

# Basic servo linkage geometry (part 1)

Written 12/21/2012 by Jack Sallade (Web Site: [www.flyrc.info](http://www.flyrc.info) Email: jack@flyrc.info)

When setting up our model aircraft we often make decisions on which servo arm or control horn to use on a given flight surface. Of course the torque and speed rating of the servo comes into play as well but I'd like to discuss the linkage geometry so that you can understand what effect these decision have on how the airplane flies. Here's the basic idea.

When you choose equal length, standard 1" control horns and servo arms and use the outermost holes to attach the linkage you are getting exactly what the manufacturer advertised. 10 degrees of rotation of the servo arm will also rotate the control surface 10 degrees and will do so while applying (as needed) the specified torque. Let's use a Hitec 425 operating at 4.8V as an example. This servo produces 46 oz/in of torque. This would be an appropriate choice for a standard 40 size trainer. Using the standard arm and horn this should give adequate service in this application. But what if you now move on to something a bit more interesting? The manual calls for these same servos on your new mid-wing, semi-aerobatic aircraft but because of the way the push rod guides are routed it appears that you are going to need a 2" servo arm. (OK my example is a bit extreme but work with me here!) Are your servos still OK for this airplane? You didn't change anything important right? The answers are maybe and you definitely did!

In reality the servo horn and control linkage are levers and like any lever, increasing or decreasing the length of that lever on one side of the pivot point will affect the amount of force being applied as well as changing the amount of travel. Force and distance of travel are essentially a tradeoff for one another.

In the case of the servo arm, lengthening it will effectively lessen the amount of force the servo is applying to the surface while increasing the surface travel. Looked at in reverse, the surface is "pressing against the servo" the same amount but you've given it a longer lever to push on, increasing the force needed from the servo to push back against it. Shortening the arm will effectively increase the force applied while decreasing the available travel. The exact opposite applies to the control horn attached to the surface. In our example we made the servo arm twice as long so we decreased our force applied from 46 to 23 oz/in while doubling the travel. This is a simple ratio of control horn over servo arm length ( $1/2$ ) times the amount of torque produced by the servo. Note that because this is a ratio, if we use any equal length horn and arm we have actually changed nothing. Getting back to our example, you may have just created a big issue. Not only have you now drastically cut the amount of torque available but making the control surface move that much further only increases the amount of wind resistance that surface is likely encountering. That first high speed dive and "attempted" pull out could be the last for that aircraft. Once enough air is flowing against the surface at a great enough angle to need more than the available torque, the servo will simply stall and the surface may even blow back as the forces grow. Without an understanding of the linkage geometry the following is likely to be heard soon after: "I pulled and it just didn't respond!?! It must have been a radio problem!"

Next time I'll discuss some ways to use this knowledge to do more than just avoid disaster!