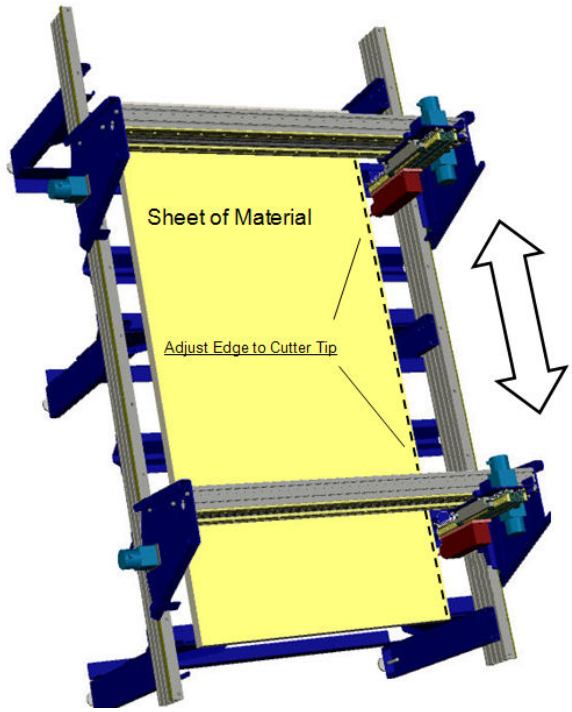
Squaring and Adjusting the X Car on PRS Tools

There are a number of good ways to evaluate whether your tool is “square”. The first is just to cut a large rectangle, the bigger the better, and measure the diagonals. They should be equal. Short of cutting something out, you can inscribe a shallow, large square or rectangle (e.g. 30x50) on your table surface (or chuck up a pencil and draw one) and measure the diagonals. Alternatively drill 4 holes at the corners of a square and measure the diagonals. In all cases, if the diagonals are equal your tool is cutting square.

The technique that will be detailed below provides a straightforward method to help you initially square your tool. Use it to get started. However, the “proof is always in the pudding.” Use the approach above when you are ready to fully ‘evaluate’ square.

Use a Square Sheet

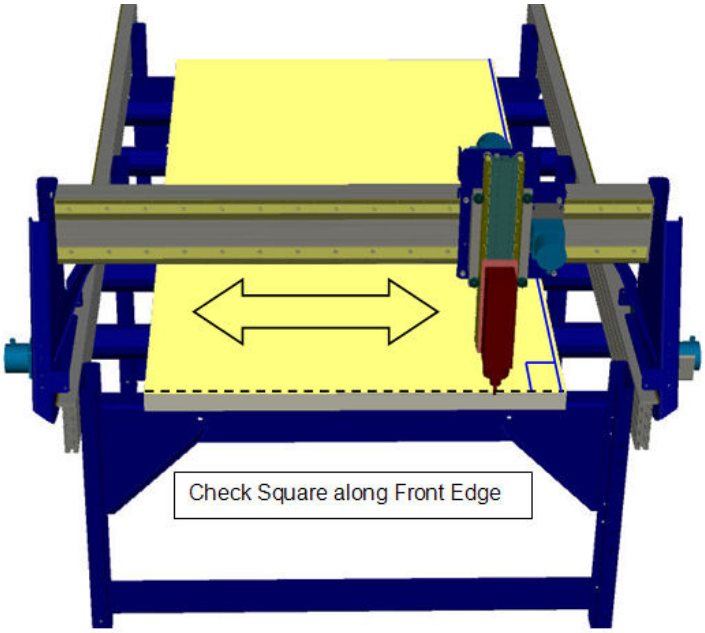
This initial squaring technique can be used either with or without the motors engaged. If you have had difficulty getting the wheels exactly aligned in the previous steps, then you may want to lower and disengage the motors from the rack to make a first pass at adjusting the alignment. You basically want to make sure the X Car in its relaxed or natural position is pretty square. If things already look about right, then leave the motors engaged.



You will need to have mounted your router or spindle to use this squaring technique. Put a cutter with a v-tip or point in the collet. The only other thing you will need is a large square sheet of material. It should be a sheet that you are confident is square because you have measured the diagonals, say a 4x4 or 4x8 piece of plywood. [NOTE: Sheets from the factory are not necessarily square. Measure each edge to make sure they are equal, THEN compare the diagonals. The bigger the size the better, so a large square sheet works better than a carpenters square. In fact, the average carpenters square is not very square. Check it well if you are using one.]

Move the YZ Car to one end of the Y axis, bring the tip of the cutter down to the edge of the material, and align the sheet up and down the X axis by moving The X Car up and down the rails, checking the position of the sheet at the tip of the cutter.

Now, because you've gotten the board parallel to the X axis, the short (Y) edge is square to the X. You can move the carriage down to one end of the sheet and move the tip of the cutter along the short edge, moving the YZ Car. By observing the tip of the cutter as it moves along the short edge, you will be able to evaluate the square of the two axes on the tool.



Relaxed Alignment vs Powered Alignment

Square is maintained on your tool by the 2, X-axis motors. The motors always move absolutely identically and they keep the X Car perfectly square when they are powered. The X Car itself, when not locked into position by the motors, is not designed to be capable of maintaining the alignment on its own. In the ideal world, the X axis will always 'relax' into a square position when powered off. But in practice, because the motors and gearboxes have a lot of friction, there may not be an exact, relaxed alignment position of the carriage and it will be possible to push one or the other end out of alignment.

To get the tool square with the motors installed and engaged, start powered off, push the carriage back and forth a few times from the center and let it take as natural an alignment position as possible. Do this over the edge of your sheet so you can check square. Your relaxed alignment should be within about 1/8" of square across the table, as indicated by your cutter tip moving up and down the Y edge of the sheet. If you are further out of alignment than this, visit the "Making Adjustment" section below.

Once the alignment is close and continuing with the motors powered off, push the one end of the car slightly to bring the whole gantry into perfect square with the board. You may need to lock one or both ends with clamps to manage this. Then, when you've got it square, turn the power to on to the Control Box, and if a PRSalpha, hit the Reset Button. The motors will power on and lock into position. Your tool is now square in X and Y, and it will remain square whenever it moves until the power is removed.

Setting the End Stops So Your Tool Will Always be Square

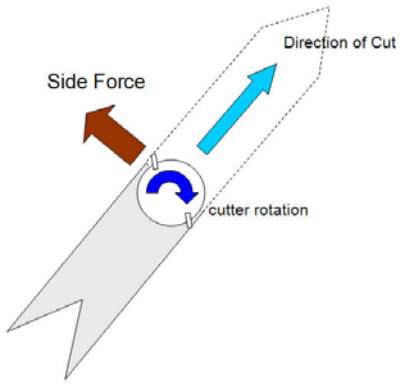
Because the X car is not intended to be able to physically maintain alignment when the power is off, after a period of being powered down you cannot be certain that in a busy shop the carriage has not been bumped a little out of square. So, you need a system for guaranteeing square each time you restart the tool. The mechanical End Stops do this for you.

First let's get the End Stops installed perfectly square at the bottom end of your tool. Do this by driving the X Car, using the KeyPad mode in the software, down to the bottom (X = 0) end of the tool. Slow down when you get close, and move the car to the point that each wheel bearing is about ¼" from the end of the rail.

Slide the End Stop on Each side into the Table Side and up against the motor pinion. Then back the X Car off and tighten the End Stops securely into place. You now have End Stops that you can use to square the car.

When you turn the tool off, park the X Car near the bottom end of the tool. Whenever you are ready to power up again, first gently/slowly pull the X car into the stops to square it, and then turn the power on. The car is square and will stay square for the duration of your work session.

Cutting Forces



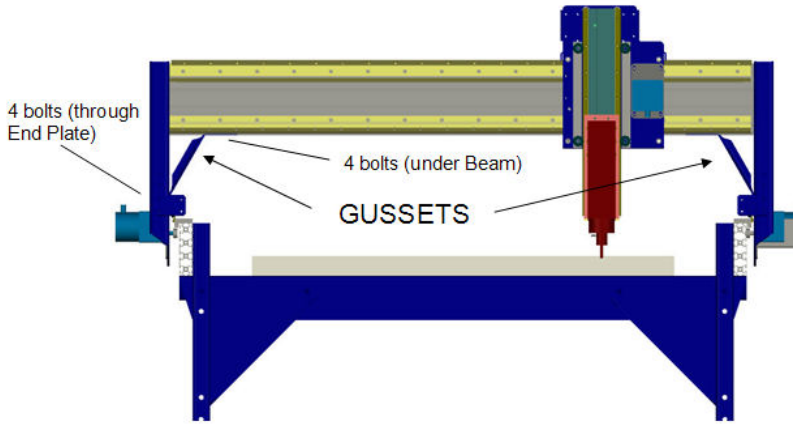
When the router bit is cutting through material, it is kicking 90 degrees to the left of the tool path. The more aggressive the cutting, the more force perpendicular to the cut. Because of the force, the router bit can bend slightly, the spindle/router may exhibit some run-out, and the tool can flex a little. For this reason, cutting forces can slightly alter the path of the tool. Such effects will alter the overall size of the shape that you are cutting by a small amount, though not the shape itself, or its squareness. For example, cutting a square in a clockwise direction forces the cutter to pull to the outside during cutting, and this can make the square slightly larger in overall size than specified. Similarly, cutting counter clockwise around an object can cause it to be slightly smaller. This is a feature of all machining. In either direction, the square should be square and as long as you are cutting at the same speed, cuts should be highly repeatable. If you are having problems with too much size variation from the intended size, try slowing the feed-rate or increasing the spindle RPMs. These changes will reduce the side force of cutting. Using a cutter that generates less cutting force because of its geometry will also reduce this type of error. Note that as a cutter becomes dull, it will require more force to push through the material and thus will also generate more side force.

Making an Adjustment for Wheel Bearing Alignment or Square

The X Car of your PRS ShopBot is the primary structural component of the tool. We build the X Car in a precision fixture that exactly spaces the wheel bearings and that assures a perfectly square and true gantry. After assembly, we handle and pack the gantry in a way that is intended to assure it stays square. However, we recognize that in the process of trucking the tool to your location, considerable stresses can be put on it and that a small amount of on-site adjustment could be necessary. The following is a general procedure for dealing with a wheel bearing that rides high or to one side, or with finding that in its relaxed condition the X Car is more than the 1/8" out of square (see above for discussion of relaxed vs powered alignment).

First, make sure that if you are experiencing a problem with the 'ride' of one of the wheel bearings or with square, you have ruled out problems with the rails not being parallel. Make sure the rails are level. Then test the ride of the wheel bearings up and down the rails and re-measure the spacing of the rails. If the rail spacing is right, and you have the same 'ride' problem up and down the axis, then proceed to make the following adjustment.

Use clamps to lock the X Car in position. This will take 4 clamps, one at the front and back of each End Plate of the car. If the car is square, the clamps will keep it locked square.



The Gussets under the beam are designed to define the orientation and position of the end plates. You'll loosen them to correct the orientation. There are 4 bolts on the Gusset at the End Plate and 6 bolts on under the beam. Make sure all bolts are loose. The ones under the beam sometimes bind after you loosen one of the others, so keep going around and make sure all are free, but try not to let them come out of the t-nuts in the beam.

For the situation where you are adjusting a wheel: with Gussets loose, if the wheel bearing has not dropped onto the rail, give the End Plate a downward tap with a rubber mallet to get the wheel bearing into position.

For the situation where you are adjusting square: with Gussets loose, use the clamps to move one side of the car the distance required to make it square, and check to see that all the wheels are correctly re-seat themselves, a tap with a rubber mallet may be necessary.

Now you are ready to re-tighten the Gussets. First, tighten the lower 4 bolts on each Gusset, then draw up the 6 top bolts tightening each a little at a time.