



2.4 GHZ for the Common Pilot

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By now, if you are even somewhat involved in RC model aviation, you most likely have heard of the newest technological achievement in our sport. If you are only just now starting to learn about RC flying, then maybe you haven't yet heard of this new development. No matter your level of RC flying experience, the development of radio systems operating on the 2.4 GHZ frequencies will greatly affect your future RC flying and you should be aware of it.

That is the purpose of this article. Most every magazine, especially the Academy of Model Aviation's "Model Aviation" magazine, has printed articles on the subject. Even Sport Aviator has reprinted one of Model Aviation's [2.4 GHZ articles in the Flight-Tech Section](#). All the articles hail the new development and explain it in great detail: Maybe in too great a detail.

Not all RC sport pilots, us "common folk" of the sport, want to know the intense technological details of our control systems. We only want to know what we *need* to know to get the most out of our sport, safely, while also knowing enough to make purchasing decisions.

Our RC control systems have become so advanced that the days of the common pilot building or repairing them is long past. It might be factual to state that our RC control systems went truly Ready-To-Fly in the late 1970's. For most of us, that was a good thing.

To be honest, few of us common pilots know, or even *care* to know, a lot of the technical details about our "radios" (what we common pilots call our transmitters and receivers and some even include the batteries in this term.) Instead, we want to turn the "radios" on, have them work continuously for months, then put them away uncharged for centuries and still have them ready to fly, without ever re-charging their 200-year old batteries. We also want our servos (the "motors that move our aircraft's control surfaces) to weigh less than 7 grams while being able to control the rudder on a 66% scale B-36.

But, as much as we would want our radios to work this way, even we radio dummies know that this is not yet possible. We have learned about the care and feeding of our transmitter and flight batteries. (See the three Sport Aviator articles, [Those Things We Call Batteries](#) Parts 1 to 3 in the Flight Tech Section). We also learned about servo torque limitations and power drain.

We learned because we had to. If we didn't learn, we started to lose airplanes. So we learned about battery memory, or lack of it, and their capacities. We learned about computer transmitter programming because knowing enhanced our aircraft's flying abilities. We learned about field testing our batteries, and about the equipment used for this task, because knowing this information saved our airplanes from those unplanned aircraft-ground interfaces.

All the technical developments made by manufacturers, and especially by the more technically-oriented modelers, have greatly enhanced our sport. Like our sport's engine "Gurus" who have made modern glow engines, electric motors and gas engines so reliable that common pilots barely need to give them a second thought now, the "Radio Geniuses" have given us reliable systems that almost never fail while performing tasks that would have seemed magical in the 1970's. Our thanks and appreciation should go to both groups for model aviation would have been a less popular, different sport that was much poorer for their absence.

From their writings and shared knowledge, common pilots have pulled what *they* needed to know to improve their own flying experience. They took as much or as little as they thought best and incorporated this knowledge into their version of our sport. But now, the Experts have given us something very special that will probably revolutionize the way we fly, not just control, our airplanes. And it is time we common pilots learned what we need to know for our flying and what decisions we need to be making in the next few years.

Let's look at this development purely from the perspective of the common sport RC pilot. How will it affect our flying and just what do we really need to know about it at this point. Using common, basic terms and targeted just on a true "need to know" basis for the common sport pilot, this is what 2.4 GHz flying will be all about. There will be some basic technical stuff but the parts you really need to know will be **identified in bold type**.

What is 2.4 GHz?



Photo 1

All of our current aircraft radio control systems operate on one of fifty channels in the 72 MHz (each MHz means the signal's frequency is one million cycles per second) radio transmission "Band". "Band" is the range of frequencies that our transmitters use to send signals to our receivers. Our Frequency Band starts at 72.010 MHz (72,010,000 cycles per second) and goes up to 72.990 MHz. Each specific frequency in this band has a 5-number numerical identifier corresponding to its number of cycles per second.

It is somewhat difficult to use the actual 5-number identifier in everyday field use because there are so many of them. Instead, we use two-digit "channel numbers". A radio system operating on the 72.010 frequency is said to be working on Channel 11. One operating on a frequency of

72.990 MHz is working on Channel 60. The other 48 radio frequencies in the aircraft 72 MHz Band have numbers ranging from Channel 12 to Channel 59 in ascending order.

The new 2.4 GHz (each GHz is one billion cycles per second) radio control systems operate in a Frequency Band that uses far shorter wave lengths. Since both transmitting and receiving antennae have lengths that are related to their frequency band, the 2.4 GHz radio systems have much shorter antenna (photo 1).

At the present time, **the transmitter antenna is not removable or collapsible**. This means that **any transmitter case you now have cannot be used** with this system. It also means that you will find the **transmitter to be slightly “tail heavy”** if you use a transmitter neck strap or tray since the heavy metal antenna is replaced by a light “plastic” one. You will also find that the ever-present **metal antenna that you have been unconsciously using as a reference point while flying is no longer there**.



Photo 2

The receiver antennae are also much shorter in the 2.4 GHz system. Even with 2.4 GHz systems that use dual receivers, the antennae are barely two inches long and usually remain inside the aircraft. The three 2.4 GHz receivers on the right side of photo 2 are just three of the many available.

The AR7000 is the standard sport aircraft receiver designed for use in all sport airplanes flown at any range. The slightly smaller and much lighter AR6200 receiver is a light weight, long range receiver designed for small sport airplanes and helicopters where weight could be a factor. The small AR6100 is for small electrics flown at short ranges.

The two receivers on the left in photo 1 are standard 72MHz items there for comparison. Note the yard-long antennae wrapped around the receivers for storage. Gone are the days of installing yard-long internal tubes to hold the receiver antenna inside the airplane or of stringing the long wire out the side or rear. **The very short 2.4 GHz receiver antennae are usually not visible outside the airplane.**

Basically and technically, the Frequency Band in which the 2.4 GHz radio system operates is the only true difference. Current systems transmit on 72 MHz and the 2.4 GHz systems transmit on, well they transmit on 2.4 GHz. That's it, all finished. Problem solved and difference identified. Thank you for reading this article and we hope it helped you better understand the new radio system developments.

“Wait a quantum minute there Frank”, you say? “That just can't be the whole story”. “There just has to be more to this than a frequency difference” you claim. So you want me to come out with

the whole truth and out with it now? OK I will, but you have to get ready to Handle The Whole Truth (sorry for the paraphrase there Jack Nicholson) and some of it may make your eyes glaze over. So hang in there and I will try to explain in common terms what this frequency change really means to us common pilots.

What does the frequency difference really mean?

In all truth, the only real difference **IS** the frequency difference. But both the Laws of the Universe and the Laws of Man partner to make this simple frequency change into a qualitative difference in the way RC flying will operate in the near future.

First up are the Laws of Man and what they do for us. In its collective wisdom, our government, in the life form of the Federal Communications Commission (FCC), has set rules for all transmitters operating in the 2.4 GHz Band. These rules might also apply to other frequency bands but that is not relative to us here. They do not apply to our current 72 MHz equipment.

The most common system now operating in the 2.4 GHz band is the portable, not wireless cell, telephone. If you have a portable home telephone with a short antenna, you have already been using the 2.4 GHz Band. (Yes, there are some 5 and 9 GHz portables but the majority still use 2.4 GHz.)

The FCC identified a problem with our portable phone systems almost before their inception. If you are talking on a portable phone and I, your next door neighbor, fire up my portable, it is possible that I could listen in on your conversation or, more likely, interfere with it. So the FCC made this major Law of Man:

For all 2.4 GHz transmitters, every transmitter must first search all the individual 2.4 GHz frequencies in its operating Frequency Band before it ever begins to transmit a signal. No open frequency means no transmitting.

You can hear this Law operating every time you press the talk button on your portable telephone. There is always a delay, usually 1-2 seconds, between pressing the talk button and hearing the dial tone. THAT DELAY is your portable phone searching its operating band BEFORE transmitting a signal to its home base. It searches through its entire frequency range until it finds a single frequency not currently in use in your area. It then, and only then, selects that frequency and transmits to the base set. Therefore, your portable telephone operates on a different frequency each time you use it; within its operating Frequency Band that is.

The 2.4 GHz radio control systems operate the same way. After you turn on your transmitter, it will search its operating frequency band (2.400-2.4835GHz), find a frequency not in use within its range, select that frequency (sometimes two frequencies but more on that later), and *only then* actually start to transmit.

This means that no 2.4 GHz transmitter will ever interfere with another 2.4 GHz transmitter that is already controlling an aircraft in flight. No Interference means no "shoot downs". There will be no need for frequency control systems for 2.4 GHz operation. Of course, a 2.4 GHz system also cannot interfere with 72 MHz operation due to the large frequency difference.

This also means that the old rule of turning on the transmitter before the receiver is now even more important. The new rule is: **Turn on the transmitter, wait five seconds and only then turn on the receiver.** If you don't do this, the servos travel to strange territories and sometimes nearly past their operating limits so put the waiting period into your daily operations.

While the Laws of Man actually helped us in this instance, (I leave it up to you whether you find that surprising or not), the Laws of the Universe are not so cooperative. 2.4 GHz waves are very short compared to MHz radio waves. Of course, this makes them “line of sight” only but then, our current 72 MHz band has the same restriction.

However, very short wave lengths mean very short antennae and waves that are easily stopped by conductive surfaces. Unlike our 72 MHz system with its yard-long receiver antenna, 2.4 GHz systems have 3 inch antennae. This means that, at any given time, some piece of metal (an engine or motor for instance) or electrically conductive item such as a servo wire, a carbon fiber spar or the landing gear will be between the receiver antenna and the transmitter.

When that happens, the short waves are blocked. They are not good at going “around” objects like our 72 MHz waves are. Nope, they just stop right in their tracks and never reach that really tiny antenna. The result is the airplane continues on its original course until one of the receiver antennae becomes unblocked. Then all is better, if not well.

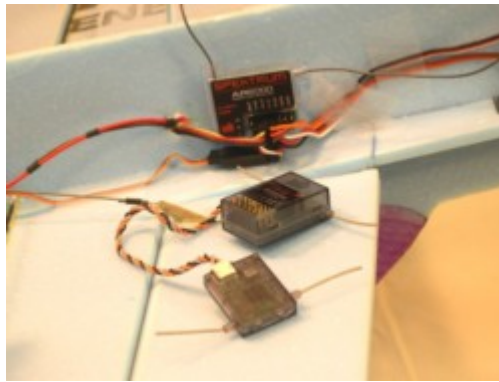


Photo 3

Recent developments have solved that range problem. Most 2.4 GHz systems use special receivers and antennae systems designed to increase the receiver’s reception abilities. Some use twin receivers. Others use special technology designed for long range use.

Do not be fooled by the *length* of a 2.4 GHz antenna. Just because the antenna wires are long does not mean it is a long-range receiver. The AR6000 receiver mounted on the airplane in photo 3 has four-inch long antenna but is designed only for short range work. The antennae are not dipole and therefore have weaker reception abilities. The smaller AR6200 receiver is for long-range flight even though its antennae are but 1.5 inches long. These antennae are dipole units.

The un-mounted AR6200 receiver in photo 3 actually contains two receivers in one and each has its own private antenna. **When using twin antenna receivers, always make sure that one antenna is about 90 degrees to the other.** That way, at least one antenna is bound to get a signal.

The receiver in photo 4 however, is designed for long range applications. Note that it uses two separate receivers, each of which connects to two dipole antennae. That makes four dipole antennae and two receivers for maximum reception potential.



Photo 4

Long-range dual receivers must be mounted at least 3-4 inches apart with their antennae at 90 degrees for maximum reception (photo 4). The main receiver is foam mounted and its antennae are 180 degrees apart. The satellite receiver is mounted vertically on the fuselage side and its antennae are also separated by 180 degrees. The two antennae systems are mounted 90 degrees to each other. Blocking reception with this arrangement is going to be difficult, if not impossible. This solves the range problem.



Photo 5

However, not all single 2.4 GHz receivers designed for use in more standard size aircraft have a satellite receiver. The receiver in photo 6 is mounted in a Hobbico NexSTAR; definitely one of the larger airplanes flown at longer ranges. This receiver uses special technology to increase reception without requiring a separate receiver. Note that the two antenna wires are about 130 degrees from each other. Always do this with single unit, long-range receivers.

It is not possible for us common folk to tell which receiver to use for short and long range work. **Read the manufacturer's information about a particular receiver and follow their recommendations as to suitability.** In our sport, we all think we know better than the manufacturer about how to do things. Honestly, that is often the case since we are an inventive group and love to tinker with things and concepts. But, not this time. **Never use a short range 2.4 GHz receiver in a larger model, above about a 40-inch wingspan, which will fly further than about 400 yards away from the pilot.** Just don't do it. It is not healthy for your airplane and certainly not for those objects and people around you.

The short receiver antennae used in long-range 2.4 GHz systems are not the simple wires that they appear to be. Most, note "most", are actually dipole systems that increase the antenna's reception ability by presenting more surface area to the incoming signal than would an ordinary

wire. **If such an antenna “wire” is broken, do not just add a piece of wire as can now be done with our 72 MHz systems.** That will not work and will cause you to lose control. Instead, send the receiver back to the manufacturer for repair.

Other Differences



Photo 6

The 2.4 GHz transmitters all transmit digitally. This fact has definite implications for us:

- Ø The signal is difficult to interfere with.
- Ø Transmission signals can be quickly decoded by the digital receiver and rapidly sent to the digital servos. This means that, when using digital servos, there is almost no “latency period” between moving the transmitter stick and having the airplane respond. **The airplane responds almost instantly.** If you don’t think this can’t mean much to you flying your sport airplane or trainer, I can promise you that it does. You just have to experience it to understand fully how this very fast response will improve your flying.
- Ø All 2.4 GHz systems today transmit a 10-number digital code to the receiver. **There is no possibility that your airplane will ever receive another transmitter’s signal and respond to it.** This is not true with our 72 MHz equipment.
- Ø Some manufacturers have taken advantage of this digital code to help save us from ourselves. Today, most of us use one transmitter to control several aircraft. We must be careful to be sure that the airplane being flown is the one “listed on the transmitter”. If not, the ailerons could move in the wrong directions or worse, making for a very interesting flight session. Certain 2.4 GHz systems now prevent this from happening. Each airplane’s receiver only responds to a different digital code even from the same transmitter. **Nothing works until the pilot redials the transmitter to the proper airplane.** (Photo 6 shows the airplane’s name “4-Star” for my Sig 4-Star 60). That’s a nice feature to have. Not all 2.4 GHz systems have this feature so read the descriptions carefully.
- Ø **Many of the current 2.4 GHz transmitters operate on two frequencies simultaneously.** Each of those dual receivers discussed above receive a different frequency from the transmitter. Which frequency depends on which two channels are free when the transmitter is first turned on. **Complete flight control information is sent on both frequencies.** That way, losing control becomes even more impossible as the airborne system needs to be able to read only one of two frequencies. In a way, this is equivalent to using two flight batteries. The airborne system only needs one battery to fly but it is good to have a backup just in case.

Getting Ready To Fly with 2.4 GHZ Systems

There is a major difference getting your airplane flight ready using a 2.4 GHz system. Like the old days of "SuperHet" AM receivers (back in the 1950's) **2.4 GHz receivers must be mated to the transmitter**. If you purchase an entire radio set, then the receiver is already mated to the transmitter. But additional receivers must be mated and the instructions show how to do this. What is actually happening is that the receiver is taught its individual digital code during the mating process. Once this is done, no other operations are needed. This operation takes about 3 minutes to do.

"Range Checking" a 2.4 GHz system is also slightly different. Instead of collapsing the transmitter antenna, not possible on a 2.4 GHz system, there is a button on the rear of the transmitter that reduces the power output to a fraction of normal. Press this button while doing the range check. The receiver should still work out to about 70 yards on most systems. Check the instructions for the particular radio system.

Speaking of transmitter power output, you will read all different ideas about this. Some say the power is too low on 2.4 GHz systems. Some say that 2.4 GHz systems are more efficient and don't need a lot of power output. **This is another time to trust the system you bought. If you use it as per the instructions, there will always be more than enough output to keep your airplane under control.** Forget about all the numbers and just fly, because it is going to work regardless of output numbers.

All other pre-flight operations are the same for 2.4 GHz and 72 MHz systems.

Practical Changes

First, 2.4 GHz systems do not need, nor can they use, frequency control systems at the flying field. The pilot never knows what frequency, or frequencies, is/are being used by the transmitter so getting a particular "pin" is impossible. Since none of the transmitters will operate on a frequency already in use, there can be no interference problems.

Second, **using 2.4 GHz systems on small electric aircraft, so-called "Park Flyers", is a great idea.** Our current 72 MHz frequencies are not always unique to RC flight in practical operations. It is possible for a powerful transmitter, such as messaging system transmitters operating at 100 watts on a frequency very close to yours, to interfere with your 0.75 watt 72 MHz system. The chances for such interference increase for flights away from model airfields.

Why? Because most flying fields have long since learned about potential interference problems in their areas and have structured their frequency allocations accordingly. But once away from this protection, the pilot is operating without this safety net. Operating a 2.4 GHz system eliminates this potential problem.

Also gone is the possibility of flying a small electric too close to a regular flying field.

Flying closer than about 2-3 miles using a 72 MHz system, the AMA recommended distance is 3 miles, to a flying field could mean either your aircraft will experience control interference or you will cause another airplane at the regular flying field to lose control. The new 2.4 GHz system eliminates this problem. **With 2.4 GHz systems, the pilot is free to fly anywhere there is a field large enough to safely do so.**

Third, for the same reasons, using 2.4 GHz systems in larger, expensive or competition aircraft is also a good idea. As a pilot's experience grows, the aircraft they are flying, and its expense, grows as well. After several years, most pilots will be flying aircraft costing \$700 or more. A few may top \$10,000!

Not to be obnoxious about this, but many experienced pilots flying such equipment usually feel, *not* always justifiably so, that the only way they will damage their expensive aircraft is by hitting something in a mid-air collision or by being “shot down” by frequency interference. Flying on 2.4 GHz reduces the potential disasters to one – The dreaded Mid-Air Collision. That reflects a 50% reduction in pilot angst and helps make each flight less worrisome and possibly more enjoyable.



Photo 7



Photo 8

Some current transmitters can be converted to the new 2.4 GHz operating system. Most transmitters that have a detachable transmission module, usually located on the back side, can be easily converted to 2.4 GHz operation. All most all of the transmitter’s Radio Frequency (RF) output circuitry is located in this module, not just the frequency crystal. Simply replace the current 72 MHz module with a 2.4 GHz one and then change the antenna to one of the short ones. Photo 7 shows a Futaba 2.4 GHz replacement module with attached transmitter antenna. Photo 8 is of the corresponding Spektrum unit where the transmitter antenna replaces (covers?) the transmitter’s existing metal antenna.

That is all that is usually required to enjoy all the 2.4 GHz advantages. However, there is a price, small in this case but still a price, to pay for this fast, simple conversion:

- Ø **Pulse Code Modulation (PCM) transmitters must be set to transmit only on PPM.**
- Ø **Any channel that is PCM only, like the tenth channel on some JR transmitters, will not work with the 2.4 GHz conversion.** For example, the 10-Channel 10X transmitter becomes a 9-Channel system because Channel 10 was PCM only.
- Ø **The Latency period lengthens on converted systems.** The transmitter’s electronics must convert the PCM signal to a digital one and then send it to the receiver. This takes a little time. The latency period is still shorter than that of a 72 MHz PCM system but remains longer than a true 2.4 GHz transmitter’s. While still shortening the aircraft’s response time, a converted system will just not be as fast as a “stock” 2.4 GHz system.
- Ø **There is no “wrong model” protection on converted systems.**

Of course, a true 2.4 GHz receiver will also be required. Most manufacturers now offer complete conversion kits for their module-equipped transmitters. It is not possible to convert a transmitter that only has an external frequency crystal since this type of transmitter has its RF output circuits built into the internal circuitry.

The Future?

So, what is the future of RC regarding this aspect of the sport? Good question and one not easily answered. Certainly 2.4 GHz systems will soon comprise the bulk of new control system sales. But the 72 MHz systems will be around for a long time. Unlike the "1991" transition from wide band systems to narrow band ones, the new 2.4 GHz systems can easily co-exist with current systems. No 10-year transition time is needed.

There is some question about being sure that all 2.4 GHz systems use compatible operating systems. The AMA and the manufacturers are working hard to make sure all other systems soon to be introduced remain compatible, as all now are. If anyone ever wondered what value the AMA has to our sport then here is a prime example, among many others, of what the AMA does for us RC pilots.

Strictly an Editorial Opinion – Only because we have been asked so often:

As 2.4 GHz use grows, expect that growth to become exponential in nature. But the 72 MHz systems will be around for at least another 10 years, maybe for 15 years. Eventually, as all new control systems sold are 2.4 GHz (or its then modern equivalent), 72 MHz use may decline to the point that our sport loses these frequencies back to the FCC. But that is probably 15 years, possibly longer, in our future and should not be used to affect some purchase decisions today.

If the new pilot wants a true, Ready-To-Fly ([RTF](#)) aircraft and it is sold only with a 4 or 5 channel, 72 MHz control system, it would be foolish not to purchase it because the control system might be obsolete in 15 years. Most pilots will have long-since disposed of their first basic control system before the 15-year period ends. But if the same RTF aircraft is also offered with a 2.4 GHz system, then you might want to select that option.

If there are really great "deals" on sophisticated 72 MHz systems out there then that would also be a great purchase. Monies saved today and the enhanced features offered by sophisticated, advanced control systems make the possible 15-year life span a mote point. Having 15 years of better flying and enhanced control while saving lots of money seems like a good prospect to me.

If you have any questions not answered in this overview, please contact me. I will try to answer them, or get answers from the experts, for you.