Loooops & Lies

Newsletter of The River Valley Flyers

Club #948

March 2019

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From the President and Editor: March is here, and the official start of spring is just a few weeks away. With all the snow that we've had over the past month, it may be a while before we can actually see the ground again. The good thing about spring is that the weather can change quickly, and the snow may disappear as fast as it came. It's kind of early to tell if this will be the case this year, but let's wait and see what happens.

The indoor flying continues on through mid-April at the East Junior High fieldhouse in Wisconsin Rapids on Friday evenings. We still have a few more sessions of the indoor flying left this year, with the final session on Friday, April 12th. If you haven't been out to participate in this event yet, come out on Friday and join us before it is all over. Please see the remaining indoor flying dates in this newsletter.

It's the time of year to start thinking about dusting off and getting out your model aircraft from their winter storage, and make sure they are ready for the flying season ahead. Now is the time to check them over carefully to make sure the mechanical and electrical systems are in good working condition. Just a little bit of preventative maintenance now can save a lot of problems from happening during the upcoming flying season. It only takes a short time to inspect your aircraft, and a little bit of effort now may save a whole lot of headaches later on this season.

With 2019 already here, we need to continue our discussion about what events our club will be having this year and what we want to do for activities this season. These activities include possible flying events and club fundraisers like we have done in years past. We have discussed these events in the past few months, and we need to finalize these decisions. These are the things we need to get done soon and will be discussing at the March meeting.
That's all I have for now, see you at the indoor flying or at the meeting on March 6th.
Don

From Our Safety Officer

Hi guys,
Just in case anyone has ever trusted the integrity of groundhogs, please look outside! As I remember 2 out of 3 both said an early Spring was in order. Anyone up for grilling groundhogs? On the lighter side, please everyone be advised of the following FAA ruling.
As of Monday, February 25, 2019, the FAA's Interim Final Rule requires drone and model aircraft pilots to display their FAA-issued registration number on the outside surface of their aircraft. I want to see everyone flying at the field this year complying with the above rule, not like we have any other option but to quit flying or ignore the rule, please don't do that. With all the snow outside and being cooped in, might as well get those airplanes dusted off and ready for a new season of flying, provided we have our registration numbers properly applied on the outside of the flying machines!
Safe and fun flying to all,

Larry
Safety Officer
RVFRC

RC Spread Spectrum Demystified

Written by David Buxton
An overview of the inner workings of 2.4 GHz technology

Go to a regional fun-fly or national event to watch airplanes and helicopters fly without the need of a frequency board. You have to wonder how it works. Is it true that the full 80 MHz wide 2.4 GHz band can support as many as 200 airplanes? If you are like me, you are not willing to accept that several radios can share the same frequency until you understand how it's done.

This article has evolved considerably—woven with popular theories and explanations that each were found to be incorrect. Too often, the correct information is buried in theoretical formulas that few of you would care to understand. The objective of this article is to present the theory of how our RC radios work in an easily understood format.

Manufacturer	Marketed Technology
Futaba	FHSS
Futaba	FASST
Spektrum/JR	DSM
Spektrum/JR	DSM2
Spektrum/JR	DSMX
JR	DMSS
Hitec	AFHSS
Turnigy	V1

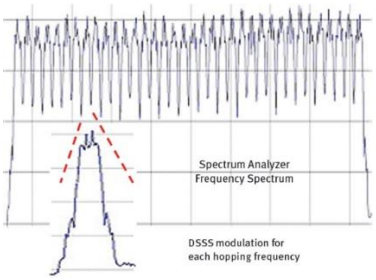
Turnigy	V2
Airtronics	FHSS-x
Wi-Fi	

2.4 GHz Spread Spectrum

The following are three important technologies used by our 2.4 GHz band radios. It is a frequency band that is increasingly popular for a growing variety of commercial products:

• **Frequency Hopping Spread Spectrum** (FHSS): Transmitter and receiver hop in unison to a mutually common pseudo random sequence of frequencies. One or more packets of data are transmitted before each hop.
• **Direct Sequence Spread Spectrum (DSSS):** Digital sequence modulation applied to the carrier frequency. It looks like noise on a spectrum analyzer and is the recommended form of modulation used by FHSS for transmitting data.

• **Cyclical Redundancy Code (CRC):** A key premise is that data sometimes becomes corrupted. The transmitter's and receiver's CRC calculation won't match if one part is slightly off. RC receivers ignore flawed packets, but Wi-Fi asks for a retry.



80 MHz wide 2.4 GHz band 36 frequency hopping channels. FHSS with DSSS modulation.

Futaba's first 2.4 GHz RC radios started out with modulated FHSS, and later models added DSSS, which was introduced as Futaba Advanced Spread Spectrum Technology (FASST). Spektrum's DSSS-only system (no hopping) was introduced as DSM, which was later enhanced with hopping frequencies called DSM2, which was followed by DSMX.

CDMA

Code Division Multiple Access (CDMA) is the DSSS technology used by our RC radios. It is designed for several radios on the same frequency. Figure 2 illustrates how each data bit is expanded using several encoding bits. Note that the encoding pattern for a '0' data bit and a '1' data bit are mirror images of each other.

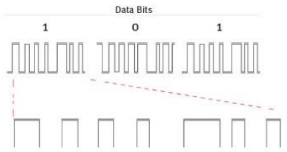


Figure 2: A direct-sequence CDMA encoding pattern.

The higher the ratio of coding bits for each data bit, the better the DSSS process can extract data from noise. The ratio is referred to as process gain (which will be illustrated and explained later). RC radios use a higher process gain than Wi-Fi. Both DSSS-encoded signals can travel as far, but our radios can extract clean data packets at a greater distance than Wi-Fi. Here are three process gain examples that help explain a key benefit of DSSS:

• Most (perhaps all) Wi-Fi uses a process gain of 11. The range is roughly 850 feet outdoors.
• Transmitters use 64-bit CDMA codes. Range can be up to 2 to 3 miles or more, depending on factors such as power output.
• GPS (not 2.4 GHz) has a process gain of

1024. Satellite altitude is 12.6 miles and the distance is farther near the horizon. GPS satellites use a common frequency for the 24 to 32 US satellites that employ different DSSS codes without frequency hopping.

Communicating Edges

It is important to understand that CDMA communicates the edges of each coding bit and not the high or low levels. This section will help you understand how it works. Those with an electronics background understand the relationship between rise time and bandwidth. The faster a signal shifts from one level to another—the wider the spread of harmonics and the wider the bandwidth.

The same thing happens if a signal shifts between two frequencies or shifts between two phases (e.g. 180°, 90°) of the same frequency. The faster the shift, the wider the spread spectrum's bandwidth. There are spread spectrum shift key technologies that accomplish CDMA edge modulation by shifting between two frequencies—two or four phases or amplitudes.

Figure 3 illustrates shift keying. Each rapid shift results in a narrow pulse of spread spectrum energy that looks like noise with a frequency response spread as seen on a spectrum analyzer.

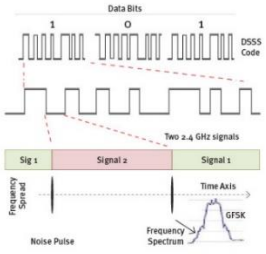


Figure 3: Shift key modulation.

Most of our RC radios use Gaussian Frequency Shift Keying (GFSK). Gaussian specifies the type of shaping filter used to translate the shift keying into spread spectrum. The Gaussian filter optimizes performance while reducing the bandwidth. In this case, less bandwidth can be a good thing.

Receiver Decoding

The CDMA illustration (Figure 4) is applicable for the different forms of shift keying. A multiplier circuit is fed with a pattern of 0s, 1s, and -1s timed by the DSSS code series used by the transmitter. Figure 5 uses an illustratively short DSS code.

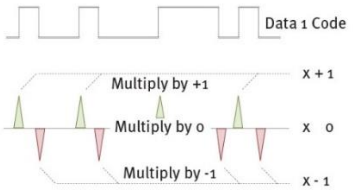


Figure 4: Decoding phase modulation data.

Most of the time, the incoming signal is being ignored because it is being multiplied by zero. Two radio systems out of sync with each other will not "see" each other. A phase lock loop (PLL) plays a vital role in keeping your receiver's 2.4 GHz clock in sync with your transmitter's clock. The PLL acts like a flywheel to keep the receiver's clock on track until the next edge is detected. The PLL speeds up or slows down to accommodate Doppler shift.

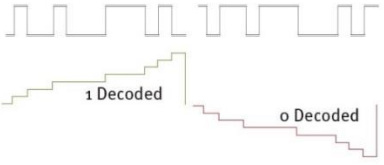


Figure 5: Translating code bits into data bits.

The output of the multiplier circuit connects to an integrator that accumulates the sum of each edge. The longer the series of coding bits, the higher the staircase will rise or descend for a final determination at the end of each data bit series. A successful decode is accomplished as long as the final summation is correctly positive or negative.

The crude simulation in Figure 6 uses a 64-bit DSSS code and noise that is more than 200 times stronger than the signal.

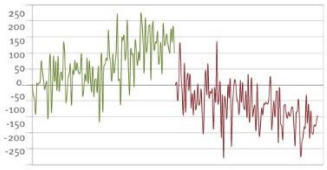


Figure 6: DSS code with noise simulation that is more than 200 times stronger than the signal.

The number of bits in the DSSS code pattern is referred to as process gain. Increasing the gain increases your receiver's ability to lift your transmitter's faint signals out of the noise at a considerable distance. It also helps to separate your radio's signal from that of other radios that may have hopped to your radio's current frequency.

CDMA timing and process gain make it possible for several radios to share the same frequency. This explains why 2.4 GHz microwave ovens and basic Wi-Fi are not a threat.

There are 2.4 GHz commercial products that can menace our radios. One of the most threatening examples is a high-powered 2.4 GHz non-spread video link using a high-gain or narrow-beam antenna. A growing number of imported products are advertised as exceeding FCC regulations. These threats are the compelling reason for FHSS.

A Closer Look

This section, with its superficially explained alphabet soup, is for those who would like to dig deeper than this article. These are the integrated circuits (ICs) that our radios use:

• Micro Linear ML2724 used by Futaba FASST.
• Cypress CYRF6936 used by JR/Spektrum's DSM, DSM2, and DSMX.
• Texas Instruments CC2500 used by Hitec, Corona, FrSky, Tactic, Futaba S-FHSS, and Wi-Spy's USB spectrum analyzer.
• Texas Instruments CC2520 used for JR's DMSS.

These are ICs designed for commercial applications. The radio manufacturers' patented features are coded into the central processing unit and microcontrollers, such as the example in Figure 7. The first three ICs listed use GFSK modulation and are used in consumer products such as cordless phones, wireless keyboards, and game controllers.

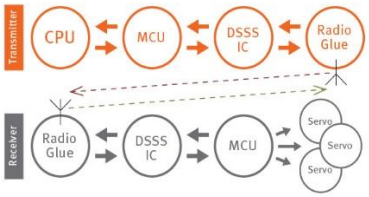


Figure 7: Micro controller unit DSSS integrated circuits.

Some model aviation enthusiasts use these ICs to build and program their own radios. Some participate in the FrSky open-source project.

What We Have Learned

Our radios use FHSS, which is modulated using DSSS, which is modulated using CDMA, which is modulated using frequency or phase shift keying. DSSS provides a robust way to increase the distance at which our aircraft can fly in spite of noise. DSSS is

also designed to accommodate several radios on the same frequency.

FHSS becomes important when threatened by commercial 2.4 GHz products that can swamp the front-end circuits of our radios at extended distances.

—*David Buxton*
david.e.buxton@tektronix.com

Remaining Indoor Flying 2018-2019

Indoor Flying continues at the East Junior High gym in Wisconsin Rapids on Friday evenings from 7PM - 10:30PM. You must be a member of the AMA, but not a member of RVF to use the gym. The cost to fly will be $5.00 per pilot, or $10.00 per flying family. Rules are the same as in previous years. Here are the remaining dates for this season:

March. 8, 15, 22, 2019
April. 4, 12, 2019

Roger Denne'e
RVF Indoor Flying Coordinator

River Valley Flyers March Meeting Notice:

When: Wednesday March 6th at 6:30 P.M.

Where:
At Hardees in 1821 Eighth Street in Wisconsin Rapids.

2019 RVF Club Membership Renewal

It's time to renew your club membership for 2019. Club membership runs from January 1st through December 31st of each year, and getting your renewal in early will avoid a lapse in membership. Memberships may be renewed at our monthly meetings or mailed to our club treasurer. See attached form in this newsletter.

Upcoming Area Events
March 2019

3/03/2019—Appleton Wi. (E) Valley Aero Modelers 34th Annual R/C Show and Auction. Site: 2311 W. Spencer Street, Grand Chute, Wisconsin. Tim Statler CD 8 A.M. till 12 P.M. Doors open at 8 A.M, $5 admission fee, Auction at 11 A.M. Visit www.flyvam.com or e-mail timflight1@aol.com for more information.

March 23rd 2019 10:00 AM to 2 PM
Rescheduled from 2-16 due to weather
Wausau R/C Sportsmen Free Winter Fun Fly All Clubs Welcome
Sunnyvale R/C Park Wausau, WI
Chili, hot dogs, sodas, hot chocolate and coffee will be provided free of charge. The shelter will be enclosed and heated to ward off any wind and cold temperatures Mother Nature throws at us.
Please Join Us to Celebrate the Fun, Flying and Festivities of 2019.
www.wausaurcsportsmen.com for more info.

River Valley Flyers Model Aircraft Club

2019 Membership Form

The "River Valley Flyers" are a model aircraft flying group interested in all aspects of Model Aviation and are located in Central Wisconsin. We are a chartered Academy of Model Aeronautics [AMA] club. All club members must also be AMA Members. We maintain a flying site in southern Portage County in the Township of Grant in the Central Wisconsin area.

Membership Categories and Dues

Full Adult Membership....$40
Age eighteen years and older by January 1st of the year of application. Includes voting rights and club field usage rights.

Family/Group Membership....$45
All members covered by a Family/Group Membership must have a direct spouse or offspring relationship, Father-Son, Husband –Wife and or Junior Member. Includes voting rights [except for junior members] and club field usage rights.

Junior Membership....$15
Under age eighteen years old by January 1st of year of application. All junior members need to be sponsored by a Full Adult Member even though they are not related by an offspring relationship. Includes field usage rights but no voting rights.

Guest Membership:....$20 For someone who belongs to another local club but wishes to access our field for flying as well. Includes field usage rights but no voting rights. Must send a copy of current AMA and Local Club Membership Cards with application.

MEMBERSHIP APPLICATION (PLEASE PRINT CLEARLY)

Please bring completed application form below with proof of AMA to RVF meeting or mail to:
Bob O'Connor 2220 Lovewood Drive Wisconsin Rapids Wisconsin 54494
Make checks payable to **River Valley Flyers** (Only Cash or Check Accepted)

Name:_____

Address:_____

City:_____ Zip:_____

Phone:_____ E-Mail_____

AMA#_____ Membership Category:_____

Dues Enclosed:_____ (Cash or Check Only