Model Aviation's Sport Aviator
The e-zine for the new model pilot

7000 Series Spectrum Radio

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ROUGHLY 18 MONTHS ago a new company introduced spread spectrum technology to the radio-control-modeling world. This first system was a surface unit for use in cars/trucks.

Almost exactly a year ago that company debuted a six-channel aircraft radio also utilizing spread spectrum technology. This new system was limited to park-size/mini-helicopter use because of range and antenna considerations.

That unit has literally taken the park-size/mini-helicopter world by storm. Modelers who are using these systems have enjoyed no longer having to worry about frequency control and interference from outside sources.

However, we've all been left wanting, wondering when we would finally be able to fly our larger, glow/gas aircraft with a similar system.

Well, members, the wait is over! Spectrum and Horizon Hobby—which brought you the Spectrum car system and then the DX6 park flyer system—released the Spectrum DX7 Full Range system at the iHobby Expo in October. Now everyone can finally fly utilizing the benefits of spread spectrum technology.

This is an exciting time for RC, and it is truly the beginning of a new era for us. Let's look at what it took for Spectrum to introduce this new system and get it ready to operate our larger aircraft. (I hope you have been following along for the last 18 months or so and have read the information we have published in MA and on the AMA Web site.)

For this update I will turn this article over to AMA Electronic Technology Committee member Dan Williams. He wrote the article "Digital Spread Spectrum: The Story So Far," which was published in the July 2005 MA. I'll drop back in following Dan's words to tell you a little more about what to expect with this new system.

The main problem that exists in a larger model when attempting to use a spread spectrum system such as the DX6 is the propensity for the large metallic and electrically conductive components to block, or directionally shield, the receiver's antennas from the signal.

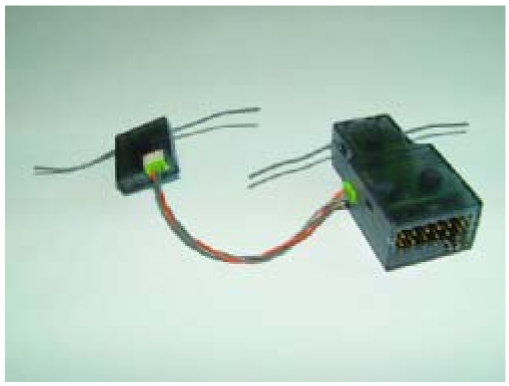
The small size of the (DX6's) AR6000 receiver and its antennas can be completely masked by a large gasoline engine, muffler, or carbon-fiber structure. At 2.4 GHz the transmitted signal's ability to "go around" the engine is greatly diminished.

For that same reason, wireless components for PC networking have the same problem going around I-beams or furnace ductwork in your house. Long-wave radios, such as AM broadcast, work well around buildings and under bridges. FM VHF broadcast radios can suffer from shadowing of buildings and structures. Your satellite radio really hates anything blocking its view of the sky and the satellite. The same problem applies to the 2.4 GHz digital spread spectrum (DSS) systems.

The AR6000 DuaLink technology uses two transmitted frequencies that send the information to the two receivers in the receiver enclosure. That's why there are two antennas protruding from the receiver.

This works well to take care of any blockage of one or the other receiver from its signal on a small model. Small motors and carbon fiber used on small models don't block both of the receiver antennas at any one time, so there's always a solid link to the aircraft.

Another problem with using signals at 2.4 GHz is that the antenna orientation can become critical. By employing a separate antenna for each receiver, and orienting them 90° to each other, they see around the various objects in the aircraft differently.



AR7000 receiver(s) with short pigtail connecting the two discrete receivers. The remote receiver should be at least 2 inches from the main receiver with the antenna oriented perpendicular to the main receiver's antenna.

AR7000 installed in a helicopter. Main receiver is mounted in the normal location. Remote receiver has Velcro on its back and is stuck to Velcro straps holding main receiver in place. Note perpendicular orientation of the two antennas.

Also, as the aircraft goes through different orientations when performing aerobatics, there's always one antenna that is going to see the transmitter signal for a solid lock. However, as the model size grows, so does the chance of large objects in the model blocking the signal to the tiny receiver box and antennas.

As model distances are increased, because of the greater ability to see large models at farther distances, the critical nature of antenna direction becomes worse. The chance that antenna orientation between transmitter and receiver causes a signal drop becomes much greater. Big models can fly longer distances. The farther away the receiver is, the less signal it can receive.

Those are fundamental limitations on the size of model the DX6 and AR6000 receiver can fly reliably. Regardless of the supposed success stories using this receiver with big models, there's a possibility that the sheer size of the receiver vs. the model can cause a problem with the RF link.

The DX7 and AR7000 receiver solve all of that. Besides the intelligence added to the DX7 transmitter, which Steve will describe, the AR7000 receiver is a total redesign of the AR6000. It too uses DuaLink technology, but it is now known as "Full Range" DuaLink technology. The receiver has undergone development to eliminate the problems inherent with combining the AR6000 with a large model.

The AR7000 continues to use a type of dual-diversity receiver design. A dual-diversity receiver uses signals from two separate receivers to process the information, and dual-diversity receivers use dual antennas.

The idea in a dual-diversity receiver is to have the two antennas located some distance apart. In doing that, any signal blockage or other problem in receiving the signal with one antenna won't be a problem with the second antenna, which is located separately.

The big difference in this system is that two RF channels are sending information simultaneously to two receivers. Add to that all the digital signal processing done from both receivers, and one has a robust signal link to the dynamic environment of a model.

The AR7000 is actually composed of two receivers with an umbilical cord between them. Now they can be located in different parts of the aircraft to take full advantage of the dual-diversity design.

By placing the receivers in different positions in the aircraft, any blockage from, say, an engine probably won't affect the other. Signal integrity is maintained and there is no signal loss.

Another advantage to the new AR7000 design is in the antennas themselves. In the AR6000 park/mini flyer receiver, each antenna is more or less a single "whip" style, or monopole antenna. The new AR7000 utilizes two "dipole" wire antennas instead of whips.

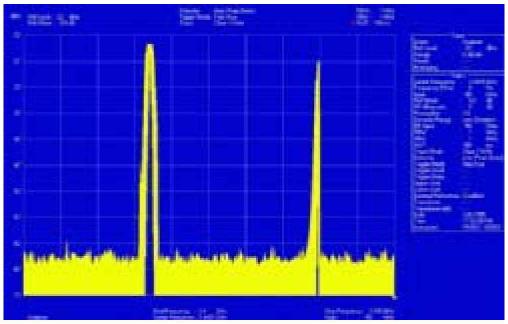
A dipole antenna has added gain (more signal received) than a wire whip antenna, plus the added "capture area" of the dipole. Capture area is physically the amount of wire exposed to the RF signal from the transmitter. The longer the antenna, the more signal that is received.

Finally, by separating the two receivers for placement and following the recommendation to orient the antennas perpendicularly (known as "orthogonal" in the RF world), all model orientation with respect to the transmitter antenna will be taken care of. No matter what attitude the model is in, an antenna will be oriented correctly for a good signal lock.

Now Steve can take on the rest of the radio-system details.

Thanks for that update on the technology and what was involved to get spread spectrum to the point we can use it in all of our aircraft, Dan.

As I mentioned in the introduction, this is an exciting time for RC modelers. Although we certainly do not see this new technology causing our 72 MHz systems to disappear, it will certainly ease the congestion at many flying sites and make flightlines at large events more enjoyable for those using spread spectrum systems and 72 MHz systems. The 72 MHz band will open up a bit as more spread spectrum systems become available.



How the new Spektrum DX7 looks on a spectrum analyzer. The sweep rate is slowed to show the two frequencies being broadcast. The waveform on the right is still building. Because of the speed at which two frequencies are sent, it is difficult to capture both full waveforms at the same time.

Models such as this Hangar 9 Katana 90 will soon be able to take advantage of spread spectrum radio technology.

The new Spectrum RC system is, once again, based on an existing JR transmitter; this time the new JR 7202. So everything except the RF link (which is significant) is JR. I've been fortunate to have been given access to this new system in early August 2006 and have enjoyed flying with it and learning about it ever since.

As does the DX6, the DX7 uses what Spectrum calls DSM (Digital Spread Spectrum Modulation). However, the DX7 and its receiver (AR7000) use what Spectrum calls DSM2: a second-generation form of this modulation.

The AR7000 receiver is also actually two receivers. However, unlike the DX6's AR6000, the AR7000 is actually an internal and external receiver. The internal is located on the main printed circuit board of the AR7000, and the external receiver is attached to the board with a 6-inch extension lead.

As Dan mentioned, each receiver has a short dipole antenna. That allows the two receivers to see a different RF environment, which improves path diversity, allowing the AR7000 to see the transmitter's signal in all conditions.

Spektrum recommends that the receivers be mounted at least 2 inches from each other and preferably with the antennas oriented perpendicular to each other. This technique maintains as much path diversity as possible. Spektrum does point out that the receiver placement has been proven not to be critical.

Along with this article are pictures of the AR7000 installed in a helicopter so you can see how I arranged the two receivers. Installation is simple, and I, too, found receiver orientation to be noncritical.

All flight testing and ground range testing I have conducted has shown excellent range for this system. In fact, I got tired of walking while doing the ground range tests. The external receiver is tiny and thin, so it's easy for which to find a home.

This system takes advantage of spread spectrum technology with another safety-enhancing feature called "Model Match," which is patented technology. It identifies each model stored in the transmitter's memory with a code that is unique to that aircraft memory position. That code is also transmitted to its receiver. This means if you attempt to operate Model 1 and the transmitter is set to the wrong model (such as Model 3), the receiver will not operate.

The DX7 is also compatible with the DX6's AR6000 receiver. However, it is important when using the DX7 with the AR6000 receiver to limit aircraft types to park size and mini/micro helicopters only.

We hope you have enjoyed this look at the latest technology available to the RC modeler. The next couple years are going to be interesting and fun as more manufacturers jump on the spread spectrum bandwagon. I suspect each will have a slightly different way of doing things.

With the cooperation of each manufacturer, we hope to be able to bring you a technical update on each new system as it is released. AMA thanks Horizon Hobby and Spektrum for being cooperative with us in the last two years as they have been working on this technology. This has allowed us to learn about it and hopefully educate you, our members, properly. MA

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