

OPERATING INSTRUCTIONS
for
SIXTEEN CHANNEL SERVO MOTOR CONTROLLER
and
SIXTEEN CHANNEL JOYSTICK AMPLIFIER

February 27, 1999

The 16 Channel Servo Motor Controller is used to adapt a 0 to 10 volt analog control signal to the pulse width modulated signal required to control model airplane-style servo motors. These can be used to animate light weight or short lived pieces of animation as are often used in motion picture special effects. This type of servo motor is not reliable enough to be used in most permanent animation applications unless your are willing to replace them on a fairly regular basis.

The 16 Channel Joystick Amplifier is used to raise the small output swing of a joystick or other potentiometer to a 0 to 10 volt level. It is often used in conjunction with the 16 Channel Servo Motor Controller. It can also be used to live puppet Atchley Mechanical FeedBack (MFB) actuators, Electronic FeedBack (EFB) pneumatic and hydraulic actuators, or any other type of device which requires a 0 to 10 VDC control input.

The Servo Motor Controller has 16 independent inputs and outputs. They can be used with MACs full-sized animation control systems or with any other source of 0 to 10 VDC control signals. Up to eight of these cards can be used directly with the outputs from each analog output card in a full-sized PC·MACs animation control system for up to 128 servo motors per analog output card. A full-sized system can contain up to two of these analog output cards to control up to 256 servo motors at one time.

The 16 Channel Servo Motor Controller is often used in motion picture special effects to control servo motors through 'live' puppetry. In this case there is no computer or animation control system used between the operator inputs and servo motor controller. The inputs can come directly from a potentiometer if it is going to be moved most or all of its stroke. When using joysticks and similar input devices, the potentiometer's wiper only travels a small percentage of the overall stroke of the pot. To boost these relatively small voltage changes up to the levels needed by the servo motor controller, the 16 Channel Joystick Amplifier can be used.

A Joystick Amplifier can be paired with a set of joysticks and calibrated for a 0 to 10 VDC output. This rig can then be moved between a number of different animated figures which are expecting this signal level without having to recalibrate them each time.

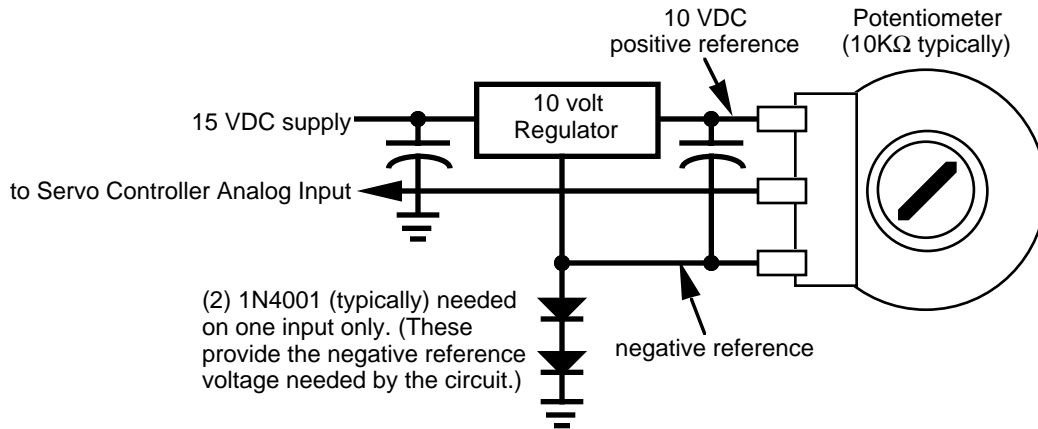
- SERVO MOTOR CONTROLLER CONNECTIONS -

The Servo Motor Controller gets its power and data through a standard J-6/A data cable. The pin out of this cable is as follows:

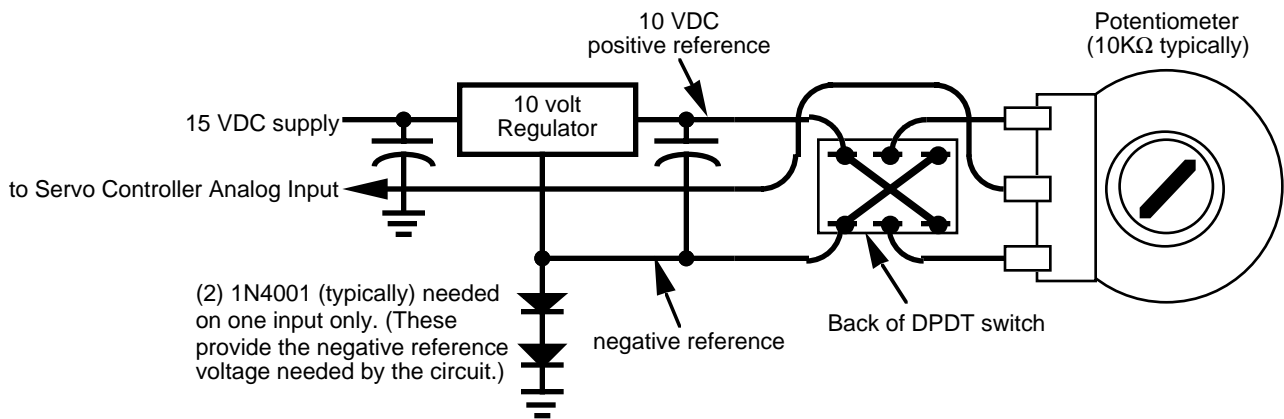
Pin #1	BROWN	GROUND
Pin #2	RED	15 Volt DC Supply Input
Pin #3	ORANGE	Channel 16 (0FH) 0-10 volt DC Analog Input
Pin #4	YELLOW	Channel 16 (0FH) Reference
Pin #5	GREEN	Channel 15 (0EH) 0-10 volt DC Analog Input
Pin #6	BLUE	Channel 15 (0EH) Reference
Pin #7	VIOLET	Channel 14 (0DH) 0-10 volt DC Analog Input
Pin #8	GRAY	Channel 14 (0DH) Reference
Pin #9	WHITE	Channel 13 (0CH) 0-10 volt DC Analog Input
Pin #10	BLACK	Channel 13 (0CH) Reference
Pin #11	BROWN	GROUND
Pin #12	RED	15 Volt DC Supply Input
Pin #13	ORANGE	Channel 12 (0BH) 0-10 volt DC Analog Input
Pin #14	YELLOW	Channel 12 (0BH) Reference
Pin #15	GREEN	Channel 11 (0AH) 0-10 volt DC Analog Input
Pin #16	BLUE	Channel 11 (0AH) Reference
Pin #17	VIOLET	Channel 10 (09H) 0-10 volt DC Analog Input
Pin #18	GRAY	Channel 10 (09H) Reference
Pin #19	WHITE	Channel 9 (08H) 0-10 volt DC Analog Input
Pin #20	BLACK	Channel 9 (08H) Reference
Pin #21	BROWN	GROUND
Pin #22	RED	15 Volt DC Supply Input
Pin #23	ORANGE	Channel 8 (07H) 0-10 volt DC Analog Input
Pin #24	YELLOW	Channel 8 (07H) Reference
Pin #25	GREEN	Channel 7 (06H) 0-10 volt DC Analog Input
Pin #26	BLUE	Channel 7 (06H) Reference
Pin #27	VIOLET	Channel 6 (05H) 0-10 volt DC Analog Input
Pin #28	GRAY	Channel 6 (05H) Reference
Pin #29	WHITE	Channel 5 (04H) 0-10 volt DC Analog Input
Pin #30	BLACK	Channel 5 (04H) Reference
Pin #31	BROWN	GROUND
Pin #32	RED	15 Volt DC Supply Input
Pin #33	ORANGE	Channel 4 (03H) 0-10 volt DC Analog Input
Pin #34	YELLOW	Channel 4 (03H) Reference
Pin #35	GREEN	Channel 3 (02H) 0-10 volt DC Analog Input
Pin #36	BLUE	Channel 3 (02H) Reference
Pin #37	VIOLET	Channel 2 (01H) 0-10 volt DC Analog Input
Pin #38	GRAY	Channel 2 (01H) Reference
Pin #39	WHITE	Channel 1 (00H) 0-10 volt DC Analog Input
Pin #40	BLACK	Channel 1 (00H) Reference

To connect a potentiometer to the input of the Servo Controller, you will need to provide a 10 VDC reference and 15 VDC power supply. The 10 volt DC and negative references can be shared by all of the potentiometers attached to a Servo Controller. Its current requirements are minimal, since about the only current flow is that through the potentiometers. The same 15 volt DC supply that powers the 10 volt reference can also be used to power the Servo Controller through one or more of the **'15 Volt DC Supply' input pins**.

When using direct potentiometer inputs to the Servo Controller, the pot must travel all or nearly all of its stroke. If it doesn't, or you can't get all of the stroke you need on the servos, a Joystick Amp may be needed. A Joystick Amplifier or the output from a PC-MACs Animation Control System will provide all of the voltage references and power supplies needed by the Servo Controller.

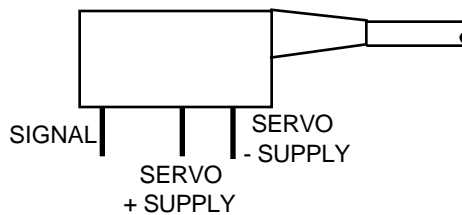


If you need to reverse the direction of any of the potentiometer inputs, you can reverse the positions of the positive and negative references for that input potentiometer. A Double Throw, Double Pole (DPDT) switch can be added if you will need to change it regularly:

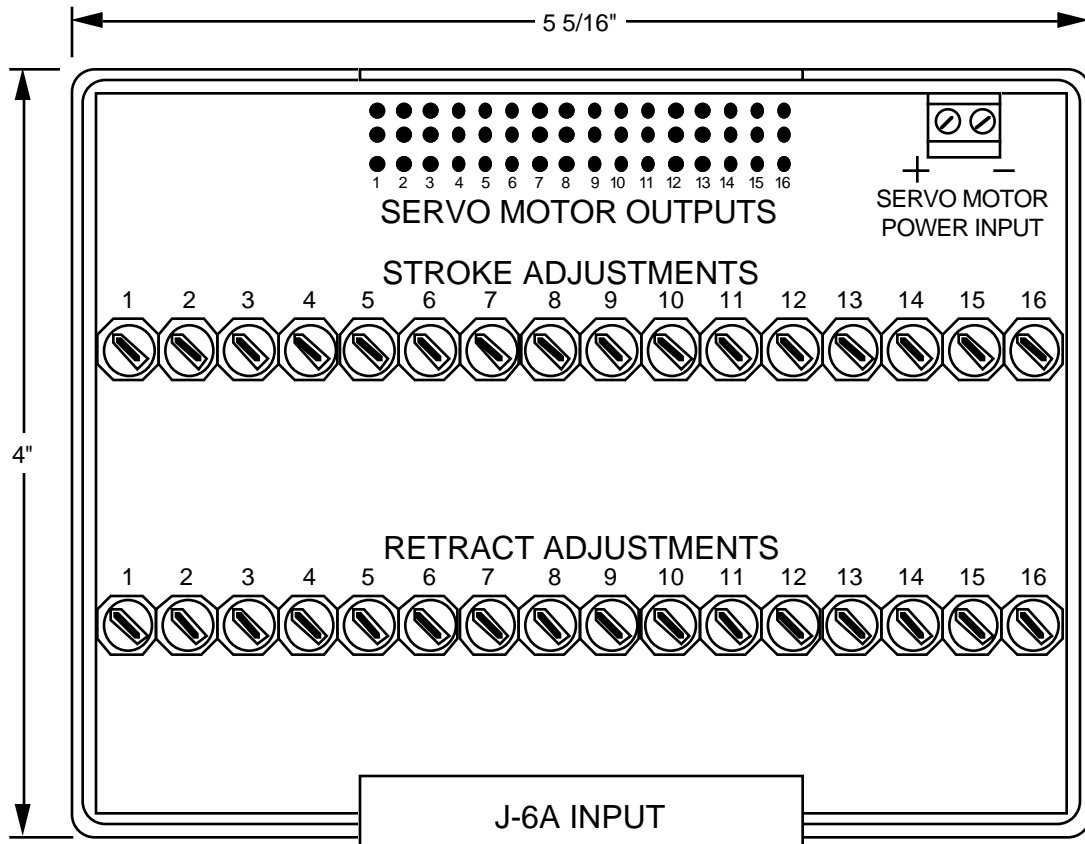


The pot must swing symmetrically around its middle point when this option is used.

The 16 servo motors are connected to the standard three pin sockets used by many brands of servo motors. Some newer servo motors use a slightly different connector, and an adapter for this style of connector is available from the servo motor manufacturers. The pin out for these servo motor connections is as follows:



The last remaining connector is for attaching the power supply which is used to power the servo motors. The power for these must come from an external source as they can potentially use a lot more current than the animation system can normally supply. Most servo motors run from a voltage between 3.5 volts and 7.5 volts. The lower the voltage the less strength and speed a given servo motor will have. A higher voltage will give that same servo motor greater speed and strength.



In some cases a lower speed is desired for the smoothness of the movement, while in other cases the need for high speed or strength may be paramount. The chief disadvantages of running the servo motors in high voltage / high speed applications are that the servo motor will run hotter and is much more likely to have a mechanical failure.

The size of the servo motor, the load it is driving, and the amount of movement it is doing can all effect the amount of current it will require. Most of the smaller servo motors draw about an amp of current at stall (This is when the servo motor shaft is held against the motor's best efforts to move it.). This condition isn't often encountered in any real world applications, but if you are planning on really abusing your servo motors you should allow about an amp per motor when selecting a power supply. Under most normal conditions, 1/4 to 1/2 an amp per servo motor will be sufficient. If your power supply is undersized, you will see a certain amount of interaction between servo motors when a number of them are moving at the same time.

To reduce the number of wires needed to run into a servo motor-controlled figure it is not uncommon to run the high current power supply leads directly from the power supply to the servos in the figure and gang the signal lines. When this is done, it is still necessary to run low current leads from the power supply to the power supply connections on the Servo Motor Controller board. If the signal line runs to the servo motors are long, it may be necessary to use shielded lines to prevent noise and cross-talk between the servos. You can tell when you have this problem when some servo motors are tending to jitter uncontrollably.

Be aware that the servo motor input signals are notoriously bad travelers. They are susceptible to any power supply noise, radio frequency (RF) interference, and even the noise from other servo motors. Try to keep these lines as short as possible. Anything over 10 feet can cause problems. Even shorter lengths can have problems under the right circumstances. Possible solutions include large capacitors across the power supply leads and pullup resistors between the signal input and the positive supply line. These must be located as close as possible to the servo motors.

Each channel of the Servo Motor Controller has two adjustments. The first sets the 'retracted' position

for the servo motor. The other sets the length of the 'stroke' away from the retract position, and therefore the extended position. The retract position is always set before you try to set the 'extend' position.

Some caution must be used when adjusting servo motors or mechanical movements which may be damaged by being commanded to go to a position beyond that which they are designed to move. In these cases it is sometimes best to adjust both the retract and stroke trimpots to a center position for the movement and then adjust them slowly outward from there.

The 16 Channel Servo Motor Controller comes in a plastic case which can be mounted by simply double face taping it where ever you need. If you need to mount it more solidly, then put screws through the back of the case as needed. The front of the case can be removed for service and adjustment after the box has been mounted.

The capabilities of the Servo Motor Controller outputs are as follows:

OUTPUT:	OPEN COLLECTOR SWITCH TO GROUND
PULLUP:	4.7K PULLUP TO + SERVO POWER SUPPLY
OUTPUT CURRENT:	16 ma MAXIMUM
OUTPUT/SERVO VOLTAGE:	5 VDC NOMINAL / 36 VDC MAXIMUM

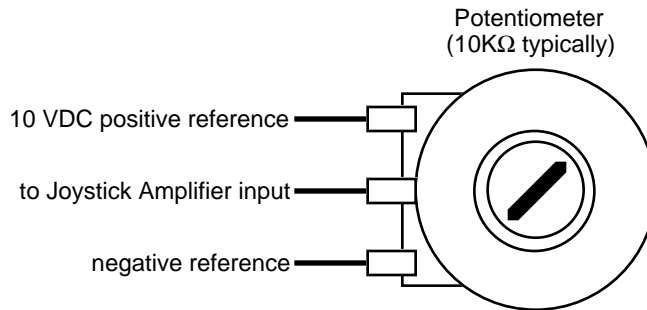
- JOYSTICK AMPLIFIER CONNECTIONS -

The inputs to the Joystick Amplifier is designed to be attached to up to 16 potentiometers. Typical value for the pots is 10 Kohm. To ease the job of wiring to the pots, a 50 wire ribbon cable is used for the input. Starting from the number one wire position, the first wire goes to one side of the pot, the next goes to the middle (wiper) pole of the pot, and the third wire goes to the third connection of the pot. This then repeats for the other 15 pots. The pin out for the connector is as follows:

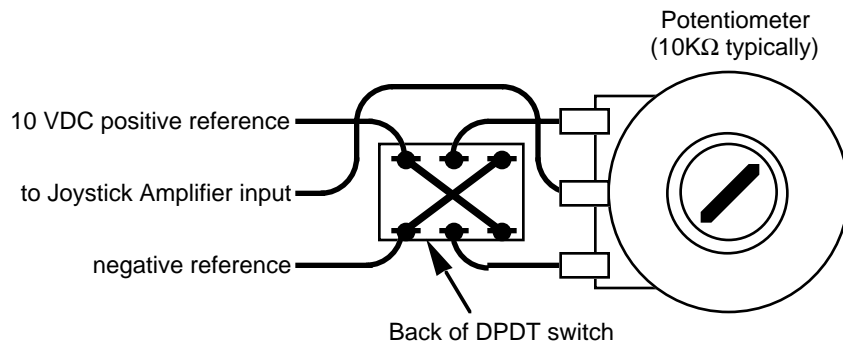
PIN #1	BROWN	Negative Reference #16
PIN #2	RED	Joystick Amplifier Input #16
PIN #3	ORANGE	Positive Reference #16
PIN #4	YELLOW	Negative Reference #15
PIN #5	GREEN	Joystick Amplifier Input #15
PIN #6	BLUE	Positive Reference #15
PIN #7	VIOLET	Negative Reference #14
PIN #8	GRAY	Joystick Amplifier Input #14
PIN #9	WHITE	Positive Reference #14
PIN #10	BLACK	Negative Reference #13
PIN #11	BROWN	Joystick Amplifier Input #13
PIN #12	RED	Positive Reference #13
PIN #13	ORANGE	Negative Reference #12
PIN #14	YELLOW	Joystick Amplifier Input #12
PIN #15	GREEN	Positive Reference #12
PIN #16	BLUE	Negative Reference #11
PIN #17	VIOLET	Joystick Amplifier Input #11
PIN #18	GRAY	Positive Reference #11
PIN #19	WHITE	Negative Reference #10
PIN #20	BLACK	Joystick Amplifier Input #10
PIN #21	BROWN	Positive Reference #10
PIN #22	RED	Negative Reference #9
PIN #23	ORANGE	Joystick Amplifier Input #9
PIN #24	YELLOW	Positive Reference #9
PIN #25	GREEN	Negative Reference #8
PIN #26	BLUE	Joystick Amplifier Input #8
PIN #27	VIOLET	Positive Reference #8
PIN #28	GRAY	Negative Reference #7
PIN #29	WHITE	Joystick Amplifier Input #7
PIN #30	BLACK	Positive Reference #7
PIN #31	BROWN	Negative Reference #6
PIN #32	RED	Joystick Amplifier Input #6
PIN #33	ORANGE	Positive Reference #6
PIN #34	YELLOW	Negative Reference #5
PIN #35	GREEN	Joystick Amplifier Input #5
PIN #36	BLUE	Positive Reference #5
PIN #37	VIOLET	Negative Reference #4
PIN #38	GRAY	Joystick Amplifier Input #4
PIN #39	WHITE	Positive Reference #4

PIN #40	BLACK	Negative Reference #3
PIN #41	BROWN	Joystick Amplifier Input #3
PIN #42	RED	Positive Reference #3
PIN #43	ORANGE	Negative Reference #2
PIN #44	YELLOW	Joystick Amplifier Input #2
PIN #45	GREEN	Positive Reference #2
PIN #46	BLUE	Negative Reference #1
PIN #47	VIOLET	Joystick Amplifier Input #1
PIN #48	GRAY	Positive Reference #1
PIN #49	WHITE	NO CONNECTION
PIN #50	BLACK	NO CONNECTION

A typical connection for a pot is as follows:

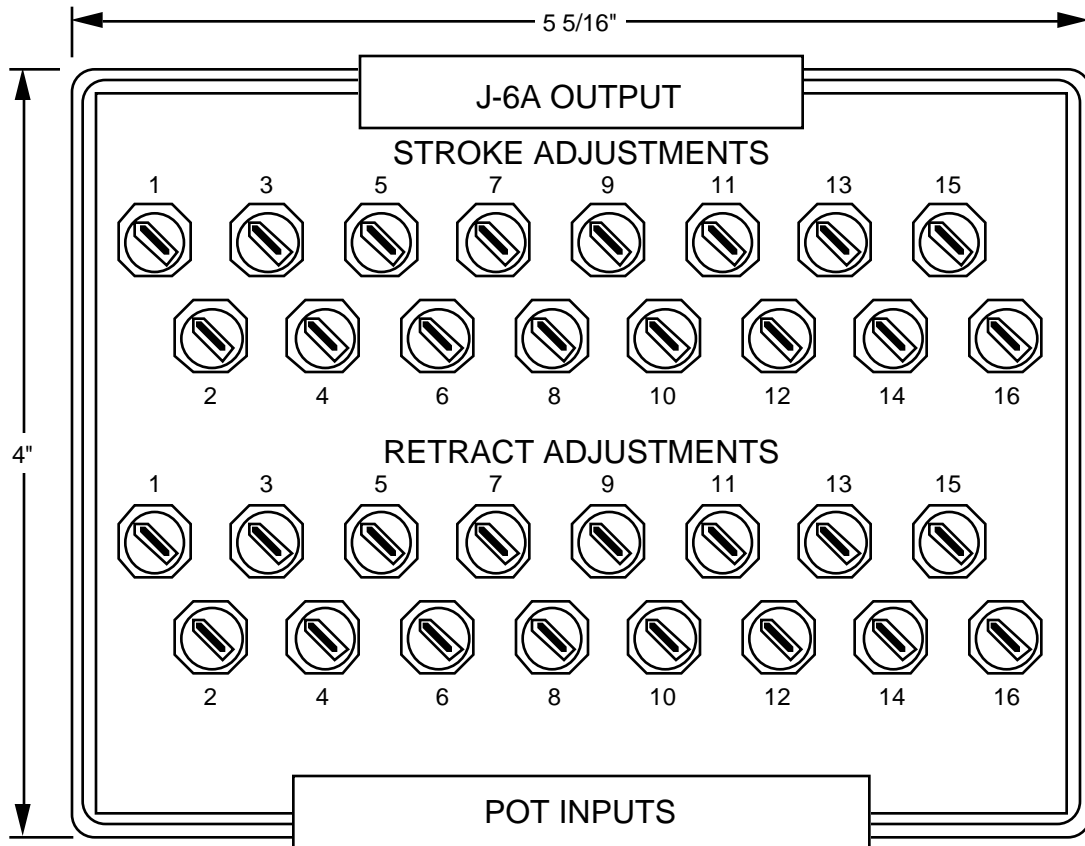


If you need to reverse the direction of any of the potentiometer inputs, you can reverse the positions of the positive and negative references for that input potentiometer. A Double Throw, Double Pole (DPDT) switch can be added if you will need to change it regularly:



The pot must swing symmetrically around its middle point when this option is used.

All of the positive and negative references fed to the pots are wired in parallel. If needed, a single pair of wires may be used for the references to a number of different pots.



The output of the Joystick Amplifier is a standard J-6/A output. The pin out for this connection can be found above in the Servo Motor Controller wiring instructions.

Each channel of the 16 Channel Joystick Amplifier has two adjustments. The first sets the output level for the 'retract' end of the pot. This is where the Joystick Amp is usually adjusted for a 0 VDC output. The second adjustment sets the 'stroke' length, and therefore the high level output for the channel. This is normally adjusted to 10 VDC. These two adjustments interact somewhat, so each will need to be adjusted in turn until the desired output levels are achieved. When used with a 16 Channel Servo Motor Controller, the adjustments on the Joystick Amplifier must be made first.

Power for the Joystick Amplifier comes from a small wall mount-style transformer attached to it. When used with the 16 Channel Servo Motor Controller, this transformer supplies power for both units through the Joystick Amp. A LED on the front of the Joystick Amp shows that it has power to it.

The 16 Channel Joystick Amplifier comes in a plastic case which can be mounted by simply double face taping it where ever you need. If you need to mount it more solidly, then put screws through the back of the case as needed. The front of the case can be removed for service and adjustment after the box has been mounted.

The output capabilities of all Joystick Amplifiers are as follows:

OUTPUT VOLTAGE:	0 TO 10 VDC
OUTPUT CURRENT:	0 TO 24 ma
OUTPUT DEVICE:	LM324
OUTPUT PROTECTION:	OVERVOLTAGE/CURRENT PROTECTION INHERENT TO LM324