

# The M-Magic “S” Controller

## Features

1. Easy to Use, Low Maintenance, “*Wiperless*” Design
2. Adjustable Coast & Brake with dual Overcurrent Protection
3. Positive Gate Design with Polarity Correct LED
4. Tri Power Choke (TPC)<sup>™</sup>
5. Adjustable Upper Voltage Limit (UVL)<sup>™</sup>
6. Adjustable Dual Range Sensitivity (Lower Voltage Limit)<sup>™</sup>
7. Traction Control (TC)
8. Self Contained (*No External Heat Sink*)
9. 20 Amp Power Transistor with 3 in<sup>2</sup> Heat Sink and Overcurrent Protection
10. Lightweight (330 g / 0.75 Lbs)
11. Can be used with two or three wire driver stations between 12 Volts and 20 Volts DC



The M-Magic “S” is the final evolutionary upgrade of the M-Magic controller. The evolutionary changes from the first version of the version of the M-Magic controller introduced in 2005 include an updated power transistor, improved overcurrent protection, addition of dual range sensitivity and the addition of the Tri-Power-Choke, Upper Voltage Limit and traction control.

Upgrades from the final specification of the previous, dual polarity, “A-Spec” controller remove the polarity switch and the series inductor. These upgrades reduce the internal resistance, eliminate some failure modes and allow more power to flow to the car. Other upgrades decrease the overlap between the lower and upper sensitivity ranges and improve the overcurrent protection for the coast/brake potentiometer. The polarity switch removal is based on personal experience and feedback received from other racers. The US track standard is positive gate where the white wire is connected to the positive terminal of the power supply through a switch or relay. The black wire is connected to the track and the red wire is connected to the track and the negative terminal of the power supply. It is a very rare track that is wired negative gate. This was not the case when the M-Magic controller was introduced in 2005. Read on to learn more about the controller’s features.

## Hookup

The M-Magic “S” controller is a positive gate design. For proper operation you must first verify the track’s polarity. To do this first place the brake/coast switch in the center (off) position. Then place the car on the track and hookup only the black wire to the black (or track) terminal. Do not connect the red wire at this time Touch the white wire to the white (power) terminal. The **Polarity Correct LED** should light up and the car should not move without the trigger engaged.

If the car takes off at speed without engaging the controller trigger then the track polarity is incorrect. The controller can be used on such a track if the black and white wires are reversed and the red wire remains disconnected.

If the track has reversing switches ensure that the switches are electrically located between the controller and the track as opposed to being located between the power supply and the controller. If the switch is wired in the latter configuration the track polarity will change with the

## The M-Magic “S” Controller

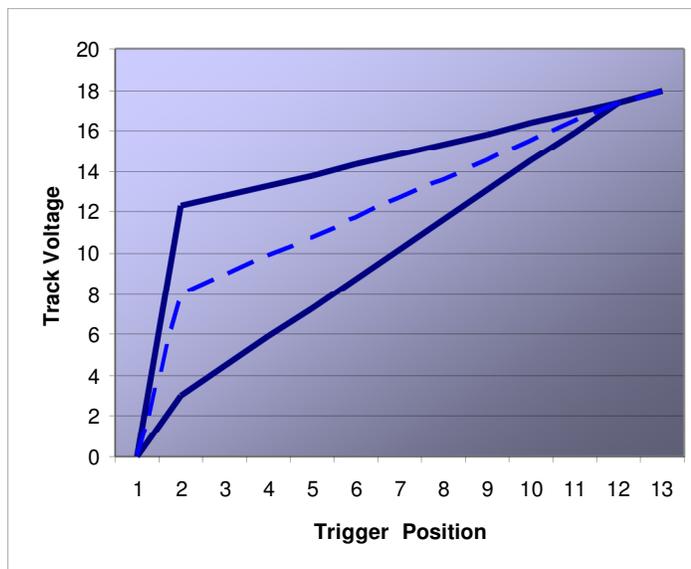
reversing switch position.

The **Polarity Correct LED** will be at maximum brightness when the car is stopped and will be off or dim when the trigger is pulled back to full power. The polarity correct LED will operate without a car on the track if the red wire is hooked up and the brake/off/coast switch is in the down (Brake) position.

The **Polarity Correct LED** will only light up if the power is on, the car is on the track, polarity is correct and the car and track are in good working order. The LED allows you to check the car’s electrical system (armature, motor brush system & pickups) and the track rails by taking a slow lap at a set trigger position. If the LED is steady or changes intensity slowly as the car enters and exits turns then the track and car electrical systems are A-OK. If the LED flickers there is a problem at that spot on the track. If the pickups are dirty and the car will not move or moves sluggishly the LED might not illuminate and will flicker as the car stutters and stalls.

### Trigger Response (a.k.a. Sensitivity)

The controller sensitivity adjustment is controlled using the sensitivity dial. The sensitivity dial sets the transistors Lower Voltage Limit (LVL) and changes the ramp rate of the controller. Turn the dial clockwise for more initial voltage and counterclockwise for less. T-jets cars tend to require less initial voltage compared to a magnet car with a rewind motor which tends to require a higher initial voltage. The operating range and output of the M-Magic on 18VDC with the sensitivity dial in the minimum and maximum positions is shown by the solid lines in the following figure. Placing the sensitivity dial in an intermediate position will result in straight line (linear) performance between the two lines as shown by the dashed line. Like a resistor controller, the M-Magic’s response is somewhat dependent on the car type so the initial voltage with a T-Jet or Gravity car may be different than with a Poly-Mod or a Restricted Open car. The values provided were obtained with a T-Jet on the track. The M-Magic will work with track voltages ranging from 12 to 20VDC.



The high/low range sensitivity switch is a short red toggle switch that is mounted horizontally below and just to the rear of the coast brake switch. Pull the toggle back toward you for low range. Push the toggle away from you for high range. In low range the adjustment provided by the Sensitivity dial shifts toward the lower solid line on the above graph. In high range the adjustment shifts toward the upper solid line.

The lower range is perfect for T-Jets and most Stock and “Superstock”, Level 4 and Level 10 cars. The upper range is for cars operating on 12VDC power. The “S” upgrade reduces the overlap between the upper and lower ranges from 25% to approximately 10%.

# **The M-Magic “S” Controller**

## **Coast and Brake**

Coast and brake controlled using the dial and the coast/brake switch. Turn the dial clockwise for more brake/coast and counterclockwise for less brake/coast. Place the switch in the down position for brakes and in the up position for coast. Place the switch in the center (off) position or remove the red wire if neither brake nor coast is desired.

In normal brake operation the coast/brake overcurrent devices will protect the brake and coast circuit. In the coast mode the coast pot and coast limit resistor are designed for a normal RO or Poly-Mod duty cycle. To prevent damage to the car's armature and controller it is recommended that you remove the car from the track when it is stopped and the coast is turned on. The following is taken directly from Mabuchi: **“DO NOT leave motor shaft locked (stopped) while power is applied, as even a short-time lock-up may cause excess heat build-up resulting in damage to the motor.”**

To prevent damage to the controller also do not “warm up” the car by turning laps unattended with the coast on. If the coast feature is used to turn laps the protective device may open and the car will stop. Likewise, the protective device may open if the car is too low and the driver relies heavily on the coast feature. The protective device will reset after the coast feature is turned off and the device is allowed to cool. The “S” design adds separate overcurrent devices for the brake and coast circuits.

## **Upper Voltage Limit**

The Upper Voltage Limit (UVL) is adjusted using the potentiometer located above the coast/brake switch and the sensitivity potentiometer. The UVL controls the gap between transistor operation and full power bypass. Normally this gap is approximately 1.4 VDC. For some car classes it is advantageous to decrease low end sensitivity and also increase the gap between transistor and full power operation. This dial in conjunction with the sensitivity dial allows that adjustment and lowers the upper line on the above trigger position vs track voltage graph shown above. Turn the dial clockwise to decrease the voltage gap between transistor and full power final voltages. Turn the dial counterclockwise to increase the voltage gap between transistor and full power final voltages.

## **Three Position Choke**

The Three Position Choke (TPC) is controlled by the three position switch located in the controller handle below the sensitivity pot. Similar to the UVL potentiometer this switch adjusts the gap between transistor operation and full power bypass. It does this by reducing the voltage applied to the track when the controller trigger is fully depressed and the transistor is bypassed. When the switch is the up (or 0) position full power bypass is enabled. In the down (or 1) position the gap between transistor and full power operation is reduced from approximately 1.4 VDC to 0.7 VDC. This is done by reducing full power bypass voltage by 0.7 VDC. When the switch is in the center (or 2) position then full power bypass voltage is reduced by another 0.7 VDC (1.4 VDC total) and there is no voltage gap between transistor and bypass operation. Normally this switch is maintained in the up (or 0) position. A suggestion for gravity cars is to try the controller with the TLC switch in the center (or 2) position and the UVL dial adjusted to reduce voltage by 30-50%.

## **Traction Control**

Traction Control (TC) reduces the amount of current that the transistor is allowed to pass onto the car for a given trigger position. Sudden throttle applications on a low traction surface can induce wheel-spin and accelerate tire degradation. The Traction Control option reduces, but does not eliminate, the possibility of these events. Traction Control was first used at the 2012 Nuvolari Enduro. It allowed me to qualify on pole and minimize tire degradation during the event. Traction Control contributed to the car dominating early in the event and charging back to win after the cars performance dropped during the mid-race night segments due to an error made when the lights were installed.

# ***The M-Magic “S” Controller***

## ***Overcurrent Protection***

The controller is protected by an external five-amp fuse. The trigger potentiometer and the coast/brake circuit are protected by separate automatically resetting polymer circuit breakers. The fuse and polymer circuit breakers are thermal devices and will not open during normal operation with any properly operating HO car but will open in the event of an overload condition or short circuit. The coast/brake overcurrent devices have been tested and will protect the brake/coast circuits from damage. These protective devices will automatically reset after the overload is removed.

The five-amp fuse will protect the power transistor from an overload condition. The power transistor rating significantly exceeds the fuse rating and is such that the fuse will fail prior to the transistor reaching its thermal limit. However, as the power transistor is an ultra-fast acting device the transistor's fuse may not protect it from damage as the result of a dead short on a battery powered track. The installed fuse is a readily available **FAST ACTING** automotive blade type fuse. Do not replace the fuse with a larger fuse. Do not replace the fuse with a circuit breaker or other thermal device such as a circuit breaker or an automatically resetting polymer device as they are slow acting, thermal devices and will not adequately protect the power transistor.

## ***Maintenance/Serviceing***

No maintenance is normally required. It is suggested that the trigger potentiometer bushing and the trigger/microswitch contact point be lubricated with a very small amount of high quality oil such as Thomas H'Oyl every three months.

The controller should not need to be returned for service during normal use. However, should the controller become damaged or fail to operate first check that the track polarity is correct, that the trigger returns to the brake position without binding and check the fuse. Check the fuse with an ohmmeter as a visual inspection may not detect a failed fuse. If these actions do not cure the problem, then contact me at [SDM2831@Hotmail.com](mailto:SDM2831@Hotmail.com) to diagnose the problem and arrange for repair.

In the interest of allowing the end user to better maintain the controller a change has been made in the way that the trigger was secured to the trigger pot shaft. The previous trigger pot was capable of continuous rotation and was glued and pinned to the shaft making calibration a tedious process. The revised design uses a single-turn pot allowing the trigger to be user calibrated should it rotate with respect to the trigger pot shaft resulting in either a large jump between transistor and bypass operation or a dead spot just before full throttle.

The calibration process is as follows. Disconnect the controller from the track and remove the plastic handle. With the trigger in the released position loosen the trigger's set screw and rotate the trigger shaft 45 degrees clockwise. Tighten the set screw snug tight and slowly depress the trigger. As the trigger is depressed the trigger pot shaft will hit its rotation stop and the trigger should continue rotate with respect to the shaft until the trigger is fully depressed. Finish tightening the set-screw and replace the plastic handle. The new trigger pot is a single-turn pot with the same footprint and power rating as the one it replaced. Like the one it replaced the new pot is rated for 10-Million cycles.

This revision of the controller was independently tested by many racers at the 2018 HOPRA Nationals held at Lenjet raceway. This design was very well received.

## ***Disclaimer***

Since the use to which the M-Magic controller may be put and the manner of storing, handling and operation are beyond control, no guarantee, expressed or implied, is made to the fitness of use stability or performance of the materials supplied. All controllers are tested prior to shipping. Controllers will be repaired for component cost plus a reasonable labor charge and shipping.

While M-Magic controller is based on various proven controller designs it is a unique design that is

## ***The M-Magic "S" Controller***

based on decades of personal HO racing experience. As opposed to some other controllers the M-Magic was specifically designed for HO and is not a repurposed 1/24th controller. Each feature of the controller has been race tested and proven in competition.

Please contact me at with any feedback, comments, questions or problems. The M-Magic "S" prototype was constructed to verify the component layout and the acceptability of the changes. My personal M-Magic controller is the fifth unit of the original specification and is used as a research and development platform to test new ideas and components. My personal M-Magic controller has been in use since 2005 without a failure. With proper care the M-Magic controller will provide many years of use.

### ***Controller Operating Temperature***

Some Gravity Car racers have observed that the UVL or TLC switch (Marked 0-2-1) on the controller can become warm to the touch when the switch is in the center position (Position 2) and the controller has been used for an extended period. This is normal. When the switch is in Position 0 (Full Up) or 1 (Full Down) the transistor is bypassed at full throttle and is generating heat only when the trigger is in mid-position. When the switch is in Position 2 the transistor is not bypassed at full throttle. As the transistor is continuously operating as a variable resistor it will continuously dissipate heat according to Ohms law.

The switch is mounted to the heat sink and it will become warm as the transistor and heat sink warm up. A long run with the switch in position 2 was performed with a stock BSRT 902 car (i.e. Super G+ or Viper V1) fitted with C4 "ceramic grade" polymer magnets and a 6-ohm motor. This is a more severe test than provided by a typical gravity car. Based on testing performed, I anticipate that the heat sink temperature will remain below 110°F (43°C) during a long run with a gravity car. This temperature is warm but not hot.

When the controller was first built in 2005, I obtained temperature data when operating a state of the art Unlimited Car to verify the acceptability of the heat sink design. The transistor has been updated twice since then and I received some test results from the 2017 HOPRA nationals. When running a state of the art Unlimited Car the current power transistor and heat sink remained below 110°F (43°C). The transistor's maximum continuous operating temperature is in excess of 250°F (120°C). The measured and expected operating temperatures are well under the transistors maximum temperature rating.

When the UVL switch is in Position 2 it acts as a full power choke and a voltage limiter and should only be placed in Position 2 when necessary. The switch should be in Position 0 or 1 at least 90% of the time. Switch Position 2 was designed for and should only be used when racing Gravity Cars. With all other cars (including T-Jets or G-Jets) the switch should be in Position 0 or 1.

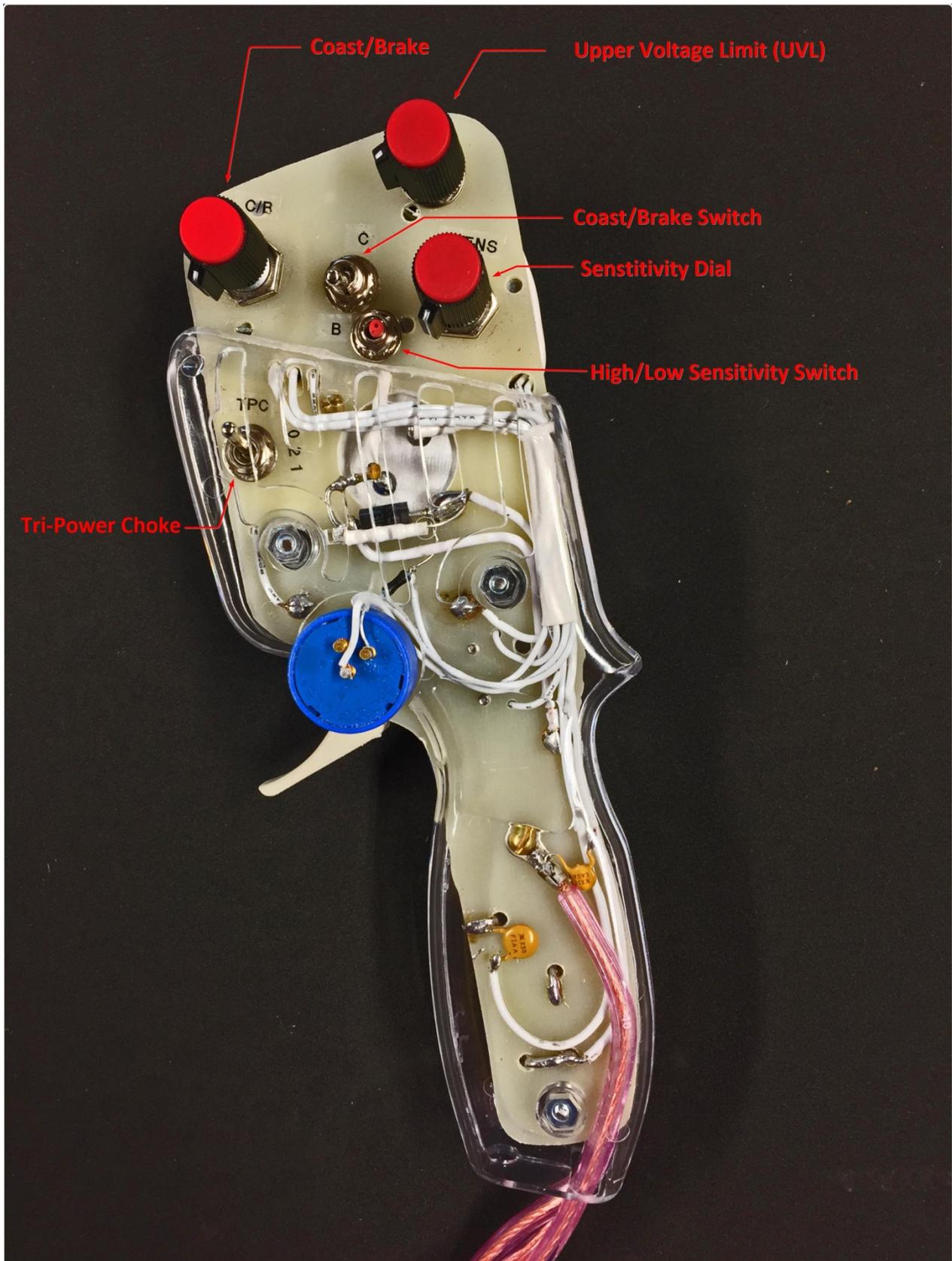
Regards,

*Steve "Maddman" Medanic*

*August 2018*

# The M-Magic "S" Controller

## Adjustments & Switches



# **M-Magic "S" Controller**

## ***Independent Test Report***

This report is a test of the original M-Magic controller prototype and was done in the summer of 2005. It is included to illustrate how the controller power circuit operates and also applies to the "S" version of the controller.

The M-Magic "controller felt very nice in the hand. I love the fact that the heat sink is inside. It felt very nice. It does not look intimidating. All the solder joints look like very nice work. (I have seen some that are not!) The inline fuse is well positioned and out of the way. Also it is not "dangley". So, the weight, looks and feel of the unit are well suited for me. The instructions are very complete. The trigger pull is a little lighter than my other units. This is something that I can adjust to.

I found the unit very driver friendly with enough adjustment to deal with any of the cars I have. I believe that what I call "linear" sensitivity has been achieved with this unit. My references to linear are trying to state that the trigger when moved slightly the car responds in a similar fashion. I have used some controllers that need to be driven at the top end or bottom end regardless of the sensitivity level used. With your unit I seemed to be able to drive the car instead of the track driving me. I could use the whole trigger range instead of just tapping on the trigger. I was still driving 100% and that is different than trying to only use 1/2 of the trigger range.

Even though many claim that their "Brand X" controller can be used for anything I have not felt comfortable with them for the classes I drive. The unit for me needs to be able to handle T-jets, G-Jets and Superstock. I believe that it is easier to dial in than the others I own. The controller doesn't have any surprises. I couldn't feel any jumps while I was putting in laps. Though I haven't been on the track for a while I sensed rather than could measure (lap times), a difference in the performance of some VERY familiar cars.

## ***Final Thoughts and Changes***

I have found that a new controller (especially a new electronic controller) can take time to learn. To get such an encouraging report right out of the box was unexpected and the results of the test were a pleasant surprise. It should be noted that a light spring was purposely installed for the test. Spring tension is easily changed and no changes are planned except to install a stiffer spring in the production controllers. No changes to the power and/or brake/coast circuits were required as a result of the testing. Other M-Magic and M-Magic "S" owners have echoed comments similar to the ones listed above.

The M-Magic design began almost immediately after I procured my second electronic controller. It failed soon after delivery and rather than returning it I started tinkering. I didn't realize how good the revised controller was until I used it at a NITRO series race with no practice or warmup. It was a case of arrive late, pull a cold car and controller out of the box, hook up and race against others who have been practicing for hours. Despite the cold turkey start and stiff competition I took an easy win in my qualifying race and ended up TQ. The race wasn't a walk in the park as the other two drivers in this qualifying race took the remaining top spots on the grid! I was amazed at how easy the controller was to dial in and how effortless it was to drive compared to my normal controller. The race was mine to lose but I had other commitments and couldn't stay to race.

Normally I would have used my primary controller and this controller would have stayed in the box. It was used as I knew that despite what happened I could not stay and had nothing to lose. The M-Magic is an evolution of that controller. I review the design constantly and encourage feedback from every owner. As a result of feedback received many changes have been made. Every change has improved the controller. The dual range version of the M-Magic controller and the addition of the UVL dial is a result of these comments. The TLC switch and traction control are based on ideas provided by fellow racers. The M-Magic "S" improves on the final version of the M-Magic controller with better overcurrent protection and less internal resistance.

The M-Magic and the M-Magic "S" controllers are linear, responsive, "driver friendly", easy to use and works equally well with T-Jets, Fray Style T-Jets, G-Jets (at 12VDC & 18VDC), Gravity, Stock, Superstock, Modified, R.O. and Unlimited cars with a wide range of adjustability.