ATCO NEWSLETTER

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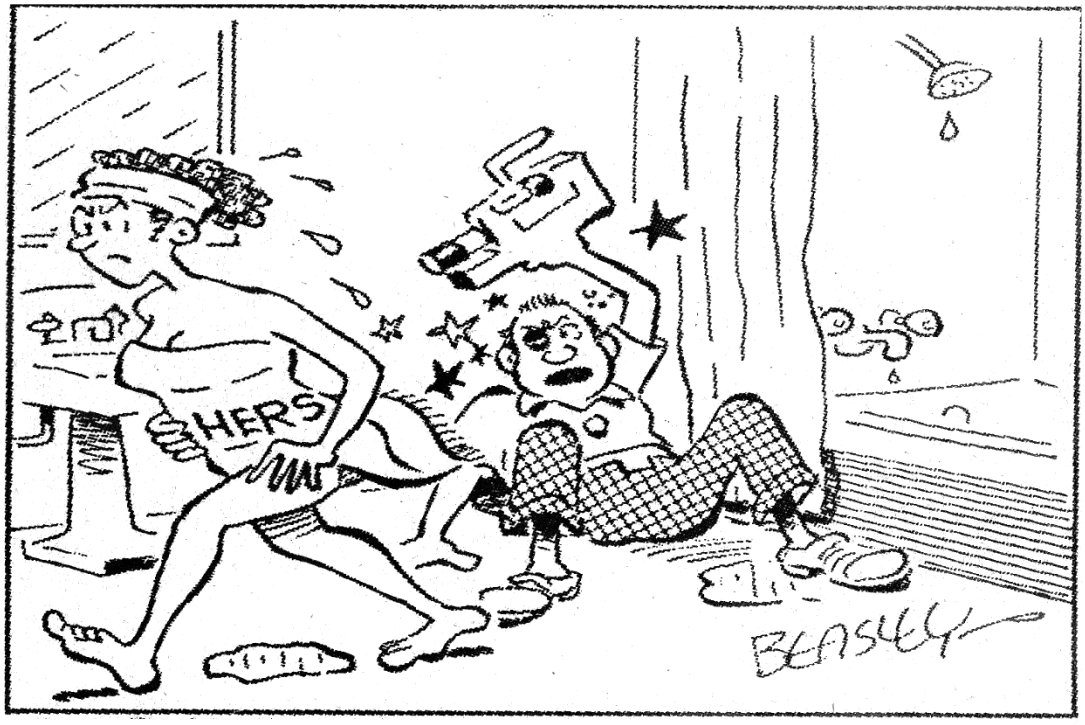
The ATCO newsletter is the official publication of a group of amateur television operators known as "AMATEUR TELEVISION IN CENTRAL OHIO Group Inc" published quarterly (January, April, July, October)

ATCO SPOTLIGHT TOPIC



All right, just wait and see if I ever let you be on candid ATV again!

ACTIVITIES ... from my Workbench

How about that! We just blink our eyes and it's Spring now, swiftly approaching summer. You know what that means…antenna time! Well, almost. The lawn and garden first. Well, at least we can THINK "antenna" while we re-work the lawn, but I digress. Let's get back on track.

Actually, there is not much going on yet as I'm anxiously waiting for Hamvention. (I guess it's all right to omit the word, DAYTON but Xenia still doesn't sound quite right either). I guess I've spent too many years at Hara Arena.

I do have some tower work to do that I let go last fall. I have a weather station on my desk with a display that says, "Low battery in Transmitter" so I better hike up the tower to replace it near the top. Why they put a solar panel attached to it that is not connected to the battery inside I can't figure out. I bought it at Hamvention back in Hara Arena days, so I guess they didn't know enough to use the solar cell to power it in the day and the battery only at night. I asked them that at a recent Hamvention and did not get a clear answer other than, "Buy a new one to get an active solar cell design".

The next thing I need to do is check on the ATCO Repeater. It's been running OK for a year now without any attention so now's a good time to check on it. The cooling fan has been on 24/7 for at least 5 years now, so I better exchange it for a new one even if the existing one is running OK. Also, this may be a good time to check to see if that roof leak that was supposed to be fixed last year ever happened.

I also need to check the 147.48 MHz receive sensitivity. I swapped out a filter last year which didn't improve anything, so I better look at it again. It works OK as is, but I feel it should have better sensitivity. Seems like a good time to check receiver sensitivity with my signal generator.

That's all for now. However, I haven't seen any significant activity, either 147.48 or ATV so what's holding you up? Dust off your equipment and get back on the air. The ATCO repeater analog ATV equipment is still on the air so there is no excuse that you don't have any digital gear. If you need help, reach out to me. I'll help repair some of your equipment or test it if needed.
…WA8RMC

70 CM MAST MOUNT PREAMPLIFIER REBUILD

This story can't be made up!

Dave Pelaez AH2AR

Stage 1: LETS SWAP PREAMPS! Vince N3BFZ contacted me regarding an Advanced Receiver Research model MSP432VDG-160 preamp that he had and mentioned it was not working up to par… He received it from Hank W4HTB who had picked it up at an estate sale. When Vince tried using it, he noticed that at times it was going into oscillation. Vince wanted to use it as a receive only preamp and I mentioned to him that I would go ahead and fix it if he was willing to trade it for a working Down East Microwave preamp. I knew that W8CWM was looking for a preamp to mount on his home-built fold over tower. Vince volunteered to press on with the trade, so we swapped amplifiers, and everyone was happy.

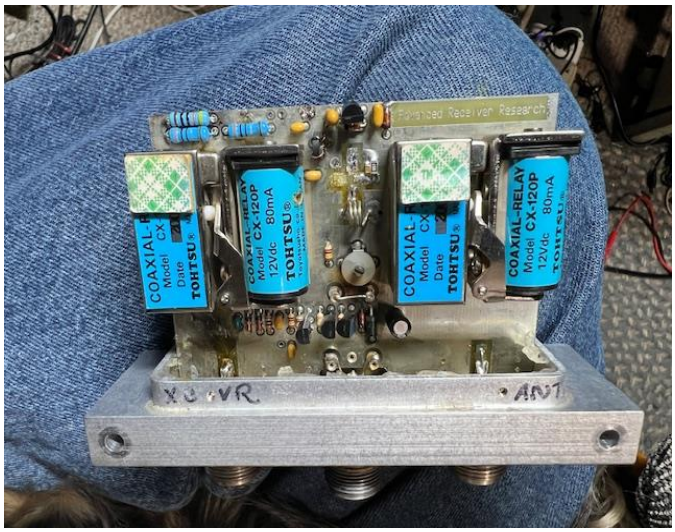
Stage 2: DON'T LET THE SMOKE OUT! Once I received it in the mail from Vince, I put it on the bench and was unable to get it to go into oscillation. I tried varying the voltage and it held steady at 18 dB gain. After running it for a few days, it continued to amplify with no hitches, so I took it over to Bill's house and mounted it to Bill's fold-over antenna tower. Using the DARA ATV repeater as a beaconing signal source, the preamplifier made a marked difference in ATV receive sensitivity at Bill's QTH. But then things went south! He tried transmitting and it immediately disabled the preamplification. Consequently, I took it home for another bench check, but this time I went ahead and attempted to inspect the internal circuit board for the first time. I was unable to get into the case. It appeared that it was sealed tight enough where the cover could not be removed from the base without possibly destroying the steel case. It somewhat reminded me of an armored sardine can.

Stage 3: USE A BIGGER HAMMER! Not wanting to damage the steel case to get to the circuit board I decided to call the manufacturer to get some advice on how to disassemble the preamp without destroying it. Jay from Advanced Receiver Research answered the phone on the first ring and was very helpful, but I was a little surprised with his suggestion. He mentioned that since the case was sealed with RTV Silicone, it would be best to put the case in a vice and smack the edges with a rubber mallet. Reluctantly, I carefully locked it in my workbench vice and a few hits with the rubber mallet did the trick! It finally came apart. Now, what is that acrid smell?!?!?

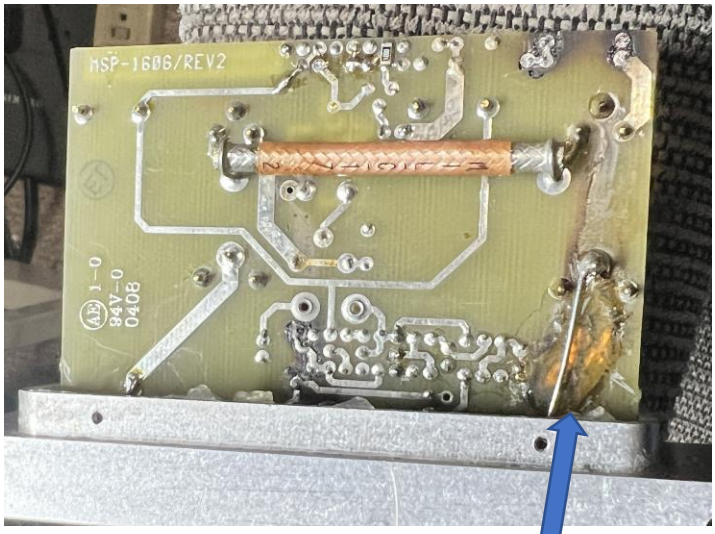
Stage 4: THE LINGERING SMOKE INSIDE THE HERMETICALLY SEALED CASE ESCAPED! Once apart, I was somewhat amazed at the damage. I immediately noticed that it reeked of burnt phenolic PCB, and I noticed an old "repair" that someone accomplished. Indeed, someone modified the preamp to be a "receive only" unit as they removed and then bypassed the stripline printed circuit tracings that took out the conducting path to the RF sensing circuit from the unit. A closer look indicated that the RF sensing transistor was inoperative.

Stage 5: THE DAMAGE WAS WORSE! My further electronics "forensics" autopsy indicated that the RF sensing transistor must have failed years back, and somebody decided to turn the preamp into a receive only unit. Doing so would set someone up for instant disaster if the next owner decided to put it into transmit/receive service. That was us! When we tried transmitting 160 watts into the receiver section (with no RF sensing relay to switch it to "passaround" the active preamplifier circuit), it ended up (literally) smoking three resistors, a diode, an SMD capacitor and the MFG1302 transistor. Could it be saved?

Stage 6: ITS ALIVE! After running down the needed parts, I installed the components and replaced the RF sensing transistor that had obviously failed years back. I also fixed the circuit board where the "modification" removed the printed circuit board tracings to the RF sensing circuit. It was now working as it should, at 18 dB gain… Back to normal! And it was ready for installation.



PCB insides halfway through repair



PC Board was "modified" by persons unknown years back as shown in the lower right corner.

Stage 7: MEANWHILE, BACK AT THE RANCH...W8CWM acquired another 70cm preamp during all this restoration and repair activity. I decided to adopt the unit as I had admittedly developed a liking to this preamp, who just like the flight of the Phoenix, has arisen from the ashes unscathed.

AMATEUR RADIO EMERGENCY PREPAREDNESS ACT (HR-1094)

Here we go again. We've all heard about government bills to allow outside antennas in order to communicate during emergencies. GREAT! Let us hope this one will pass but don't set your hopes too high. I'm in support of it but historically the FCC and Government do not want to go head-to-head with HOA's. It's important here because to be effective, we generally must have outside antennas for ATV operation. I'll keep my fingers crossed. WA8RMC

A summary of the proposed bill is below:
https://www.wicker.senate.gov/2025/2/senators-wicker-blumenthal-reintroduce-legislation-to-protect-amateur-radio-operators

However, if you're so inclined to read the official bill, it's at:
https://www.arrl.org/files/file/Advocacy/HR1094%20House%20Private%20Land%20Use%20Bill.pdf

The Amateur Radio Emergency Preparedness Act (S. 459) was re-introduced in the Senate on February 6, 2025. to protect the rights of amateur radio operators to install antennas necessary for emergency communication, particularly in situations where Homeowner associations might restrict such installations.

THE BILL ADDRESSES THE FOLLOWING:

Protects against HOA restrictions to:
Prohibit homeowner association rules that would prevent or ban amateur radio antennas, ensuring operators can install necessary equipment for emergency communication.
Approval processes:
Clarify process for installing amateur radio antennas to make it easier to navigate HOA requirements.
Provides a federal right of action:
In cases of disputes with HOAs, it would provide a federal private right of action for amateur radio operators.
Ensures emergency communication:
Amateur radio operators play crucial role to provide emergency communication during disasters when other systems might be down.
Addresses HOA restriction:
Supports vital public service by amateur radio operators who contribute to community preparedness and emergency response.

Amateur Radio Emergency Preparedness Act Re-Introduced
Legislation Will Increase Communication Options During Natural Disasters WASHINGTON – U.S. Senators Roger Wicker, R-Miss., and Richard Blumenthal, D- Conn., and Representatives August Pfluger, R-Tex., and Joe Courtney, D-Conn. announced their joint re-introduction of legislation in the Senate and House to restore the right to Amateur Radio operators to install the antennas necessary to serve their communities. Homeowner association rules often prevent Amateur Radio operators from installing antennas at their homes even though Amateur Radio has proven to be essential in emergencies and natural disasters such as hurricanes when other means of communication fail. "Mississippians should have access to every possible means of warning for natural disasters, including amateur radio operators. In an emergency, those warnings can mean the difference between life and death," Senator Wicker said. "The Amateur Radio Emergency Preparedness Act would remove unnecessary roadblocks that could help keep communities safe during emergencies like tornadoes, hurricanes, and fires." "When disaster strikes, amateur radio operators provide vital, often life-saving information, which shouldn't be hindered by prohibitive rules or confusing approval processes. The Amateur Radio Emergency Preparedness Act eliminates obstacles for ham radio enthusiasts, allowing them to continue their communications and serve their communities in the face of emergencies," said Senator Blumenthal. "Natural disasters and other emergency situations that hinder our regular lines of communication are unfortunately unavoidable, which is why we must

bolster our emergency preparedness by removing the barriers amateur radio operators often run into when installing antennas. Amateur radio always plays a vital role in public safety by delivering critical information to people. My district is home to dozens of amateur radio operators ready to volunteer in the event of an emergency, and I am proud to lead this legislation," said Congressman August Pfluger. "As we know from recent natural disasters, amateur radio operators in Connecticut can be a critical component of disaster response and emergency management. It is in our communities' best interest that we give them the capabilities to operate at the highest level, and with the re- introduction of this bill, we've taken a strong step in that direction," said Congressman Courtney.

Background:
The Amateur Radio Emergency Preparedness Act of 2025 (H.R. 1094 and S. 459) would require homeowner associations to accommodate the needs of FCC-licensed Amateur Radio operators by prohibiting the enforcement of private land use restrictions that ban, prevent, or require the approval of the installation or use of Amateur Radio station antennas. Homeowner associations have often prevented installation and use of such antennas through private land use restrictions. This has hindered voluntary training for emergency situations and blocked access to necessary communications when disaster strikes. Among other provisions, this legislation would:

- Prohibit homeowner association rules that would prevent or ban Amateur Radio antennas;
- Specify an approval process for installing Amateur Radio antennas;
- Provide a Federal private right of action to Amateur Radio operators in disputed cases.

On behalf of America's Amateur Radio licensees, Rick Roderick, the President of The American Radio Relay League, re-confirmed the ARRL's full support for the passage of the Amateur Radio Emergency Preparedness Act of 2025 and extended his thanks and appreciation to Senators Wicker and Blumenthal and Congressmen Pfluger and Courtney for their unflagging leadership of the bi-partisan effort to support and protect the rights of all Amateur Radio Operators.

RIGEXPERT OFFICE DESTROYED IN RUSSIAN MISSILE ATTACK

[Kyiv, 12 Feb 2025] – Today, RigExpert's administrative office was destroyed by a Russian ballistic missile. Fortunately, all employees are safe.

Despite this difficult situation, the RigExpert team is committed to restoring operations as soon as possible to continue providing our products to you. We are working tirelessly to minimize delays and fulfill our commitments. Besides, we are maintaining our usual customer support operations. Please, don't hesitate to get in touch.

"Our top priority is the safety of our team and the continuity of our operations. While our administrative office is in ruins, our production facilities survived, allowing us to continue serving our customers and partners," said [Ashot Andeev, CEO].

RigExpert is committed to resuming full operations as soon as possible and will keep stakeholders informed throughout the recovery process. For further information, please contact: **office@rigexpert.com**

RigExpert is a leading manufacturer of antenna and cable analyzers, known for its commitment to innovation and quality. Despite current challenges, the company remains dedicated to supporting the global amateur radio and communications community.

DARA Hamvention ATV Update

An experiment to determine whether there would be any isolation issues for simultaneous ATV Booth demo activities.

The Moderator of the ATV forum at Hamvention will be WA8RMC, Art Towslee, and he will be introducing KD6W, Joel Wilhite as the forum's guest speaker. Joel will be discussing the topic "A beginner's review overview of Digital Amateur Television" and he will also be giving a talk on how to build and operate an ATV station. To that end, I wanted to verify before Hamvention that Joel's QAM demonstration at the ATV Booth can operate simultaneously with the in-place DARA ATV DVB-T crosslink since these separate systems will only have 1 MHz of separation. The QAM signal's 6 MHz bandwidth, centered on 423 MHz, spans from 421 MHz to 426 MHz. Alternately, the 2 MHz wide bandwidth of the incoming DVB-T DARA ATV repeater signal entering the receiver spans from 427 MHz to 429 MHz. I went ahead and obtained a QAM modulator and the test ran successfully. I determined that there will be some antenna separation required to optimize isolation since we will be able to use the side of the building as obscura between the two antennas. Additionally, the RF power for the QAM link can be adjusted to prevent spectral spreading from encroaching into the 1 MHz guard band. As they say, mileage may vary as the environmental conditions of the test are subject to change, when the real world comes rolling through. On a side-note, the modulator obtained for the test had an unfortunate "accident" after the test was completed. I purchased the used modulator from e-bay and its only flaw was a dim display. So after completing the experiment, I failed to unplug the modulator's A/C power source (remember... dim display!) I didn't know the modulator was still powered up and I "allowed" it to continue to transmit. Unfortunately, it continued to run without a 75 ohm termination on its RF output connector... for two days! Its RF power output dropped from -19 dBm down to -75 dBm as I had obviously damaged its final transistor. I know now why I ordered a spare!
…AH2AR

DATV OPERATION using QAM (Quadrature Amplitude Modulation)

Joel Wilhite will use QAM at Hamvention this year. Great! It seems like a good fit for the application. Then ask, "why not use it for more DATV applications"? Well, it depends! Let's briefly discuss the pros and cons and let you decide if you want to try it elsewhere. However, QAM was designed primarily for cable operation in the USA where the signal is contained and not subject to multipath interference. **To receive a QAM signal, all you need is an unmodified TV receiver**. That's a powerful asset. However, when you subject it to over the air conditions, the ground rules change. Back in 2002 we tried to use it for our ATCO repeater in downtown Columbus, Ohio and were very disappointed. We gave up trying to make it work. We had enough height (650 ft above street) but the tall buildings around it and other transmit sources in the area made success impossible.

The main issue is the fact that the QAM format contains very little multipath error correction, so the software simply rejects any signal that is out of phase with the incident signal. There may be some areas that will be "quiet enough" to allow good reception using QAM but it may be a challenge. I encourage anyone to try it and report their experiences to me. Ham Radio/TV is open to experimentation so "go for it"!!! The main factors to consider are:

- Perfect if you want to use a standard unmodified TV for reception.
- There are many manufacturers of QAM modulators that are very inexpensive.
- There is very little (none) built-in error correction so multipath is an issue.
- To minimize reflections, good cable practices are necessary. A cable SWR can produce issues.
- Highly directive antennas may be necessary to minimize non incident signal reception.
- Receiver sensitivity may be insufficient because most TV's require higher level signals.
- Adding a preamp at the receiver may prove ineffective because of the increased signal distortion.
- To cope with the above variables, it may be necessary to increase transmit power to compensate.
- A shorter overall reception range could result but try it and see if it is successful for **your** application.

…WA8RMC

WHAT IS MICROLED?

Do You Need It in Your Next TV? By Will Greenwald March 15, 2025
From PC Mag January 2025 Apple News. **(https://apple.news/ArGnRG4txRlyeD1tBYh-D5Q)**

If LED, QLED, OLED, and mini-LED don't already confuse you, there are now two distinct types of MicroLED TVs. Here's what you need to know about the latest television display technology.

TV terminology has gotten a bit more confusing. Recently, most high-end TVs could be distinguished as OLED or QLED models. Then, mini-LED backlights entered the mix, and most TVs with that technology also use QLED. Now, MicroLED has become a common term, and it's being used in two entirely different ways, so we're here to demystify the moniker and help you understand how it fits in with similar-sounding TV technologies.

Back to Basics: Understanding LED vs. Mini-LED vs. QLED

To explain MicroLED, first take a step back and understand the basics of light-emitting diode (LED) technology. An LED is basically a very tiny light bulb (most modern light bulbs comprise bundles of LEDs). LEDs are used in most TVs as the backlight for the liquid crystal display (LCD) that produces the picture. The LCD controls the colors of the individual pixels of the screen but doesn't generate any light, and LEDs behind the panel make the pixels glow. The LEDs are much bigger than the pixels, so each one lights up many pixels at a time. This can cause light bloom, where light bleeds over edges and makes some pixels look lighter than they should, producing a glow or halo effect.

Sylvox's 110-Inch Pro Cinema, a mini-LED TV on display at CES (Credit: Will Greenwald)

Good LED TVs have many zones and can control the brightness of each zone to improve contrast. TVs that use a large number of tiny LEDs to form hundreds or thousands of individually adjustable zones are called mini-LED TVs. They're still LED TVs, just with smaller LEDs and in greater numbers.

The LEDs that light up these TVs are almost always one color. White is the standard color for cheaper LED TVs, though higher-end QLED TVs use blue. QLED is short for QD-LED, or quantum dot LED. Quantum dots are tiny particles in the LCD layer of high-end TVs that react to and change blue light into a much wider range of color than typical LCDs can show with white light alone. Most mini-LED TVs are also QLED TVs.

OLED: Tiny Glowing Cells

If you want to get the lighting perfect on a pixel-by-pixel basis, you need to use a different type of display technology. OLED stands for organic light-emitting diode, and is mechanically and chemically wildly different from the LED and LCD combinations discussed above.

The LG Evo G4 is one of the best OLED TVs we've tested (Credit: Will Greenwald)

OLED TVs basically act like glowing LCD panels, where each pixel is a tiny cell that doesn't just change color but also generates its own light. This technology is considered some of the best because it can show an incredible range of colors with perfect black levels on screens that are much thinner than LED-lit LCD panels can be due to their backlights. Some of our top TV picks, like the LG Evo G4 and the Panasonic Z95A, are OLED models.

The Best OLED TVs We've Tested

LG 65-Inch Evo G4 OLED TV Review
4.5
Outstanding
$2,396.99 at Amazon
$3,399.99 Save $1,003.00

Samsung 65-Inch S95D 4K OLED TV Review
4.0
Excellent
$2,397.99 at Amazon
$2,797.99 Save $400.00

LG C3 65-Inch Evo OLED TV (OLED65C3PUA) Review
4.5
Outstanding
$1,346.99 at Amazon
$1,499.99 Save $153.00

Panasonic 65-Inch Z95A OLED TV Review
4.5
Outstanding
$2,799.99 at Amazon

MicroLED: A Display Tech With an Identity Crisis

That brings us to MicroLED, which seems to be having an identity crisis of late. The concept has been used for some time now, particularly by Samsung's very expensive and niche The Wall video display. More recently, the term reentered the scene with a new definition courtesy of Samsung's RGB MicroLED TV proof of concept announced at CES 2025.

Let's start with the more well-established version. MicroLED screens like The Wall take LEDs to a pixel level, using an individual cluster of tiny colored lights for each pixel they show. Like OLED, they do not use an LCD panel. When you see a huge glowing video billboard, it's probably made of red-green-blue (RGB) LEDs the size of light bulbs spread out over dozens or hundreds of feet. Putting that display technology in a more "reasonably" sized TV in the range of 100 to 150 inches—as Samsung did with The Wall requires shrinking those lights down, a process that is extremely difficult and expensive.

TCL's MicroLED TV at CES (Credit: Will Greenwald)

The Wall is currently available in a 146-inch 4K version for $220,000, while a 110-inch version of The Wall in 2K resolution is $80,000. Hisense recently said that it's getting into the MicroLED TV arena with its 136MX. It hasn't announced pricing, but Hisense has told me that it should be cheaper than The Wall, which still means the high five digits at a minimum. TCL also has a MicroLED TV, the 163-inch X11H Max, which launched last year in China for around $110,000. In other words, a MicroLED TV is out of reach for most consumers.

Sony also makes large MicroLED displays, but unlike Samsung's The Wall, they aren't even remotely feasible for home theaters. Sony's Crystal LED video walls are specifically for large installations like in retail stores or museums.

RGB (Micro)LED: Tiny Colored Light Bulbs

Creating confusion, Samsung's RGB MicroLED concept shown at CES uses color LEDs for its backlight system, instead of white or blue ones. To be clear, this is an LCD TV, so it's very different from The Wall, which uses RGB LED clusters on their own, with no LCD panel, to form the picture. Hisense's 116-inch TriChroma LED TV (116UX) uses the same idea as Samsung's RGB MicroLED concept: Color LEDs that can improve the range and accuracy of the panel they're lighting. Sony has also jumped on the trend, recently announcing a "new display system" that utilizes RGB LEDs for a TV's backlight.

Samsung's RGB MicroLED TV at CES (Credit: Will Greenwald)

Each RGB LED can be brightened or dimmed to push colors beyond what the LCD can show on its own. These LEDs are still based on backlight zones (Samsung said its RGB MicroLED TV has 80,000), so colors aren't boosted pixel by pixel.

How to Calibrate Your TV Like a Pro

We won't know exactly how good these new colored backlight arrays can look or what drawbacks they might have until we can test them in more controlled environments, but early observations are promising. Adding RGB colors to the mix can potentially turn the effect of light bloom into color bleed, but with so many tiny LEDs, it's difficult to notice it unless you're pressing your face against the screen. The colorful demonstration footage I saw from Hisense and Samsung at CES didn't display any apparent color bleed. They both looked extremely vibrant and comparable with high-end OLED TVs at a glance. Press events and trade shows aren't suitable situations for seriously judging picture quality, though, so I'm eager to get these TVs in PC Labs for further analysis.

TL;DR: All the Different LEDs

Hisense TriChromia 116UX, which uses RGB LEDs and an LCD panel (Credit: Will Greenwald)

So, to sum things up: Samsung has an RGB MicroLED TV concept that is completely different from its own The Wall MicroLED TV. Hisense has its own MicroLED TV that is like Samsung's The Wall, as well as a TriChroma TV that is *not* a MicroLED TV but is very similar to Samsung's RGB MicroLED TV. Sony has MicroLED displays, but they're strictly for large installations and not home theaters. Sony is also

working on an RGB LED panel, but hasn't announced an actual TV using it yet. And TCL has its own MicroLED TV that isn't an RGB LED TV.
If you're still confused, I don't blame you, so here are the key terms to know:

- **LED**: The tiny bulbs that light up most TV screens.
- **LCD**: The color-changing panel that LEDs light up on most TV screens.
- **Mini-LED**: Really tiny bulbs that light up most TV screens.
- **QLED**: Extra tiny particles in the LCD panel work with blue LEDs to show wider colors. Can be mini-LED, but not necessarily.
- **OLED**: Not LED or LCD, but a premium TV display technology that works like both put together, controlling color and light.
- **MicroLED**: Really, *really* tiny bulbs. Works more like OLED in concept than LED since it controls both color and light and doesn't use an LCD panel. Extremely expensive.
- **RGB LED**: Really, *really* tiny bulbs not quite small enough to show each pixel. They control both color and light but work with an LCD panel to enhance the panel's colors and contrast.

Should You Buy a MicroLED TV?
Well, unless you have $100,000 or more to throw around, no. Conventional MicroLED TVs are more expensive than even the biggest OLED TVs and are really only available as part of home theater installations priced in the six digits. Samsung's RGB MicroLED TV is still only being teased and doesn't have any official retail launch details. Hisense will be rolling out its TriChroma TV later this year, but it also doesn't have pricing info yet. Sony, meanwhile, doesn't even have a name for its version of the technology yet, so that's going to be a while, too. Beyond price, the big question is how well these TVs perform. We'll have to wait a bit longer before we know whether they deliver on their promise.

HAMVENTION AMATEUR TELEVISION FRIDAY NIGHT DINNER

The ATV Friday Night Dinner will be on May 16 at 6:30 PM at the China Garden Buffet Restaurant (937-781-9999), 112 Woodman Drive in Dayton, Ohio 45431 (Airway Shopping Center). The all you can eat Buffet Dinner is $11.99. We will have dinner and then ATV presentations concluding at 9 PM. All are invited.

Door prizes will be awarded.

HAMVENTION DARA / ATCO ATV BOOTH ACTIVITIES

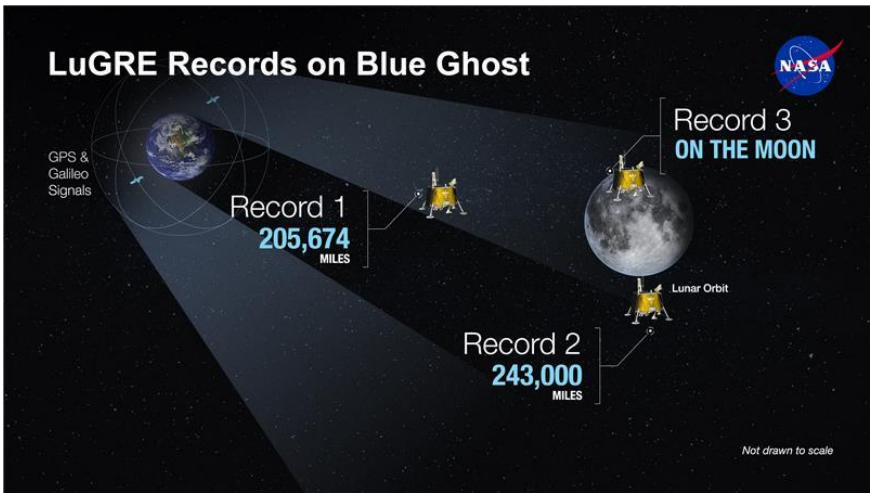
Are you planning to go to Hamvention this year? If so, be sure to stop by booths 1004 and 1005. They are the second and third tables on the left as you enter building 1. That building is the first building as you enter from gate 3. I will be demonstrating the VersaTune receiver and Joel Wilhite, KD6W will show his QAM transmit setup with actual signals from The DARA repeater location. There will always be an empty chair available to sit for a spell and discuss ATV.

NASA SUCCESSFULLY ACQUIRES GPS SIGNALS ON MOON

An artist's concept of the Blue Ghost lunar lander receiving GNSS signals from Earth.
Credits: NASA/Dave Ryan

NASA and the Italian Space Agency made history on March 3 when the Lunar GNSS Receiver Experiment (LuGRE) became the first technology demonstration to acquire and track Earth-based navigation signals on the Moon's surface.

The LuGRE payload's success in lunar orbit and on the surface indicates that signals from the GNSS (Global Navigation Satellite System) can be received and tracked at the Moon. These results mean NASA's Artemis missions, or other exploration missions, could benefit from these signals to accurately and autonomously determine their position, velocity, and time. This represents a steppingstone to advanced navigation systems and services for the Moon and Mars.



An artist's concept of the LuGRE payload on Blue Ghost and its three main records in transit to the Moon, in lunar orbit and on the Moon's surface.
NASA/Dave Ryan

"On Earth we can use GNSS signals to navigate in everything from smartphones to airplanes," said Kevin Coggins, deputy associate administrator for NASA's SCaN (Space Communications and Navigation) Program. "Now, LuGRE shows us that we can successfully acquire and track GNSS signals at the Moon. This is a very exciting discovery for lunar navigation, and we hope to leverage this capability for future missions."

The road to the historic milestone began on March 2 when the Firefly Aerospace's Blue Ghost lunar lander touched down on the Moon and delivered LuGRE, one of 10 NASA payloads intended to advance lunar science. Soon after landing, LuGRE payload operators at NASA's Goddard Space Flight Center in Greenbelt, Maryland, began conducting their first science operation on the lunar surface.

With the receiver data flowing in, anticipation mounted. Could a Moon-based mission acquire and track signals from two GNSS constellations, GPS and Galileo, and use those signals for navigation on the lunar surface?

Then, at 2 a.m. EST on March 3, it was official: LuGRE acquired and tracked signals on the lunar surface for the first time ever and achieved a navigation fix — approximately 225,000 miles away from Earth.

Now that Blue Ghost is on the Moon, the mission will operate for 14 days providing NASA and the Italian

Members from NASA and Italian Space Agency watching the Blue Ghost lunar lander touch down on the Moon.

Space Agency the opportunity to collect data in a near-continuous mode, leading to additional GNSS milestones. In addition to this record-setting achievement, LuGRE is the first Italian Space Agency developed hardware on the Moon, a milestone for the organization.

The LuGRE payload also broke GNSS records on its journey to the Moon. On Jan. 21, LuGRE surpassed the highest altitude GNSS signal acquisition ever recorded at 209,900 miles from Earth, a record formerly held by NASA's Magnetospheric Multiscale Mission. Its altitude record continued to climb as LuGRE reached lunar orbit on Feb. 20 — 243,000 miles from Earth. This means that missions in cislunar space, the area of space between Earth and the Moon, could also rely on GNSS signals for navigation fixes.

Traditionally, NASA engineers track spacecraft by using a combination of measurements, including onboard sensors and signals from Earth-based tracking stations. The LuGRE payload demonstrates that using GNSS signals for navigation can reduce reliance on human operators because these signals can be picked up and used autonomously by the spacecraft, even as far away as the Moon.

Firefly's Blue Ghost lander captured its first sunrise on the Moon, marking the beginning of the lunar day and the start of surface operations in its new home. Firefly Aerospace

The LuGRE payload is a collaborative effort between NASA's Goddard Space Flight Center in Greenbelt, Maryland, the Italian Space Agency, their industry partner Qascom, and Politecnico di Torino.
Funding and oversight for the LuGRE payload comes from NASA's SCaN Program office. It was chosen by NASA as one of 10 funded research and technology demonstrations for delivery to the lunar surface by Firefly Aerospace Inc., a flight under the agency's Commercial Lunar Payload Services initiative.
Learn more about LuGRE: https://go.nasa.gov/41qwwQN

The joint NASA, Italian Space Agency, Qascom, and PoliTO LuGRE team at NASA's Goddard Space Flight Center.
NASA

About the Author

Katherine Schauer
Katherine Schauer is a writer for the Space Communications and Navigation (SCaN) program office and covers emerging technologies, commercialization efforts, exploration activities, and more.

VERSATUNE PROGRESS

As many of you know, we are working on the design of a completely self-contained DVB-T / DVB-S receiver for DATV use. It's taking much longer than expected but understandable given the circumstances. I'm doing the hardware which is pretty much complete because I'm retired and can devote much of my time to it. Bob Tournoux , N8NT, on the other hand has a full-time job so it's an "after work" commitment. Besides, the software is an unknown part of the equation so as expected, we ran into many obstacles and had to start over a few times when we realized we were taking the wrong approach. (writing software for the Raspberry Pi computer board is **not** straight forward when you have minimal experience with it). Now, the hard part is behind us, so we hope the "light at the end of the tunnel" is not a train this time. We **ARE** making progress with some software "tricks" and compromises to be able to get to where we are now.

I will have a working prototype at Hamvention booth 1004 and 1005 to display, same as last year, **but actually working this time.**

Below is a snapshot of the operational description of the unit.

OPERATIONAL DESCRIPTION:

This receiver is designed primarily for digital Amateur Television reception operation as a stand-alone scanning receiver / DATV repeater controller. It can be used as a simple self-contained receiver for individual use or as the receive portion of an Amateur Television repeater. It can be programmed to scan up to 7 separate stored frequency selections from up to 5 selected RF sources.

An "auto scan" mode will be included. If selected, all enabled inputs will be sampled one at a time for a selected duration, then go through the enabled slide show selection before repeating the sequence.

It will receive DVB-S/S2/S2X (250-2150 MHz) and DVB-T/T2 (52-900 MHz) digital television signals from one onboard tuner with 2 separate RF input connections. (An expanded frequency range will be available as soon as the tuner module manufacturer sends me a new tuner chip for it). It will also have PCB pads for the addition of one available optional tuner. The received signal is processed to output composite or HDMI video / audio output signals. When an active signal is not received, it can output up to 7 separate sequential "slide show" identification screens from jpeg, mov or internet sources using internal stored registers or selected Ethernet internet or USB sources.

Setup is accessed using a Windows PC computer interface or Smartphone menu and transferred to the receiver via Bluetooth, WiFi or Ethernet data ports in real time. Ethernet access allows internet parameter selection from a remote repeater installation. All setup parameters are stored and transferred in real time to the VersaTune receiver when the setup screen is exited. VersaTune will use this for all operational parameters.

DiSEqC 1.0 operation is included which allows LNB / preamp voltage of 13V or 18v and 22KHz selection control. It has an active internal current limit circuit to prevent circuit failure due to shorted or overloaded external RF cable circuitry.

HARDWARE:

Enclosure: Enclosure is black ABS plastic approx. 6” deep x 6” wide x 2” high from Hammond. One side is modified to access the Raspberry Pi micro-HDMI ports and composite video/audio jack. Front and rear panels are aluminum. Front panel has power on/off push-push switch, “power on” LED, “Signal Lock” LED and (3) LEDs to represent the binary value of the received channel. Rear panel has a DC connector for +12VDC power from an included separate “wall wart” power supply, (3) available USB ports (port #3 is reserved for internal communication), TTL level I/O via a DB9 connector and (2) RF “F” input connectors for the DVB-S and DVB-T inputs. Circuit pads exist for an optional added tuner.

…WA8RMC

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USA ATV REPEATER DIRECTORY April 2024

NOTES:

1. All repeaters are NTSC, VUSB-TV, 6 MHz channel, unless otherwise noted. Some repeaters use non-standard lower sideband inputs VLSB to reduce interference with FM repeaters in upper portion of band. The frequency listed is the video carrier frequency.
2. Digital TV lists center frequency. 6 MHz channel, unless otherwise noted. dt = DVB-T, ds = DVB-S, da = ATSC
3. For full details, go to the listed web site, or send an e-mail to the contact person
4. Some ATV groups also post repeater info on www.qrz.com under their call sign

Location	Call Sign	Output(s)	Input(s)	Modes	Web Site & Contact for info
ARIZONA					note: AZ is linked to W6ATN in S. CA & NV www.atn-tv.org
Phoenix, White Tank	W7ATN	1253.25	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	wb9kmo@gmail.com kwjacob@icsaero.com
Mesa	W7ATN	421.25 1289.25 dt	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	wb9kmo@gmail.com kwjacob@icsaero.com
Tucson, Mt. Lemmon	W7ATN	1277.25	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	wb9kmo@gmail.com kwjacob@icsaero.com
CALIFORNIA					W6ATN rptrs linked to AZ & NV
Orange Santiago Peak	W6ATN	1253.25 5910 fm	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wa6svt@gmail.com
Los Angeles, central Mt. Wilson	W6ATN	1265.25	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wa6svt@gmail.com
Los Angeles, north Oat Mtn.	W6ATN	919.25 3380 fm	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wa6svt@gmail.com
Jobs Peak	W6ATN	1253.25	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wa6svt@gmail.com
San Bernardino Snow Peak	W6ATN	1242 / 4 dt	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wa6svt@gmail.com
Santa Barbara	WB9KMO	1289.25	434.0 434 / 2 dt 2441.5 fm	VUSB, FM DVB-T	www.atn-tv.org wb9kmo@gmail.com linked with W6ATN
San Diego	KD6ILO	423 dt 1243 dt 1268 ds	441 dt 1286 ds 5885 fm	DVB-T, DVB-S, FM	kd6ilo@yahoo.com also AREDN mesh
San Jose	W6SVA	427.25	910 fm, 1255 fm	VUSB, FM	www.k6ben.com :w2nyc@pacbell.net
Clayton	W6CX	1244.5 ds	1292.5 1273 915 ds 1273 fm	DVB-S, FM	www.mdarc.org info@mdarc.org
Palomar	W6NWG	1241.25	915 fm 2441.5 fm	VUSB, FM DVB-S	w6nwg@palomararc.org mountain.michelle@gmail.com
COLORADO					
Boulder	W0BTV	423 / 6 dt or 421.25 5905 FM	1243 / 6 dt 441 / 6 dt 439.25	DVB-T, VUSB, FM	www.kh6htv.com kh6htv@arrl.net
Pueblo	W0PHC	423 / 6 dt	441 / 6 dt	DVB-T	billn@billnicoll.com www.puebloradio.org
DELAWARE					
Wilmigton	KC3AM	423 / 6 dt	439.25 LSB	DVB-T AM	KC3AM@verizon.net qrz.com
FLORIDA					
Cape Coral	W1RP	421.25	439.25	VUSB	paul@cardlink.com
Cocoa Beach	K4ATV	427.2	439.25	VUSB	www.lisats.org
Panama City	KV4ATV	434.0	919.25	?	kv4atv@gmail.com
S.W. Idaho	WI7ATV	1257 fm	426.25	VUSB, FM	ka7anm@yahoo.com under construction
IOWA					
Davenport	W0BXR	421.25	439.25	VUSB	http://www.arcsupport.com/drac/

Location	Call Sign	Output	Input(s)	Modes	Web Site & Contact for info
KANSAS					
Wichita	KA0TV	421.25	439.25	VUSB	k0wws@arrl.net
KENTUCKY					
Bowling Green	KY4TV	421.25 423.0 /2	439.25 1280 fm	VUSB FM DVB-T	w4htb@ieee.org www.qrz.com www.atn-tv.org
LOUISIANA					
New Orleans	WD0GIV	421.25	439.25	VUSB	wd0giv@att.net
MARYLAND					
Laurel	W3BAB	421.25	434.0	VUSB	www.qsl.net/w3bab
Towson	W3BAB	1291 fm	434	VUSB, FM	www.qsl.net/w3bab
Baltimore	W3WCQ	439.25 911.25	426.25 1253.25	VUSB	http://bratsatv.org/ brats@bratsatv.org
MICHIGAN					
Jackson	KC8LMI	923.25	439.25, LSB	VUSB	KC8LMI@hotmail.com
Grand Rapids	K8DMR	421.25	439.25	VUSB	ron_fredricks@att.net
Flushing	KC8KCG	1253.25	439.25 LSB	AM	kf8ui@mscginc.org
Flint	KC8KGZ	1253.25	439.25	VUSB	www.mscginc.org kf8ui@mscginc.org
MINNESOTA					
Wabasha	KD0HWX	421.25	439.25	VUSB	jonmcpete@yahoo.com
MISSOURI					
St. Louis	W0ATN	426 / 4 dt	440 / 4 dt	DVB-T	k0pfx@arrl.net
NEBRASKA					
Omaha	WB0CMC	421.25	434.0	VUSB	wb0cmc@cox.net
NEVADA					
Las Vegas	N7ZEV	1253.25 912 fm	434.0 434.0 / 2 dt 2441 fm	VUSB FM DVB-T	frank.n7zev@gmail.com linked to W6ATN S. CA & AZ
NEW JERSEY					
Vernon	W2VER	5885 fm	5665 fm	FM	jaythienel@yahoo.com
OHIO					
Columbus	WR8ATV	423 / 2 dt 427.25 1258 fm 1268 ds 2397 mesh 10350 fm	439 / 2 dt 439.25 1288 fm 1288 ds 10450 fm	VUSB AM FM DVB-T DVB-S MESH	www.ATCO.tv gkenmorris@gmail.com towslee1@ee.net
Dayton	W8BI	421.25 428 / 2 dt 1258 fm	439.25 439 / 2 dt 1280 fm 1280 dt	VUSB FM DVB-T	www.w8bi.org dpel@aaahawk.com
Van Wert	W8FY	434.0	923.25	VUSB	ka8zge@w8fy.org
OREGON					
Portland	W7AMQ	1257 fm	426.25	FM VUSB	belles73@comcast.net
Portland	WB2QHS	426.0	910 fm	VUSB FM	emellnik@emavideo.com
PENNSYLVANIA					
Delaware County	KC3AM	421.25	439.25 LSB	VLSB AM	KC3AM@verizon.net
PUERTO RICO					
Aguas Buenas	KP4IA	426.25	439.25 1252 fm	VUSB FM	kp4ia@yahoo.com
WASHINGTON					
Seattle	WW7ATS	1253.25	434.0	VUSB	https://www.qsl.net/ww7ats/ ww7ats@gmail.com qrz.com

Revision Notes:
Aug. 2019 --(1) corrected data for Kentucky (2) changed call sign for Boulder, CO Sept. 2019 - -added Pueblo, CO
Oct. 2019 --added San Diego, CA Feb. 2020 -- changed K6BEN to W6SVA, CA --added KC8KGZ, MI Mar. 2020 -- added Davenport, IA May 2020 -- corrected typos Jan. 2021 -- updated Boulder, CO repeater info June 2021 -- found 20 more ATV repeaters listed on www.repeaterbook.com -- attempted to contact all of their trustees to confirm them. Most are obsolete listings and are no longer on the air. Added only two -- Cocoa Beach, FL, Wichita, KS,
April 2023 – re-configured most listings, added 1280 for W8BI

LOCAL HAMFEST SCHEDULE

This section is reserved for upcoming Hamfests. They are limited to Ohio and vicinity easily accessible in one day. Anyone aware of an event incorrectly or not listed here; notify me so it can be corrected. This list will be amended, as further information becomes available. To see additional details for each Hamfest, Control Click on the blue title and the magic of the Internet will give you the details complete with a map! To search the ARRL Hamfest database for more details, CTL click ARRLWeb: Hamfest and Convention Calendar …WA8RMC.

04/26/2025 Tusco Amateur Radio club 2025 Hamfest, Computer/Electronics Show

Location: Dover, OH
Type: ARRL Hamfest
Sponsor: Tusco Amateur Radio Club
Website: http://www.w8zx.net/hamfest

04/27/2025 - Athens Hamfest

location**:** Athens, OH
Type: ARRL Hamfest
Sponsor: Athens County Amateur Radio Association
Website: https://www.ac-ara.org/

05/10/2025 - 05/15/2025 RV Radio Network Rally

Location: Navarre, OH
Type: ARRL Convention
Sponsor: RV Radio Network

05/15/2025 - 05/18/2025 Four Days In May

Location: Fairborn , OH
Type: ARRL Convention
Sponsor: QRP Amateur Radio Club International
Website: http://qrparci.org/fdim

05/16/2025 - 05/18/2025 Dayton Hamvention

Location: Xenia, Ohio
Type: ARRL Convention
Sponsor: Dayton Amateur Radio Association
Website: https://www.daytonlocal.com

06/07/2025 - FCARC Summer Hamfest

Website: http://w8fy.org
Location: Delta, OH
Type: ARRL Hamfest
Sponsor: Fulton County Amateur Radio Club
Website: https://k8bxq.org/hamfest

07/19/2025 - NOARSfest

Location: Elyria, OH
Type: ARRL Hamfest
Sponsor: Northern Ohio Amateur Radio Society
Website: https://www.noars.net/hamfests/noarsfest/

07/20/2025 - Van Wert Hamfest

Location: **Van Wert, OH**
Type: **ARRL Hamfest**
Sponsor: **Van Wert Amateur Radio Club**

08/09/2025 - Cincinnati Hamfest℠

Location: Owensville, OH
Type: ARRL Hamfest
Sponsor: Milford Amateur Radio Club
Website: https://CincinnatiHamfest.org

WEDNESDAY NITE ZOOM NET

Every Tuesday night @ 8:00 PM WA8RMC **used to** host a net for ATV topic discussion. However, in order to consolidate the two nets, ATCO on Tue. and the DARA on Wed. we'd like to have only one net on Wednesday, same time at 8 PM. We'll rotate the net control host duty so you won't be bored with just me. All are invited as we get check-ins from around USA & sometimes from international participants. Normally there's 12-20 check-ins.

To join ZOOM for the first time, simply type **https://zoom.us/join** then download, install the .exe program and run it. ZOOM will start. Click on **join**, enter the **9670918666 meeting ID** then the **191593 password.** Use video or just audio if you don't have a camera.

ATCO TREASURER REPORT - de N8NT

OPENING BALANCE (01/20/25) ……..……..……$ 4984.48

CLOSING BALANCE (06/20/25)…….... $ 4984.48

ATCO CLUB OFFICERS

President: Art Towslee WA8RMC
V. President: Ken Morris W8RUT
Treasurer: Bob Tournoux N8NT
Corporate trustees: Same as officers
Repeater trustees: Art Towslee WA8RMC
Ken Morris W8RUT
Secretary: Mark Cring N8COO
Newsletter editor: Art Towslee WA8RMC

ATCO MEMBERSHIP INFORMATION

Membership in ATCO (Amateur Television in Central Ohio) is open to any licensed radio amateur who has an interest in amateur television. It is now a free publication so all people on my Email list are automatically either members or guests).

ATCO publishes this Newsletter quarterly in January, April, July and October. It is sent to each member without additional cost. All Newsletters are sent via Email.

Your support of ATCO is welcomed and encouraged.

ATCO REPEATER TECHNICAL DATA SUMMARY

Location: Downtown Columbus, Ohio
Coordinates: 39 degrees 57 minutes 47 seconds (latitude) 82 degrees 59 minutes 58 seconds (longitude)
Elevation: 630 feet above the average street level of 760 feet ASL (1390 feet above sea level)
TV Transmitters: 423.00 MHz DVB-T, 10W FEC=7/8, Guard=1/32, Const=QPSK, FFT=2K, BW=2 MHz, PMT=4095, PCR=256, Vid=256, Aud=257
427.25 MHz Analog VSB AM, 50 watts average 100 watts sync tip (cable channel 58)
1258 MHz 40 watts FM analog
1268 MHz DVB-S QPSK 20W SR=3.125MS, FEC=3/4, PMT=32, Video=162, Teletext=304, PCR=133, Audio=88, Service =5004)
Two video channels on this output: Channel 1 is fed from all receivers. Channel 2 is fed from 439.25 analog receiver.
2397 MHz Mesh Net transceiver 600 mw output (channel 1 minus 2). ID is WR8ATV-2
10.350 GHz: 1W continuous analog FM
Link transmitter: 446.350 MHz: 5W NBFM 5 kHz audio. This output used for control signals & to repeat 147.48 MHz and 449.975 MHz input.
Identification: 423, 427, 1258, 1268 MHz, 10.350 GHz transmitters video ID every 10 min. with active video and information bulletin board every 30 min.
423 MHz digital, 1268 MHz digital & 10.350 GHz analog - Continuous transmission of ATCO & WR8ATV with no input signal present.
Transmit antennas: 423.00 MHz ~~--~~ ~~8 element Lindsay~~Single slot rib cage horizontally polarized ~~53~~ dBd gain "omni"
427.25 MHz - Dual slot horizontally polarized 7 dBd gain "omni" major lobe east/west, 5dBd gain north/south
1258 MHz - Diamond vertically polarized 12 dBd gain omni
1268 MHz - Diamond vertically polarized 12 dBd gain omni
2397 MHz~~————~~ - Ubiquiti dual polarity omni 13dBi gain slot for channel 1 minus 2 MESH Rx/Tx operation
2397 MHz - Comet Model GP24 vertically polarized 12 dBd gain omni (Used for experimental Mesh operation)
10.350 GHz - Commercial 40 slot waveguide horizontally polarized 16 dBd gain omni
Receivers: 147.480 MHz - F1 audio input with touch tone control. (Input here = output on 446.350)
439.000 MHz - DVB-T QPSK, 2MHz BW. Receiver will auto configure for FEC's. (Input here = output on all TV transmitters)
~~-~~439.250 MHz - A5 NTSC video with FM subcarrier audio, Upper sideband. (Input here = output on all TV transmitters & also direct output to 1268 MHz DVB-S~~-~~ output channel 2.)
449.975 MHz - F1 audio input aux touch tone control. 131.8 Hz PL tone. (Input here = output on 446.350).
1288.00 MHz - F5 video analog NTSC. (Input here = output on all TV transmitters)
1288.00 MHz - DVB-S QPSK SR=4.167MS, fec=7/8. PIDs: PMT=133, PCR=33, Vid=33, Aud=49 (In here=out on all Trans.)
10.450 GHz - F5 video analog NTSC. (Input here = output on all TV transmitters)
Receive antennas: 147.480 MHz~~-~~ - Vert. polar. Diamond 6dBd dual band (Shared with 446.350 MHz link output transmitter)
439.00/439.250 MHz - Horizontally polarized dual slot 7 dBd gain major lobe west (Shared with 439 digital & 439.25 analog receivers)
1288.00 MHz - Diamond vertically polarized 12 dBd gain omni (shared with analog and DVB-S receivers)
2398.00 MHz - Comet Model GP24 vertically polarized 12 dBd gain omni (inactive at this time because MESH is on 2397)
10.450 GHz - Commercial 40 slot waveguide horizontally polarized 16 dBd gain omni

Auto mode Input control:	Touch Tone	Result (if third digit is * function turns ON, if it is # function turns OFF)
	00*	turn transmitters **on** (enter manual mode-keeps transmitters on till 00# sequence is pressed)
	00#	turn transmitters **off** (exit manual mode and return to auto scan mode)
	264	Select Channel 4 Doppler radar. (Stays on for 5 minutes) Select # to shut down before timeout.
	004	Select 10.450 GHz receiver. **(Always exit by selecting 001)**
	001	Select 2398 MHz receiver then 00# for auto scan to continue
Manual mode analog) Functions:	00* then 1 for Ch. 1	Select 439.25 analog /43~~8~~9 digital receiver (if video present on digital, it is selected. Otherwise,
	00* then 2 for Ch. 2	Select 1288 digital receiver
	00* then 3 for Ch. 3	Select 1288 analog receiver
	00* then 4 for Ch. 4	Select 2398 receiver
	00* then 5 for Ch. 5	Select video ID (17 identification screens)
	01* or 01#	Channel 1 439.25 MHz analog/439 digital rcvr. scan enable (~~hit~~ 01* to scan this channel & 01# to disable it)
	02* or 02#	Channel 2 1288 MHz digital receiver scan enable
	03* or 03#	Channel 3 1288 MHz analog receiver scan enable
	04* or 04#	Channel 4 2398 MHz scan enable
	A1* or A1#	Manual mode select for 439.25 receiver audio
	A2* or A2#	Manual mode select for 1288 digital receiver audio
	A3* or A3#	Manual mode select for 1288 analog receiver audio
	A4* or A4#	Manual mode select for 2398 receiver audio
	C0* or C0#	Beacon mode – transmit ID for twenty seconds every ten minutes
	C1* or C1#	No function at this time
	C2* or C2#	No function at this time

ATCO Newsletter
c/o Art Towslee -WA8RMC
438 Maplebrooke Dr. West
Westerville, Ohio 43082