

The Ham Radio Communicator

Devoted Entirely to Amateur Radio

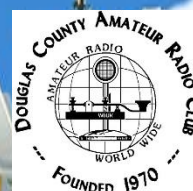
January 2018

www.w0uk.org

Breadboards
Stealth Antennas
Satellites in space
CW Class
Technician Class

HAPPY NEW YEAR 2018

**Douglas County Amateur Radio Club
Lawrence, Kansas**



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The MIC



The purpose of THE MIC column is provide a place for anyone to make comments to the club. Please send me your comments and they will be placed here.

We had a great CHRISTMAS dinner and a good time was had by all. A total of 20 folks came and ate and paid dues for 2018. We talked about the New Year and what the club was going to accomplish. We voted in the new officers and managers and read Roberts rules. I only forgot the last one and Bill corrected me on that. Thanks Bill. It looks like it will be an interesting year to come. Come to a meeting pay your dues and enjoy our great hobby. Thanks everyone for a great 2017. It's been a great ride. 73's. **Jim Eckler KC0IDF**



As we chart our course into and through the New Year of 2018, we should pause and reflect on the progress we've made last year, before turning our attention and focus to goals for 2018.

In 2017, we started out the year with some new ham gear left by Santa, and vowing to hang and/or improve our antennas. Some resolutions were a bit ambitious, but others were achieved.

2017 Field Day dawned a bit chilly, but sunny and dry; however, the location at Well's Overlook proved to be excellent location again. Stations were set up and antennas hung. A couple of tents held the CW and SSB/Digital stations. Good food, and great group of people rounded out the experience. The Saturday testing session was very successful too!

The opportunity to relocate our repeater to a tall tower SE of Lawrence could not be passed up. With some elbow grease from dedicated hams, the repeater is now up and running.

A special event to Nowhere, KS, provided a lot of fun in October. Most of the contacts were made mostly on the U.S. borders using 20 meters – east coast, west

coast, and gulf coast. October also, provided a visit from our ARRL Sectional Manager, Ron Cowan, and the yearly Chili cook off.

December provided another opportunity to railroad, ah, I mean, elect club officers, and enjoy another great meal and fellowship.

So, now it's time to look ahead to 2018 year, and do some dreaming of what we'd like to see accomplished this year. Someone said, "Planning is dreaming with due dates." Well, I'm not sure we want to be that rigid, but I would like to set some goals. Possibly stretch the club to try to achieve something previously not thought possible. Stay tuned as the club officers do some planning for an exciting new year.

Have a Happy New Year!

See you at the club meeting on January 10, 2018 at 7:00 pm at Flory Meeting Hall.

New Year's resolution ... To get on-the-air more and enter more contests.

73,
Jim Cessna – AC0KN



Thank you Jim Eckler and Jim Cessna for your reflections on the past year and your thoughts for 2018. Both of you have done an outstanding job leading the club and providing a quality club newsletter. I will be looking forward to working with you and all the newly elected officers and managers to make 2018 the best year yet for our Amateur Radio Club. Hopefully by the time of our January meeting the club officers will have met and solidify our goals for the 2018.

Happy New Year,
John Harris – N6UOP



2018 Douglas County Amateur Radio Club (DCARC) Officers and Managers:

President: John Harris - N6UOP

Vice-President: Virginia Filardo - KD0LFH

Secretary: Kevin Oneslager - KS0EGL

Treasurer: Bill Musick - KCONFL

Programs: Ken Filardo - KA0THK

Training: Ken Filardo - KA0THK

Activities: Matt Hilt - K0TOY

Web Site: David Kamet - KE0ELY, Bill Wachspress – K0BTY

Newsletter: Jim Cessna - AC0KN

Repeater: Skyler Huffman KU0JHK, John Harris - N6UOP

MEETING MINUTES

By Jim Cessna – AC0KN



PRESIDENT: Jim Eckler

The President opened the December 13, 2017 meeting at 7 pm. Each person attending was asked to introduce themselves with their name and call sign.

The nominees were elected into office are:

President - John Harris

V-President - Virginia

Treasurer - Bill Musick

Secretary – Kevin Oneslager

Program manager & Training - Ken Filardo

Activities manager – Matt Hilt

SECRETARY: Kevin Oneslager

A motion was made, seconded, and approved, to accept the meeting minutes.

TREASURER: Bill Musick

Bill gave the Treasurer's report.

ADJOURN:

A motion made and seconded to adjourn the meeting. Meeting was adjourned.

A Christmas dinner was enjoyed by one and all who attended. We had 20 people in attendance.

MICRO-CONTROLLERS

Microcontroller

From Wikipedia



A **microcontroller** (or **MCU** for *[microcontroller unit](#)*) is a small [computer](#) on a single [integrated circuit](#). In modern terminology, it is similar to, but less sophisticated than, a [system on a chip](#) or SoC; an SoC may include a microcontroller as one of its components. A microcontroller contains one or more [CPUs](#) (processor cores) along with [memory](#) and programmable [input/output](#) peripherals. Program memory in the form of [Ferroelectric RAM](#), [NOR flash](#) or [OTP ROM](#) is also often included on chip, as well as a small amount of [RAM](#). Microcontrollers are

designed for [embedded](#) applications, in contrast to the [microprocessors](#) used in [personal computers](#) or other general purpose applications consisting of various discrete chips.

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other [embedded systems](#). By reducing the size and cost compared to a design that uses a separate [microprocessor](#), memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. [Mixed signal](#) microcontrollers are common, integrating analog components needed to control non-digital electronic systems.

Some microcontrollers may use four-bit [words](#) and operate at frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications. Other microcontrollers may serve

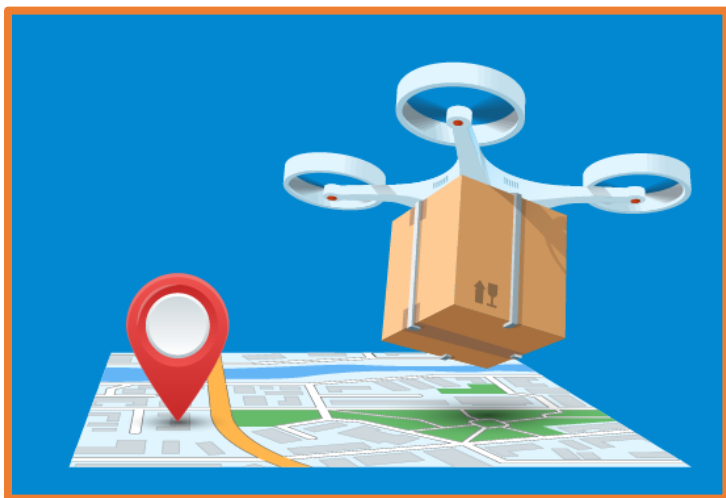
performance-critical roles, where they may need to act more like a [digital signal processor](#) (DSP), with higher clock speeds and power consumption.

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ROBOTICS

Pros & Cons of Trump's Drone Expansion Program

By Steve Crowe October 30, 2017



The United States is far behind other countries when it comes to integrating commercial drones into the airspace. But last week President Trump and Secretary of Transportation Elaine Chao announced the Unmanned Aircraft Systems Integration Pilot Program in hopes of fixing that by jump-starting drone flights beyond the visual line of sight (BVLOS), nighttime

operations and flights over people.

In 2016, the Obama administration opened the skies to small drones for education, research and routine commercial use, but severe restrictions remained. This new program will look to build upon that work by allowing national and local regulators figure out the best way to manage commercial drone use.

The Federal Aviation Administration (FAA) estimates by 2021 commercial drones will grow tenfold to about 442,000. And in less than a decade, the potential economic benefit of integrating commercial drones into the nation's airspace is estimated to equal up to \$82 billion and create up to 100,000 jobs, according to a recent study by AUVSI. The White House said this new program aims to remove the barriers that could restrict the commercial drone industry from taking off in the US.

Read More:

http://www.robotictrends.com/article/pros_cons_of_trumps_drone_expansion_program?eid=399017737&bid=1912830

PUBLIC SERVICE

Science You Can Use

By Jack K. Horner W0JKH



Dear Science: Is a “whole-house” surge protector a good investment? -- Buck R.

Dear Buck: The short answer is a qualified “yes”. Here’s an example. My wife and I lived for about 15 years in a desert region that experienced relatively few thunderstorms. Our house happened to be located higher than almost all houses near it.

The residence did not have a whole-house surge protector. During those 15 years, nearby lightning strikes caused electrical energy surges on the power lines serving the house. These surges damaged beyond repair a washing machine and a dishwasher. Both appliances were only about halfway through their normal service life. It cost approximately \$1500 (total) to replace them. A whole-house surge protector that cost about \$500 (installed) would likely have spared those appliances. Assuming the depreciated value of the appliances at the middle of their normal service life was about \$750, the protector would have saved about $(\$750 - \$500 =) \$250$. If the appliances had been new when the surges occurred, the protector would have saved us \$1000. If the surge had been larger and all the appliances in the house were new, the protector could have saved us \$10,000.

Here’s a longer answer. Voltage spikes and why they matter. An electrical energy surge on a wire, characterized by a relatively large, short-duration (a few millionths of a second) increase in voltage along that wire, is called a voltage spike. Let’s assume for the sake of this discussion that the “wire” of interest includes the electrical power wiring and electrical devices in your house.

A voltage spike can enter residential wiring in two ways: it can come from the electrical supply lines or cables entering the building, and it can come from within the building. In a typical house, most voltage spikes are caused by devices inside the house that contain a relatively large electrical motors that cycle on and off, such as the motors in an air conditioner or refrigerator.

A voltage spike can cause extensive damage to household electrical devices. How often a voltage spike will occur, and what damage it will do when it does, depends on many factors, including the frequency and severity of thunderstorms, the relative elevation, the kind of electrical appliances, and the wiring configuration, at your site.

The circuit breakers in your house provide no protection against voltage spikes.

What is a surge protector? Almost all electrical/electronic appliances intended for residential use are rated to operate at approximately constant voltage. In a typical US house, that voltage is either about 120 volts, or about 220 volts, depending on appliance. A voltage spike, by definition, can exceed these ratings by hundreds to thousands of volts.

A surge protector is an electrical device that is designed to block, limit, or divert, within specified limits, otherwise damaging electrical energy that arises from a voltage-spike event on the wiring in your house. A whole-house surge protector is a surge protector designed to help protect against the electrical energy effects of voltage spikes that appear on electrical power wiring anywhere your house, regardless of where the spikes originate.

Twenty years ago, few household appliances could be damaged by typical electrical voltage spikes. Today, essentially every household appliance contains electronics (e. g., a “control board”) that can be destroyed by an electrical voltage spike. Replacing just the control board in a major modern household appliance such as a washing machine, electric oven, or dishwasher, for example, can cost \$500 per appliance, per incident.

Including the labor of a licensed electrician, a whole-house surge protector costs about \$500, installed. Under typical residential conditions, the protector will last at least 10-15 years, the nominal service life of most large residential appliances. If a whole-house surge protector on average saves at least one \$1000-appliance every five years, therefore, the protector will more than pay for itself.

Is a whole-house surge protector enough surge protection in a typical residence? No. A high-quality whole-house surge protector is sufficient to protect the electronics in typical large household appliances such as washing machines, dishwashers, refrigerators, electric ovens and ranges, and air

conditioners, from anything but a direct lightning strike on your house.

Computers, TVs, radios, and phones connected to external phone lines, in contrast, contain much more sensitive electronics and need special surge protection. You should use a separate surge protector specifically designed to protect sensitive electronics like these. Look closely at the protector's specification before you buy. The device should be UL listed. The protector's Joules rating should be more than 2000 joules and have a response time of less than a microsecond (less than 1000 nanoseconds). These devices are available at most hardware and consumer-electronics stores, cost \$50 - \$100 each, and typically contain several electrical outlets.

A surge protector will not protect your house from a direct lightning strike on your house or on an antenna connected to it. For further information, see <<https://www.thisoldhouse.com/ideas/surge-protection>> or consult a licensed electrician.

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Lawrence KS 66046
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Voice: [785-424-7579](tel:785-424-7579)

Calendar of Events

| DATE | TIME | EVENT |
|--|---|---|
| 01/27/2018 | 10:00-15:00 | KS DAY: KS joined union 1/29/1861 |
| 01/27/2018 01/28/2018 | | Winter Field Day https://www.winterfieldday.com/ |
| 01/27/2018 01/28/2018 | 10:00-17:00 10:00-15:00 | WW1USA – Commemorating Wilson’s “14 Points” speech Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 02/3/2018 | 08:00-13:00 | Mine Creek Winterfest Ron Cowan KB0DTI 913-757-3758 kb0dti@peoplestelecom.net |
| 02/17/2018 | 09:00-16:00 | Freeze Your Keys – W0EBB 14.058 14.325 7.035 7.240 Gary Auchard w0mna74@gmail.com |
| 04/07/2018 | | MS-WALK – Kansas Speedway Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 04/21/2018 | 08:00-14:00 | Ararat Shrine Hambash Ararat Shrine Temple 5100 Ararat Drive Kansas City, MO 64101 www.hambash.com |
| 04/21/2018 | | GARMIN (Olathe) Marathon Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 04/21/2018 | 0000-2359Z | International Marconi Day (K2M, GB4IMD, EI6YXQ) http://gx4crc.com/gb4imd/ |
| 04/26/2018 | | Morse Code Day https://www.daysoftheyear.com/days/morse-code-day/ |
| 05/12/2018 | | Armed Forces Day Layne LaBaume, AE1N ae1n@gmail.com |
| 05/12/2018 05/13/2018 | 10:00-17:00 10:00-15:00 | WW1USA – Commemorating The Battle of Cantigny Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 05/18/2018 05/19/2018 05/20/2018 | 07:30-18:00 07:30-17:00 08:00-13:00 | Dayton Hamvention http://hamvention.org/ |
| 05/19/2018 05/20/2018 | | William Becknell Heritage Days – Starting of the Santa Fe Trail 1821 |
| 06/10/2018 | | Lone Star Bike Ride (Lone Star Lake, Lawrence) http://www.kansascyclist.com/events/Calendar.html |
| 06/16/2018 | | Tour de Cure Wheel to Weston Steve Rainey WD0DPB wd0dpb@comcast.net 913-963-9089 |
| 06/23/2018 06/24/2018 | s-time: 13:00 e-time: 13:00 | Field Day http://www.arrl.org/field-day |
| 07/14/2018 | 08:00-13:00 | Warrensburg Hamfest Crest Ridge Middle School 50 Hwy and 58 Hwy 5 miles West of Warrensburg Ken Smith, KO9R klsmith92@gmail.com 660-441-0007 |

| | | |
|---------------------------|--------------------------------|---|
| 07/21/2018 | | Moonlight Bike Ride Steve Rainey WD0DPB wd0dpb@comcast.net 913-963-9089 |
| 07/18/2018- 07/27/2018 | | Boy Scouts Jamboree On The Air (JOTA) http://www.summitbsa.org/events/jamboree/overview/ |
| 08/19/2018 | | Salina Convention |
| 08/25/2018 | | Joplin Hamfest |
| 08/25/2018 08/26/2018 | 09:00-21:00 09:00-15:00 | KS QSO Party www.ksqsoparty.org |
| 09/03/2018 | | Bike for the Brain www.bikeforthebrain.org Steve Lester KD0EKS 913-390-3570 stevekd0eks@gmail.com |
| 09/8/2018- 09/9/2018 | 06:00 08:00 | Hawk 100 Run Clinton State Park, Lawrence, KS Contact: Bill Gery KA2FNK at 913-575-3763 ka2fnk@gmail.com |
| 09/8/2018 09/9/2018 | | William Becknell Heritage Days – Starting of the Santa Fe Trail 1821 |
| 09/22/2018 09/23/2018 | | Bike MS Olathe to Lawrence and Back Herb Fiddick, NZ0F 913-744-0586 |
| 09/15/2018 | | Bikers 4 Babies Kansas Speedway Matt May, KC4WCG kc4wcg@twc.com 913-927-4148 |
| 09/23/2018 | 13:00 | Lawrence Crop Hunger Walk http://www.crophungerwalk.org/lawrenceks |
| 09/22/2018 09/23/2018 | 10:00-17:00 10:00-15:00 | WW1USA – Commemorating the Muse-Argon Offensive Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 10/20/2018 | 08:00-13:00 | Southside Hamfest Mill Creek Upper Elementary School 308 South Cleveland Ave. Belton, Mo. 64012 Dave Nielnhuser KC0CMD 913-636-9696 info@southsidearc.net |
| 10/19/2018- 10/21/2018 | | BSA-JOTA Les Mignerey, KB0MEF Assistant Section Manager for Radio Scouting South Texas Section, ARRL West Gulf Division Houston, TX 77070 kb0mef@arrl.net |
| 11/03/2018 | 08:00-13:00 | Raytown Hamfest Ararat Shrine Temple 5100 Ararat Drive Kansas City, MO 64101 Joel Griebshaber KC0ELZ kc0elz@sbcglobal.net |
| 11/11/2018 | 10:00-17:00 | WW1USA – Commemorating Armistice Day Herb Fiddick NZ0F 913-744-0586 hfiddick@gmail.com |
| 12/31/2018 01/01/2019 | s-time: 18:00 e-time: 18:00 | Straight Key Night http://www.arrl.org/straight-key-night |

ANTENNAS

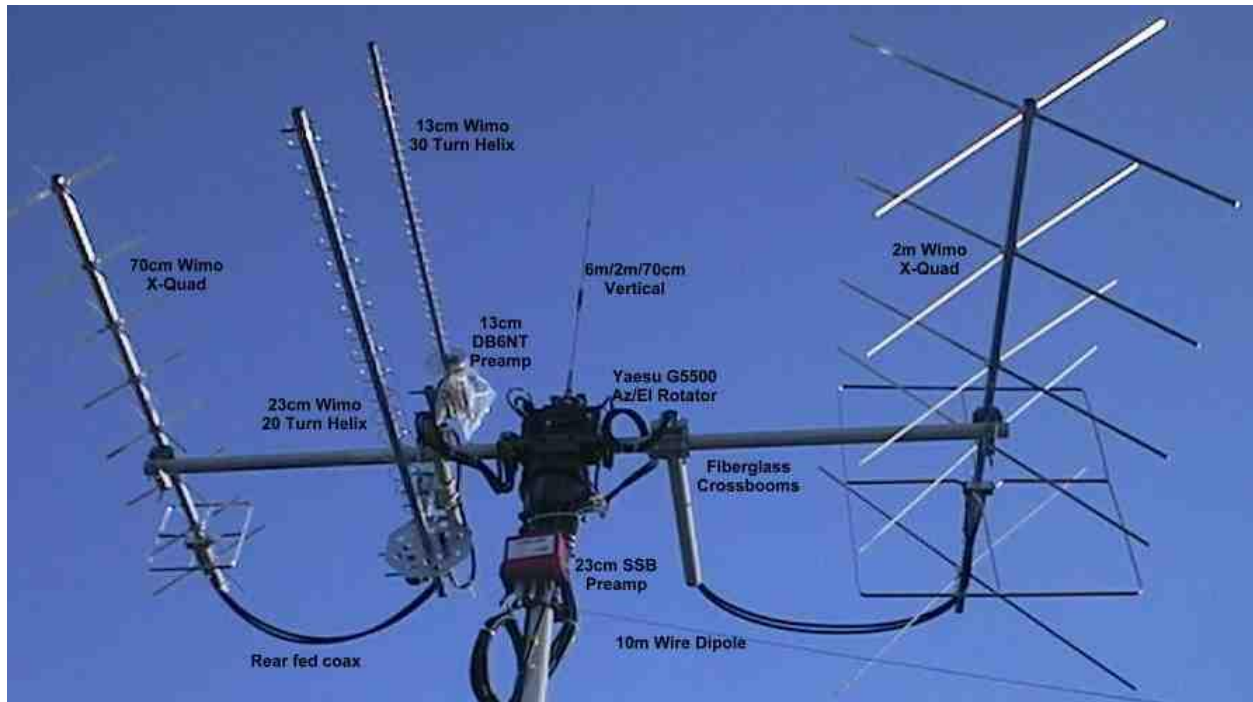


“Low Clearance 10 ft 11 inches” ... Things that make you go “Hum”.

SATELLITE COMMUNICATIONS

Satellite Antennas

From Internet



Just tell your neighbors you are from another planet and your just need to, “Call home.” They will completely understand.

Satellite AO-91

By John Brier KG4AKV

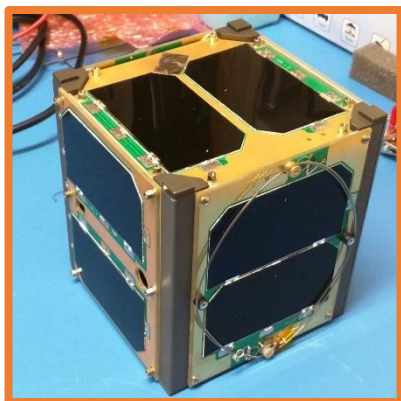


Figure 1 AO-91

[AO-91](#) is an FM repeater [1] satellite with a strong 2 meter downlink (receivable with a rubber duck) and an incredibly sensitive receive system on the 70 cm uplink. There are reports of people getting into the bird using a handheld inside a house. That is incredible. If there are no issues, this will likely become another “Easy Sat” like AO-51 was. It’s currently being tested by [AMSAT-NA](#) but it will be open for general use very soon.

For years, the only FM bird was SO-50. It has a great receiver but the downlink is not strong (only 250 mW), so it isn’t easy for beginners to use. AO-85 is another FM satellite that was launched a couple years ago. It has a powerful transmitter, but due to an [antenna system issue](#), it doesn’t receive well. Getting into it with a handheld at only 5 watts can be difficult for beginners and experienced ops alike. Many people use 50 watt

mobile FM rigs to compensate for this issue. Its transmit audio can also be low and/or “muffled,” making it hard to complete contacts with some low audio portable stations (on satellites it’s better to talk close to the microphone and loud than far away and low).

AO-91 is of the [same design](#) as AO-85 but the AMSAT engineers seem to have addressed the issues AO-85 had. It has a great receive system and great transmit audio. Compared to SO-50, the things that may be difficult for beginners to deal with are tuning the uplink to compensate for the Doppler affect, and to a lesser degree, dealing with signal fades.

SO-50 is 2 meters up and 70 cms down. The Doppler affect is more pronounced the higher in frequency you go. On 2 meters with FM, you don’t need to compensate much, if at all. On SO-50 you never have to tune the 2 meter uplink. You do tune the downlink, which is easy to do because while other people are talking on it, you can hear when it’s off frequency, and can easily adjust until its right.

AO-91 is the opposite. Its 70 cms up and 2 meters down. If you are off frequency on the uplink you may not be able to get in at all. If you don’t have full-duplex capability so you can hear the downlink while you transmit (highly recommended), you won’t be able to tell. I believe they chose a 70 cm uplink instead of a 2 meter uplink because there is considerable unlicensed 2 meter usage in certain parts of the world that can interfere with the operation of satellites on that band. For example, I have heard reports of hearing cordless phones on satellites like AO-51 while it was in range of South America, and taxi cab drivers while it was in range of Mexico.

The other thing beginners may be affected by are signal fades. AO-85 and AO-91 both sometimes seem to have transmit signal fades as they tumble. It probably depends on where you are in relation to the satellite and its antennas, and how it’s tumbling, because at least with AO-85, it isn’t a persistent issue. But SO-50 doesn’t have strong fades at all in my experience.

I personally am very excited about how much excitement and how many new hams AO-91 could bring into the ham radio space communications community. During launch on Saturday the [amsat.org](#) website was hard to reach because there were so many people trying to load the

liveblog about the launch. Here's to AMSAT-NA for putting this bird up there and for its good life and long service to the community.

NOTE: Even though you can hear the downlink with a rubber duck and maybe even get into the bird with an HT inside a house, you should ideally use a directional antenna like the [Arrow II](#) or the [WA5VJB cheap LEO Yagi](#). Full duplex operation is also highly recommended.

NOTE: Do not try to use the repeater until AMSAT-NA has announced that it is open for general use to the public. Currently it is in beacon mode and occasionally they are turning on the repeater for use by designated AMSAT engineers and support. Check the News and Events section at the bottom of the [AMSAT.org website](#) for updates.

AO-91 frequencies:

Downlink: 145.960 MHz.

Uplink: 435.250 (67.0 Hz tone)

1. Technically it's a "transponder" not a repeater but to make it easy to understand you can think of it like a standard analog FM land based repeater, except it's cross band.

AO-91 Commissioned, Declared Open for Amateur Use!

From ARRL Letter

AMSAT-NA's latest Amateur Radio CubeSat, RadFxSat (Fox-1B), now known as AO-91, has been opened for general use. AMSAT Engineering officially announced that AO-91 was ready for use at 0650 UTC on Thanksgiving Day, November 23. AMSAT VP of Engineering, Jerry Buxton, N0JY, turned over operation to Mark Hammond, N8MH, and AMSAT Operations during a contact on the AO-91 repeater during the pass over the Eastern US, AMSAT said in a bulletin.

The latest CubeSat in the Fox series was launched on November 18 from Vandenberg Air Force Base in California. Telemetry is downlinked via the DUV sub-audible telemetry stream, which can be decoded using [FoxTelem](#) software.

A 1U CubeSat, RadFxSat (Fox-1B) is a joint mission of AMSAT and the Institute for Space and Defense Electronics ([ISDE](#)) at Vanderbilt University. AMSAT constructed the rest of the satellite, including the spaceframe, on-board computer, and power system. The Amateur Radio package is similar to that currently on orbit on AO-85, with an uplink on 435.250 MHz (67.0 Hz CTCSS) and a downlink on 145.960 MHz. --
Thanks to AMSAT News Service



SHACK ACCESSORIES

Rigs I've Owned: 1955 – 2017 (so far, hi)

By Phil Anderson - WØXI



Got my Novice ticket in ~ 55, can't remember the exact date. Lee Bergren, WØAR, KC, MO, loaned me a tube receiver and I built a 13 watt crystal controlled CW amplifier TX using a 2E26 tube (with the B+ connection on the top). Mother came home and found me on the roof stringing out a dipole, opps!

Was fairly inactive while at KU taking the [Electrical Engineering] EE courses for a BS. Graduated in '63 and moved to Poughkeepsie, NY, working for IBM, and while there got a tech ticket and operated 2 meters. Remember the neighbor across the hall got lots of diagonal lines on his TV. Another neighbor introduced me to bagels.

Came back to Lawrence 1971, lived near S Junior High and purchased a Heathkit 8A 5 watt transceiver. Hung a dipole in the garden behind the house. At this time WØXR loaned me a Collins 75A4 tube receiver – what a neat tube unit. Dial was great and the rig received well on



all HF bands. Soon after that moved to a farm west of Lawrence with big plans for a rhombic – never did get it up since our Kantronics business was growing and took me to Japan, and most European countries, including my favorite Germany. We went to the Friedrichshafen Germany (Europe's Dayton) about 12 years in a row, as I recall, and of course Dayton and many US ham fests over the years. We sold many packet units then but I never had a packet station at home!

I retired two weeks before 911 and six weeks later joined a startup near Amherst, Massachusetts, called Millivision. We build units that received millimeter waves at a frequency of 94 GHz. That was a fun, educational and more than a full time project. The units had no connection to ham radio but some of the guys there were also hams, of course.

Got back to Lawrence in a couple of years and settled in, buying and using a number of rigs and antennas and operating mostly CW. My favorite rigs were – and still are – the Yeasu 450 all



band 100 watts, and the Elecraft K3, also 100 watts, along with a panadapter, two screens, HRD software and SteppIR Vertical. Ran all of these until a couple of weeks ago. It took a bit of work to

take down the SteppIR vertical. Bill M came by and helped out.

Now moving to a retirement community in Lawrence in late November and planning for another – perhaps allusive – remote antenna system somewhere in the county. The plan so far is to connect an Elecraft K/0 – that looks exactly like an Elecraft K3 transceiver – as the duplex station in town and then use my old K3 at the remote site via the internet. This has been successful for many K3 owners. At this point, hunting for a good location in the county with internet for the K3 and my SteppIR antenna. Stay tuned, hi. Phil. WØXI.



Figure 2 Speed sensor with shroud removed

Background

I have a 1956 Onan 4 kW generator that I use as backup power for my home. I like this generator because it has an 1800 RPM twin cylinder engine configuration running on propane and has excellent reserve power for motor starting. It is also fuel efficient, running over 4 hours per gallon under light loads. My problem is that since I changed to LED light bulbs, the house load is often too light to keep the mechanical governor working correctly, resulting in higher frequency and voltage at light loads. After verifying that the governor was working and adjusted to the best of its ability, I found that if it was adjusted for correct frequency at a light load it had excessive frequency and voltage drop when a motor load is started. While I briefly thought about using a current meter to switch on a dummy load to maintain a minimum load condition, I decided that adding an electronic speed control system would be a better way to solve the problem.

Modification System

One of the difficulties of a generator system is that unlike a car where a gear motor type actuator is sufficiently fast, a fast acting solenoid type throttle actuator is required to achieve good response to step loads. After researching suitable devices I realized the solenoid was going to be the more expensive part of the system. I did find relatively inexpensive speed sensors (\$15) and electronic controllers (\$50) and quickly decided not to try to "home brew" a controller. I was able to purchase the complete electronic regulator system package consisting of an inductive speed sensor, controller, and throttle solenoid for \$160.

To achieve quick control response time, the speed sensor is positioned to count the passing of teeth on the generator flywheel's starter gear. The starter gear on this generator has 102 teeth, providing a nominal sensing frequency of 3060 Hz, a lot higher resolution than using rectified 120 Hz from the generator or 30 Hz from the ignition as the speed sensing source.

The electronic speed regulator has an integrating action that will maintain speed regulation within 1% over all static load conditions. This is a significant advantage over mechanical regulators which have a somewhat linear relationship between engine speed and throttle position and load. The load step performance of a control system is determined by the combined performance of multiple components, including the frequency of the speed sensor, the response time of the solenoid. In my system the response is ultimately limited by the engine's cylinder firing rate of 30 Hz. While the 1800 RPM generator operation is desirable for efficiency, noise, and lifetime, it does limit the step response performance over that of an engine running at 3600 RPM engine (or an engine with a greater number of cylinders).

The electronic control is suitable for use with diesel or gas engines and has adjustments and inputs for functions I do not need (generator paralleling, idle operation, and speed ramp up/down rates, remote speed control). I did not attempt to investigate these additional capabilities during this project.

Mechanical mounting of control system components

The speed sensor needs to be positioned facing the flywheel gear teeth, so the sensor was located on the flywheel guard near the top where the guard is roughly parallel to the gear teeth. A jam nut arrangement is used to set the recommended 1/32 inch spacing between the gear and sensor. I was able to find a location near a fan guard mounting hole, and fabricated a threaded steel block for the sensor from some scrap 1/4" thick steel strap which used the existing mounting hole on the engine.

The solenoid was able to be mounted to the flat surface on the electrical control box of the generator, with a linkage rod to the throttle. The linkage rod from the mechanical governor to the throttle was disconnected. An extension for the throttle lever was fabricated to increase the control linkage movement from 3/4 inch to 1.25 inch to better match the solenoid's range. This also solved a clearance problem with the ignition coil as the control linkage is routed in the opposite direction from the original governor. The actuator was supplied with adjustable length ball ends, allowing the linkage to be offset from a straight line without binding and simplifying adjusting the throttle range to that of the solenoid. The solenoid had mounting ears on two surfaces, allowing a plate to [be] mounted to the solenoid's other mounting holes to provide a mounting surface for the electronic control.

Testing and adjustment

The electronic speed control contains several adjustments to optimize performance of the generator system. In addition to the static load speed adjustment setting, there are also adjustments for gain and stability which are set to achieve the best dynamic response. There are also to switch settings that are used with these adjustments. To reduce the chance of over speed when first started, I reduced the speed setting prior to starting the engine.

Initial operation with factory settings produced a slow speed oscillation at about 45 Hz generator frequency. The gain and stability were adjusted for stable operation and frequency set to 60 Hz. The load step response was then checked using two 1500 watt space heaters for a load and trying different settings of gain and stability controls to obtain best performance. The results were unacceptable, taking about 3 seconds to recover from a 25% load step. Trying different switch settings resulted in much faster oscillation, but after re-adjustment of the gain and stability controls good response was obtained. The generator now adjusts to a 25% load step in about 1/4 second with minimal frequency change, and a 50% load step in about 1/2 second with less than 5% frequency transient. There is some experimentation required with the different switch positions and gain and stability controls to match the controller to the generator and engine combination.

Additional Operating and Safety Functions

As with any equipment installation or modification, it is necessary to assess any changes that may be required to insure correct operation, and protection of equipment and personnel in the event of possible failures. This requires an extensive check list for a generator, as it involves many systems from the interconnection to the electrical and fuel systems to waste heat and exhaust management.

The controller has logic that keeps the throttle closed until the speed sensor detects engine cranking, then opens the throttle to the starting position (another adjustment on the controller). Once the speed sensor indicates the engine has started, it switches to controlling the engine speed. If the engine stops due to fuel shutoff or low oil pressure, the controller opens the throttle to maximum as the engine slows, then closes the throttle after the engine stops. Loss of the speed sensor signal will also close the throttle. After these observations I concluded the controller provides adequate operation protections when functioning normally.

With any electronic speed regulation, there is the risk of wide open throttle operation if the electronic regulator fails or if the throttle linkage jams or disconnects. While the engine might survive for a short time, the resulting frequency and over voltage condition would not be desirable (nor would flying debris if mechanical failure occurs), so an independent over speed shut down is required. I am currently adding a switch to the existing mechanical governor system which will be utilized to shut down the generator if an over speed occurs and provide this needed safety function.

Since my generator is located in an enclosed space, I am using a 12 volt car radiator fan to insure adequate cooling of the generator shelter. The maximum combined load of the electronic control and fan is about 10 amps, while my generator only has a float charger adequate to run only the ignition. A 25 amp 15 volt switching power supply (\$30) is being added which operates from the generator output and is connected to the battery through a diode with output adjusted for 13.6 volts. A low cost 12 volt temperature controller (\$10) is also being used to shut down the generator if excessive operating temperature from a fan failure or air intake blockage occurs.

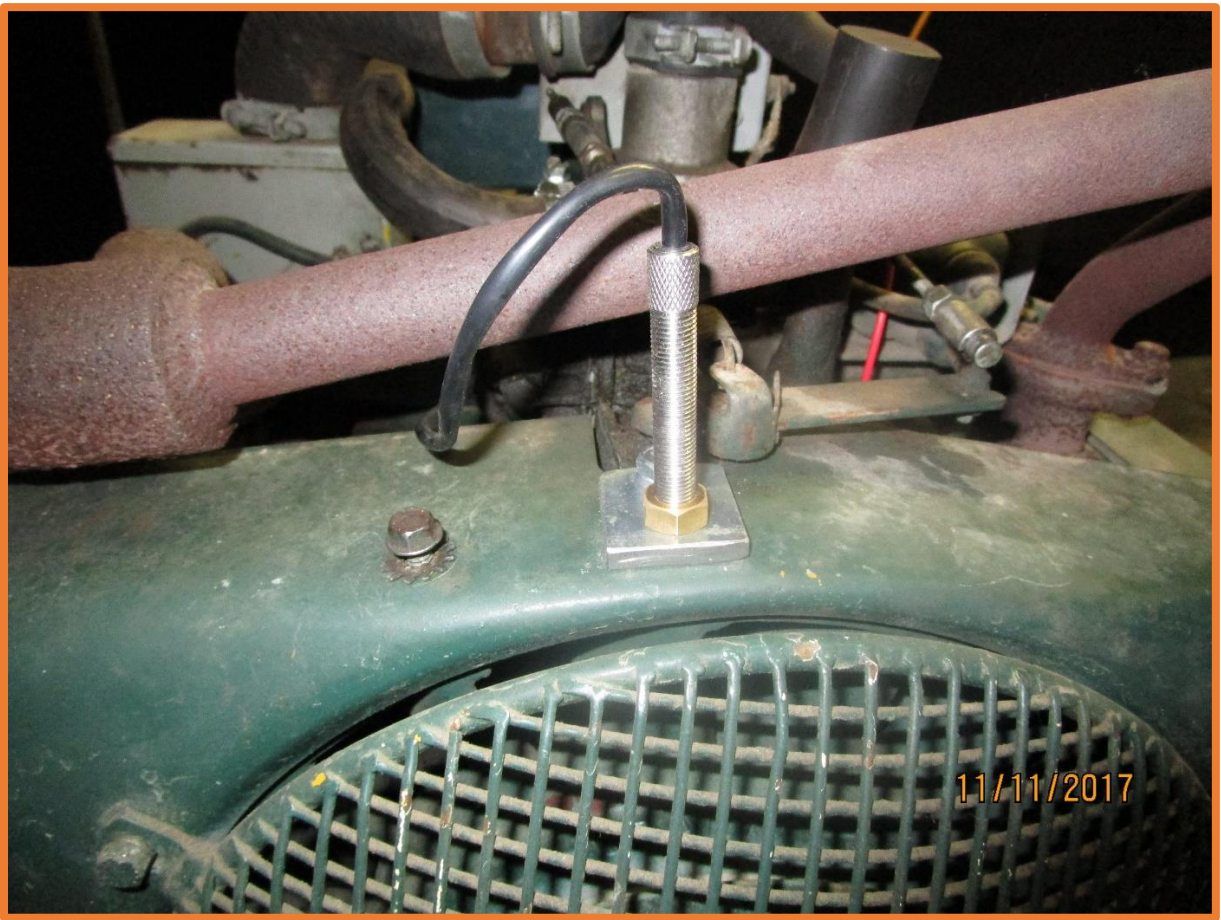


Figure 3 Speed Sensor shroud installed

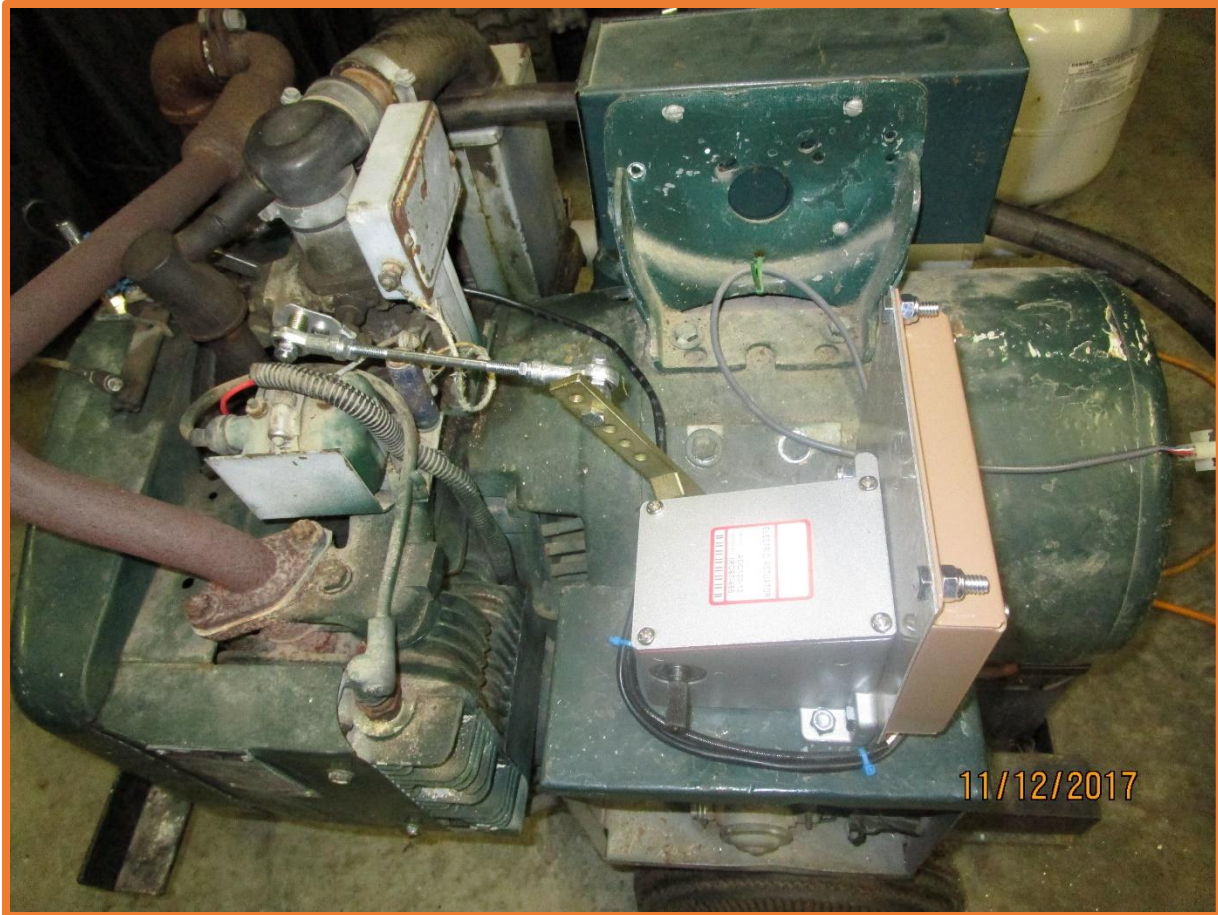


Figure 4 Installed components on generator



Figure 5 Controller and throttle linkage

RADIO-SPORT

2018 ARRL Contest Calendar

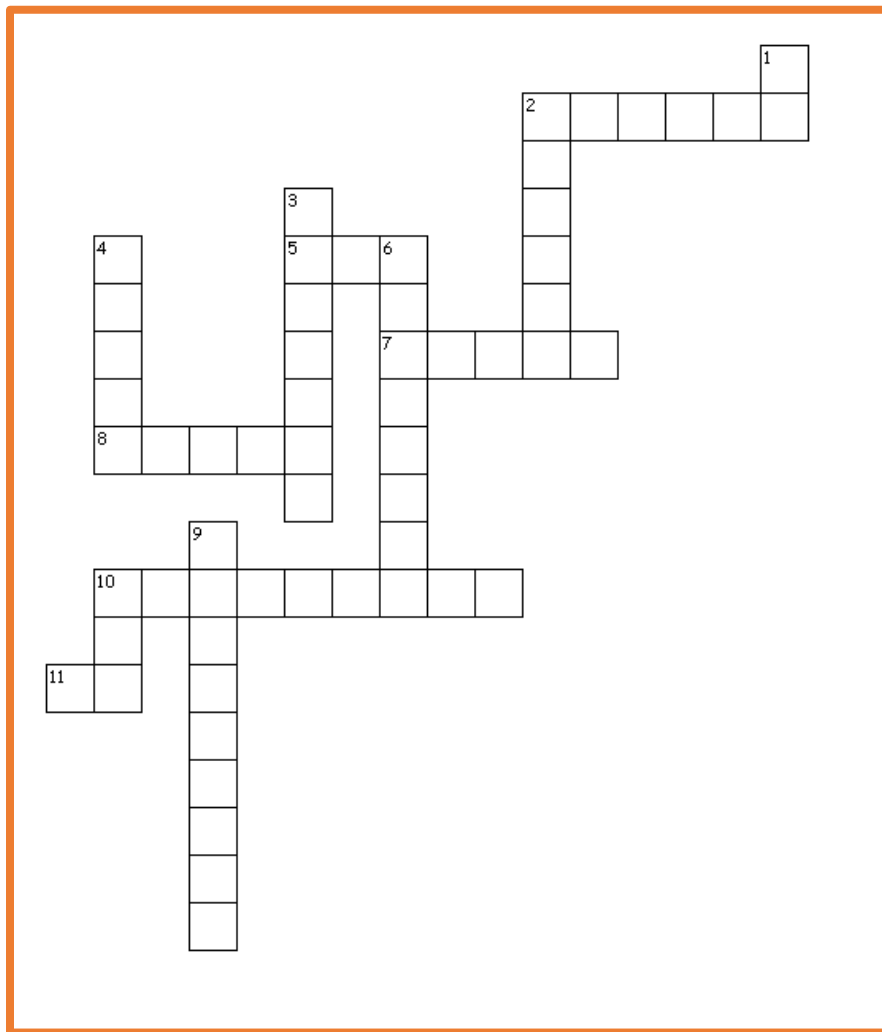
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|--|--|
| January 2018 1 <u>Straight Key Night</u> 6 <u>Kids Day</u> 6-7 <u>RTTY Roundup</u> 20-21 <u>January VHF</u> | February 2018 12-16 <u>School Club Roundup</u> 17-18 <u>International DX – CW</u> |
| March 2018 3-4 <u>International DX– Phone</u> | April 2018 15 <u>Rookie Roundup – Phone</u> |
| May 2018 | June 2018 9-11 <u>June VHF</u> 17 <u>Kids Day</u> 23-24 <u>Field Day</u> |
| July 2018 7-8 <u>IARU HF World Championship</u> | August 2018 4-5 <u>222 MHz and Up Distance Contest</u> 18-19 <u>10 GHz & Up – Round 1</u> 19 <u>Rookie Roundup – RTTY</u> |
| September 2018 8-9 <u>EME - 2.3 GHz & Up</u> 8-10 <u>September VHF</u> 15-16 <u>10 GHz & Up - Round 2</u> | October 2018 6-7 <u>EME - 50 to 1296 MHz</u> 15-19 <u>School Club Roundup</u> |
| November 2018 3-4 <u>EME - 50 to 1296 MHz</u> 3-5 <u>Nov. Sweepstakes – CW</u> 17-19 <u>Nov. Sweepstakes – Phone</u> | December 2018 1-3 <u>160 Meter</u> 8-9 <u>10 Meter</u> 16 <u>Rookie Roundup–CW</u> |

WA7BNM Contest Calendar

<http://www.hornucopia.com/contestcal/>

HAM RADIO CROSS-WORD PUZZLE

From puzzlemaker.discoveryeducation.com



Across

- 2. TX on one freq RX on another freq
- 5. Moonbounce
- 7. A ham radio mentor or teacher
- 8. Component allows current to flow in one direction
- 10. Number of complete cycles per second
- 11. Voltage with a constant polarity

Down

- 1. Distant stations in a foreign countries
- 2. Amateur Radio wire antenna
- 3. Express ratios of power, voltage, or current
- 4. A basic unit of capacitance
- 6. Negatively charged particle
- 9. Intended to mislead the receiver
- 10. U.S.Federal agency regulates freq spectrum

HAM RADIO CROSS-WORD PUZZLE SOLUTION

DC Voltage with a constant polarity
DECEPTIVE Intended to mislead the receiver
DECIBEL Express ratios of power, voltage, or current
DIODE Component allows current to flow in one direction
DIPOLE Amateur Radio wire antenna
DUPLEX TX on one freq RX on another freq
DX Distant stations in a foreign countries
EME Moonbounce
ELECTRON Negatively charged particle
ELMER A ham radio mentor or teacher
FARAD A basic unit of capacitance
FCC U.S.Federal agency regulates freq spectrum
FREQUENCY Number of complete cycles per second

EMERGENCY MANAGEMENT

Amateur Radio Emergency Service (ARES)



The Amateur Radio Emergency Service® (ARES) consists of licensed amateurs who have voluntarily registered their qualifications and equipment, with their local ARES leadership, for communications duty in the public service when disaster strikes.

ARES Membership Requirements

Every licensed amateur, regardless of membership in ARRL or any other local or national organization is eligible to apply for membership in ARES. Training may be required or desired to participate fully in ARES. Please inquire at the local level for specific information. Because ARES is an Amateur Radio program, only licensed radio amateurs are eligible for membership. The possession of emergency-powered equipment is desirable, but is not a requirement for membership.

How to Get Involved in ARES

Fill out the [ARES Registration form](#) and submit it to your local Emergency Coordinator.

Sign-up to receive an ARES e-Newsletter at <http://www.arrl.org/ares-e-letter>.

ARES is activated before, during and after an emergency. Generally, ARES handles all emergency messages, including those between government emergency management officials. RACES, on the other hand, almost never starts before an emergency and is active only during the emergency and during the immediate aftermath if government emergency management offices need communications support. RACES is normally shut down shortly after the emergency has cleared.

| REPEATER | FREQUENCY | TONE | LOC | MODE | DAY | TIME | NET |
|----------|-------------|------|-------|--------|-------------------|----------------|--------------|
| W0UK | 146.760 MHz | 88.5 | DCARC | Analog | Sunday Tuesday | 20:00 20:00 | ARES Club |

Douglas County Auxiliary Communications Team (ACT)



Douglas County Auxiliary Communications Team (ACT) volunteers are licensed amateur radio operators who provide alternative communications capabilities to Douglas County, Kansas. The ACT volunteer works under the direction of emergency management staff to provide adjunct communications capabilities to the Emergency Management Operations Center and/or any disaster response organization. ACT volunteers may be assigned other responsibilities during disaster situations.

Meeting Location

Judicial and Law Enforcement Center, 2nd floor

Douglas County Emergency Operations Center (EOC)

111 East 11th Street, Lawrence, Kansas 66044

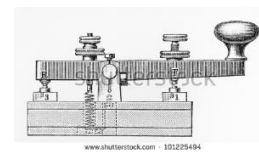
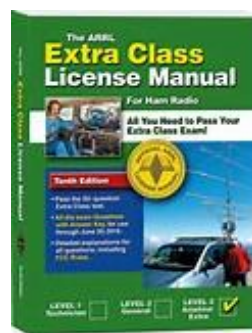
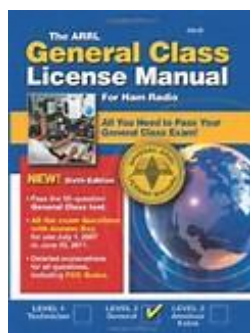
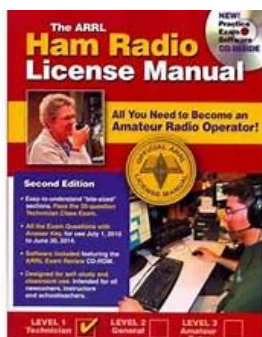
How to Volunteer

To volunteer for ACT, please complete the [Emergency Management Volunteer Application](#) (PDF format) and submit it by email (through a submit button on the form) or in-person to: Douglas County Emergency Management, 111 East Eleventh Street, Lawrence, KS 66044

HAM CLASSES: CW & TECHNICIAN CLASSES

By Santa Fe Trail Amateur Radio Club

| | | |
|-------------------------|--|--|
| Class Offered: | CW CLASS and / or TECHNICIAN CLASS | Register for one or the other or both. |
| Contact: | Jim Cessna | AC0KN@arrrl.net |
| PLACE: | Salvation Army 420 E. Santa Fe St. Olathe, KS 66061 | Taught by the Santa Fe Trail Amateur Radio Club |
| SDATE: | 01/06/2018 | 8 Saturdays in a row |
| EDATE: | 02/24/2018 | |
| W5YI Test: | 03/03/2018 09:00 | \$14 |
| TIME: CW class | 08:30 – 09:45 | \$5 includes CD |
| TIME: Tech class | 10:00 – 12:00 | \$30 includes manual |
| REGISTER ON-LINE | registration@sftarc.org | |
| | | |



CW Not required for license, but lots of fun.

The Technician Class is the first of three ham radio licenses. It is the entry to ham radio. The classes are geared towards the student with no electrical or electronic experience. The ham classes will provide, at a slower pace (8 consecutive Saturdays), the instruction necessary to obtain the Technician Class ham license.

This course follows the ARRL License manual and it is structured to provide an understanding of the subject matter. Topics are taught at a slower pace, and presented in simpler terms to increase student comprehension.

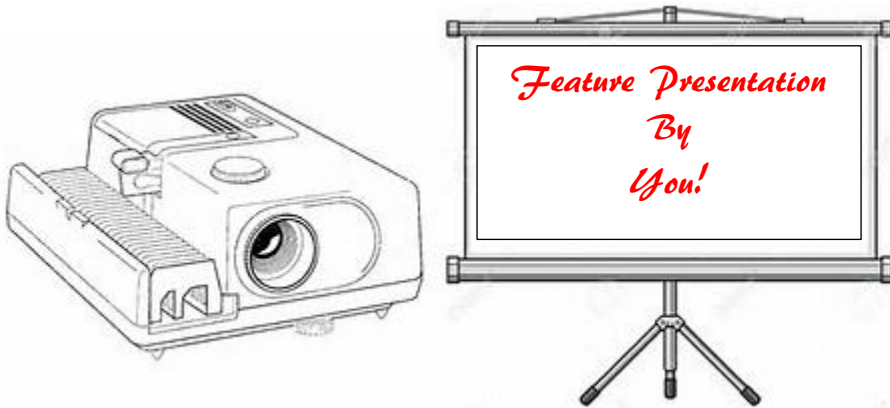
Latest enrollment date and money will be collected on the first day of class.

TEST SESSIONS

| W5YI TEST SESSIONS | LOCATION | CONTACT |
|-----------------------------------|---|---|
| Second Saturday 09:00 AM | Fire Station #1 950 N. Spring Street Independence, Mo. (24 Hwy/Spring) | Norma Hatfield (W0KC) 816-536-0469 normalibby@sbcglobal.net |
| Third Saturday 09:00 AM | Blue Valley Library 9000 W. 151 Street Overland Park, Ks 66221 (West of 151 & Antioch) | Jim Lee (N0KCB) 913-745-5121 jimlee@kc.rr.com |
| Forth Saturday 09:00 AM | Mid-continent Public Library 850 NW Hunter Dr. Blue Springs, Mo. 64105 | Jim Arnold (N0SAK) Arnold-j@swbell.net |
| Odd Nbr Months 07:00 PM | City Hall 234 Main St. Carbondale, Ks. 66414 | W. Paul Mills (AC0HV) 785-286-3506 Ac0hv@mills-usa.com |

| ARRL TEST SESSIONS | LOCATION | CONTACT |
|-----------------------------------|---|---|
| First Saturday | Kearney Library 100 S. Platte-Clay Way Kearney, Mo. 64060 | Bill Gerle (N0JJA) 816-289-6301 Bill.n0jja@gmail.com |
| Second Saturday 02:00 PM | Topeka Public Library 1515 SW 10 th Ave. Topeka, Ks. 66604 | W. Paul Mills (AC0HV) 785-286-3506 Ac0hv@mills-usa.com Pre-Registration Requested! |

TECHNICAL DEMOS



| | | | |
|-------------|-----------------|------------------|--------------|
| 2018 | | | |
| DATE | SUBJECT | PRESENTER | EMAIL |
| 01/10/18 | Presentation: | | |
| 02/07/18 | Activity: | | |
| 03/07/18 | Presentation: | | |
| 04/11/18 | Activity: | | |
| 05/09/18 | Presentation: | | |
| 06/13/18 | Activity: | | |
| 07/11/18 | Presentation: | | |
| 08/08/18 | Activity: | | |
| 09/12/18 | Presentation: | | |
| 10/10/18 | Activity: | | |
| 11/07/18 | Presentation: | | |
| 12/12/18 | Christmas Party | | |

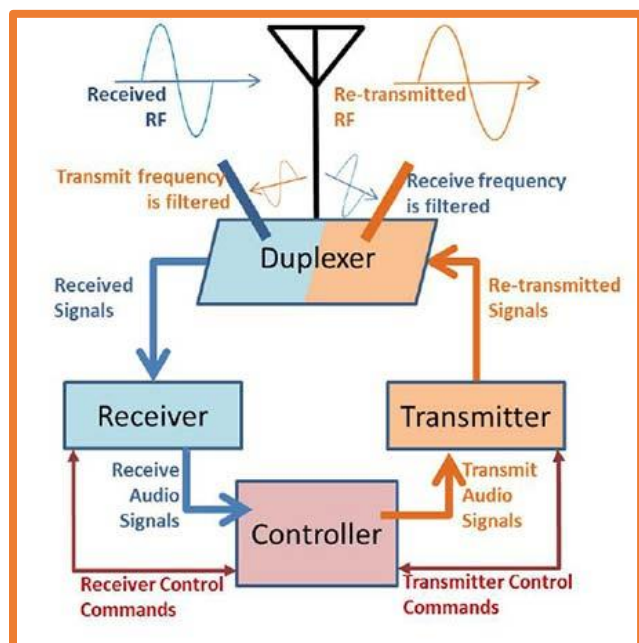
CONTACTS



| | | |
|----------------|--|--|
| PRESIDENT | John Harris N6UOP | john.harris21@sbcglobal.net |
| VICE PRESIDENT | Virginia Filardo KD0LFH | vhfilardo1116@yahoo.com |
| SECRETARY | Kevin Oneslager KS0EGL | kevin@prometheusinc.net |
| TREASURER | Bill Musick KC0NFL | blackcat@sunflower.com |
| EMER MGMT CORD | Bill Musick KC0NFL | blackcat@sunflower.com |
| TRAINING MGR | Ken Filardo KA0THK | ka0thk@arrl.net |
| PROGRAM MGR | Ken Filardo KA0THK | ka0thk@arrl.net |
| ACTIVITIES | Matt Hilt K0TOY | k0toy@yahoo.com |
| FIELD DAY | Ken Filardo KA0THK | ka0thk@arrl.net |
| HAM CLASSES | Ken Filardo KA0THK | ka0thk@arrl.net |
| ARES | Bill Musick KC0NFL | blackcat@sunflower.com |
| REPEATER | Skyler Huffman KU0JHK John Harris N6UOP | john.harris21@sbcglobal.net |
| WEB SITE | David Klamet KE0EFY Bill Wachspress K0BTY | info@w0uk.com |
| NEWSLETTER | Jim Cessna AC0KN | jimrcessna@aol.com |

REPEATERS & NETS

| REPEATER | FREQUENCY | TONE | LOC | MODE | DAY | TIME | NET |
|----------|-------------|-------|-----------------------|--------------------------------|-------------------|----------------|--------------|
| W0UK | 146.760 MHz | 88.5 | DCARC | Analog | Sunday Tuesday | 20:00 20:00 | ARES Club |
| N0APJ | 147.030 MHz | 88.5 | Douglas Co | | | | |
| N0RC | 442.000 MHz | | Basehor | | | | |
| K0USY | 444.750 MHz | 88.5 | Lawrence | | | | |
| K0USY | 444.800 MHz | 88.5 | Lecompton Lawrence | Analog | | | |
| K0USY | 444.825 MHz | 88.5 | Lecompton | DMR P25 Fusion D-Star | | | |
| K0HAM | 444.900 MHz | 88.5 | Linked KS | | | | |
| W0OQW | 147.390 MHz | 151.4 | Ottawa | | | | |



W0UK 146.760 MHz repeater Lawrence, KS
Repeater upper-right in cabinet.
Large 4 gray Duplexers for 2m.

MEETINGS

| DAY OF WEEK | PLACE | TIME | EVENT |
|---------------------------|--|--------------|---------------------------------------|
| Tuesdays | Dairy Queen 1835 Mass St. Lawrence, Ks. 66044 | 11:30 am | Lunch |
| Saturdays | Hy-Vee 4000 W 6 th St. Lawrence, Ks. 66049 | 6:00 am | Breakfast |
| 2 nd Wednesday | Douglas Co. Fairgrounds 2130 Harper Lawrence, Ks. 66046 | 7:00-9:00 pm | Club Meeting at Flory Meeting Hall |
| Last Tuesday | Hy-Vee 3504 Clinton Pkwy Lawrence, Ks. 66047 | 11:30 am | Ladies Luncheon |



MEMBERSHIP APPLICATION

Make Check/Mail to:

Douglas County Amateur Radio Club
3916 Bob Billings Pkwy.
Lawrence, KS 66049

DATE: _____ **NEW MEMBER:** ____ **RENEWAL:** ____

| CATEGORY | AMT |
|-----------------|------------|
| Regular | \$25 |
| Regular Family | \$30 |
| Senior | \$20 |
| Senior Family | \$25 |
| Student | \$20 |
| Associate | \$15 |

| | |
|---------------|--|
| CALL: | |
| NAME: | |
| ADDR: | |
| CITY: | |
| STATE: | |
| ZIP: | |
| PHONE: | |
| EMAIL: | |



WE WANT YOU! To Join Our Ham Radio Club!

VENDOR LINKS

RADIOS

| | | |
|-----------------------------------|--------------------------------------|--|
| <u>ALINCO</u> | <u>DMR HAM RADIO</u> | |
| <u>ELECRAFT</u> | <u>SDR RADIO</u> | |
| <u>FLEX RADIO</u> | | |
| <u>ICOM</u> | | |
| <u>KENWOOD</u> | | |
| <u>TEN-TEC</u> | | |
| <u>YAESU</u> | | |

ANTENNAS

| | | |
|--|---|--|
| <u>ALPHA-DELTA</u> | <u>JET STREAM</u> | <u>PACIFIC ANTENNA</u> |
| <u>BUDDIPOLE</u> | <u>M2 ANTENNA</u> | <u>SPIDERBEAM-US</u> |
| <u>CHAMELEON</u> | <u>MFJ ANTENNA</u> | <u>TENNADYNE</u> |
| <u>COMET</u> | <u>SCORPION ANTENNA</u> | <u>LNR PRECISION</u> |
| <u>CUSHCRAFT</u> | <u>STEPPIR ANTENNA</u> | <u>VARI-TEN</u> |
| <u>D&L ANTENNA</u> | <u>TARHEEL ANTENNA</u> | |
| <u>DIMOND ANTENNA</u> | <u>INTERNATIONAL ANT CO</u> | |
| <u>GAP ANTENNA</u> | <u>LDG ELECTRONICS</u> | |
| <u>HY-GAIN ANTENNA</u> | <u>MOSLEY ELECTRONICS</u> | |

TOWERS

| | | |
|--|--|--|
| <u>ALUMA</u> | | |
| <u>GLEN MARTIN</u> | | |
| <u>ROHN</u> | | |
| <u>TEXAS TOWERS</u> | | |
| <u>TASHJIAN TOWERS</u> | | |
| <u>US TOWER</u> | | |

MORSE KEY

| | | |
|------------------------------------|--|--|
| <u>BENCHER</u> | | |
| <u>BEGALI KEYS</u> | | |
| <u>KENT KEYS</u> | | |
| <u>VIBROPLEX</u> | | |

STORES

| | | |
|---|--|--|
| <u>S</u> | | |
| <u>ASSOCIATED RADIO</u> | <u>RF PARTS CO</u> | |
| | | |
| <u>CHEAP HAM</u> | <u>SSB ELECTRONICS USA</u> | |
| <u>DX ENGINEERING</u> | <u>WEST MOUNTAIN RADIO</u> | |
| <u>GIGAPARTS</u> | <u>WIREMAN</u> | |
| <u>HAM RADIO OUTLET</u> | | |
| <u>HAMMOND MFG</u> | | |
| <u>HEIL SOUND</u> | | |
| <u>UNIVERSAL RADIO</u> | | |
| <u>MAIN TRADING CO</u> | | |
| <u>QUICKSILVER</u> | | |
| | | |

FILTERS

| | | |
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| <u>PALOMAR ENGINEERS</u> | | |
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SOFTWARE AND SOUND CARD

| | | |
|-----------------------------------|--------------------------------------|--|
| <u>RT SYSTEMS</u> | <u>TIGERTRONICS</u> | |
| | <u>TIMEWAVE TECH</u> | |

BATTERIES/CHARGERS

| | | |
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| <u>HITEC COMM SOLU</u> | | |
| | | |

BUYING ELECTRONIC SURPLUS

| | | |
|---------------------------------------|--|--|
| <u>ALL ELECTRONIC</u> | | |
| | | |

CIRCUIT BOARDS

| | | |
|------------------------------------|--------------------------------------|--|
| <u>ACCUTRACE</u> | <u>SAELIG CO INC</u> | |
| <u>EXPRESS PCB</u> | | |

COMPONENTS

| | | |
|--|--|--|
| <u>ALL ELECTRONICS</u> | | |
| <u>SAELIG CO INC</u> | | |

DATA LOGGING

| | | |
|--|--|--|
| <u>MEASUREMENT COMPUTING</u> | | |
| | | |

DESIGN/ENGINEERING/REPAIR SERVICES

| | | |
|------------------------------------|--|--|
| <u>ACCUTRACE</u> | | |
| <u>EXPRESS PCB</u> | | |

DEVELOPMENT PLATFORMS/TOOLS

| | | |
|--|--|--|
| <u>TECHNOLOGIC SYSTEMS</u> | | |
| | | |

EDUCATION

| | | |
|--|---------------------------------|--|
| <u>COMMAND PRODUCTIONS</u> | <u>PARALLAX</u> | |
| <u>M.E. LABS</u> | <u>POLABS</u> | |

EMBEDDED SYSTEMS

| | | |
|--------------------------------------|--|--|
| <u>SAELIG CO INC</u> | | |
|--------------------------------------|--|--|

| | | |
|--|--|--|
| <u>TECHNOLOGIC SYSTEMS</u> | | |
|--|--|--|

ENCLOSURES

| | | |
|------------------------------------|--|--|
| <u>HAMMOND MFG</u> | | |
| | | |

LCDS/DISPLAYS

| | | |
|--------------------------------------|--|--|
| <u>SAELIG CO INC</u> | | |
| | | |

MICROCONTROLLERS / I/O BOARDS

| | | |
|--|--|--|
| <u>M.E. LABS</u> | | |
| <u>TECHNOLOGIC SYSTEMS</u> | | |

MISC./SURPLUS

| | | |
|--|--|--|
| <u>ALL ELECTRONICS</u> | | |
| | | |

MOTORS / MOTOR CONTROL

| | | |
|--|--|--|
| <u>HITEC COMM SOLU</u> | | |
| <u>SERVOCITY</u> | | |

ROBOTICS

| | | |
|--|--|--|
| <u>HITEC COMM SOLU</u> | | |
| <u>SERVOCITY</u> | | |

TEST EQUIPMENT

| | | |
|--------------------------------------|--|--|
| <u>POLABS</u> | | |
| <u>SAELIG CO INC</u> | | |

TOOLS

| | | |
|---------------------------------|--|--|
| <u>PANAVISE</u> | | |
| <u>POLABS</u> | | |

TRANSFORMERS

| | | |
|------------------------------------|--|--|
| <u>HAMMOND MFG</u> | | |
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WIRE, CABLE AND CONNECTORS

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| <u>ALL ELECTRONICS</u> | | |
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WIRELESS PRODUCTS

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| <u>LEMOS INTERNATIONAL</u> | | |
| <u>TECHNOLOGIC SYSTEMS</u> | | |

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