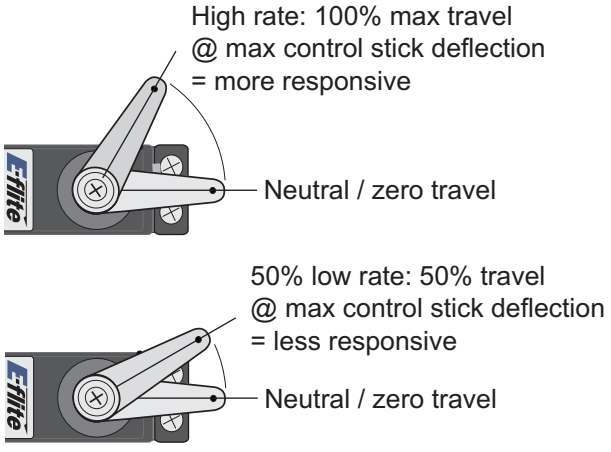
Heli Radio Optimization (Dual Rates and Exponential)

Nearly all transmitters today come with "dual rates" or multiple "flight modes" that allow the pilot of a fixed pitch heli to switch between a *high rate* (faster) control response and a *low rate* (milder) control response. More capable collective pitch helicopters use flight modes to switch between the normal mode used for upright hovering and basic maneuvering to a stunt or "idle up" mode that allows the pitch of the main rotor blades to be reversed during inverted flight. There's much to cover before getting into aerobatics, therefore all control discussions pertaining to upright hovering and general maneuvering will assume that the low rate or normal mode settings are being used.

"Exponential" is another useful feature (pg. A-5) available on all computer radios that enables pilots to further improve a helicopter's handling by helping to make the controls less twitchy. It's common for novice pilots to think that they don't need to bother all that fancy computer stuff because they're not yet doing anything fancy, but compared to an experienced pilot who has the skill to compensate for a less than optimum setup, it's actually novice pilots that can benefit the most from investing in a computer heli radio capable of multiple flight modes and exponential. If the only thing stopping you from taking advantage of a computer radio is apprehension about learning to program it, that's easy to work past by creating another model memory in the radio that won't be used for flying so you are free to experiment and thereby learn how to program without any concern about screwing it up. Note: The only time learning to program a radio doesn't make much sense is when sitting on a couch reading the manual. It makes far more sense when the heli is in front of you with the switches on (with the motor unplugged for safety) so you can see the cause-and-effect of your programming. When concerns about making a mistake are removed because you're going to end up erasing the practice model memory at some point, most people actually find learning how to program the radio stimulating and fun!

Dual high-low rate example



When used correctly, the dual rate and exponential features available on all computer radios can be great tools to make a heli more comfortable to fly so that you can concentrate on flying your best.

In order to remain focused on flying and not on flipping switches, set up your radio to control high and low rates with one switch.

KPTR: Radios featuring dual rates and exponential are not just for advanced flying, but can make flying a lot easier for a novice.

Travel Setup and Balanced Controls

As a rule, how quickly a helicopter responds to control inputs is a function of how far the control mechanisms "travel", regardless of whether the heli is small, large, high or low performance. Because larger helis are easier to see and tend to be more stable and handle wind better, people sometimes attribute a smaller heli's quicker response to its size and thus assume that they have to get used to it, but when using a computer radio, even a small heli can be made to handle comfortably by changing the travel or dual rate percentages.

The manufacturer's travel and dual rate recommendations are often good starting points, but don't make the mistake of thinking that they will be optimum for you, nor are they necessarily what the manufacturer intends you stay with. To fly your best, each pilot must adjust the travel settings for each control to suit his or her immediate skill/comfort level, i.e., what feels ok to a rank beginner at first will likely start feeling slow or sluggish as his skills and confidence improve. Thus, the "optimum" travel percentages for each pilot can only be determined by the pilot himself at a given time, a.k.a., listen to your gut.

Novice pilots often feel that the low rate travel percentages specified by the manufacturer are still a bit too responsive for the first few flights, thus newcomers flying for the first time may want to consider lowering the manufacturer's low-rate recommendations another 10%. As long as you're not flying in wind or in a very small area, the most significant drawback of a docile setup is at some point things might feel a bit boring, but at least the helicopter remains intact and you can always start increasing travel from there.

When you begin to develop a feel for your helicopter, start evaluating whether the control response is the same in all directions. "Balanced" controls refers to the ideal condition where the aileron, elevator and rudder controls are all equally sensitive. A lack of control continuity, i.e., when one control is noticeably more or less responsive than the others, can have an appreciable impact on pilot performance when the pilot has to continually remind himself to use different control pressures depending on the input he's making. Of course, a novice pilot isn't going to be able to make theses judgements right away, but when that time comes, rather than you trying to get used to the heli, adjust the helicopter to suit you.

Note: For a variety of reasons, it's common to end up with different percentages programmed into the radio to achieve the same control feel in all directions. Pilots often make the mistake of assuming that things are the same in both directions because the "numbers" on the screen are the same, but end up hindered because there's an imbalance such as the heli responding faster to the left than to the right. So, ultimately concern yourself with achieving good control balance and less with the numbers.

After adhering to the mechanical setup specified by the heli manufacturer, how the heli responds in the air is determined by the travel and dual rate percentages programmed into the radio. It's standard practice to change the percentages to achieve the responses that best suits the skills and comfort level of the pilot. It's also not uncommon to end up with different percentages programmed into the radio to achieve the same "balanced" control response in all directions.

KPTR: The "best" travel settings are those that compliment the comfort and skill level of the individual pilot.

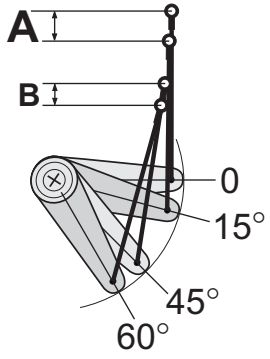
The Exponential Advantage

Programmable exponential or "expo" improves a helicopter's handling by helping to create a more linear control response through the full range of travel. Explained: Due to the changing servo arm-pushrod geometry, the heli's controls move at a faster rate through the first half of servo arm travel than they do through the last half (see graphic). As a rule, 15-20% expo on the aileron and elevator compensates for the changing servo arm geometry to produce a more linear and therefore predictable flight control response. Modern tail rotor gyros tend to have such a great stabilizing effect on the tail that typically 10% or less expo is needed on the rudder.

Note: Low rate recommendations are based on an "average" pilot, which may prove to be a bit too responsive for a rank beginner, consequently, manufacturers tend to recommend large amounts of expo (30%+) to help further tame the low rate response. While large amounts of expo will indeed tame the feel of the heli, sluggish isn't good either! Anyone who has driven an old car with slop in the steering knows how much harder one has to work just to keep the car going straight. That's because the slop or lag in the steering response prevents the operator from correcting deviations while they are yet small, thus prompting larger corrections that often result in getting more response than is needed. As long as it's not overly sensitive, a tight control response is better because it enables drivers/pilots to correct deviations at the instant they occur when just a small nudge on the controls will do the job.

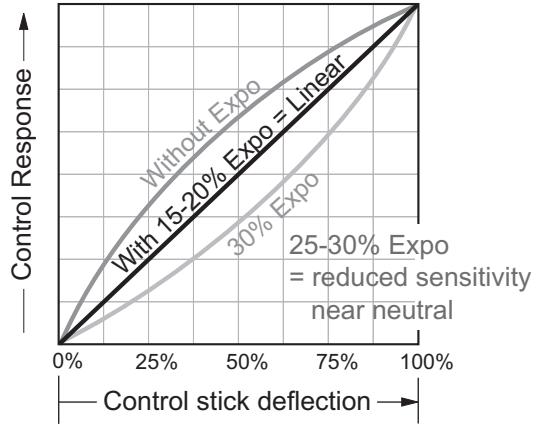
Some purists think that it's better to learn without expo, and some get carried away thinking that if a little expo is good, more is even better, but both would be incorrect. It's pilots that attempt to use large amounts of expo to compensate for an improper setup and/or bad technique that end up doing more harm than good, but a reasonable 15-20% expo on the aileron and elevator channels is always a smart addition to your fundamental heli setup.

In conclusion, when evaluating your heli response, if it's deemed to be too responsive, before you start adding expo, first try reducing the travel or dual rate percentage in the radio. If you're generally happy with the handling, but feel the heli reacts too abruptly when initiating inputs, then it would be appropriate to increase expo. Or, if you're 95% happy with the control response but feel that your heli's response is a bit sluggish, don't hesitate to take some expo out.



Example: As the angle of the servo arm relative to the pushrod linkage becomes more acute, the "rate" of increase lessens (**A**, **B**). The travel rate disparity is greatest when the servo arm draws a large arc (25% @ 60 degrees of travel) and is less when the arm moves less. On average, 15-20% expo at full deflection compensates for the travel disparity to produce a more linear control response.

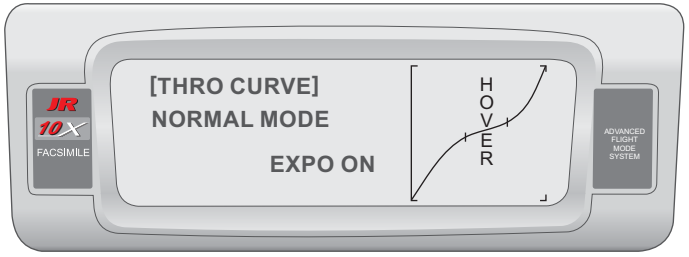
Control Response Depiction



Without expo, the normal servo arm geometry causes control inputs near neutral to be more touchy. 15-20% expo compensates for the servo geometry to produce a more linear control response through the full range of control stick deflection. Greater than 20% expo produces a softer control response near neutral, but also sacrifices the ideal 1-to-1 correlation between control inputs and heli response, and therefore some predictability.

KPTR: 15-20% expo produces a more predicatble liner control response.

Normal Mode Throttle Curve and Mixing Rules-of-Thumb



Once the average hover power setting is determined, many pilots like to then flatten the throttle curve a bit around that setting in order to create a larger sweet spot where the heli less sensitive to throttle changes when hovering in the "normal" flight mode. Throttle curves tend to go hand in hand with the pitch curve of the main rotor blades, so at some point you may wish to also experiment with flattening the pitch curve in the normal mode to make the "collective" (left stick) control response even more subtle during hover.

Programmable "mixes" give you the option to automatically link another control with your primary input to reduce or eliminate some of the unwanted additional tendencies associated with certain inputs. It's often said that if the heli is set up perfectly, you should never have to use mixing, and that's certainly the ideal. However, for a variety of reasons, even when you've done your very best to setup the heli correctly, a helicopter may still exhibit some unwanted tendencies that a small mix can correct and thereby make the heli easier to fly. For example, if your heli consistently drifts to the left whenever right rudder is applied, you may choose to create a rudder-aileron mix that tilts the swashplate ever so slightly to the right when applying right rudder, etc., etc..

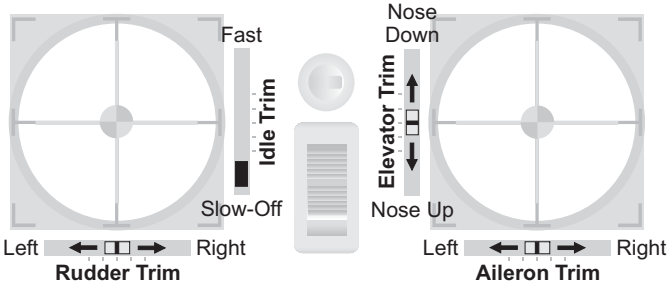
As a rule, mixes should be limited to no more than 5%. Pilots need to use mixing sparingly because the mix that helps one circumstance could end up causing a deviation somewhere else. Limiting your mixes to 5% or less should help make flying a little easier without having a noticeable impact on other maneuvers.

Note: Fixed pitch helis are especially prone to displaying additional tendencies when inputting rudder (tail-rotor), and therefore may require more than the 5% mix rule-of-thumb, but needing any more than a 5% mix on a collective pitch heli indicates problems with the mechanical setup that deserve attention (usually the servo arm and pushrod geometry is not the same all around and/or the gyro is not up to the task). Consequently, make sure that all the servo arms are perpendicular to the pushrods and invest in the best gyro you can afford to ensure a well behaved heli.

KPTR: Mixes can make things a little easier, but are no substitute for a proper setup and learning good control skills.

Flight Trimming Rules-of-Thumb

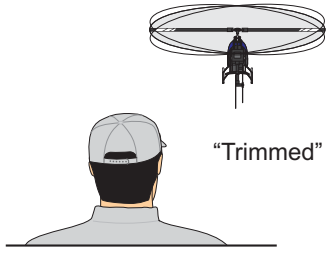
For various reasons, your heli will require slight trim adjustments from time to time. As a rule, adjustments are made to the aileron, elevator and/or rudder trim when the helicopter displays a tendency during hover to consistently deviate in the same direction, thus requiring repeated corrections in the opposite direction. Example: If the nose of the helicopter repeatedly turns (yaws) to the left or right, adjust the rudder trim in the opposite direction until the nose remains stationary without much input from you. If the helicopter consistently tilts either forward or backward, adjust the elevator trim in the opposite direction. And, if the helicopter repeatedly banks to the left or right, adjust the aileron trim. Just how much trim to put in depends on how much effort it takes to correct, i.e., if you only need to make tiny corrections, possibly a click or two of trim will be sufficient. But if the heli is so far out of trim that you need to hold in a notable stick input, several clicks may be required. Note: If no wind exists, needing a large trim adjustment indicates an improper mechanical setup and/or incorrect gyro settings.



Trim example: On a calm day, having to hold in right rudder to prevent a consistent left yaw tendency is corrected with right rudder trim. The rudder (or any other control) is trimmed correctly when the helicopter no longer displays a tendency to deviate in the same direction, or, the pilot has to make roughly the same number of left and right corrections.

The practice of performing short test hops consisting of lifting off a few feet and then settling back to the ground to determine what trim adjustments are needed is asking a novice pilot to do a lot in short amount of time. Realistically, the best approach is to first practice trim adjustments in a simulator until they become routine, and then apply that experience to the real world. As a rule, after making a trim adjustment, you'll have to fly the heli for awhile to determine whether further trim adjustments are actually needed. I.e., the deviations you encounter after the initial trim adjustment may actually be caused by something you did or something else, and therefore you'll needed to fly awhile longer to be certain whether another trim adjustment is truly(?) necessary.

Wind will have a significant impact on the heli's behavior, which can cause a pilot to believe that certain aileron and elevator trim adjustments are needed, only to find out that opposite trim is needed when the heli is turned relative to the wind. Therefore, when you start maneuvering in wind, you'll have to "average" the trim so that the corrections you make to compensate for the wind are roughly equal as you expose different sides of the heli to the wind.



KPTR: Having to repeat or hold in a correction despite calm winds is the primary indicator of needing trim.