h) Smpte Error Count. This is the number of good consecutive frames of Smpte that the DAC-Quad must receive before it believes it. Typically

this set to around five. This 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 DAC-Quad 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)

i) 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

j) 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

k) If there is an attempt to start a show while another show which is unsteppable[6] 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

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

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

m) v1.0 AutoDownload file header

n) 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'
    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

o) the current output level of each ServoMotor output

J) Reload Defaults

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

If the 'number system' is set to milliseconds, the DAC-Quad presumes you are mainly interested in the ServoMotor outputs, so instead of setting the 'minimum' to '0' and the 'maximum' to '100%', it will default to '1.000ms' and '2.000ms', which is the range of movement that most ServoMotors expect as a defuilt range.

P) Play/Loop

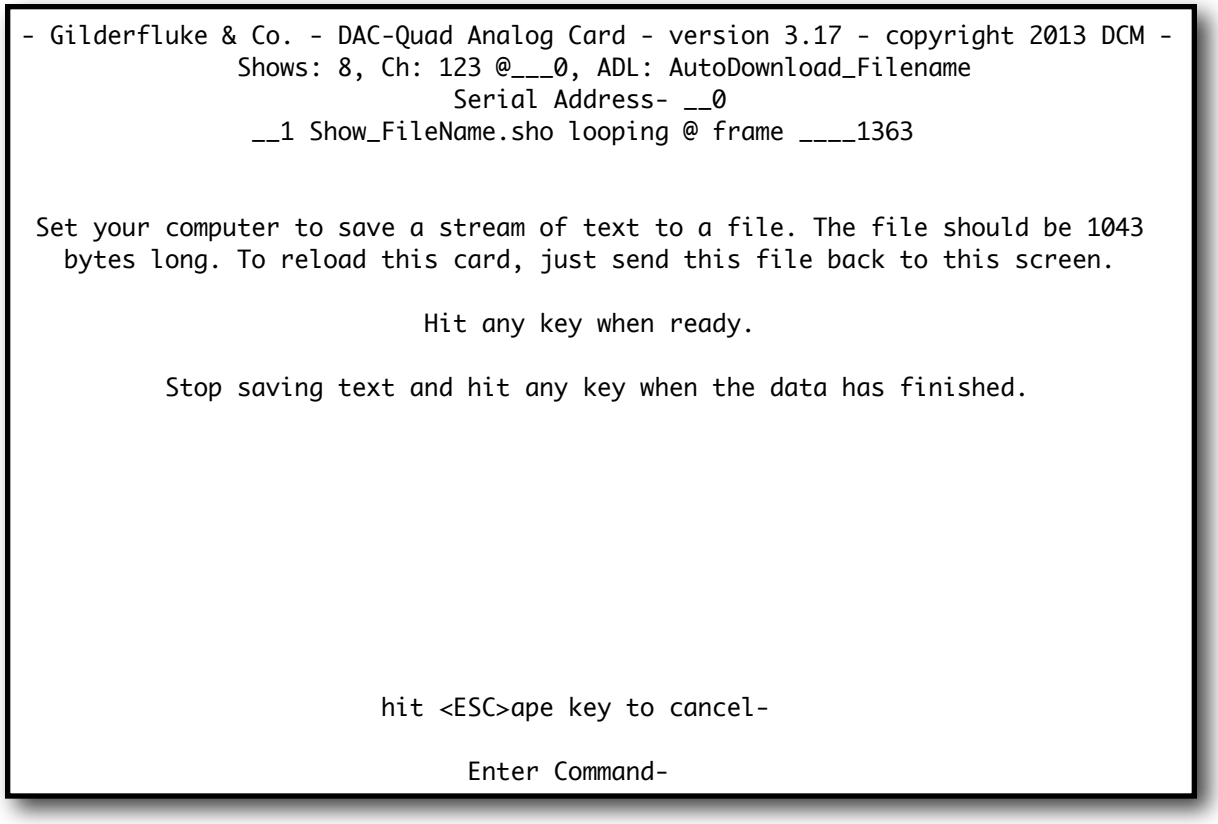
If operating as a 'Dumb' Brick, allows you to select and play a show.

H) Halt

If operating as a ‘Dumb’ Brick, allows you to stop the currently playing show.

R) Save Configs

This command is used to save the current configuration of the DAC-Quad through the serial port to a file on your computer. This file can then be reloaded into this, or any other DAC-Quad. To use this command, you first invoke it, then following the instructions, you set your computer to receive a string of ASCII characters.



You then press any key to tell the DAC-Quad to send out it's configuration. When it has finished, you then tell your computer to stop saving characters, and then hit any key to tell the DAC-Quad to redraw the screen.

V) Verify

This command verifies the data stored in the DAC-Quad's flash memory. 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

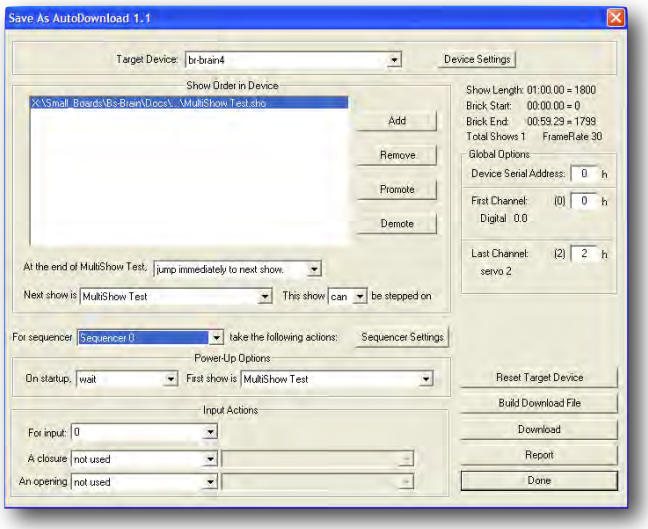
This exits the configuration mode and returns the DAC-Quad to the command mode. When exiting you must enter a 'y' or 'n', to preserve compatibility with some other Gilderfluke & Company cards.

Optically Isolated Trigger Input Actions

The following Input Actions are used to start, stop, and generally control the DAC-Quad through its two optically isolated trigger inputs. The optically isolated trigger inputs can be used as the sole method to control the DAC-Quad, or as an adjunct to the DAC-Quad's primary serial port.

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 DAC-Quad.

The DAC-Quad has two Trigger Inputs. You can set different Input Actions for the 'closing Edge' [7] on the input and the 'opening Edge' [8].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 DAC-Quad 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.

---

[7] 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 DAC-Quad's 'status' command and 'main' menu.

[8] 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 DAC-Quad'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 DAC-Quad to start the selected show with the 'looping' flag set. On the DAC-Quad'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 DAC-Quad 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 DAC-Quad'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 DAC-Quad'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 DAC-Quad'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 DAC-Quad'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 a DAC-Quad playing immediately, and prevents the DAC-Quad from being restarted until the 'Clear E-Stop' input action is received, or the DAC-Quad 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 DAC-Quad and an E-Stop button will 'fail safe' on the DAC-Quad.

On the DAC-Quad's menus, the show status will be shown as 'E-Stop', to indicate that the DAC-Quad 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 a DAC-Quad. 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 DAC-Quad.

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 the first activation of this input, the DAC-Quad 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 DAC-Quad 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 DAC-Quad.

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 [10]. On each activation of this input, the DAC-Quad 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

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

[10] 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 DAC-Quad 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 DAC-Quad. 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 DAC-Quad ‘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. If the wind level gets to the preset ‘threshold’, the anemometer ‘closes’ this input. This tells the DAC-Quad 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 DAC-Quad to scale the outputs to 100%, and return the fountain to normal operation.

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 DAC-Quad 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 DAC-Quad's input scan rate, which can result in unexpected shows being selected and played.

Serial Port Commands

The following commands are used to start, stop, and generally control the DAC-Quad through its primary serial port. The serial port commands can be used as the sole method to control the DAC-Quad, or as an adjunct to the DAC-Quad's two optically isolated trigger inputs.

The DAC-Quad'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 DAC-Quad's (and other GilderGear's) RS-232 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.

Typical modem programs you can use with Gilderfluke & Co. equipment are Terminal.exe (which came with Windows 3.1) and HyperTerm.exe (which comes with later versions of Windows), or GilderTerm. The shareware Z-Term can be used on Macintosh computers.

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 DAC-Quad 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 DAC-Quad, the serial address for a card is permanently at '00'. The '(card address)' for a DAC-Quad is always '00'.

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 DAC-Quad. 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 DAC-Quad. If you want to update the status information displayed, you must hit the 'Card Status' command again.

When the DAC-Quad receives this command, it will respond with the following:

```
Gilderfluke & Co.
DAC-Quad
v3.17 - copyright 2013 DCM
Shows: 2, Ch: 123 @ ___0, ADL: AutoDownload_Filename
DAC-Quad Name @ Serial Address: __0
show #__1 Show_FileName looping @ frame ______38
input A: open
input B: open
```

Status Dump

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 DAC-Quad 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 DAC-Quad(s) addressed by the command. The shows will always start from the beginning (frame zero). If an addressed DAC-Quad is looping shows, it will have the 'LOOPING SHOWS' flag reset.

If the DAC-Quad 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 a DAC-Quad 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 DAC-Quad, they can be set to ignore additional start commands while they are playing. This allows individ-

ual shows to be 'stepped' upon or not. If the DAC-Quad 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 DAC-Quad(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 DAC-Quad 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 DAC-Quad(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 DAC-Quad. These commands can be used to select an individual show on the selected DAC-Quad(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.

I) Show Pause Commands:

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

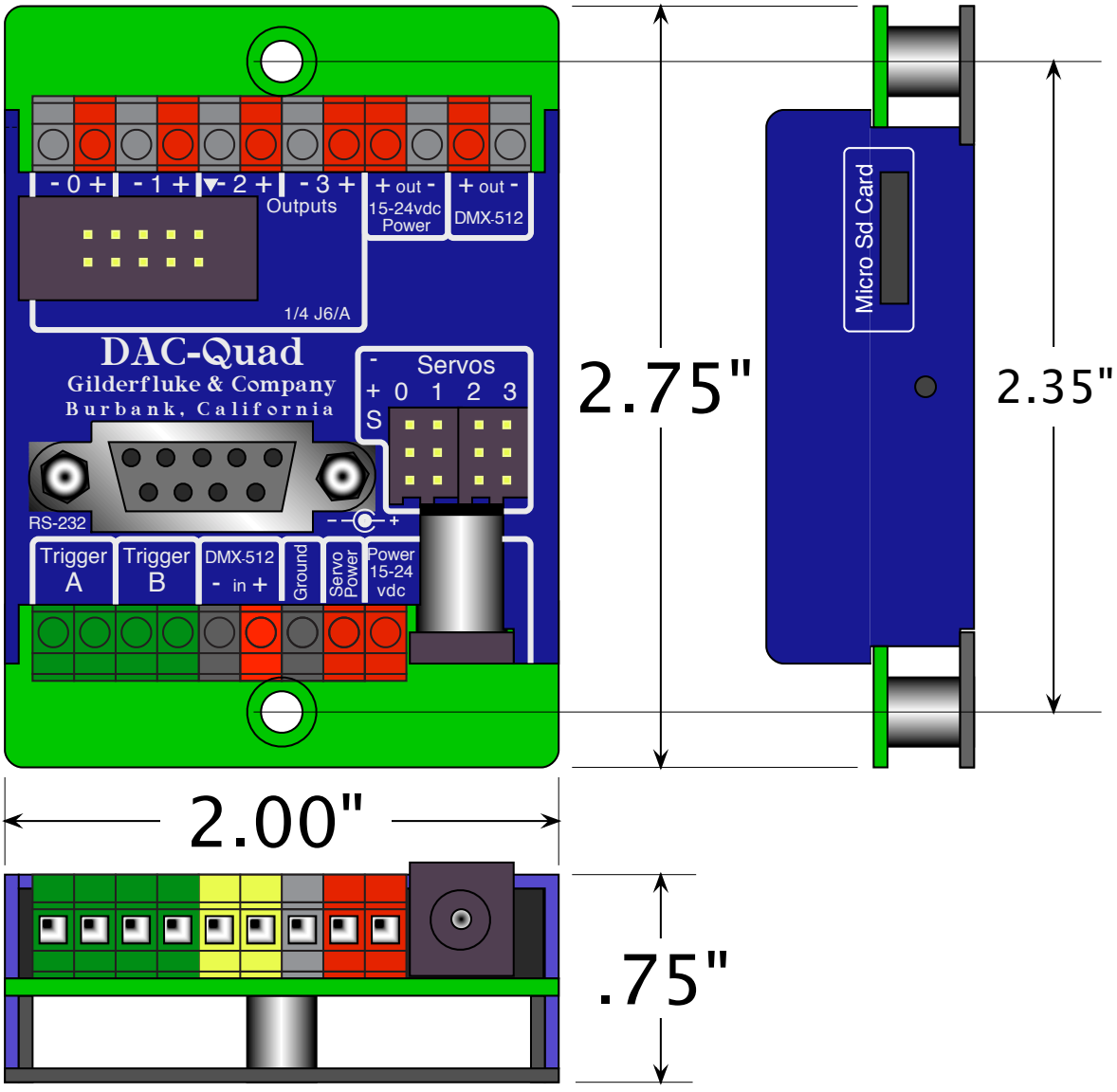
Any show can be paused at any point during its playback. The outputs are frozen at the 'levels they were at the instant the PAUSE command is received.

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

DAC-Quad Dimensions & Mounting

The DAC-Quad can easily be mounted in one of several ways:

1) All of the Br-miniBrick sized pieces of GilderGear can easily be mounted in 2-¾" Snap-Track. This includes the DAC-Quad.
2) A pair of DIN Adapters can be snapped onto the back of the DAC-Quad. Once snapped into place, you'll have a devil of a time getting them off again. They allow the DAC-Quad to attach to standard DIN rail.
3) There are two .156" diameter mounting holes for mounting the DAC-Quad to a panel. They are on 2.35" centers.
4) It is not uncommon to simply attache self-adhesive Velcro to the back of a DAC-Quad and stick it to your control panel.



this page is not blank

DAC-Quad Firmware Updates

The firmware in a DAC-Quad can easily be upgraded at any time. To update the firmware:

1) Download the DACQUAD3.FRM file from the Gilderfluke & Co. website
2) Unzip the file (if needed)
3) Place the DACQUAD3.FRM file onto a formatted Sd/SdHC flash card
4) Power down (or disable) whatever the DAC-Quad is controlling. You don't want your show to do anything unexpected during the update
5) While the DAC-Quad is running, remove the Sd/SdHC flash card it is using
6) Replace it with the Sd/SdHC flash card that holds the DACQUAD3.FRM file
7) The DAC-Quad will update itself
8) Once the firmware update has completed, remove the Sd/SdHC flash card that has the DACQUAD3.FRM file on it
9) Insert the the Sd/SdHC flash card with your shows on it
10) Power back up (or enable) whatever the DAC-Quad is controlling.

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

The first stage is comparing the DACQUAD3.FRM file on the Sd card. It then flashes a little slower as it reads the DACQUAD3.FRM file in from the Sd card. It then flashes back and forth much more quickly as it reprograms the microcontroller in the DAC-Quad.

Under no circumstances remove power from the DAC-Quad while firmware is being updated. A partial firmware update may 'brick' the DAC-Quad, 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%