



# Radio Waves

News you can use for license instruction and radio science education

ARRL — The national association for AMATEUR RADIO

Winter 2016

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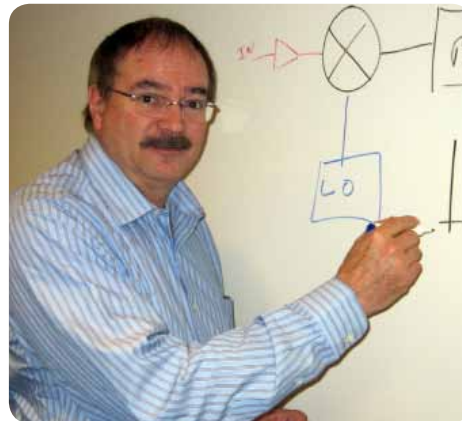


## Don't Miss...

The Arizona Science Center, located in Phoenix, Arizona, offers young people an “informal, hands-on approach to science exploration and inspiration.” A big part of that approach is its on-site ham radio station, W7ASC. Be sure to check out the article, “A Hundred Kids a Day” in QST’s February 2016 issue for an inside look at how W7ASC is introducing a new generation to the exciting and educational world of Amateur Radio. Read the article online [here](#).

## In-Depth Licensing Class Probes Electronics

BY TOM OSWALD, KD7VZW



Instructor Tony Baca, WV7I, shares his expertise.

The Hewlett-Packard Boise Amateur Radio Club decided to take a new approach to the locally available ham radio instruction. We chose to offer a class at the General level, with the goal of having students understand what they were doing, why they were doing it, and the reasoning behind the exam answers. We would teach the material in a way that had students finish the class feeling they were truly Amateur Radio operators.

Given the larger goal, the class would have to offer detailed examinations of many of the key concepts in Amateur Radio, often exploring ideas in more depth than required by the test. It quickly became apparent that the time required for a General class had to expand from 15 hours to 32.

Our four Amateur Extra class instructors, each with a different area of expertise, designed their own instruction materials. To avoid “death by PowerPoint,” the class involved a mix of whiteboard talks, hand-outs, demonstrations, hand-built slides, and hands-on teaching. We also took the time to set up an actual HF station and antenna, offering thorough explanations of its operations. We used this as a springboard to convey communications protocols.

With the basics established, instructors next offered extensive units on electronics, parallel and series circuits, electronic components, coaxial cables, connectors, and power supplies. Highly technical material came next, with comprehensive discussions on receivers and transmitters, antennas and how they work, propagation, and operating DX. We demonstrated CW, SSB, and some digital modes, repeating on-air communications to cement the ideas discussed. Each student then built or assisted in building a 20 meter halfwave dipole. The antennas were tuned in the parking lot, providing additional opportunities to discuss antenna Q, band pass, and SWR.

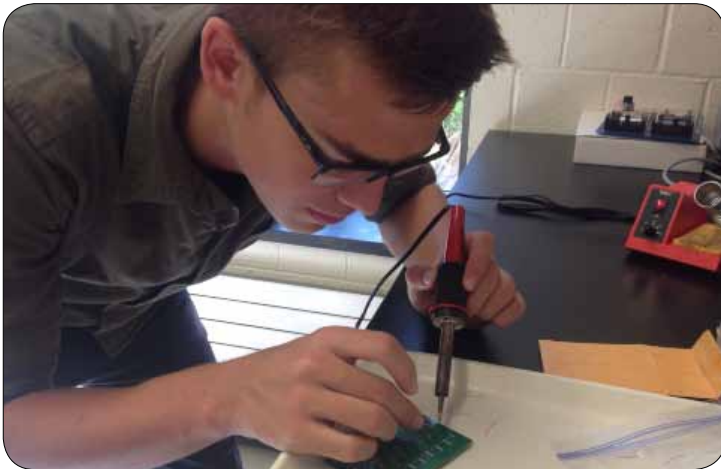
While passing the test was only a secondary goal, after this comprehensive instruction, all students passed their General exam and several passed their Extra.

*Tom Oswald, KD7VZW, is president of Hewlett-Packard Boise Amateur Radio Club.*

## Exploring Complex Concepts through Electronic Kit Building

**A**mateur Radio teaching tools come in all shapes and sizes, so STEM school teachers are almost guaranteed to find a perfect lesson fit. Proving the point is Lynn Scully, an engineering teacher at the private Blair Academy in northwestern New Jersey. She's begun incorporating into her classes an analog-to-digital conversion (ADC) comparator kit designed by Mark Spencer, WA8SME, ARRL's Education & Technology curriculum consultant. Scully, a recent graduate of the ARRL Teachers Institute, shares her experience with *Radio Waves*:

We used the kits, designed by Mark Spencer, to complement our lesson on binary search and the functions of microcontrollers, and to allow the stu-



A Blair Academy student constructing the ADC board.

dents extensive soldering experience. The kit came with all the parts: switches, resistors, thermal resistor, and printed circuit board. The students soldered all the components onto the printed board, and reviewed each component's function in the circuit as they proceeded. The finished product, powered by a battery, then was adjusted to produce a random resistance from 0 to 255  $\Omega$ . The range was chosen to represent 2 to the eighth power — a byte — and allow students to use switches to activate resistors to simulate a binary search.

This project enhanced students understanding of binary search, parallel circuits, hands-on construction, soldering, thermal resistors, and the proper use of a multimeter.

What a great learning project! My experience at both TI-1 and TI-2 were fabulous thanks to the dynamic and inspired teaching of Mark Spencer. I owe my limited, but growing, knowledge of electronics and radio communications to him and this wonderful class offered by ARRL.

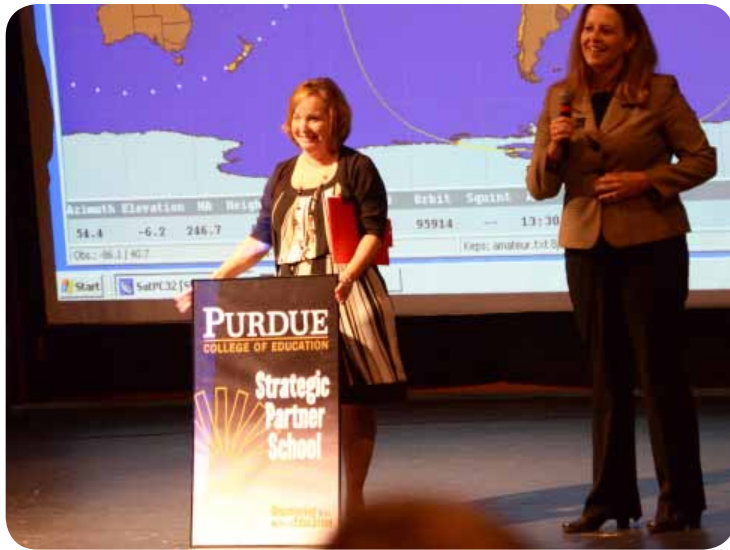
For more information on the comparator kit and other educational kits available for use in lessons, follow the link found in the box below.

### The ADC Exploration Board

The purpose of this instructional board is to show how a computer does analog-to-digital conversion (ADC) to change an analog voltage (one of infinite possibilities) into a digital numerical value that, in turn, can be manipulated by a computer. ADC is the cornerstone of digital signal processing (DSP) and, frankly, any handling of real-world signals by computers today. The ADC Exploration Board simulates an 8-bit ADC circuit that is common in most programmable interface controllers (PICs) manufactured today. For additional details on this and other educational kits, visit [www.arrl.org/etp-kits-projects](http://www.arrl.org/etp-kits-projects), and click on the link for Digital Signal Processing Fundamentals.



## Two Schools Experience ARISS Impact



Dr. Carla Johnson of Purdue University's College of Education (right) presents Principal Kelly McPike (left) with a poster recognizing Maconaquah Elementary School as a Strategic Partner School. The College of Education at Purdue donated \$4,000 for the purchase of radio equipment, which made the contact possible. (Eric Stoff photo)

When students at Maconaquah Elementary School in Bunker Hill, Indiana, made an ARISS contact on August 8, 2015, they owed many thanks to Purdue University, which had previously granted them about \$4,000 toward the purchase of radio equipment. That day, it would be used to make a once-in-a-lifetime call.

Maconaquah, a rural institution located near Grissom Air Reserve Base (named for astronaut Gus Grissom), is a model school for technology, academics, and STEM. Its 5th grade high-ability teacher Cassandra Knolinski says she was encouraged to file an application for the ARISS contact by Miami County (Indiana) Amateur Radio Club president Bill McAlpin, WD9GIU. With McAlpin's help — and the donated equipment — students interviewed astronaut Kimiya Yui, KG5BPH, and received Yui's personal responses to 20 questions.

In addition to the grant money, Purdue University also gave the teachers and students an author-signed copy of *Becoming a Spacewalker: My Journey to the Stars*, a children's version of Indiana-born astronaut Jerry L. Ross's autobiography. Each child also received a shirt from the school that said, "I talked to an astronaut on the ISS at Maconaquah Elementary School."

West Michigan Aviation Academy, an Aviation and Engineering STEM-focused charter school in Grand Rapids, Michigan, started readying for its ARISS adventure in the fall of 2015, with teachers from each department developing lesson plans and activities using the contact as a jumping-off point.

The science department held discussions on wave theory; the engineering department designed a unit on orbital mechanics, calculating changes in the ISS altitude due to speed and weight changes; the aviation department conducted career research on becoming an astronaut or other space-related professional; the aviation maintenance class researched maintenance issues that have arisen during missions; and the English department researched the biography of several crew members and offered units about living on the ISS. The school's aviation-focused speech class, "Flight Brief," developed the pre-contact presentations that were given to the entire student body the day of the contact. Several departments continued units even beyond the contact, so its benefit for the school is ongoing.

"I have used the contact as a springboard to launch a small radio club at the school," says Les Brown, Aviation/Chief Pilot at WWMA. "Although we are off to a slow start, we do have interest in a Technician licensing class that several students and even a few faculty have signed up for."



The excitement's palpable during the pre-contact discussion, held just before the ARISS contact, is seen on the faces of these West Michigan Aviation Academy students. (WMAA yearbook staff photo)



## Outreach

### West Chester Amateur Radio Association on Hand for Pi Day

The West Chester Amateur Radio Association (WCARA) and the National Voice of America Museum of Broadcasting joined forces to mark last year's Pi Day, the annual celebration of the mathematical constant. WCARA volunteers at the museum demonstrated basic radio facts to students attending "Pi Day + 6" event on March 20 (Pi Day is actually March 14) in West Chester, Ohio.

Almost 2,000 students and parents from the local Lakota school district attended the second annual Lakota LEADS (Lakota's Enrichment and Academic Development of Students) Pi Day STEM event intended to pique student interest in science, technology, engineering and math concepts. VOA Museum volunteer and board member



Joe Gruber, WD8AZQ, managed a team of engineers who created an exhibit with interactive lab activities covering basic magnetism, electromagnets and induction, electromagnetic waves and modulation. Attendees also had fun challenging the VOA "Power Tower," a maker project created by the VOA team. Lakota West High School physics students helped explain concepts to school children from grades K-8. The VOA Museum booth was one of 50 displays at the event.

Pi is the symbol used in mathematics to represent a constant — the ratio of the circumference of a circle to its diameter — which is approximately 3.14159, or in calendar terms, March 14.

## Georgia Youth Nets

A recently formed youth net offers young hams the opportunity to chat with their peers across the metro Atlanta area — and perhaps across the country. A project of the Mill Springs Academy Amateur Radio Club (Alpharetta, Georgia), the net runs for an hour on Wednesdays starting at 7 pm EDT on the NF4GA repeater (145.47 Sweat Mountain). Echolink participation is strongly encouraged so young people from all across the country can get involved. Only youth 18 and under are invited to participate, and designated adult mentors will kick off the net off and keep the discussions going and on track.

To participate, connect to node NF4GA-R (number 560686). The NFARL Do Drop In chat room (<http://nfarl.dodropin.org/>) will be active during the net as well, and young hams are invited to check in there, too.

### New ARRL Web Page for Youth Net Information

ARRL has published a new page on its website to share information about Amateur Radio nets created for youth participation. During the dry spells between bigger operating events like School Club Roundup, Kids Day, and Field Day, regular participation in a net develops operating skills and confidence and builds connections within the community of young hams. A few nets that we know about — nets hosted from Michigan, Louisiana and Georgia — are already listed, but we would like to receive and share information about others. Please visit the page at [www.arrl.org/youth-nets](http://www.arrl.org/youth-nets) to find details about existing nets and to submit information about others.

# Instructor Corner — News, Ideas, Support

## Resources for Classroom Instruction

The web is teeming with suggestions and support for incorporating Amateur Radio-related instruction in the classroom. Below are some resources readers may find interesting and helpful:

- SparkFun Electronics offers “How to use a multi-meter to measure resistance, voltage, directionality of diodes, polarity of LED, capacitance, temperature, current” [here](#) and a tutorial on analog-to-digital conversion [here](#).
- A video from The Online Engineer explaining radio wave propagation is posted on YouTube [here](#).
- A simple project to make a piezoelectric generator, using basic circuit components is posted on YouTube [here](#).
- 4-H offers a four-part series for teaching electronics concepts to younger students that can be found [here](#).
- Charles Kitchin, N1TEV, known for the simple regen radio receiver design published in the September 2000 issue of *QST*, offers a YouTube video program suitable for middle school or junior high school science class [here](#).

## Cool Tool for Teachable Moments

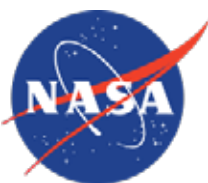
### Building Kits (and Helping Others)

Instructors can now help students learn basic component theory and building techniques while also helping people in need. The HumanaLight, offered by grass-roots non-profit Ears to our World (ETOW), is an easy-to-build kit for a bright, long-lasting LED mini-lamp that's powered by the residual energy in depleted AA batteries.

Proceeds of kit sales benefit ETOW, which provides self-powered, world band radios and other appropriate technologies to schools and communities in the developing world. Visit [www.earstoourworld.org/humanalight](http://www.earstoourworld.org/humanalight).



Assembled HumanaLight kit.



**Jet Propulsion Laboratory**  
California Institute of Technology

### New Educational Materials for Engineering Instruction

Are you concerned about how engineering fits into your K-12 science curriculum? The education team at NASA's Jet Propulsion Laboratory has created a set of videos and supporting text for educators to illustrate how real-world engineering at NASA can be applied to the Next Generation Science Standards.

The new instructor guide has a video for each grade span and NGSS “Engineering, Technology, and the Application of Science” performance expectation. Each video shows how JPL applies the standard, offers a lesson plan or activity, and offers suggestions for making the standard relevant. Check out the guide at [www.jpl.nasa.gov/edu/teach/resources/engineering-in-the-classroom.php](http://www.jpl.nasa.gov/edu/teach/resources/engineering-in-the-classroom.php).

## New Amateur Extra Class Question Pool

The new Amateur Extra class question pool, effective July 1, 2016, through June 30, 2020, is now available at the National Conference of Volunteer Coordinators (NCVEC) website ([www.ncvec.org](http://www.ncvec.org)). The published version with a date of February 5 includes errata from the initial release on January 8. This is the final version and may be used for test and study material preparation.

Question Pool Committee chair, Roland Anders, K3RA, describes the new question pool as “a fairly significant change relative to the current pool, which expires on June 30. The primary changes are modernization of the pool. All in all, the Question Pool Committee has worked to keep the Extra class exam up to date, to provide a high-quality examination, and to insure that the incoming Extra class amateurs are well qualified to be leaders in the hobby.”

The most significant topics covered by new questions include:

- digital communications
- digital test equipment
- software defined radio
- propagation/space weather
- common antenna types
- associated operating topics

While questions were removed to make room for the new questions, the committee also removed questions to make the level of difficulty more consistent. Approximately 60 questions were edited for clarification or grammatical issues. The total number of questions increased slightly from 700 to 712.

The ARRL VEC wishes to thank the NCVEC Question Pool Committee for their hard work on behalf of the volunteer testing community.

## Resources for License Instruction

Instructors looking for new ideas to freshen up their lessons and help students prep for exams as well as operating should check out the following Internet resources:

### Free Ham Apps

For testing assistance for both iOS and Android tablets, point your web browser to:

- [Ham Radio Exams \(iOS\)](#)
- [Ham Test Prep \(Android\)](#)
- [Amateur Radio Electronics \(Android\)](#)

### New Amateur Extra Question Pool Analysis / Aids for Instruction

Fred Benson, NC4FB, shares his comparison of the old and new Amateur Extra class question pools [here](#). He also provides editable Amateur Extra (2016–2020) subelement *PowerPoint* slide sets (in zipped format) that can be downloaded. The slide sets cover subelements E0–E9, and are in tandem format with the first slide displaying the questions and answer choices and the second slide displaying the questions and answer choices with the correct answer choice accentuated. The slide sets may be used without attribution. Richard Bateman, KD7BBC, author of Ham-Study.org materials also shares an analysis of the new Extra pool [here](#).

## Yahoo! Discussion Group for License Instructors

The Ham Radio Instructor’s Yahoo! Group is for Amateur Radio operators who are currently teaching or interested in teaching Amateur Radio classes. The group discusses members’ experiences teaching and ways to become better teachers, including new ideas, techniques, and materials. Recent discussions have included what questions to ask when surveying students, what plans members have for teaching upcoming classes, and whether or not it’s a good idea to combine Technician and General classes.

The group is owned and moderated by Dan Romanchik, KB6NU. He is the author of the *No-Nonsense Amateur Radio license study guides* and teaches

Amateur Radio classes in Ann Arbor, Michigan. There are currently 482 members of the group, and they average two to three discussions per month. To join the group, go to [https://groups.yahoo.com/neo/groups/ham\\_instructor/info](https://groups.yahoo.com/neo/groups/ham_instructor/info).



# Education & Technology Program News

## Summer 2016 Teachers Institute Schedule Announced

The ARRL Education & Technology Program has announced the summer schedule for the Teachers Institute on Wireless Technology. This expenses-paid, professional development program is in its 13th season. The 2016 schedule offers two sessions of Introduction to Wireless Technology (TI-1) and one session of the advanced Remote Sensing and Data Gathering (TI-2). A private donation has made possible an additional session of the TI-1 to be offered to teachers in the Denver area, which will be hosted by Douglas County STEM Academy in Highlands Ranch, Colorado.

Read more about the upcoming workshops in the March *QST* article found [here](#), which includes details about the topics covered, and on the ARRL website [here](#).

### 2016 Teachers Institute on Wireless Technology

TI-1 Workshops: Introduction to Wireless Technology		
Date	Location	Application Deadline
June 20-24, 2016	Parallax, Inc., Rocklin, CA	May 1, 2016
July 25-29, 2016	ARRL Headquarters, Newington, CT	May 1, 2016
TI-2 Workshop: Remote Sensing and Data Gathering		
Date	Location	Application Deadline
July 18-21, 2016	Dayton Amateur Radio Association, Dayton, OH	May 1, 2016

Applications are available on the ARRL website [here](#). Contact Debra Johnson at [djohnson@arrl.org](mailto:djohnson@arrl.org) with questions, or to request brochures to share with teachers in your community.

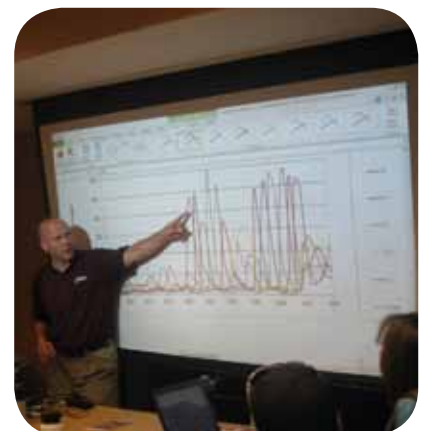
### 2015-2016 ETP Grant Awards

The ARRL Education Technology Program awarded four station grants and three progress grants for the 2015–2016 school year. Resources awarded ranged from license manuals, foxhunting equipment, and a marine buoy, to transceivers and a complete station. Schools in Texas, California, Wisconsin, Colorado, and Ohio benefited from the program, which relies on donations from members, clubs and in-kind assistance from Ham Radio Outlet. Find more information about the program as well as the application at [www.arrl.org/etp-grants](http://www.arrl.org/etp-grants).



### ARRL Celebrates Milestone

Amateur Radio on the International Space Station (ARRL ISS) is gearing up for its 1000th educational radio contact in March 2016. Since the first Amateur Radio contact with a school in December 2000, astronauts and cosmonauts aboard ISS have talked to students in 44 U.S. states and in 51 other countries!



Instructor Matt Severin, N8MS, reviews FunCube telemetry data with TI-2 participants. (Debra Johnson, K1DMJ, photo)



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Education & Technology Program:

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Teachers Institute on Wireless Technology:

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ARRL Program:

[www.arrl.org/amateur-radio-on-the-international-space-station](http://www.arrl.org/amateur-radio-on-the-international-space-station)

**Access Radio Waves**

Find this and other issues of *Radio Waves* in interactive online format at [www.arrl.org/radio-waves](http://www.arrl.org/radio-waves)

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## Recent Licensing Statistics

The following report of FCC licenses issued is supplied by Maria Somma, AB1FM, ARRL VEC Manager. Somma notes that 2015 was another outstanding year for Amateur Radio licensing. Licenses issued are down only slightly from 2014, which was a record-setting year. The total number of U.S. amateurs has continued to grow each year since the FCC license class restructure in 2007. As of December 31, 2015, the number of licensees reached an all-time high of 735,405.

NEW and UPGRADED FCC LICENSES ISSUED PER YEAR					
FCC License Activity	2011	2012	2013	2014	2015
Technician	21,316	23,974	25,621	29,223	28,504
General	9,667	10,132	9,567	10,902	11,179
Amateur Extra	3,426	3,259	3,023	3,672	3,618
<b>Total Issued</b>	<b>34,409</b>	<b>37,365</b>	<b>38,211</b>	<b>43,797</b>	<b>43,301</b>

## Announcements, Upcoming Events, Opportunities, and Deadlines

**FAR Scholarships** — The Foundation for Amateur Radio is accepting applications until **April 15, 2016**. The application process is open to all licensed Amateur Radio operators worldwide. Visit [www.farweb.org/2016-scholarship-information](http://www.farweb.org/2016-scholarship-information).

**ARRL Proposal Window** — The ARRL Program's proposal window for accepting submissions from educational organizations seeking to host scheduled contacts with the ISS is **February 15 – April 15, 2016**. Visit [www.arrl.org/hosting-an-ariss-contact](http://www.arrl.org/hosting-an-ariss-contact).

**Teachers Institute, Summer 2016** — The deadline for applications for the 2016 Summer Teachers Institute is **May 1, 2016**. Application forms are available online at [www.arrl.org/teachers-institute-application](http://www.arrl.org/teachers-institute-application).

**Kids Day, June 18, 2016** — Kids Day gives young people on-the-air experience and provides a chance to interest them in getting a license of their own. See [www.arrl.org/kids-day](http://www.arrl.org/kids-day).

**ARRL Field Day, June 25 – 26, 2016** — Information about this opportunity for public outreach and getting young people on the air can be found at [www.arrl.org/field-day](http://www.arrl.org/field-day).

You are subscribed to receive the ARRL Instructor/Teacher E-Letter. If you have an ARRL website user account, you can manage all of your e-mail preferences at [www.arrl.org/myarrl](http://www.arrl.org/myarrl). If you do not have an ARRL user account, contact us at [ead@arrl.org](mailto:ead@arrl.org) with a request to subscribe/unsubscribe.



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