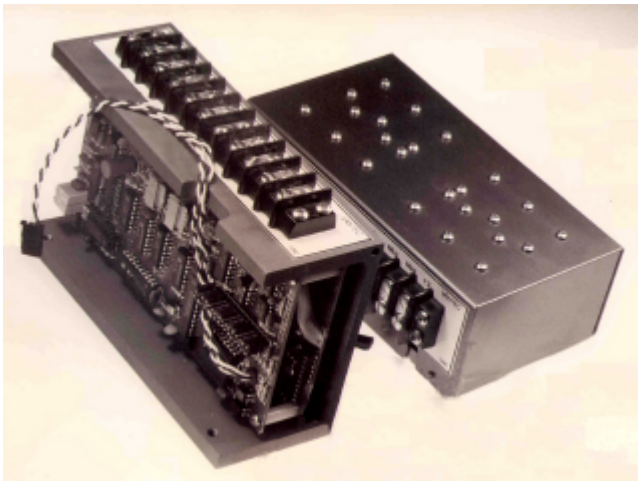
VANTEC

Help: **(800)882-6832**

R/C AUTONOMOUS BULLY POWER CLASSIC PWM SERVO AMPLIFIER

MANUAL



- **MODELS RBSA13 - RBSA26E**
- **BUILD MONSTER POSITION SERVOS**
- **POSITION or VELOCITY**
- **CLOSED LOOP CONTROL**
- **21 KHz PWM RATE**
- **SMOOTH & QUIET**
- **LAG/LEAD ADJUSTABLE**
- **CLASSIC DESIGN USED**

OVERVIEW: The RBSA **BULLYs** are closed-loop **P**ulse **W**idth **M**odulation servo amplifiers with a selection of output ratings big enough to push hundreds of pounds around! They are commanded by a single channel from a conventional **R**adio/**C**ontrol receiver. The *optically isolated* input plugs into your Futaba J, Hitec, JR, or Airtronics receiver like any other servo. Use these stand-alone units to build your own custom battery powered position servos with potentiometer **F**eed**B**ack or velocity servos with DC tachometer FB. The sturdy output circuitry drives DC Permanent Magnet brush commutated motors. Powerful proportional position servos may be constructed quickly by using SKF, Warner, or similar linear actuators with built in FB potentiometers.

They are not simply "boosted" hobby servo electronics but instead employ 10 bit digital techniques to convert the Servo Command Pulse to a stable command voltage for classic analog processing. The analog circuitry compares the command voltage with the FeedBack element voltage to generate an error signal. Servo systems require electronic compensation for mechanical attributes like inertia. Unlike hobby servos the **BULLY** features a full compliment of adjustments to facilitate stable servo systems up to the limits of the mechanics.

The error signal is then converted to 21KHz PWM to drive a modern MOSFET H-bridge output amplifier. No special heatsinks are required. Provision for low current limit switches that close to shunt the PWM drive are provided Finally, a microprocessor performs house keeping functions for a well behaved system under fault conditions. See Block Diagram.

Velocity applications are briefly covered in the back of the manual.

POSITION SERVO INSTRUCTIONS: The **BULLY** must be set up by you for your actuator and system. This includes feedback calibration, lag/lead components, TrimPots, and Logic Jumpers. After establishing proper operation plug-in parts should be secured with silicone or solder to prevent them from falling out under vibration.

The factory default setting for the Logic Jumpers and TrimPot adjustments are for the **Position Servo mode,** with a specified failsafe position, and the STanDard transfer curve. Providing you are constructing a position servo we recommend modifying the jumpers and adjustments ONLY AFTER you have the system operational.

HOWEVER, every installation has different feedback requirements so calibration resistors R44 and R49 must be installed by you BEFORE the system can be tried. The **RBSA** requires your FB element to be between 2.5K and 25K ohms. It must be designed for servo service with suitable bearings, be monotomic, and driven by low backlash gears. Actuators are available with built in FB pots. Ideally your feedback element supplies a DC voltage range over its desired mechanical range that matches or tracks the **S**ervo**C**ommand**P**ulse's resultant analog voltage which nominally is a +-0.939 mV

VANTEC RBSAc SERVO AMP

change from 2.5 V for each +-1 microsecond change from 1.533 ms; OR:

SCP milliseconds	Equivalent FB voltage	Comments
.896	**3.1**	***absolute limit***
1.533	**2.5**	CENTER
2.175	**1.895**	***absolute limit***

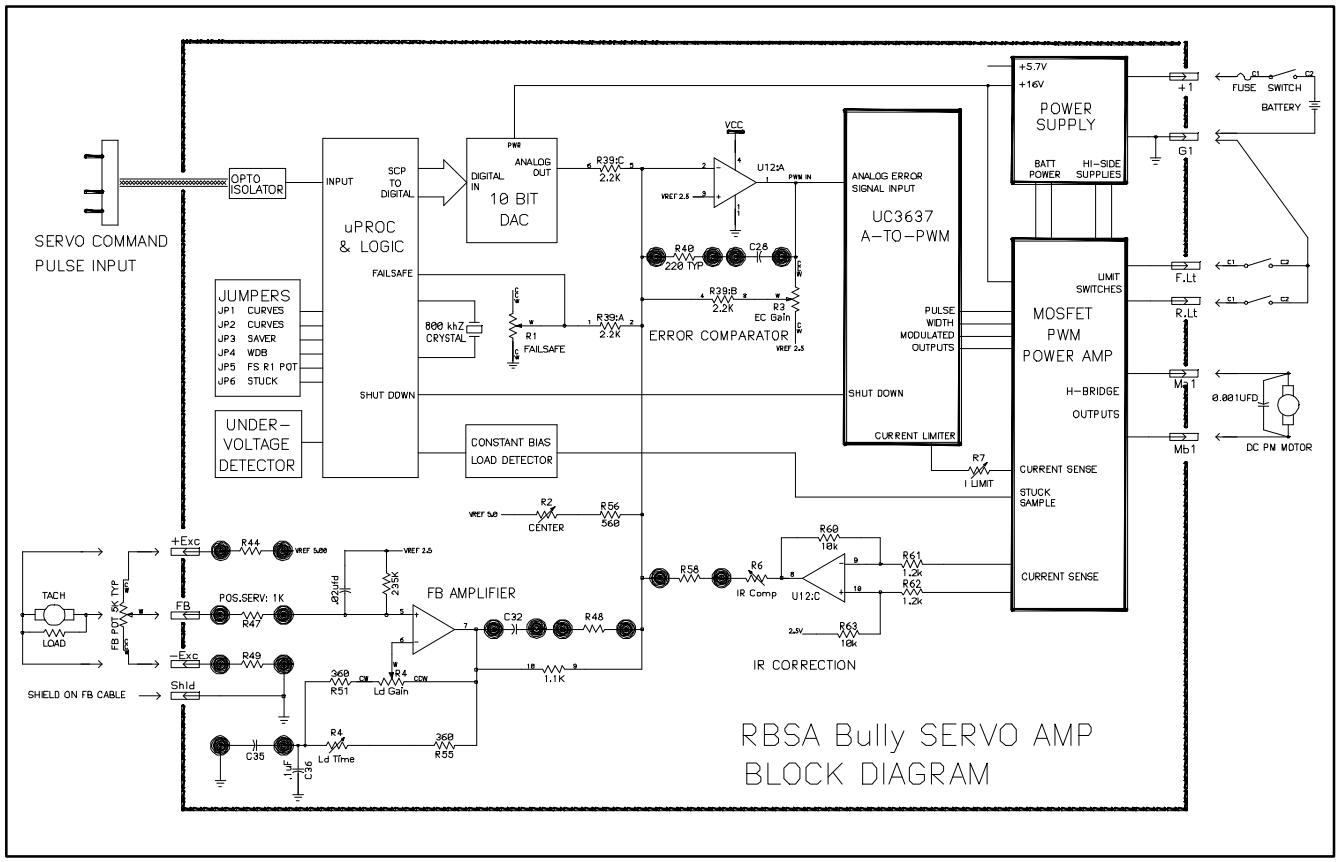
While 1-2ms is the nominal pulse span commonly mentioned actual radios may vary. For example: the Futaba FP-8UAP swings between 1.12 ms and 1.94 ms with 100% ATV, 100% Dual Rate, no trim, and factory settings, on the aileron channel.

The RBSA excites the FB potentiometer by 5V through calibration resistors from the -Exc and +Exc terminals. The -Exc terminal plug-in calibration resistor is R49 to ground. The +Exc plug-in calibration resistor is R44 to +5V. These resistors plus the FB potentiometer form a three resistor voltage divider so the proper excitation voltage on the FB element may be set. More voltage on the FB pot yields less servo travel. The mechanical center of your mechanical system should yield a FB pot voltage of 2.50V. Note that this may be or not be the FB pots actual center, use the excitation resistors R44 and R49 handle the offset. The load on your FB pot wiper is 235K at 2.5 V. Trimpot R2 Center provides some adjustment for SCP and excitation tolerances.

A Calculator program for Windows95/MS-DOS is available from our www.vantec.com website. Resistor R47 is 1k and is in series with the FB pot wiper and a capacitor forms a "wiper noise" filter.

UNDERSTANDING THE ADJUSTMENTS: No servo amplifier and motor, no matter how powerful, can stop instantaneously because of inertial lag. So it is necessary to anticipate closure to the target position. When the servo is moved slowly it stops easily but at full speed it takes longer to stop. The time necessary is proportional to the speed. The rate-of-change in FB voltage yields this needed speed information. VANTEC introduces Lead compensation in the FB amplifier before the error comparison circuitry. The FB amplifier has a fixed gain DC section to accurately know position and an AC delta-rate section to derive the Lead compensation. This AC gain momentarily modifies the position output to anticipate closure to the target position.

The **RBSA BULLY** provides adjustable compensation that includes **Lead Gain, Lead Time, Error Comparison Gain, Centering, and FailSafe** TrimPots plus plug-in components for other parameters. *Vantec has set these for your initial*



operation so it is only necessary to have a rudimentary understanding of them.

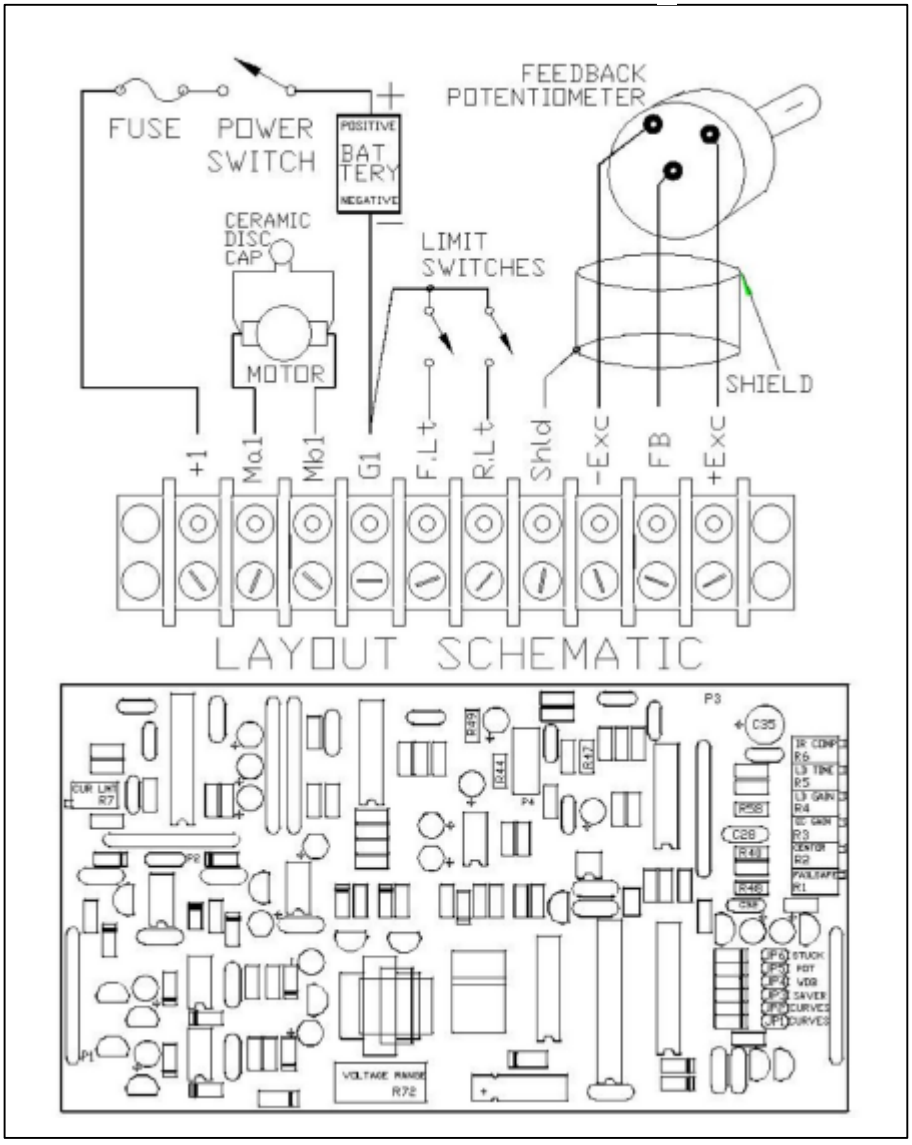
See the Block Diagram. The AC gain and frequency response are adjustable by R4 Ld Gain and R5 Ld Time trimpots. VANTEC expresses the frequency response as time; think of it as braking time. Because mechanics size and inertia vary widely among applications a plug-in compensation capacitor C35 is provided. It is the course adjustment and R5 Ld Time is the fine adjustment. Clockwise on this and all 25 turn trimpots increases their function. R5 Ld Time adjusts over a 20:1 range. Begin by using the default C35 value already installed. Typcial C5 values range from 1ufd to 22ufd tantalum; observe polarity. The greater the system inertia the larger C5 needed.

Too much lead time yields an over damped position servo which slows prematurely. To little lead time yields overshoot of the target position. Begin by using the overdamped default setting.

ERROR COMPARISON AMPLIFIER: It features adjustable trimpot R3 EC Gain and plug-in integration components R40 and C28. Start by using the default reduced gain TrimPot setting and 220 ohms and .056ufd respectively.

WIRING: Follow the layout schematic. Do not power the **RBSA** from batteries under charge, battery eliminators or chargers without consulting factory.

POWER & MOTOR: Observe battery polarity. The Part Number chart shows the minimum size wire for battery power and motor wiring; wire with the minimum length wire practical and keep this wiring separated from the R/C receiver and SCPulse cables. Ground your chassis at a single point but don't use the chassis to conduct current. Include the smallest regular-blow fuse in the +1 lead that will support normal operation.



Install a .001 ufd "102" ceramic disc capacitor and/or AC type MOV directly across the servo motor brushes for RFI protection. Two additional .001 ufd ceramic disc capacitors may be necessary, one between each brush and the motor case.

FB ELEMENT: To wire the FB element use a single shielded cable with the shield connected to the Terminal Block Shld only. Do not bundle with any other wiring.

LIMIT SWITCHES: Optional low current limit switches may be connected on F.Lt and R.Lt. Connect their common directly to G1 and combine with no other wires. The switches must close to shunt PWM drive for the pertinent direction.

SERVO COMMAND PULSE: The input plugs into your receiver like a servo. Only the receiver common and Servo Command Pulse signal wire are required to drive the optical isolator inside the **RBSA**. The unit neither takes power from nor supplies power to the R/C receiver; thus the plus (red) wire

is not used. If supplied with universal connectors and used with some Futaba receivers observe connector orientation since polarizing lip is absent. No harm will come from incorrect servo plug in. The RBSA works only with FM and PCM receivers.

Use the full length supplied R/C antenna and locate it away from other wires and metal structures.

MOUNTING: Don't mount the unit directly adjacent to the R/C receiver. Operation near maximum ratings may require cooling air or mounting the RBSA side-opposite-the-terminal-block to additional heat dissipating surfaces such as your metal robot frame. No special heatsinks are required. While mounting remove the cover to monitor mounting screw length; screws should not thread into the case more than 1/8".

INITIAL OPERATION: Recognize the likelihood that the FB will be backwards, the limit switches reversed, the compensation all wrong and the motor will go wild. Take precautions to limit the damage. Disconnect from mechanical load and remove hard stops. Initially leave the motor *disconnected.*

POWER FOR THE FIRST TIME: If at any time the **RBSA** gets too hot to hold, cease operation and investigate. Leave the motor *disconnected*. Power up cautiously at the lower end of the RBSA voltage range with no SCPulse input. Verify excitation and FB values by manually turning the motor and observing that the voltage swing at the Terminal BLock FB over the intended mechanical travel is 2 to 3 Volts.

POWER FOR THE SECOND TIME: With power off connect the motor to the **RBSA** ***but with a substantial series resistor selected to limit speed and torque.*** Power up cautiously at the lower end of the RBSA voltage range with no SCPulse input. The motor should not run.

Apply a 1.5 ms SCPulse and observe servo operation. If the servo jams in one direction the *motor* polarity is probably wired backwards relative to the feedback.

Provided the servo responds to slow movement of the joystick cautiously check the position extremes to validate R44 & R49. If the servo jitters or hunts slightly reduce the EC gain by turning EC gain CCW.

With a 1.5ms SCPulse adjust R2 Centering +-3 turns to mechanically center or stop the servo. If greater adjustment seems required the FB excitation resistors R44 & R49 are not quite correct. (Clue for resetting the default Centering: Vantec has set the Centering trimpot by disconnecting the FB pot and adjusting to null as indicated when the motor stops.)

If basic position servo operation is achieved by the servo following your joystick and it does not jam then advance to the third power up.

POWER FOR THE THIRD TIME: With the power off connect the motor directly to the RBSA by eliminating the motor series resistor. Power up cautiously at the lower end of the RBSA voltage range with no SCPulse input. The motor should not run. Apply a 1.5ms SCPulse and observe the servo go to center position and stop. The dynamic characteristics will change dramatically; expect re-adjustment. Adjust R3 EC gain CW so the servo just oscillates, then back off CCW till it stops oscillating. In the majority of cases with the initial components and settings the **RBSA** will have over-damped compensation. If overdamped turn R5 Ld Time CCW. With proper compensation it should be possible to increase EC, try it. Repeat compensation adjustment. If the system is still overdamped with R5 fully CCW then reduce the value of C35. Repeat adjustments.

Adjust the compensation for Critical Damping by commanding the servo with abrupt step commands. Incrementally increase R3 EC Gain and repeat compensation pot adjustments. Maximum R4 Ld Gain should not be required. Excessive R4 Ld Gain is manifest by the servo hesitating rather than slowing as it approaches the target position in response to an abrupt step command. There is some

SPECIFICATION CHART

Part Number	Voltage Range	Con't Amps	TypLoss LegOhms	Approximate Size	Wgt Oz.	Min. Wiring Size AWG	Comments
RBSA13	9-15	24	.006	6.25 X 2.2 X 4"	25	16	Versatile 12V BULLY
RBSA16E	9-15	40	.004	6.25 X 2.3 X 4.5"	39	12	**Extruded** Aluminum Case
RBSA23	18-30	24	.006	6.25 X 2.2 X 4"	25	16	Drives SKF linear actuators.
RBSA26E	18-30	40	.004	6.25 X 2.3 X 4.5"	39	12	**Biggest** 24 VDC BULLY !

trade-off between Lead gain and Lead time but less gain/more time is preferred. Finally fine tune for smooth slow operation.

Backlash in geartrains, FB element drive and even rocking of the FB pot wiper will limit the resolution that can be achieved. Stable maximum R3 EC Gain is seldom realized, we suggest going 1/2 turn CCW from oscillation stop point to assure stability.

OTHER ADJUSTMENTS: When calibration and compensation is satisfactory the FAILSAFE jumper may be implemented. When the R/C Servo Command Pulse fails the servo can do one of several things. It can continue the last known command or assume a failsafe position or speed (velocity systems) which you set with trimpot R1Failsafe. An SCPulse less than .87 ms and greater than 2.2 ms, or pulses not repeating between 9.5ms and 200ms will initiate a FailSafe. Some PCM radio systems have functions that may override this feature. Test this feature by un-plugging the Servo Connector.

FailSafe operator	POT	**W**ide**D**ead **B**and
Hold	OFF	Don't Care
R1FailSafe position	ON	OFF
ShutDown/stop	ON	ON

CURVES: Four jumper selectable transfer curves determine the servo response to the joystick: STanDard, and optional LINEARized, EXPOnential, and unusued CUSTOM. STanDard provides a 1:1 response and is the only response curve factory supported.

	JP1	JP2
STD	OFF	OFF
LINEARize	ON	OFF
EXPO-nential	OFF	ON
CUSTOM	ON	ON

The SAVER and STUCK jumpers options are NOT available. SAVER & STUCK jumper = open

VELOCITY SERVOS: The RBSA Velocity applications require a DC tachometer that generates a positive voltage for one direction of rotation and a negative voltage for the other. The tach common terminal needs to be connected to 2.5V so zero RPM nets "stopped". By plugging in 4.7K for both R44 and R49 and then connecting the +Exc and -Exc terminals together a 2.5V node is developed for the tach connection. Like the position FB, the tach should supply a voltage output over its intended RPM range that tracks the SCP voltage. An external voltage divider may be required to satisfy the tach manufacturer's load resistance requirements in concert with FB voltage requirements. To aid in calculating voltage division R47 feeds a 235K impedance.

For Velocity Servo applications a certain and wide "stopped" joystick position is desired. This is opposite the smooth and contiguous response desired for a position servo. Install the Wide DeadB jumper for velocity applications. This jumper also shuts down the servo during FailSafe when the POT jumper is installed.

JMP1-2, WDB = as required

SAVER & STUCK jumper = open

An alternative FB path for velocity FB is provided through optional IR compensation. It is implemented by installing resistor R58 and adjusting R6 IR Comp. This FB works by monitoring the motor current. When "stopped" there is no FB. As the motor torque load is increased it draws more current and the positive IR FB increases the PWM drive duty cycle to maintain speed, albeit crudely. Excessive positive FB will cause the motor to run away. Experiment.

WARRANTY & REPAIR: Our one year *limited* warranty covers parts and repair labor for a nominal charge for units not abused, tampered with, or immersed. These products are ***not safety devices nor for use in life-critical or life-support systems.*** Specifications and price subject to change without notice. Patented. Some trade names & trademarks owned by others.