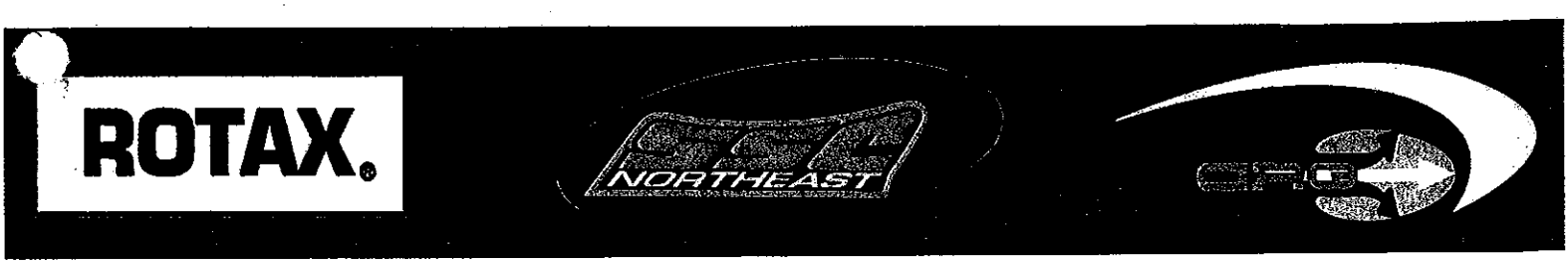
RM ENTERPRISES

Kart Tuning Manual



Introduction

"Setting up" a race kart chassis seems to be as much art as science. Even major championship repeat winners often differ greatly with regard to set-up solutions. This manual is based on both the specific recommendations of the CRG Factory Race Team and the dominant, if not exclusive, opinions of kart racing champions.

All recommendations come from reliable sources, but keep in mind that when making chassis/kart adjustments, "If it doesn't get better going one way, try going the other." There are many different paths to be taken on the road to good handling and maximum speed.

Finally, if you just want a very workable overview to get you on the track as soon as possible, look at the "Basic" chapters, including the Troubleshooting chart at the end of the book.

Later, if you want more detail, go to the more "Advanced" and "Theory" sections and you will find much deeper explanations of what is really happening with virtually everything that affects the chassis performance of your kart.

Basic Chassis Setup

Base Setup (Normal Track Conditions)

The following settings are recommended as a starting point for a dry track with normal levels of grip (not "green"/slippery or not with high amounts of rubber causing high grip)

- Weight Distribution should be 43.0% front, 57.0% rear, and 50/50% side/side.
- Toe should be set out 1/16" to 1/8" (1-3mm).
  For hard compound tires, set toe out at 1/8" – 1'4" (3-6mm).
- Caster/Camber adjusters at front spindles should be set at II top, II bottom
- More caster may be needed over the weekend to fight tire wear and loss of grip.
- Front bumper should *always* be tight.
- Front width should be 45 1/2" to 46".
- Side pod bars need to be loose, but with bolts tight.
- Seat should be at standard mounting points
- Rear wheel hubs should be medium length.
- Rear ride height should be as low as possible.
- Rear track should be set just below the legal limit, within the rules, (55" for many classes, 50" for Juniors). (CRG: 139 cm or 54.75")
- Axle should be medium stiffness
- Seat struts should be in place.
- Torsion bar should be in horizontal position, but tight.
- Rear bumper should be tightened to about 100 inch pounds

Tire Pressures

• Hard compound tires (cold)	12-13 psi
• Medium compound tires (cold)	9-10 psi
• Soft compound tires (cold)	8-9 psi

Basic Chassis Tuning

If front end of kart is not gripping in corners (understeering)

- Move out one wheel spacer on both spindles
- If front of kart becomes too wide, move wheels back to original spacing and change C/C adjusters from II/II to II/III or III/III.
- Fit shorter hubs to rear axle
- Raise hot rear tire pressures 0.5 to 1 psi.
- Remove seat struts, if fitted
- Use softer rear axle

The back end is sliding (loose) at the entrance of the corner or there is too much front-end bite.

- Move in one wheel spacer on both spindles
- Lower 0.5 to 1 psi in the rear tires
- Move weight away from the front of the kart
- Lower the front of the chassis
- Put less caster in. (adjusters at I/II or I/I top/bottom)
- Tighten the front bumper if not already tight (should always be tight).
- Check to make sure your toe is set at neutral
- Fit stiffer rear axle
- Fit longer hubs
- Fit seat struts (four total)
- Tighten rear bumper if not already tight (should always be tight).
- Raise rear ride height

The kart is hopping at the rear in corners.

- Put shorter wheel hubs on the axle.
- Set the rear track to or close to the maximum allowed width if not already done.
- Raise the air pressure in the rear tires by 0.5 to 1 psi.
- Lower any ballast to a lower vertical position on the rear of the kart.
- Lower the rear ride height to the maximum if not already done.
- Change to a softer axle
- Remove seat struts

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Advanced Techniques and Theory

General Theory

To enable us to properly set up a kart chassis, we must first understand the most basic principals of the racing kart, which is a unit made up of tubes and front steering geometry, propelled through a live axle (one without a differential). Making adjustments to enable the race kart to turn without oversteer or understeer is difficult and challenging. Achieving a well-balanced chassis set up is part art and part science.

Kart racing chassis are designed in a manner to allow it to turn the only way it can without having a differential – with the inside rear tire lifting off the track on corner entry. The outer rear tire drives "around" the outer front tire allowing the chassis to efficiently turn into the corner because the inner rear tire is off the track surface.

If the inner wheel does not lift, no matter how much you turn the steering wheel, the front of the chassis wants to keep going straight, creating an understeer or "push" condition.

When a chassis lifts up the rear wheel properly, then the chassis can pivot and turn. Therefore, the kart must be set up with sufficient side grip to enable the inner rear tire to lift upon corner entry, as it is faster to drive the kart through the corner than to try to slide through.

Generally, when the chassis elements are on soft settings, the kart has less grip. As the chassis elements are made more rigid, grip will be increased, however there are points of diminishing return where the chassis will get too firm to perform properly.

A kart will typically perform best when the rear width is set as wide as possible and the front width is as narrow as possible, *while providing a fast, well-balanced and stable package*. You cannot simply set the chassis on these maximum and minimum settings and hit the track, but this concept will help create a target for your efforts to tune a "happy" chassis.

It is best to work on the end of the kart that is not handling well. If, for example, the problem is understeer, try to solve the problem first by adding more front grip. If that is not successful, try taking grip away from the rear to balance the chassis.

When the kart is properly set up, steering effort will be reduced and it will seem to "float" through the corners. Remember, the front and the rear of the kart must be in balance, with neither end too tight or too loose. If you turn the steering wheel and the motor load increases, the chassis is "bound," and wasting horsepower. Free up the chassis and gain horsepower!

Engine power is be wasted in several ways, including:

- Brake pad drag
- Friction in the wheel bearings
- Incorrect wheel alignment.
- Misaligned engine/sprockets

Such problems cause increased rolling resistance, which means more power is required to achieve the same acceleration and speed. Since the engine doesn't magically gain power to overcome rolling resistance, the kart just goes slower. If the increased rolling resistance is due to bad alignment, the kart will probably also handle poorly. Small improvements all add up to faster lap times and race wins on the track.

Often, the most stable set up is one where the kart tends to understeer just a bit into corners while under brakes and then turns to neutral steering when the power is applied and the kart is driven out of the corner. This is not massive understeer, just enough to show that understeer may be present. A kart set up this way is very stable into corners and is easy to drive. Remember, oversteer may be tons of fun, but it is, unfortunately, slow.

When setting your kart chassis, it is a good idea to find the longest corner and set the kart up to bounce a bit (just this side of hopping) on this corner, this bounce should not be enough to put you off line. It should be kept within easily controllable limits. If the kart is set up this way, then it will be giving maximum grip through the longest corner and this is where the greatest saving in lap times is available.

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General Set Up Conditions

Chassis Attitude

The chassis attitude (frame in relation to ground) should slope from front to rear – the front being slightly lower than the rear. Adjusting the ride height with axle carriers in the rear and or kingpin shims up front, attains this.

Engine Types

Generally, 100cc karts will be set up to control understeer, as they do not have the power to require maximum rear grip. Excessive grip will slow the kart down, overall. Shifter karts require a higher amount of weight on the rear wheels and more chassis tuning to create increased rear grip.

Tall Drivers

Tall drivers in 100 cc karts will want to make adjustments to reduce grip in order to overcome the additional leverage their higher center of gravity can produce. This may be done with more flexible seats (check Tillett), a MET30 or softer axle, maximum rear tread width, medium to short wheel hubs, no seat struts and a general softening of the chassis.

Terminology

Axle run out: The variance of an axle from being perfectly round. This is usually measured with a dial indicator.

Ballast: Weight, normally lead, added to raise the combination of kart and driver up to the minimum legal weight for the racing class.

Bearing carrier: The element, normally three, in which the rear axle bearings are mounted.

Caster: The tilting to the rear, of the top of the kingpin on which the front wheel spindle pivots.

Camber: The tilting in of the top of the front tires toward each other is negative camber. Tilting out is positive camber.

Chassis lift: The raising of the inside rear wheel on corner entry. The lift or "jacking" is caused by a combination of frame stiffness, axle stiffness, caster and other factors.

Chassis bind: A combination of elements including too much frame stiffness, overly stiff axle, etc. that cause the kart to have too much grip, restricting performance.

Chassis scaling: Weighing the kart and driver, preferably on digital scales to determine weight distribution.

Clutch kart: A single speed kart with an automatic centrifugal clutch. Typically, this type of kart will have a low revving four stroke (Briggs and Stratton or similar) or a high revving 100cc two-stroke engine (HPV, Yamaha or similar).

Darting: An unstable condition where the kart is overly responsive to steering input.

Digital scales: Highly accurate electronic scales to be used to determine weight distribution.

Frame tweaking: The gradual bending of a kart frame to achieve optimum weight distribution.

Grip: The level of adhesion between the kart tires and the track.

Hopping: The kart bounces as throttle is applied near the apex of the turn.

Jacking Effect: The raising of the inside rear wheel on corner entry. The lift or "jacking" is caused by a combination of frame stiffness, axle stiffness, caster and other factors.

Kingpin: The pin on which the individual front wheel spindle pivots.

Live axle: A single piece rear axle without the differential that allows an automobile's wheels to rotate independently.

Nylock nuts: Nuts with a nylon center that allows the nut to lock securely to the bolt, avoiding loosening in use.

Oversteer: the tendency of the rear of the kart to slide outward at corner entry or mid corner. It's important to understand that this tendency must be occurring as you enter the corner, not on corner exit, when application of power can bring about *power induced oversteer.*

Power induced oversteer: tendency of the rear of the kart to slide outward at corner exit under hard power application. Steady state throttle should not upset the chassis balance.

Push/kick: Occurs at the apex of the turn as the kart transitions from brakes to application of throttle. The kart rear kicks out suddenly at the apex.

Pyrometer: A device used to measure the temperature of the tread of a kart tire upon returning to the pits.

Rear Track: The overall measured width of the rear taken from the outside edges of the rear tires.

Ride height: The distance of the kart chassis from the track.

Road race (Enduro) track: Normally a winding track that is over a mile in length and typically used for automobile racing.

Seat strut: A brace mounted between the seat back and the bearing carrier to add stiffness to the kart chassis.

Shifter kart: A kart with a gearbox (normally six speeds) and manual clutch. Most shifters have 80 or 125cc two stroke engines.

Side bite: Lateral adhesion between the kart tires and the track.

Slick tires: Tires without tread to be used on a dry track.

Spindle bolt: The pin on which the individual front wheel spindle pivots.

Sprint Track: A track, normally between 1/2 and 3/4 miles in length, intended primarily for kart racing.

Torsion Bar: Used to add or reduce chassis stiffness by adding reinforcement to the kart frame.

Tire Compound: The degree of relative hardness or softness of a tire, influencing both adhesion and durability.

Toe in: The condition of front-end alignment when the front edges of the tires are closer to each other than the rear edges.

Toe out: The condition of front-end alignment when the rear edges of the tires are closer to each other than the front edges.

Understeer: the kart will not turn into the corner due to lack of front-end grip. This is sometimes called "push," which is more correctly lack of turn-in capability due to the front tires being overpowered by excessive rear traction. Although these terms are often used interchangeably, understanding the difference will help you to set up your chassis more correctly.

Weight Distribution: The percentage of weight on each tire or pair of tires. For example, if the total weight of a kart is 160 pounds and the rear tires weigh a total of 90 pounds, the kart would have approximately 56% of its weight on the rear.

Wet tires: Tire with full tread to be used under wet track or rain conditions. These tires are normally of a soft compound.

Wheel spacer: A metal ring that slides over the front wheel spindle to change the overall width of the front of the kart.

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Front End Adjustments

Some of the most important handling adjustments are made at the front of a kart. Problems that occur when entering a corner are frequently due to an improperly adjusted front end. Front-end bite and steering response can be corrected by simple adjustments, and toe setting is a good place to start.

Set steering dead ahead during front wheel alignment and keep wheel movement suppressed by using Vice Grips on the nylon steering block to lock the column or use a couple of tie downs from the steering wheel to the seat back.

Toe in/out

Toe settings will affect weight distribution, top speed, and cornering response. The more toe in or toe out, the slower the top speed becomes due to excessive drag by the tires. Despite this negative effect, increasing the toe out can have some benefits. For example, increasing toe out will increase initial cornering response, thus giving the driver a better turn into the corner and reducing understeer. However, if the kart is overly sensitive to steering wheel movement at the point of turn in and begins to oversteer, the toe out settings may be too high. With toe-out, the inside front wheel moves down in relation to the chassis more than it will with zero toe or toe-in. On a dry surface, a toe setting of 0 to 3 mm out is recommended. For a very high-speed track, setting close to zero toe may help top speed. Toe in is not normally used on a kart.

Generally, the goal is to have zero toe when the chassis is loaded with the weight of full fuel and driver, sitting on the track. Therefore a heavier driver will need more unloaded toe out than a lighter driver.

Remember that the kart chassis will deflect under the driver's weight and this deflection can affect toe, caster and camber settings in particular.

On road racing tracks in particular (as opposed to sprint tracks), most karts will probably handle and accelerate better with toe set to absolute zero.

However, on sprint tracks, slight toe-out will help turn-in to corners, but rarely more than two millimeters (except in wet conditions, when larger toe-out settings can be helpful).

When setting the amount of toe, make sure that the toe is equal on each side.

If you reset caster and camber settings, you will have to reset toe as well.

Ackerman

Ackerman steering makes the front tires turn at a different rate. For example, the front inside tire will turn faster than the outside tire when turning into a corner. This creates a faster steering response, thus causing flex through the chassis when turning. Adding Ackerman makes the kart steer more positively. At the same time, the driver will notice a decreased amount of steering input needed to turn the kart. As a result, the kart becomes more sensitive to the driver's input. In contrast, decreasing Ackerman makes the kart steer more slowly, and more steering needed to corner. Ackerman steering is standard.

The spindles will usually have 2 tie rod hole locations; the inside hole increases Ackerman, while the outside hole decreases Ackerman. The tie rods can be lengthened or shortened to fit either hole.

Caster/Camber Adjusters

The adjusters at the front spindles should start at a II/II (top/bottom) setting. Refer to the Caster/Camber chart at the end of the manual for the effect of various settings. Generally, karts are quite sensitive to caster adjustments and are not as sensitive to camber changes.

Caster has the greatest effect at corner entry and during the first third of the corner.

Camber has the greatest effect in the middle third of the corner.

The final third of the corner is controlled largely by rear axle setup.

When caster and camber are <u>both</u> set correctly, there will be even wear across the tire face.

Caster

Caster affects the grip of both the front and rear of a kart. It does this by transferring weight to the opposite rear wheel during cornering. Although it may seem complicated, there are a few simple rules to follow concerning caster.

If the caster is decreased, the kart will be easier to steer. Some drivers have noted that it adds feel to the kart and increases bite on the front end. It may be

advisable to decrease the caster setting if the track conditions are providing too much grip. The kart will free up and be more drivable if caster is removed.

The driver may want to add caster if the conditions are cold, or if the class requires hard compound tires. This will offer more front grip, less rear grip and help eliminate under-steer. For most applications, use the ll/ll, t/b settings on the front end adjusters. Smaller drivers should decrease their caster, while larger drivers should increase their caster.

Many teams take caster out of the chassis for qualifying when tires are fresh and not fighting for grip. Caster also causes change of camber when the steering is turned, resulting in more negative camber on the outside front wheel and more positive camber on the inside front wheel.

Importantly, increased caster also increases the jacking effect on the front wheels which helps unload the rear axle (inside wheel) more on corner entry. If a soft rear axle is being used, it is possible that increasing caster will alleviate an understeering condition by unloading the rear axle more and help balance the chassis. Since the rear tire is lifting sooner in the corner, there is, in effect less rear grip at this point.

Generally, karts are fairly sensitive to caster changes. Therefore, it is quite effective as a primary tuning tool.

Camber

Camber is measured by how far the front tires are leaning in or out as viewed from the front of the kart. If the tire is leaning in the kart has negative camber. If the tire is leaning out, the kart has positive camber. Camber is usually adjusted when the track surface is wet. In these conditions, the driver can negatively adjust the camber to find more grip. Camber is the setting mostly responsible for maintaining the maximum outside front tire rubber on the road in corners, particularly mid-corner. Setting camber to zero will nearly always be the best starting point, and can be fine tuned using tire wear as a guide, or tire temperatures across the tread.

Generally, karts are not as sensitive to camber changes as caster. However, camber must still be used as an additional tool in tuning the chassis, particularly for mid corner performance.

Front Width

The most common adjustment made to change the handling of a kart is by working with its front track, or front-end width. Widening the front track will create more of a jacking effect when the wheels are turned. This will result in more front-end grip and quicker turn in. Narrowing the front track will have the opposite effect. This will result in slower turn in and less front-end bite.

Also, the lack of jacking effect will not raise the inside tire on corner entry, preventing the kart from rotating into the corner and increasing a "push" condition due to the excess traction provided by both rear wheels remaining on the track.

If the kart pushes or understeers entering a corner, widen the front track. If the front track is at maximum width and the kart still pushes, move the front wheels back to the starting position and increase caster/camber. If the kart is over gripping or "binds" on the front when the wheels are turned, reverse the procedure.

A very general rule of thumb is; the less available grip, the more scrub radius, (increase of front width), caster and starting tire pressure should be used. (For more detail on the relationship of starting (cold) tire pressures and racing (hot) tire pressures, read the section on Tires.)

Rear End Adjustments

The rear end adjustments include wheel hub length, track, rear ride height, axle stiffness, bearing locations and seat struts. Changes to these settings are usually made when handling problems occur on the exit of the corner.

Wheel Hub Length

CRG makes three different wheel hub lengths for their chassis. It's highly recommended that a karter purchase all three of these sizes, as they are the most commonly adjusted setting on the kart and change have significant impact on chassis balance. Longer hubs provide more rear grip. So if the kart over steers as it exits a corner, a longer hub may be desirable.

Short hubs are used when the kart under steers at the exit of the corner. If the driver runs out of track surface as he/she exits the corner, perhaps they are experiencing under steer, actually push. Switching to shorter hubs will reduce grip at the rear and may be desirable in a situation like this.

Overall choice of hub length should ultimately be based on how flat the tire is wearing. If the kart is running little caster, a soft axle and generally feels good, but the rear tires are still "coning" (the inside of the tire is wearing faster than the flat or outside), decrease the rear width. If the problem persists, increase the hub length or turn the bearing carriers facing out to support the axle end more.

Rear Track

The general rule is to run the rear of the kart as wide as feasible, assuming the chassis is performing well. For sprint racing in the US, most rules dictate a maximum rear track of either 52 or 55 inches.

Most CRG manufactured chassis are designed for rules allowing a 55-inch rear track. Therefore, it is important to set the kart's rear track to the maximum that the rules allow. Also, a wider rear tread will provide a smoother ride.

There is a interrelationship between rising/falling grip and stability in the 52" to 55" range with maximum grip in the 54" range. *Smaller track width dimensions will provide more grip, but at the expense of stability.*

However, this adjustment is made as a last resort. The driver should always change to short wheel hubs before decreasing rear track. If necessary, narrow

the rear track in 1/8-inch increments, as most chassis are very responsive to minor changes.

Generally, it's best to start at the 55" dimension, as this gives the ability to narrow the rear slightly for more grip if needed to balance the chassis. This also a very stable setting. It becomes necessary to narrow the track when the rear of the kart has too little grip. Keep the operating range of movement on the rear width in a fairly small range. Generally, don't come from the legal maximum with more than 1.5 to 2".

Narrower: more grip, but less stable.
Wider: more stable, but less grip.

Axle Stiffness

There are a wide variety of axle hardness available for CRG chassis. *The axle has a very strong influence of rear grip characteristics.* In almost all cases you will use a mid-range axle. The hard or stiff axle is used when the weather is cold, in slippery track conditions, or when rules mandate the use of harder compound tires. The softer axle is used if conditions are extremely grippy, or where there is excess rubber build up.

In general, higher horsepower karts need stiffer axles for more traction. Lower horsepower karts have a greater need to free up the chassis and will run softer axles.

Tall drivers generally need softer axles to help reduce grip.

Rear Ride Height

Most chassis have two settings for the rear ride height. The chassis should be run with the higher ride height for better grip. The higher ride height creates more leverage, which gives more weight transfer to the outside tires. The result of this is increased grip for the driver. Lowering the ride height will have the opposite effect and cause the kart to oversteer. Only in cases where there are very tacky track conditions should the ride height be decreased.

Remember that ride height is literally how high the kart is above the track. So raising ride height of the rear of the kart will require placing the bearing carrier bolts in the *lower* bolt holes.

Wheels

Wheel stiffness has a similar effect on grip (at both ends of the kart) as axle stiffness. Softer wheels such as spun aluminum will have less grip than cast or forged magnesium wheels, as a general rule.

Softer wheels can also promote uneven tire wear. A soft wheel will tend to wear the inner portion of the tire. It is generally best to run a stiffer wheel.

Using rear wheels with less offset effectively stiffens the rear axle, as it will be necessary to move the hubs inward in order to maintain the same overall rear width. Therefore, an offset that allows the hubs to be moved outward will effectively soften the rear axle.

Seat Struts

Most conditions will call for two seat struts on each side of the seat for a total of four. These struts should run from the very top of the seat to the two outer bearing cassettes. On the motor side, it may only be possible to use one strut. The seat struts allow the high leverage point of the driver to transfer load to the rear tires. This essentially creates more rear end bite. When seat struts are removed, the driver's high leverage point is not taken advantage of and minimal load is transferred to the rear tires.

Usually, one would want to remove or loosen seat struts if trying to reduce rear grip. Tall drivers, for example, will have less need for seat struts.

Rear Torsion Bar

The rear torsion bar can be left out when you want to reduce rear grip. However, if you want to increase rear grip, place the torsion bar in flat position.

Even more rear grip can be achieved if the torsion bar is placed vertically. In a low grip situation, (as in the rain, or a damp track, or such as a parking lot, or temporary circuit, perhaps street) the installation of the torsion bar in any capacity will net the rear end more grip due to the fact that it will not allow the chassis to transfer weight and lift up the inside wheel as much, or as long, therefore coming down and driving the kart off of the turn sooner.

Front Bumper

The front bumper should remain tight at all times. There is a school of thought that loosening the front bumper will provide less front grip, however the current generation of CRG manufactured karts perform most consistently with the front bumper tight.

Rear Bumper

The rear bumper should be kept tight at all times. 100 inch pounds is considered a fairly tight setting. As mentioned above, there is also an opinion that loosening the rear bumper will provide less rear grip, however the current generation of CRG manufactured karts perform most consistently with the rear bumper tight.

Tire Pressures

Tire pressures can range from as low as 6 psi up to around 30psi depending on the compound of the tire, temperature, surface of the track, and overall chassis set-up. For most applications you should stay between 10psi and 14psi. For SL tires, like a Bridgestone YGC, one can go as high as 16psi. With Dunlop SL4's you can go as high as 18psi. For extremely hard tires, such as Bridgestone YBN's, one will need to run tire pressures as high as 30psi. All tires have a range in which they work the best.

In general, the higher the tire pressure, the faster the tires will come up to temperature and the more grip one will have. However, if too much air pressure is put in the tires, the contact patch with the track surface will be reduced, and as a result adhesion will be lost.

See the section on Tires for more detail.

Side Pod Bars

In almost all circumstances, leave the side pod bars loose. Tightening the side pod bars will give the kart more side bite and generally tighten the chassis. Let the bars fit loosely in the chassis, but be sure the bolts themselves are tight (use Nylock nuts).

Bearing Carriers

The axle bearing carriers can have influence on the axle stiffness, since the portion of the axle between the bearing and the hub is the part that flexes. If you widen the rear track, you are losing a bit of traction because the distance from the bearing carrier to the hub is greater. The normal installation is with the long carrier pointed inwardly.

To effectively soften the rear axle a bit, the third bearing can be set loose in the frame housing. The normal bolts are replaced bolts of smaller cross section and the bearing is not secured with locking screws to the axle.

Turning the long portion of the bearings outward will stiffen the axle ends, gaining grip. Bolting the third bearing securely in place and tightening the set screws to the axle will also stiffen the axle and increase grip. Remember, the bearings all function like fulcrums with the axle working like a lever, so the flexing on both sides of the bearings affect the overall stiffness of the rear assembly.

If the bearing is not moving smoothly in the hanger, it can absorb and release energy in an uncontrolled manner, which can cause hopping in corners.

Rear Axle Assembly Run out

The wheels, axle, hubs, tires, etc. will all inevitably have a certain amount of run out, or deviation from being perfectly round. Sometimes these small individual irregularities can add to each other to form a significant out of round condition. This will, in effect, often feel like an out of balance tire, and will tend to upset the kart at the middle and exit of the turn when dynamic loading is greatest.

The kart may feel loose and hopping, but the effect can be subtle to the driver. The tuner may keep trying to tighten the kart to the point of binding, but the problem is run out.

Careful assembly of components will help minimize run out by using the irregularities of each individual element to balance each other and not provide a cumulative problem

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Maximum Grip Setup (Low Grip Track)

The following settings are recommended as a starting point for a dry track with little grip. These types of tracks are often referred to as "green," given the inherent lack of grip in them. The attempt here is to gain more grip from the kart. The following recommendations should aid in this.

- Weight Distribution should be 43.0% front, 57.0% rear, and 50/50% side/side.
- Toe should be set out 1/16"-1/8". (CRG: 0- 4mm toe out)
- Caster should be at maximum. (CRG: set adjusters at III top, III bottom for maximum front grip)
- Front bumper should always be tight.
- Front width should be 45" to 46". (CRG: 117 cm, 46" for maximum front grip)
- Front ride height (by spindle shims) should start in middle,
- Use both shims under front spindle to raise ride height if more front grip is needed.
- Side pod bars need to be loose (Bolts with locknuts).
- Seat should be set according to factory recommendations.
- Rear wheel hubs should be medium to long (for maximum rear grip).
- Rear ride height should be as high as possible (axle in lowest position).
- Rear track should be set just below the legal limit, within the rules. (CRG: 137 cm or 54" for maximum rear grip)
- Axle should be medium to stiff. (CRG: stiff axle for maximum rear grip)
- There should be at least two seat struts on each side of the seat.
- Rear torsion bar should be in, positioned in either the flat or vertical location.
- Rear bumper should be tight.

Low Grip Setup (High Grip Track)

The following settings are recommended as a starting point for a dry track with much grip, perhaps one on which a lot of rubber has been laid down.

- Weight Distribution should be 43.0% front, 57.0% rear, and 50/50% side/side.
- Toe should be set out 1/16" to 1/8" (1-3mm). (Zero with driver in place)
- Camber should be set at -1/2 degree to 0 degree. (CRG: set adjusters at II top, II bottom)
- Add positive caster past neutral.
- More caster may be needed over the weekend to fight tire wear and loss of grip.
- Front bumper should always be tight.
- Front width should be 44" to 44 1/2".
- Side pod bars should always be loose.
- Seat should be as low as possible (can be as low as 3/4" above the track).
- Rear wheel hubs should be of the shortest length.
- Rear ride height should be as low as possible.
- Rear track should be set just below the legal limit, within the rules, 55" for many classes. (CRG: 139 cm or 54.75")
- Axle should be soft.
- Seat struts should be removed or loosened.
- Rear torsion bar should be removed.
- Rear bumper should be tight.

Rain Set-Up

Obviously the first change is fitting rain tires. But, beyond that, racing in the wet is extremely challenging, even more so if you are stuck with a dry set-up. The changes below will serve to soften the chassis and improve adhesion in the wet.

- Move the front wheels out as far as possible. Some manufacturers have extensions that attach to the spindle, making it possible for the front track to increase even more.
- Rear track should be moved in as far as possible; move the rear wheels in until the centerline of the rear tread aligns with the inside edge of the front tires.
- Set front ride height as high as possible.
- Set front end for maximum caster. (CRG: top-III, bottom –III)
- Increase camber if possible. (Alternate setting: top –III, bottom –II)
- Toe should be set from 1/4" to 1/2" out.
- Front and rear bumpers should be tight.
- Increase tire pressure: the front tire pressures should be at least 15 pounds, the rear tire pressures should be around 20 pounds. This will make the tires heat up faster. Low tire temperatures can be significant problem in the wet. See the section on tires for more detailed information.
- Use only short rain hubs.
- Use only aluminum wheels. (magnesium will corrode)
- Remove torsion bars.
- Move the rear of the seat up around 1" to 1 1/4" above normal recommendation.
- Rear ride height should be as high as possible.
- Shield water from splashing on the brake rotor. Taping up the seat struts usually accomplishes this.
- Tape closed each side pod, to prevent water from entering.
- Spray the ignition with a water repellent, such as WD40.
- Drill two holes in seat bottom for drainage.

Chassis Set Up Procedure

Measuring the Chassis

In order to effectively determine if the chassis is straight, it will be necessary to remove the seat and set the kart on a stand.

First measure the parallel relationship between the front stub axles and the rear axle (with the wheels set straight ahead). Measure each side of the kart from the back of the rear axle to both the bottom and the top of the king pin bolt. Both sides should be equal.

If these dimensions are not the same, it will then be necessary to stretch the side of the chassis that is shorter. This can be achieved by jacking between the bearing hanger at the rear and the king pin post. Normally, it will be necessary to jack the chassis a little further than the difference, as it will spring back. However, be cautious and go in small steps to avoid too large an adjustment. it is vital that the kart be the same length on both sides, before attempting further adjustments.

Now check to see if the rear axle is located centrally in the chassis. This is best done by first measuring from the chassis tubes and then checking the axle diagonally with the tops of the king pins. This diagonal check is important and will tell you if the chassis runs out of line of center. If the diagonal check shows up a fault in the chassis, it is best to leave the chassis alone and simply offset the axle slightly to overcome the problem. Once this is done, the ends of the rear axle can be used accurately for setting the position of the rear hubs.

Once the chassis is the same length on both sides, and the axle is centered, it is time to center the steering with regard to front hubs being parallel to the rear axle. This is necessary in order for the kart to steer evenly in both directions and track in a straight line.

First, lock the steering wheel into a straight ahead position by using either Vice Grips on the nylon steering bearing or by using tie downs from the wheel to the seat back. Then, by placing a metal carpenter's level (or a fluorescent light tube) against one rear wheel, adjust the corresponding front wheel to be exactly parallel to the guide. In effect, the distance from the front edge of the wheel rim will be identical to the distance to the rear.

Once the first wheel is set (with the steering straight ahead), then set the opposite wheel to zero toe. This establishes your central reference point. Now, for example if you want a total of 2mm toe out, without driver, move the front of

each wheel out 1mm (for a total of 2mm). Now, your steering is perfectly straight and your toe out is set, as well.

Progression of Chassis Tuning in Shop

- Measure chassis front to rear and side to side.
- Center steering and set front wheels straight.
- Set caster and camber to the recommended settings.
- Set toe out .
- Weigh the kart to be sure the chassis corner weights are correct.
- Set front and rear track, ride heights, etc.

Progression of Tuning at the Track

When testing at the track, drive a corner as fast as you can and then ask yourself what is keeping you from going through the corner faster. Careful thought will normally help you determine if the kart is sliding in the front (understeer), sliding in the rear (oversteer), hopping, etc. Once you know what the problem is, you can begin solving it.

In general, start with an axle that you feel will work, use medium hubs and set the rear width in the middle of the proper range. Then change track width to adjust for oversteer or understeer. As you reach the limit of the track adjustment, switch hubs and go back to the center of the track width range for more testing.

Never change more than one item at a time or you won't know what is helping or hurting your setup!

The following are the most common adjustments at the track:

- Tire pressures
- Reposition weight
- Adjust frame stiffness (add/remove struts, etc.)
- Adjust front and/or rear track
- Adjust ride height
- Change rear hubs
- Softer or stiffer wheels

Proper record keeping is critical. Write down every change, so that you can go back to your base settings, if your changes are not helping.

Maintenance

First, pull every bearing and moving part off the chassis. Then, thoroughly clean and oil where necessary. Make sure that each moving part is in good condition and if it appears doubtful, replace it. Aerosol white lithium grease is excellent for rear bearings. It is sometimes desirable to remove the debris guards on the bearing to ease maintenance.

Make sure that all king pin bearings are fitted properly and not worn. The same applies to steering shaft bearings, tie rod ends, wheel bearings and axle bearings. Check the kart for any cracks and repair where necessary. Then reassemble using new Nyloc nuts throughout.

Finally, your must be certain that the rear axle, the brake disc and the front wheels all run free. Wheel balance is also important, although fronts are a bit more critical than rears.

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Kart Scaling & Weight Distribution

Weight distribution on a kart has huge influence on the final performance of the kart on track. The mass of the driver is often greater than the kart itself, so this mass must be positioned properly. So, scaling the kart is perhaps the most important thing a driver or team can do to ensure proper handling of their machine.

When the kart is scaled properly, ideal weight distribution is achieved. Therefore, the kart will have the potential to perform at its optimum level. If the kart is not scaled properly, the opposite will be true. The machine will never perform at its optimum level, nor will it respond positively to chassis adjustments.

Some problems of an improperly scaled kart include under-steer, excessive or insufficient load on any one tire, chassis binding, and lack of side bite in cornering among many other problems. An improper weight distribution can also lead to incorrect diagnosis of handling problems at the track. For most karts, the following weight distribution is recommended as a starting point:

43% Front Weight
57% Rear Weight
50%/50% Left/Right Weight

Any lead that might be added should be added as low as possible, For drivers that are near maximum weight, it may be more advantageous to be overweight and have a properly balanced chassis. The stopwatch will tell.

For most chassis, the seat bottom should be about 2 cm (3/4") below the bottom of the frame. A tall driver can go to as little as 3/4" ground clearance from the seat bottom.

The four seat bolts should be very tight with no movement. If seat struts are fitted, four is the best number to use with mounting from the top of the bearing carriers to as high a point on the seat as possible.

Tall drivers can consider using a more flexible seat to reduce chassis stiffness. They may also want to omit seat struts to reduce grip.

These are just recommended starting points. Weight can be moved around at the track to fine tune the handling characteristics of the chassis. Moving weight to the front of the kart will provide more front-end grip. If weight is moved to the rear of the kart, the effect will be more rear-end grip. Weight can also be moved vertically up or down. Moving the weight upwards will provide more grip wherever the weight is located. For example, if weight is placed high on the seat, we could expect more grip in the rear of the kart. If weight is placed lower on the seat, we would expect the kart to lose rear-end grip.

Seat Placement/Adjustment

The seat placement is the single most important weight adjustment on the kart and is done before the scaling process. Proper seat placement may result in almost perfect weight distribution before the weight is added to the kart. You may find that after running the kart a bit, you will have a number of mounting holes drilled in your seat to allow you to shift the seat for changing track conditions. For example, you might move the seat forward to fight an understeering kart by adding more weight to the front end.

A good starting point for an average weight driver is to use the following:

Rear edge of upper seat back direct to axle:	23cm
Front edge for seat to front frame rail:	58cm
Seat bottom below frame:	2cm

Remember, this is only the start. The location of the seat can be a very effective tuning tool. In time, your seat may look like Swiss cheese, but it still works.

Scaling the Kart

- The following steps are very important to the scaling accuracy of your kart.
- Use digital scales for highest accuracy and repeatability
- Be certain that the floor is level. If necessary, place shims under the appropriate corner scales. This is very important.
- Set caster and camber evenly on both sides of the kart.
- Set spindle heights evenly on both sides of the kart.
- Set toe (always remember to set toe after setting caster and camber) and center the steering wheel. If the wheels are not centered during weighing, the geometry of the kart will cause each corner to be loaded incorrectly. As a result, the readings on your scales will be false. Set steering dead ahead and keep wheel movement suppressed by using Vice Grips on the nylon steering block to lock the column.
- Check that tire pressures are at <u>race</u> settings (hot pressures) .
- Fill the fuel tank to the front break. Remember that fuel weights will change during the race.
- Have the driver (wearing full race gear including helmet) sit in his/her normal driving position (hands on the wheel) before the scale reading is taken. Try to avoid unnecessary movements of the head or arms, as these actions will result in a false reading.
- Zero all scales and take down the readings.

Adjusting Kart Weight

If necessary after weighing, adding weight can aid in perfecting the distribution. With many drivers, weight usually has to be added anyway. A good general rule for the location of added ballast is to center the weight somewhere on the seat, given that the mass of the kart needs to be centered as best as possible. Adding weight to the seat aids in this. The area under the front edge of the seat is excellent for 4-5 pounds of ballast. Generally the weight should be added as low as possible. Lead shot in the frame should not be used.

If the driver does not need to add weight, they are probably at the weight limit of their class. Drivers in this case are always reluctant to add weight just to improve the weight distribution. However, there is evidence that adding the weight to perfect the weight distribution is more beneficial than leaving the ten pounds off. It is ultimately up to the driver to test both methods, then choose the quickest alternative.

After the correct distribution is achieved, the driver should make one more observation. The front wheels should weigh within five pounds of each other. The same situation applies to the rear wheels too. If this is not the case, re-check the factors effecting weight distribution given above and re-scale the kart. If the problem still exists, you may have to readjust the seat again and start the process all over again. Only then will the proper distribution be achieved.

Tweaking the Chassis

If the side to side weights are outside an allowable range, you may need to "tweak" the frame in order to get proper weight distribution. There are several means of adjusting the chassis. The following is on method.

If the front corner weights are not equal, place the kart on a flat floor. Place an extra wheel or a floor jack under the front wheel that is heaviest. Then, with someone standing on the rear wheels (lean against the seat), push down on the light front side of the kart.

This should be repeated until the both front wheels carry the same amount of weight. Once the front is even the back will also be even.

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Tires (Care and Feeding)

Tire Pressures

The first thing that must be determined for a kart tire is correct inflation pressure if you want to get the best performance from any individual kart tire. That is easily said, but the real problem is the word " correct " because it meaning varies delicately with conditions such as driver, frame, course layout, road surface, weather and temperature, to name but a few. The manufacturer's approved pressure is usually from around 11 to 18 psi and the proper inflation pressure should be selected from that range to match individual conditions.

Lowering inflation pressure improves grip because the effective contact area is increased and there is a better tire cushioning effect. If pressure is lowered too far, however, contact becomes uneven and driving is more difficult.

Increasing inflation pressure generates heat faster and allows the tire to begin to grip sooner. However, too much inflation pressure will distort the tire cross section, lifting the tread and lose grip. Try for pressures that do not increase more than 2-3 psi in a race session.

Finding the correct balance between heat/grip/wear is the key to success.

A good way to determine the regular inflation pressure for medium compound tires: 10 psi can be considered a good starting point for both front and rear tires. Drive for a while with the tire inflated to this pressure and then change inflation pressure from 1-3 psi until you find the inflation pressure you think is best.

Generally, when a tire is at approximately the correct inflation pressure, it will rise approximately 2 psi from cold to hot readings.

- Hard compound tires (cold) 12-13 psi
- Medium compound tires (cold) 9-10 psi
- Soft compound tires (cold) 8-9 psi

Pyrometers

An even better means of evaluating pressures is the use of a pyrometer to measure tire temperatures across the tread face.

These should be taken immediately upon re-entry to the pits. The laser types are easier to use, but the probe types are a bit more accurate as they are not measuring a rapidly cooling surface (you need three measurements per tire) but a bit into the interior where the heat is better held.

- Too much heat in the center of the tread usually indicates too much pressure,
- A cooler center indicates too low pressure.
- Hottest on both interior edges can mean too much negative camber.
- Hottest on both interior edges can also mean too much caster.
- Too cool on the interior edge may mean a need for more camber.
- Try for equal tire temperatures across each tire face
- Temperatures may vary somewhat from one tire to another

Pyrometers - not!

An alternative that will come your way with experience is simply to examine the surface of the tire. A properly inflated tire on an aligned chassis will have a slightly grained surface not unlike sandpaper. A tire that is running too cool, is a hard compound or just not being used aggressively enough to build up heat will be smooth with no graining. If you see smooth graining, but the interior edge of the tire is showing small strips of rubber or much more aggressive rubber deposits, that look like the rubber is being overheated, then, guess what? You are probably running too much castor, camber, or there is another condition that is overheating that edge. The point is, that the edge will look different than the rest of the tire because it is running hotter.

Varying Conditions

Understeering / Oversteering:

Raise rear tire pressure about 0.5 to 1 psi to correct understeering and lower inflation pressure in the rear tires by the same amount to counteract oversteering. The opposite is also true for front tire inflation pressure. This should not be changed to extremes, however, because sidewall stiffness caused by the proper inflation pressure is needed on the front wheels. This effect may vary with different tire designs and manufacturers.

Generally, if using soft compound tires, rear pressures less than 10 psi should not be used to correct oversteer. Look elsewhere (hubs, rear tread width, etc.) for a solution.

Change in atmospheric temperature

The general rule is to raise inflation pressures slightly as the temperature falls and lower it as the temperature rises. If there is a significant difference between morning and afternoon temperatures, raise the inflation pressure a little in the morning for a better grip by increasing the load to generate heat. Lower it in the afternoon to reduce generation of heat by the tire. This rule applies for summer and winter also.

Compounds:

Tire pressure can be raised when using hard compound tires. With high grip compounds, pressures can be lowered.

Variations in road surface:

Lots of rubber residue on the road surface causes greater resistance and on such a surface it is good to lower air pressure to reduce heat generation by the tire. This holds especially true in summer.

Rain Tires and Abrasive Tracks:

Use the same inflation pressure as for dry conditions or raise the pressure 1-6 psi. When the track dries out, however, a heavy load is imposed on the pattern blocks of rain patterned tires on the corners and the tires are subject to course abrasion. The best remedy is to change to slicks as soon as possible but it's also possible to use wet tires, with reduced inflation pressure, for driving with a good grip.

Extreme wet conditions:	25-30 psi
Moderate wet conditions:	20-25 psi
Drying conditions:	15-20 psi

Course abrasion also affects slick tires if the friction coefficient of the road surface is very high, when drifting or putting a heavy load on the tires. Use the same remedies to this as explained above for wet tires.

Rim Width:

Overall stiffness is changed uniformly as inflation pressure is varied but by changing the rim width, lateral and vertical stiffness, especially lateral stiffness, can be greatly varied. Furthermore, since the contact area does not change appreciably as it does with an alteration in inflation pressure, grip remains the same but fine changes can be made in maneuverability (steering response, smooth slides, true following of the rear tires). For example, if the rear slide is not smooth, a wider rim than standard is called for. However, the range in which rim width can be varied is within ± 0.5 inches (approx. 13mm).

Maneuverability:

Maneuverability can also be changed by varying tire size (tread width). On racing circuits with many braking points or on karts with powerful engines, larger rear tires will improve braking and traction force. On circuits and frames that cause understeering, large front tires can be used or smaller rim size. Oversteering is corrected by doing the opposite. For freeing up the kart, a smaller size with less grip is indicated but when more grip is needed a larger size is called for.

Please note that tire sizes are often dictated by the class in which the kart is running, so this option may be limited.

Tire Diameters

The external diameter (circumference length) of a tire varies in response to different conditions. This must be taken into consideration also when selecting the gear ratios. It is generally accepted that the gear number must be changed for each 12-15mm change in the length of the circumference. This amount of change in diameter occurs quite easily with a variation in inflation pressure and other conditions.

Mismatched tire diameters can have a very negative effect on handling, therefore efforts should be made to run tires of matching diameters. Under some conditions, setting the kart up with equal tire diameters may be more effective than trying to use identical tire pressures.

The rear tires are most important and should not vary in circumference more than 10mm.

Tires can be stretched in diameter by inflating them to 40psi or so and letting them set overnight. This is even more effective if the tire can be left in the sun for a period of time. Then recheck (by measuring circumference) when the tire is at proper race pressure.

High air pressure	Diameter increases
Low air pressure	Diameter decreases
Immediately after mounting new tire on rim	Diameter small
Some time after mounting new tire on rim (stabilizes after about 6 hours)	Diameter increases
Tire temperature rises (after running)	Diameter increases
Worn tire	Diameter decreases
High speed running	Diameter Increases

The Moving Target of Proper Pressures

Ultimately, one of the difficulties in setting correct tire pressures lies in the condition of lower pressures producing more grip once the tire is up to proper operating temperature. However, higher pressures bring the tire up to operating temperature sooner, ultimately at the expense of grip later in the race compared to a lower pressure at that same tread temperature.

Therefore, proper pressures are often based on how soon and how long optimum grip is needed. This principal is more relevant in lighter direct drive or clutch karts. Heavier shifter karts tend to generate higher tire temperatures more rapidly due to their increased power and weight.

New Tire Break-in

The final curing of the rubber of a racing tire takes place in the first laps taken with a new tire. Therefore, the proper procedure is to take two or three laps to gradually bring the tire up to temperature, then only a few more laps at normal operating temperature. It is then imperative that the tires be allowed to completely cool down before racing on the tires. Any other process risks the performance and longevity of the tires.

Setting Up for SL Tires

The first basic thing to realize about SL tires is that they give less grip. As a result the wide rear stance of a kart that runs on open tires will not necessarily work. To start setting up on SL tires, set the kart up fairly wide and then after several laps bring the rear track in 1.0cm (0.5cm per side). Keep on repeating this procedure until the back of the kart stops sliding and starts to lift when cornering. Each time out on the track it is necessary to travel about four laps before testing for grip as the SL tires require considerable warming up.

Once you have the kart handling consistently in both directions and you find that you have the rear end of the kart handling well, but the front is pushing or understeering, the first step is to widen the front track.

This can usually be achieved by spacing the front wheels out on the stub axles.

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Trouble Shooting Guide

Adjustments recommended for different handling problems. Always make only one adjustment at a time.

The back end is loose at the entrance of the corner or there is too much front end bite.

- Move in one wheel spacer on both spindles
- Lower 1 psi in the rear tires
- Move weight away from the front of the kart
- Lower the front of the chassis
- Put less caster in. (adjusters at I/II or I/I top/bottom)
- Check to make sure your toe is set at neutral (driver in kart)
- Fit stiffer rear axle
- Fit longer hubs
- Fit seat struts (four total)
- Raise rear ride height

The front end of the kart is "pushing out", there is under-steer, or the back end is tight at the entrance of the corner.

- Move out one wheel spacer on both spindles.
- Raise the air pressure in the rear tires by 1 psi.
- Add weight to the front of the kart
- Add more caster. . (adjusters to III/II or III/III top/bottom, if starting @ II/II))
- Raise the front end of the kart
- Check to make sure your toe is set at neutral, if so, add more toe out.

The kart is sliding on all four wheels too much or there is not enough side bite.

- Tighten the torsion bars.
- Lower the hot tire pressures in all 4 tires by 1 psi.

The kart is not sliding enough on all four wheels or there is too much side bite.

- Loosen or remove the torsion bars.
- Raise the hot tire pressures in all 4 tires by 1 psi.

The kart is loose at the exit of the corner.

- Put longer wheel hubs on the axle.
- Set the rear track to around 54" or 137mm.
- Raise the air pressure in the rear tires by 1 psi.
- Raise any ballast to a higher vertical position on the rear of the kart.
- Raise the rear ride height to the maximum if not already done.
- Change to a stiffer axle.
- Add seat struts (four)

Kart is tight at the exit of the corner or the front end is under-steering at the exit of the corner.

- Put shorter wheel hubs on the axle.
- Move in the rear track by up to 1/2 inch.
- Raise the air pressure in the rear tires by 1 psi.
- Change the axle to softer, if not already done.
- Lower any ballast to a lower vertical position at the rear of the kart.
- Remove one set of seat struts.
- Lower the rear ride height.

Kart understeers or oversteers, but only in one direction

- Check kart corner weights are equal
- Check for twisted or bent chassis.
- Check that all settings on one side of chassis are same as opposite
- Check equal side to side tire pressures

The kart "darty" on the straights and dives rapidly into the corners.

- Too much toe out. Try around 1/8" (3mm) for normal conditions (zero with driver in place).
- Front track too narrow, widen by one spacer each side

The kart is hopping at the rear in corners.

- Put shorter wheel hubs on the axle.
- Set the rear track to or close to the maximum allowed width if not already
- Raise the air pressure in the rear tires by 1 psi.
- Lower any ballast to a lower vertical position on the rear of the kart.
- Lower the rear ride height to the maximum if not already
- Change to a softer axle
- Remove seat struts

Push/kick.

- Move seat forward
- Decrease rear tread width
- Increase front tread width
- Increase rear tire pressure

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Quick Troubleshooting Chart

Remedies are listed in approximate order of relative effectiveness with most effective listed at top.
Many of the items below are of simiar effectiveness to those adjacent in the list.

MOST EFFECTIVE	OVERSTEER	UNDERSTEER	PUSH/KICK	HOPPING	REMARKS
Seat Position	Move back	Move forward	Move forward	Seat back lower	Very effective tuning tool
Axle	Stiffer axle	Softer axle	Softer axle	Softer axle	Don't narrow too much.
Seat Struts	Add or tighten	Remove or loosen	Remove or loosen	Remove or loosen	
Rear Wheel Hubs	Fit longer	Fit shorter	Fit shorter	Fit shorter	
Rear Width	Decrease	Increase	Decrease	Increase	
Front Width	Decrease	Increase	Increase	Decrease	
Front Ride Height	Lower	Higher	Higher	Not effective	
Rear Ride Height	Higher	Lower	Lower	Lower	
Caster	Decrease	Increase	Not effective	Not effective	Effective on both ends of kart

LESS EFFECTIVE	OVERSTEER	UNDERSTEER	PUSH/KICK	HOPPING	REMARKS
Rear Tire Pressure	Decrease	Increase	Increase	Not effective	Tune for even tire wear, not fixing chassis
Front Tire Pressure	Increase	Decrease	Decrease	Not effective	Don't soften too much or will lose sidewall stifness
Rear Wheel Width	Increase	Decrease	Decrease	Not effective	
Front Wheel Width	Decrease	Increase	Increase	Not effective	
Toe	Not effective	Increase	Not effective	Not effective	
Camber	Less negative	More negative	Not effective	Not effective	
Side Pod Bars	Tighten	Tighten	Loosen	Loosen	Tightening stiffens chassis considerably
Torsion bar	Tighten	Tighten	Loosen	Loosen	
Front Bumper	Loosen	Tighten	Tighten	Not effective	
Rear Bumper	Tighten	Loosen	Loosen	Loosen	

CRG Caster and Camber Chart

CASTER	CAMBER	UPPER	LOWER	REMARKS
maximum	central (mid track)	III	III	maximum caster
more	more positive	II	III	
more	more negative	III	II	
central (mid wb)	**max. negative**	0	II	maximum negative camber
central (mid wb)	**central (wide track)**	II	II	**Factory neutral setting**
central (mid wb)	**max positive**	II	0	maximum positive camber
less	more positive	II	I	
less	more negative	I	II	
minimum	central (mid track)	I	I	minimum caster

Fixed Bottom Carrier:
Position I on top carrier will give more negative camber and less caster.
Position II gives less negative camber than adjustable carrier and no effect on caster.
Position III will give more negative camber and more caster.

NOTE: Adjusters must be installed in the following manner. Left side adjusters will be identical and numbered in a clockwise manner. Right side adjusters will be numbered in a counterclockwise manner.
With both tops and bottoms set (to inside) at "II", top fronts on both sides will be "I" and bottom fronts will be "III".

CRG Axle Chart

Diameter	Axle code	Alternate code	Hardness	Thickness
40mm	K	KQ & KA	235-250	3.0mm
40mm	MAF	M	195-210	
40mm	MB		180	
40mm	AZ	MZ2	180-190	3.0mm
40mm	MZ	MOGO H	160-175	3.0mm
40mm	ZZ	MOGO M	150-160	
40mm	MET30	MOGO S	130-140	3.0mm
40mm	AZ4		110-115	3.0mm
40mm	AZ5		100-110	3.0mm
40mm	MET25		100	2.5mm
50mm	T5		230	2.0mm
50mm	T2		200	2.0mm
50mm	M20	MOGO M20	160	2.0mm
50mm	T-4		130	2.5mm
50mm	T-1		120	2.5mm
50mm	T-6		100	2.0mm
50mm	T-3		90	2.0mm
50mm	S-25	MOGO S-25	80	2.5mm
50mm	S-20	MOGO S-20	60	2.0mm