February 2025

The Big Island Hamgram

The newsletter of the Big Island Amateur Radio Club

Board elects officers; members treated to user-friendly clinic on decibels

BIARC off and running in the new year

Meeting date change

Due to Super Bowl Sunday falling on our regular meeting day, the next BIARC monthly sessions will take place on Sunday, February 16, at our regular venue: Kamana Senior Center at 127 Kamana St. in Hilo.

The executive board meeting starts at noon (online access link: https://meet.google.com/drq-zprg-fmt).

The regular membership gathering starts at 2 p.m. (online access link: https://meet.google.com/ooq-mmne-ync)

Luke McKay, WH6GRW, will present a program on Meshtastic at the 2 p.m. session.

Meshtastic (tm) is an open-source network application which is built on top of the LoRa protocol (which is itself developed and licensed by Semtech.)

According to the Meshtastic website, meshtastic.org, it is "an open source, off-grid, decentralized, mesh network built to run on affordable, low-power devices." While Meshtastic offers an optional basic encryption-free "Ham" mode, it is primarily designed to run with ISM band restrictions and offering fully encrypted group and station-to-station messaging.

"I will provide a brief introduction to the chirp spread-spectrum modulation of LoRa packets, the modified flood routing algorithm of Meshtastic, some of the various hardware options available, and some potential use cases of this network -- including emergency communications, remote sensing, asset tracking, and others," says Luke. "Demo hardware will be available to connect with the dozens of nodes already online here in Hawaii."

ET's 'easy mode for decibel math'

The January membership program featured "Decibels!" – an homage by William Polhemus, NH6ET, to the concept and history of decibels and their uses and importance to radio communications. For example, in determining signal strength, power ratios, antenna gain and path budgets.

And after working through and demonstrating the various formulaic ways to employ decibels to work for us, NH6ET taught us his "easy mode for decibel math."

If you need a refresher, or missed NH6ET's January presentation the first time around, his slide show is available in pdf format on the club website, biarc.net.

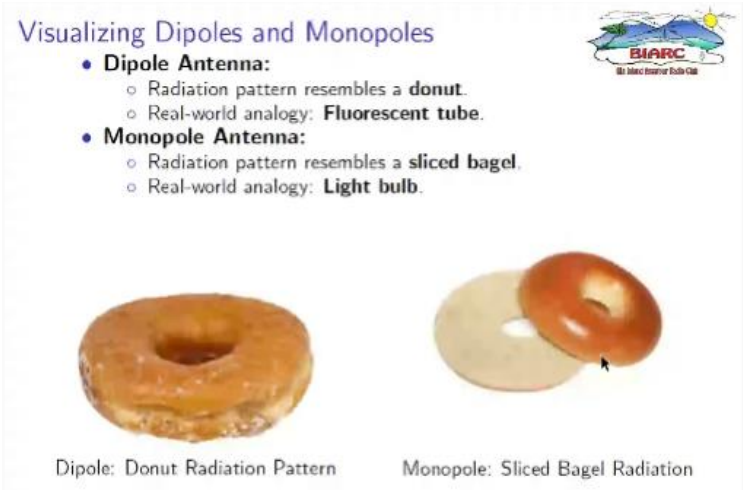
It also is printed, in full, at the end of this newsletter.

Step 1: Start with the Sign
- +: Move the decimal point to the **right**.
- −: Move the decimal point to the **left**.

Step 2: Read the Tens
- Each 10 tells you how many places to move the decimal point.

Step 3: Handle the Ones
- Each +3 dB: Double the value.
- Each −3 dB: Halve the value.
- Each remaining +1 dB: Add 20
- Each remaining −1 dB: Subtract 20

Why It Works:
- It's simple, quick, and close enough for RF work!



Waimea Hamfest is Feb. 15

The Original Big Island of Hawaii International Swap Meet / Hamfest

The Hawaii Island International Hamfest will be held on Saturday, February 15, at the Waimea Community Center, next to the ballfield off Kawaihae Road in Waimea (Kamuela).

There will be a $10 donation per table per seller. There will be a $5 donation per attendee at registration.

One raffle ticket is included with registration. Additional tickets will be available for $1 apiece.

Schedule:

8 am - breakfast at Hawaiian Style Cafe
9 am - vendor setup
9:30 am - Doors open to the public. Be sure to get your raffle tickets for the "Big ticket item"
12:30 pm – Presentation
1 pm - Event ends

Guest Speaker this year: To be determined.

Information:

There will be surprise giveaways throughout the day.

Talk in on 146.940 Maui Repeater, 147.32 Waimea Repeater (tone 100)

This is an event sponsored by the Kohala Hamakua Radio Club (KHRC).

This is an island-wide event, so tell all your radio friends.

For more information, contact Steve Milner – wh6n@arrl.net

Please note: This non-commercial event promotes the trading of equipment and information between hams and the general public and promotes the open exchange of exploring Ham radio as a hobby.

The K7RA Solar Update

Tad Cook, K7RA

ARRL thanks Tad Cook, K7RA, for 34 years of service. Since 1991, Tad has been producing the K7RA Solar Report for the benefit of ARRL members. It has informed our readers and listeners each week of what they can expect from solar conditions. *With Tad's blessing, we are saddened to inform you that he is in the final stages of a valiant fight with ALS.* For many months, he's been working to continue producing the solar report, often from a hospital bed. Tad has let us know that the time has come to for him to stop working on it. Last week's report was his final one. Please join us in sending our best wishes and sincere gratitude to him for his decades of service to ARRL.

In Brief...

President George Washington's 293rd birthday will be celebrated by the Mount Vernon Amateur Radio Club (MVARC), K4US, Alexandria, Virginia, on February 15 , 2025 from 1500Z - 2000Z and on February 16 from 1500Z - 1600Z. Club members will be operating from the Mount Vernon greenhouse on the original grounds of the former plantation of George Washington and his wife, Martha. Frequencies include 7.042, 7.242, 14.042, and 14.242 MHz. QSL cards and additional information are available by contacting the MVARC, P.O. Box 7234, Alexandria, VA 22307. The MVARC is an ARRL Affiliated Club.

KH6GG re-elected president of BIARC Executive Board

Thomas Avila, KH6GG, was re-elected club president at the first BIARC Executive Board meeting of the new year on Jan. 12. Others on the 2025 leadership team are Vice President David Miller, KH6CZ, Secretary Joseph Rosenbaum, WH6JOE, and Treasurer Tony Kitchen, WH6DVI. The seven-member board also includes two at-large directors, Mark Watanabe, WH6FSA, and Shawn Farley, WH6GXZ, and our KH6EJ station trustee, William Polhemus, NH6ET.

Members of the club are encouraged to get involved at a committee level on one or more of the BIARC standing committees. There are many ways to help, and the committee activities vary widely.

As NH6ET noted, the committee level is where things happen. And the committees need "boots on the ground." So, if you see a committee focus that interests you, hop aboard.

Here are the committees:

Public Service/Communications: Chair Les Hittner, K0BAD.

Operating Activities: Chair Joseph Rosenbaum, WH6JOE.

Education and Outreach: Chair David Miller, KH6CZ

Programs: Chair William Polhemus, NH6ET

Digital Systems: Chair Luke McKay, WH6GRW

Voice Repeaters: Chair Trevor Manago, KH6IM

Meeting refreshments: Chair Jim Tatar, WH6EMN

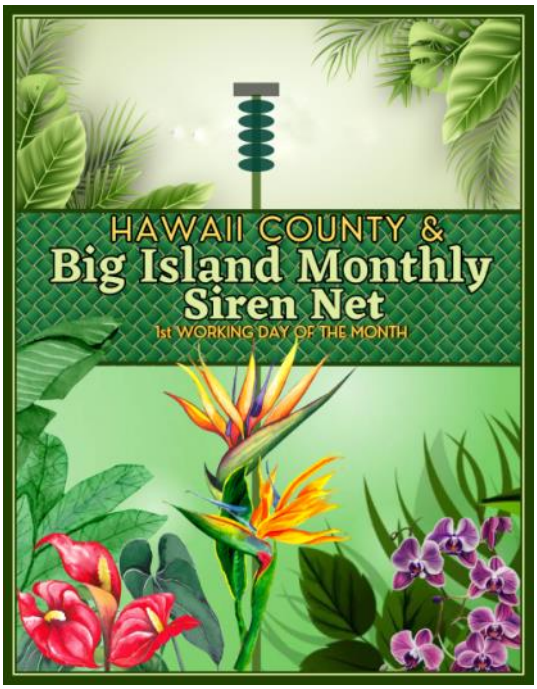
The BIARC board meets at noon on the second Sunday of each month, followed by the 2 p.m. monthly membership program, at Kamana Senior Center in Hilo. All members are welcome at both sessions, and the meetings are accessible live via the Internet. Find the links on our website, biarc.net.

The Monthly Siren Test

February 3, 2025

Courtesy of the Big Island ARES Group

Location	Observer	Mode	Status	Notes
			NOT WORKING	
Ainaloa (HA910)	WH6DVI	Mauna Kea	Not Working	
Keokea Park Kohala (HA 502)	WH7RE	Email	Not Working	
Kehana Beach (HA916)	KH6AQ	Text	Not Working	
			WORKING	
Ainako Park (HA117)	WH6FSA	Allstar	Working	
Banyan / Kam (HA104)	KH6ATU	Allstar	Working	
Captain Cook (HA702)	WH6WF	Text	Working	
Carvalho Park (HA114)	NH6WT	DMR	Working	
Cooper Center Volcano (HA936)	KH7DQ	Mauna Kea	Working	
Downtown Federal Bldg (HA107)	WH6FDE	Email	Working	
Hawaiian Beaches #2 Wela St (HA911)	KH7LM	Mauna Kea	Working	
Hawaiian Beaches Park #1 (HA907)	KH7LM	Mauna Kea	Working	
HOVE Reef Blvd #3 (HA809)	WH6FC	DMR	Working	
HOVE Reef Blvd #3 (HA809)	WH6EPH	DMR	Working	
HPP #1 Paradise / Ala Kai (HA925)	KH6CZ	Mauna Kea	Working	
HPP #2 4th & Awapuhi (HA912)	WH6HAA	Mauna Kea	Working	
HPP #3 6th & Makuu (HA913)	NH6OV	Mauna Kea	Working	
Kaumana Iiwipolena Rd (HA108)	KH7BR	Email	Working	
Kawaihae Harbor (HA407)	WH6EHJ	Mauna Kea	Working	
Kulaimano Ctr Pepeekeo (HA110)	KH6RDO	Allstar	Working	
Laupahoehoe Point (HA202)	WH6FSI	Allstar	Working	
Leilani Estates (HA915)	WH6EXM	Text	Working	
Leleiwi (HA101)	KI6HBZ	Mauna Kea	Working	
Lowe's Store Pepeekeo	KO6QT	Allstar	Working	
Lowe's Store Pepeekeo	KH6RDO	Allstar	Working	
Naalehu (HA801)	WH6HC	DMR	Working	
NELHA Kona (HA611)	WH6GTD	Text	Working	
Old Kona Airport (HA609)	KH7MS	DMR	Working	
Ookala (HA304)	WH6GDC	Allstar	Working	
Paauilo (HA301)	AH6JA	Email	Working	
Pahala (HA804)	WH7BR	Allstar	Working	
Palani / Kuakini Kona (HA601)	NH6SP	Allstar	Working	
Puako General Store #1 (HA405)	WH6EHJ	Mauna Kea	Working	
Waa Waa (HA937)	NH7PE	Text	Working	
Waiaka Bridge Kamuela (HA402)	WH6EHJ	Mauna Kea	Working	
Waikaumalo Park Ninole (HA123)	WH6FIQ	Text	Working	
Waimea Park Kamuela (HA401)	WH6EHJ	Mauna Kea	Working	
Honokaa (HA302)	KH6RF	Mauna Kea	Working	



BIARC Executive Board
Regular Meeting
January 12, 2025
Kamana Senior Center

The meeting was called to order at 12:01 pm by Board President Thomas Avila. A quorum of 6 board members were present.

Attendance:

Board members: Thomas Avila, David Miller, Tony Kitchen, William Polhemus, Mark Watanabe and Joseph Rosenbaum.

Secretary's Report and Minutes:

William moved and David seconded to approve the November 2024 secretary's report. Motion passed.

Treasurer's Report:

See attached. Since December 2024, we have received $733 in dues and donations. Payments are still being processed. Joe moved and Thomas seconded to approve the November 2024 treasurer's report, subject to audit. Motion passed.

At 12:10 pm, William moved and Tony seconded to recess the meeting due to excessive noise. Motion passed. At 12:18 pm Thomas resumed the board meeting. During recess Shawn Farley joined the meeting.

Officers slate:

William moved and Mark seconded to adopt the slate of officers as follows: President: Thomas Avila, Vice-President: David Miller, Treasurer: Tony Kitchen, Secretary: Joseph Rosenbaum, At-Large Directors: Shawn Farley and Mark Watanabe. Motion passed. William Polhemus remains as club trustee.

Committee Reports:

Digital Systems:

Discussion was held regarding the club Discord server. There is a need for an administrator and moderator. A small percentage of the club membership moved over to this platform and some committee members may be out of the loop. Efforts will be made to reach out and see if they still want to be committee members.

. William moved and Joe seconded to to nominate Luke McKay, WH6GRW, as chairperson of the digital systems committee. Motion passed.

Education and Outreach:

See report. Tony moved and William seconded to reaffirm David Miller as chairperson of the education and outreach committee. Motion passed. William moved and Tony seconded to accept the donation of a TV monitor from David KH6CZ and Fred WH6HAA, to be used in ongoing outreach activities. Motion passed.

Operating Activities:

Plans are in the works for two outings, Field Day **(https://www.arrl.org/field-day)** and the CQWW SSB contest **(https://cqww.com/)**

William moved and Thomas seconded to to reaffirm Joe as chairperson of the operating activities committee for 2025. Motion passed.

Programs:

Tony moved and ? seconded to reaffirm William as chairperson of the programs committee. Motion passed. The January 2025 program will be a presentation on decibels and a talk by Tony about the new ARES plan. The February program is to be determined. Discussion was held on upcoming programs, such as how to beat the noise and a club build project.

Continued on next page

BOARD MINUTES: ***From previous page***

Public Service Communications:

William moved and Tony seconded to approve Les as interim chairperson of the public service communications committee.

Voice Repeaters:

Tony moved and David seconded to nominate Trevor KH6IM as chairperson of the voice repeaters committee. Motion passed.

ETC.

- William moved and Tony seconded to table the budget until the February meeting. Motion passed.

William moved and Tony seconded to to renew the club's membership in VOAD Voluntary Organizations Active in Disaster(https://www.nvoad.org/ David donated the membership fee of $25.

- William moved and Joe seconded to reaffirm David Miller as the primary club representative to VOAD and their members, with Tony as alternate representative. Motion passed.
- Shawn left at 1:15 pm.

Discussion was held on committees recruiting new members.

The next meeting will be held on February 16th at the Kamana Senior Center in Hilo.. The Executive Board meeting will be at 12:00 pm and the regular club meeting will be at 2:00 pm.

Respectfully submitted,
Joseph Rosenbaum,
Secretary

Fund Summary:
As of: 11/09/2024

Year	BIARC Equipment Budget	Donations (Credit)	Equipment Purchases & Maintenance Costs	$ Covered By Repeater Fund	Repeater Fund Balance
2017	$600.00	$273.00	$932.75	$332.75	-$59.75
2018	$1,000.00	$235.00	$266.98	$0.00	$175.25
2019	$500.00	$255.00	None	$0.00	$430.25
2020	$500.00	$501.72	$436.78	$0.00	$931.97
2021	$600.00	$1,595.00	$1,548.28	$948.28	$1,578.69
2022	$950.00	$729.00	$0.00		$2,307.69
2023	$950.00	$455.75	$2,626.92	$586.84	$2,176.60
2024		$858.85	$0.00		**$3,035.45**

Notes: This fund holds amounts donated to be used for repeater maintenance & upgrades.

Humanitarian Fund:

Year	$ Donated	Amount Spent	Balance
2022	$395.00	$140.00	$255.00
2023	$158.75	$0.00	$413.75
2024	$53.25	$0.00	$467.00

BIARC Operating Statement

	2024 Budget (Proposed)	Actual*– As of 11/09/24
Income:		
Dues	$1,300.00	$1,642.50
Repeater and general Donations	$400.00	$858.85
Humanitarian Donations	$100.00	$53.25
PayPal Convenience Fees	$26.00	$34.65
Donated Equipment Sold		$210.00
Total Income	**$1,826.00**	**$2,799.25**
Disbursements:		
Club Liability Insurance	$220.00	$200.00
Club Equipment Insurance***	$220.00	$0.00
Equipment	$400.00	$0.00
Club Activities	$400.00	$174.47
P. O. Box Fee	$280.00	$282.00
Humanitarian Awards	$100.00	$0.00
VOAD Dues	$25.00	$25.00
Printing/Publicity	$170.00	$157.82
Office Supplies/Bank Fee/Misc.	$40.00	$3.50
Online Services	$48.00	$131.42
Paypal Transaction Fees**	$13.00	$31.97
Total Expenses	**$1,916.00**	**$1,006.18**
Net (Income - Expenses)		**$1,793.07**

Account Balances:	as of: 11/09/2024
BOH checking Account	$4,084.18
Namecheap Balance (Website)	$1.00
Paypal Account Balance	$1,464.13
Total	**$5,549.31**

Fund Balances: (10/12/2024)	
Infrastructure fund	$3,035.45
Humanitarian Fund	$467.00
Emergency Reserves	$1,000.00
General Fund	$1,046.86
Total Funds	**$5,549.31**

* Income figures show dues and donations received for the 2024 dues year.

** Budget estimate based on 20% Transactions via PayPal, with fees averaging 4.65%

KH6CZ photos show the hard-working club volunteers in action, bringing info on ham radio to the younger generations via community outreach programs.

The E&OC Report January 2025

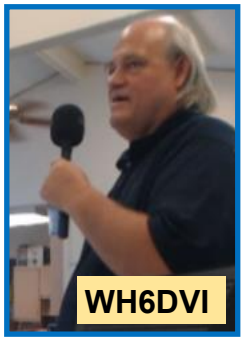
- Education and Outreach Committee
Current Membership
Fred Fischer (WH6HAA), Mark Watanabe (WH6FSA), Jim Tatar (WH6EMN),
Joe Rosenbaum (WH6JOE), Les Hittner (K0BAD), David Miller (KH6CZ)
Recruitment
Open solicitation of new Committee members.
Partnerships
Confirmed Programs for most months of 2025.
- Museum of Science and Technology with Puna Elementary Schools
- YMCA Summer Program
Potential /Planned Programs
Senior Schools in Puna
IEEE Engagement
Volcano Arts and Science
Equipment and Supplies
Donation of Video Monitor and Offboard Speaker to BIARC by Fred, David, and Les.
ARRL/ARES and club materials donated by Tony and Les
Club Banner by Mark for all BIARC and E&OC events.
HF - Club radio (991a) or member rig donated by Mark.
FM, FRS - Member radios (mobile, handi-talkie), battery, and antennas donated for events by Mark, Jim, and David.
Program Content
The "E&OC Voice" was donated primarily by Joe with the able support of the balance of the "E&OC Crew"
Video presentations under development, including apps/programs such as Global Universal Clock, Winlink, etc
- BIARC membership in Hawaii VOAD
Renewal 2025 fee donated on behalf of BIARC by E&OC
BIARC Representative(s)
Tony Kitchen (WH6DVI), David Miller (KH6CZ)

David Miller
KH6CZ
E&OC Chair

The BIARC channel on Youtube is: https://www.youtube.com/@BigIslandAmateurRadio-Club

All hams invited to sign up for Hawaii ARES, a free program with lots of training opportunities

At the BIARC January membership session, Tony Kitchen, WH6DVI, encouraged hams to sign up for ARRL's ARES (Amateur Radio Emergency Service) program.



It is free, and largely a training organization which helps prepare operators to be able to offer assistance, if possible, during times of emergency when traditional communications are down. One example would be helping to send health and welfare messages during an emergency.

Thanks to Joe Tabrah, AH6T for a job well done

Effective Dec 1, 2024 Joe Tabrah, AH6T, has stepped down as the Section Emergency Coordinator (SEC). Kevin Bogan, AH6QO will assume the position of SEC.

Special thanks to Joe for being the ARES manager for this past year.

Joe will stay involved with ARES as an advisor to the management team. Congratulations and thanks to Kevin for stepping up to accept this position. Kevin has extensive experience in emergency communications and is active in several organizations including VOAD and Skywarn where he represents ham radio interests.

Aloha, Alan AD6E / KH6TU
ARRL Pacific Section Manager

https://hawaiiares.net/
look under **Hawaii ARES Database** to join this free network of amateur radio operators. Lots of training and many opportunities for community service are available.

The Amateur Radio Emergency Service (ARES) is made up of Amateur Radio operators, who register their equipment and qualifications with ARES. These operators provide volunteer communications services in times of disaster or civil emergency.

The ARES national organization is comprised of smaller regional organizations, each being within an ARRL Section. This web page serves the Hawaii Section, covering the entire state of Hawaii, managed by the Hawaii ARRL Section Emergency Coordinator (SEC). Hawaii ARES is segmented into four counties, which are aligned with Hawaii Bureau of Homeland Security Regions. Each county is organized into districts, each having an assigned District Emergency Coordinator DEC) or Emergency Coordinator (EC).

What: Ham Radio Open House for World Amateur Radio Day 2025
Who: All amateur radio operators worldwide
When: WARD is Friday, April 18, 2025, at 0000 UTC until Saturday, April 19, 2025 at 0000 UTC but the Ham Radio Open House can be held any time in April, as works best for your local club.
Where: A global event covering all regions of the International Amateur Radio Union (IARU)
Why: World Amateur Radio Day, held on April 18 each year, is celebrated worldwide by radio amateurs and their national associations which are organized as member-societies of the International Amateur Radio Union (IARU). It was on this day in 1925 that the IARU was formed in Paris. American Radio Relay League (ARRL) Co-Founder Hiram Percy Maxim was its first president. A major theme for 2025 is celebrating 100 years of IARU.
How:
Get Ready for "Ham Radio Open House" for World Amateur Radio Day 2025
To help promote amateur radio science and technology, and to honor the 100th anniversary of the International Amateur Radio Union (IARU), ARRL is inviting radio clubs and schools to organize a Ham Radio Open House in April, centered around World Amateur Radio Day on April 18, 2025. The event is intended to highlight the Amateur Radio Service for its development and practice of the latest radio communications and technology, and as a hands-on pathway into science, technology, engineering, and mathematics (STEM) fields for the next generation. In April 2025, amateur radio clubs, school stations, and other groups will have the opportunity to advance public knowledge about ham radio by welcoming their communities into their stations for the Ham Radio Open House, around World Amateur Radio Day. The focus will be on scientific advancement and demonstrating cutting-edge technology. This is a chance to not only shape the conversation about modern ham radio but also to show how it serves as a steppingstone and testbed for many young people pursuing future STEM education and high-tech careers.

Shanghai Coast Radio Station XSG will host a global amateur radio special event on February 12 – 13, 2025. The station will celebrate its 120th anniversary and World Radio Day from 00:00 UTC on February 12 to 24:00 UTC on February 13. All contacts with XSG will be cross-band contacts in Morse code and XSG will operate on its authorized frequencies outside of the amateur radio bands. Amateur radio operators making contact will operate within their own allocated amateur frequencies. XSG transmission frequencies are 4105, 6780, 8502, and 12871.5 kHz. XSG receive frequencies are 3521.3 – 3526.3, 7021.3 – 7026.3, 10121.3 – 10126.3, 14021.3 – 14026.3, and 21021.3 – 21026.3 kHz. For more information email: hadt@shhadt.com.

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FCC upholds record $34,000 forfeiture against amateur licensee

The Federal Communications Commission (FCC) assessed a record $34,000 forfeiture against an amateur radio licensee for “willfully and repeatedly operating a radio station without authorization and interfering with the radio communications of the United States Forest Service … while the U.S. Forest Service and the Idaho Department of Lands were attempting to direct the operations of fire suppression aircraft working a 1,000-acre wildfire on national forest land outside of Elk River, Idaho.

As ARRL News first reported in 2022, the FCC proposed the fine against Jason Frawley of Lewiston, Idaho, for allegedly interfering with radio operations of the U.S. Forest Service during firefighting activities for the Johnson Creek Fire near Elk River in July 2021.

The FCC stated in the Notice of Apparent Liability (NAL) that Frawley holds an Extra-class Amateur Radio Service license, WA7CQ, and is the owner/operator of Leader Communications LLC, licensee of eight microwave licenses and one business license.

In response, Frawley acknowledged that he operated on a frequency reserved for government use and for which he lacked authorization but argues that he did not cause interference to the government’s fire suppression activities that were being coordinated on the channel and acted with “good faith and non-malicious intent to help.”

Frawley requested a reduction or cancellation of the proposed forfeiture based on the number and duration of the unauthorized transmissions, his history of compliance and corrective measures, and his inability to pay the proposed forfeiture.

In the Forfeiture Order released on January 3, 2025, the FCC rejected Frawley’s request and assessed the full proposed forfeiture of $34,000.

In Brief...

Radio Club Limburg, the North Limburg region, The Netherlands, will activate special event station PA8ØOV to commemorate Operation Veritable and celebrate 80 years of freedom after World War II. Operation Veritable in early 1945 cleared the way for Allied troops to cross the Rhine River and begin to move into Germany. PA8ØOV will be on the air February 14 - 16, 2025. All amateur radio operators are invited to make contact. For information about times and frequencies visit rclb.nl/pa80ov.

The Northern Arizona DX Association is hosting the annual W7P Pluto Discovery Anniversary special event February 15 – 24, 2025, and the organizers need amateur radio operators to help. The event is a tribute to Pluto's discovery in 1930 by Clyde Tombaugh, with members transmitting from their home QTHs. Special guest operator Doug Tombaugh, N3PDT, Clyde’s nephew, will join from Kansas City as W7P/Ø. Operators at the Lowell Observatory will work from a heated trailer just outside of the new $53 million Marley Astronomy Discovery Center using a Kenwood TS590SG for SSB, an Elecraft K3 for CW/SSB/Digital, and a Yaesu FT991 for FT-8 or FT-4 modes. Operators are also welcome to bring their own radios. This year’s event also celebrates the 10th anniversary of the New Horizons spacecraft's flyby of Pluto, featuring insights on the radio equipment that sent signals back to Earth. For more details, visit www.nadxa.com or contact Bob Wertz, NF7E, via email at Bob6315@earthlink.net.

Decibels!

Big Island Amateur Radio Club

Decibels!

Decibels!

Decibels!

Objectives

- Introduce the concept and history of decibels (dB).
- Explain their uses and importance in radio communication.
- Cover practical applications, including:
  - Signal strength
  - Power ratios
  - Antenna gain
  - Path budgets
- Explore common "flavours" of decibels:
  - dBm
  - dBmv
  - dBi
  - dBd
  - dBc
  - dBfs
- Provide real-world examples.

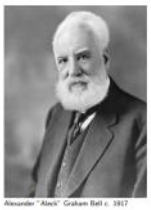
What is a Decibel?

- A unit to compare two values, such as power or intensity.
- Simplifies working with very large or very small ratios.
- Developed at Bell Labs in the 1920s, named after Alexander Graham Bell.
  - The "Bel" was introduced by engineers at Bell Labs in the 1920s as a logarithmic measure of power loss.
    - Based on a single-wire, ground-return telephone system's signal loss over 1 mile.
  - The Bel proved too large a unit for practical use, so they adopted the "decibel" (1/10th of a Bel).
    - Engineers do it in metric. "Deci" means one tenth.

Bell Laboratories

Why Do We Need Decibels?

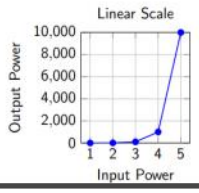
- Makes large ratios easier to express.
  - To make big and small numbers easier to compare.
- Helps compare signal strength, gain, and losses, all using the same unit.
- Essential for RF work, including antenna theory, radio design, and troubleshooting.

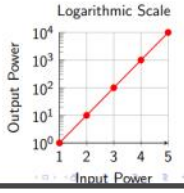


Alexander "Alec" Graham Bell c. 1917

Decibels: Simplifying Large Ratios

- A logarithm tells you how many times to multiply a number by itself.
  - Example:
    $$\log_{10}(100) = 2 \quad \text{because} \quad 10 \times 10 = 100$$
- Why use logarithms?
  - Example: How many watts of drive does Roy need for his surplus broadcast amplifier to output exactly the legal limit?





Large Ratios in RF Power

- **Why Handling Large Ratios Matters:**
  - RF power spans a huge range, from strong transmit signals to extremely weak received signals.
  - Linear scales (e.g., watts) make it difficult to compare values.
  - Logarithmic scales (e.g., dBm) simplify the comparison.

Watts Scale

- **Legal Limit**: 1500 watts
- **Weak Signal**: 0.00000000000001 watts
- **Ratio**:
$$\frac{15}{0.00000000000001}$$
- **Difference**: 1.5×10^{17}

dBm Scale

- **Legal Limit**: 61.671 dBm
- **Weak Signal**: −120 dBm
- **Ratio**:
$$\frac{61.671}{-120}$$
- **Difference**: 181.671

Why Use Decibels in RF?

- **Simplifies Calculations:**
  - Gains and losses in RF systems are often multiplicative.
  - Decibels turn these into simple addition/subtraction.
- **Practical Examples:**
  - **Signal Strength:**
    - Received Signal Level (RSL): −120 dBm
    - Transmit Power: 61.671 dBm
  - **Antenna Gain:**
    - Adding gain: +15 dBi
  - **Cable Loss:**
    - Subtracting loss: −3 dB
- **Why It's Useful:**
  - Makes large ranges easier to compare.
  - Turns complex multiplications/divisions into simple addition/subtraction.

Why Logarithms for Power?

- **Historical Context:**
  - The Bel was developed at Bell Labs in the 1920s to quantify power loss in telephone lines.
  - Early systems used a single-wire ground-return configuration.
  - Observation: A power loss over 1 mile was roughly an **order of magnitude** (10 : 1).
- **Evolution to Decibels:**
  - 1 Bel = 10 : 1 ratio = one order of magnitude = 10 dB.
  - $10 \cdot \log_{10}$ naturally aligns to orders of magnitude in our ten finger based decimal number system.
  - Decibel (dB) became standard for practical use.

Calculating Decibels

- **Decibel Formula:**
  - Power (dB):
$$P_{\text{dB}} = 10 \cdot \log_{10}\left(\frac{P_1}{P_2}\right)$$
  - Voltage (dB):
$$V_{\text{dB}} = 20 \cdot \log_{10}\left(\frac{V_1}{V_2}\right)$$
- **Key Concepts:**
  - Power ratios: $10 \cdot \log_{10}$. Because we are working with 1/10th steps of a Bel.
  - Voltage ratios: $20 \cdot \log_{10}$, because of its squared relationship to the power.
- **Examples:**
  - Power:
$$10 \cdot \log_{10}(1500) \approx 31.76\,\text{dB}.$$
  - Voltage:
$$20 \cdot \log_{10}(10) = 20\,\text{dB}.$$

Decibel Rules of Thumb

- **Simple Decibel Rules:**
  - Doubling power adds +3 dB
  - Halving power subtracts −3 dB
  - 10 × power = +10 dB.
- **Practical Examples:**
  - 100 watts → 200 watts : +3 dB.
  - 100 watts → 50 watts : −3 dB.
  - 100 watts → 1000 watts : +10 dB.
- **Why It Matters:**
  - Simplifies power calculations in RF systems.
  - Saves time during design and troubleshooting.

Understanding Relative dB Units

- **What Are Relative dB Units?**
  - dB is a **relative measurement**: compares two quantities to a reference.
  - Examples: Power, voltage, gain, signal strength.
- **Common Relative dB Units:**
  - **dBm**: Power relative to 1 mW.
$$P_{\text{dBm}} = 10 \cdot \log_{10}\left(\frac{P}{1\,\text{mW}}\right)$$
  - **dBi**: Antenna gain relative to an isotropic radiator.
  - **dBd**: Antenna gain relative to a dipole.
  - **dBc**: Relative to carrier power (e.g., spurious emissions, sideband noise).
  - **dBmV**: Voltage relative to 1 mV.
  - **dBFS**: Relative to **full scale**, used in digital systems.
- **Why Use Relative dB Units?**
  - Simplifies comparisons over large ranges.
  - If we choose the right ones, we can do apples to apples math. For instance, dBm and dBi to get EIRP.

Antenna Gain: Focused Power

- **What is Antenna Gain?**
  - Gain measures how well an antenna focuses energy in a specific direction.
  - Relative to:
    - *dBi*: Isotropic radiator.
    - *dBd*: Dipole antenna (0 dBd = 2.15 dBi).
- **Why It's Important:**
  - Higher gain improves signal strength by focusing energy.
  - Example: Yagi antenna vs. dipole.
- **Quick Tips:**
  - Gain in *dBi* = Gain in *dBd* + 2.15
  - Antenna salesmen will use dBi because the number is bigger and more inticing.

What is an Isotropic Radiator?

- **Definition:**
  - A **theoretical antenna** that radiates power equally in all directions (a perfect sphere).
  - Serves as a **reference** for measuring antenna gain in dBi.
- **Why Is It Important?**
  - Provides a standard reference for antenna performance.
  - Gain in dBi: Compares how well an antenna focuses energy versus isotropic radiation.
- **Characteristics:**
  - Perfect spherical radiation pattern.
  - Impossible to construct physically, but useful for calculations.
- **Real-World Analogy:**
  - A **flare in the sky** radiates light uniformly in all directions, similar to an isotropic source.
  - A star, like our **sun**.

Dipoles and Monopoles: Directional Radiation and Gain

- **Dipoles and Monopoles:**
  - **Dipole Antenna:** Two poles radiating energy in a **donut-shaped pattern**.
    - Real-world analogy: **Fluorescent tube**. The electrode caps create a null at each end.
  - **Monopole Antenna:** Single pole radiating energy in a **pattern akin to a sliced bagel**.
    - Real-world analogy: **Light bulb**. The base creates a null.
- **Radiation Patterns:**
  - Energy is concentrated in specific directions, by taking it from other directions, creating **nulls** where little or no radiation occurs.
- **Thermodynamics and Gain:**
  - Energy isn't "lost" in the nulls; it is **redirected** to focus more power in specific directions.
  - This directional focus creates **gain**:
    Gain = power density compared to an isotropic radiator.
- **Why It Matters:** Higher gain antennas focus more energy in desired directions, improving efficiency and range.

Visualizing Dipoles and Monopoles

- **Dipole Antenna:**
  - Radiation pattern resembles a **donut**.
  - Real-world analogy: **Fluorescent tube**.
- **Monopole Antenna:**
  - Radiation pattern resembles a **sliced bagel**.
  - Real-world analogy: **Light bulb**.

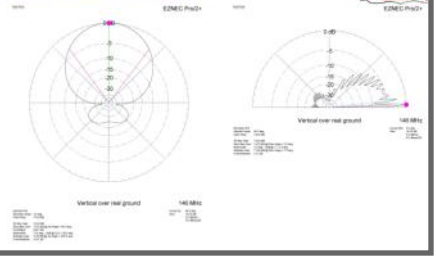
Dipole: Donut Radiation Pattern

Monopole: Sliced Bagel Radiation

Understanding Antenna Front-to-Back Ratios

- **What is the Front-to-Back Ratio (F/B)?**
  - A measure of an antenna's ability to focus energy in the desired direction (front) while minimizing radiation in the opposite direction (back).
- **Expressed as:**
$$\text{F/B Ratio (dB)} = 10 \cdot \log_{10}\left(\frac{\text{Power (front)}}{\text{Power (back)}}\right)$$
- **Typical Values:**
  - Omni-directional antennas: 0 dB (equal radiation in all directions).
  - Yagi antennas: 10 – 20 dB (good rejection of rear signals).
  - High-gain directional antennas: 30 + dB (excellent rejection).
- **Why It Matters:**
  - Reduces interference from signals behind the antenna.
  - Improves reception of weak signals in the desired direction.
  - Essential for reducing noise and increasing signal-to-noise ratio (SNR).

Antenna Radiation Patterns



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WHAT'S IN A DECIBEL?

From previous page

Other Types of Gain: Amplifiers and LNAs

- **What is Gain?**
  - Gain increases the power or amplitude of a signal.
  - Measured in **positive dB** (e.g., +10 dB).
- **Common Types of Amplifiers:**
  - **Power Amplifiers (PAs):**
    - Boost the transmitted signal to a higher power level.
    - Example: 5 W → 100 W = +13 dB.
  - **Preamplifiers (Preamps):**
    - Boost weak signals before processing.
    - Example: Amplifying a faint RF signal for better reception.
  - **Low Noise Amplifiers (LNAs):**
    - Amplify weak signals while adding minimal noise.
    - Critical for satellite and weak-signal communications.
- **Why Gain Matters:**
  - Improves **signal-to-noise ratio (SNR)**:
    - Makes weak signals easier to detect and process.
  - Enables communication over longer distances.
- **Quick Tip:**

$$\text{Total Gain (dB)} = G_{PA} + G_{Preamp} - L_{Cable} - L_{Connectors}$$

S-Units vs. Decibels: A Historical Perspective

- **S-Units: The Early Days**
  - Developed as a **qualitative system** for radio operators to describe signal strength.
  - Pre-dates the formal adoption of decibels in radio communications, as a **quantitative system** of signal strength.
  - Original S-meters provided **approximate** signal strength readings without standardization.
- **The Hybrid System**
  - Decibels were incorporated into S-unit scales to **standardize** measurements.
  - Modern S-meters use:
    - **S1 to S9:** Approximately **6 dB per S-unit**.
    - **Above S9:** Signal strength expressed directly in decibels (e.g., S9+10 dB).

Comparing Antenna and Cable Configurations

Dipole with 100' RG-58

- **Transceiver Power:** 100 W (50 dBm)
- **Amplifier Gain:** +10 dB
- **Antenna Gain:** 2.15 dBi
- **Cable Loss:** −5.5 dB
- **EIRP:** 56.65 dBm

Performance:

- Amplifier mitigates cable loss, but overall efficiency is limited.
- Poor cable reduces usable power for both transmit and receive.

Yagi with 50' LMR-400

- **Transceiver Power:** 100 W (50 dBm)
- **Antenna Gain:** 7.5 dBi
- **Cable Loss:** −0.75 dB
- **EIRP:** 56.75 dBm

Performance:

- Yagi's gain improves both transmit range and received signal clarity.
- Lower cable loss ensures efficient power use and better SNR on reception.

Understanding Losses in RF Systems

- **What is Loss?**
  - Loss occurs when power is **dissipated or absorbed** rather than transmitted.
  - Measured in **negative dB** (e.g., −3 dB).
- **Common Types of Loss:**
  - **Cable Loss:**
    - Power dissipated as heat due to resistance in coaxial cables.
    - Increases with the length of the cable and the frequency of the signal.
    - Example: 100 ft of no name RG-8X at 144 MHz: −4.5 dB
  - **Connector Loss:** Each connector introduces a small loss (usually < -0.2 dB).
  - **Atmospheric Loss:** Absorption of RF energy by the atmosphere, more significant at higher frequencies.
  - **Filters:** Duplexers and other filters can ass significant loss (sometimes > 3 dB.)
  - **Obstruction Loss:** Loss due to objects (e.g., buildings, trees, a Puu) blocking the signal. This can include the curvature of the earth!

Path Loss and Decibels

- **Free Space Path Loss Formula:**

$$L = 20 \cdot \log_{10}(d) + 20 \cdot \log_{10}(f) + 20 \cdot \log_{10}\left(\frac{4\pi}{c}\right)$$

  - d: Distance (meters).
  - f: Frequency (Hz).
  - c: Speed of light (3×10^8 m/s).
- **Key Insights:**
  - Path loss increases with **distance** (d).
  - Path loss increases with **frequency** (f).
- **Practical Implication:**
  - Higher frequencies and longer distances mean higher losses.
  - Highlights the importance of high power, efficient antennas, and optimized frequencies.
- **Quick Example:**
  - $f = 2.4$ GHz, $d = 1$ km:

$$L = 20 \cdot \log_{10}(1000) + 20 \cdot \log_{10}(2.4 \times 10^9) - 147.55$$

  - Approximate loss: 100.04 dB.

Putting It All Together: A Path Budget

- **What is a Path Budget?**
  - Combines **gains** and **losses** from transmitter to receiver.
- **Key Formula:**

Received Power (dBm) = Transmitter Power (dBm)+Gains (dB)−L

- **Example:**
  - **Transmitter Power:** 5 W (37 dBm).
  - **Amplifier Gain:** +10 dB.
  - **Cable Loss (Tx Side):** −5.5 dB.
  - **Free Space Path Loss (100 km at 144 MHz):** −115.61 dB.
  - **Cable Loss (Rx Side):** −0.75 dB.
  - **Antenna Gain (Rx):** +7 dBi.

Decibels and Signal Strength

- **What is Signal Strength?**
  - Signal strength is the power level of a received signal, typically measured in **dBm**.
- **S-Meter Scale (Typical):**
  - S1 : Weak signal (−121 dBm).
  - S9 : Strong signal (−73 dBm).
- **Rule of Thumb:**
  - +6 dB: Corresponds to **1 S-unit increase**.
  - **Example:** Going from S7 to S9 adds 12 dB of signal strength.
- **Why It Matters:**
  - Helps quantify signal quality and communication effectiveness.
  - Guides antenna rotation, helps assess the noise level at Gary's house.

Maxwell's Equations and Path Loss

- **Wave Propagation:**
  - Maxwell's equations govern how electromagnetic waves propagate:
    - Changing magnetic fields create electric fields (**Faraday's Law**).
    - Changing electric fields and currents create magnetic fields (**Ampère's Law**).
- **Inverse Square Law:**
  - Radiated energy spreads spherically.
  - Intensity decreases with distance: Power Density $\propto \frac{1}{d^2}$
- **Why It Matters:**
  - Path loss arises from these fundamental principles:
    - Greater distances = weaker signals.
    - Higher frequencies = more loss.
- **Quick tip:** Double the distance = four times the loss (-6dB).

Path Budget: Calculation and Outcome

- **Path Budget Calculation:**

Received Power (dBm) = 37+10−5.5+2.15−115.61−0.75+7

Received Power = −65.71 dBm

- **Outcome:**
  - The received signal (−65.71 dBm) is **well above typical 2-meter receiver sensitivity** (−120 dBm).
- **Fade Margin:**
  - **What is it?**
    - Additional signal strength above the receiver's sensitivity needed to account for signal fading due to environmental factors.
    - Typical fade margin values range from 10 dB (clear line of sight) to 20 dB (urban or obstructed paths).
  - **This Example:**
    - Received power (−65.71 dBm) provides a fade margin of approximately 54.29 dB.

Path Budget Example: Radio Mobile

Mauna Loa to NH6ET			
Old Mauna Loa Tower (1)		(2) NH6ET QTH	
Latitude	19.585412 °	Latitude	19.543596 °
Longitude	-155.450067 °	Longitude	-154.872111 °
Ground elevation	2491.2 m	Ground elevation	37.0 m
Antenna height	8.0 m	Antenna height	8.0 m
Azimuth	94.29 TN | 84.53 MG °	Azimuth	274.49 TN | 264.70 MG °
Tilt	-2.59 °	Tilt	2.04 °
Radio system			**Propagation**
TX power	28.00 dBm	Free space loss	143.46 dB
TX line loss	0.30 dB	Obstruction loss	0.67 dB
TX antenna gain	25.00 dBi	Forest loss	0.00 dB
RX antenna gain	25.00 dBi	Urban loss	1.00 dB
RX line loss	0.60 dB	Statistical loss	19.44 dB
RX sensitivity	-90.00 dBm	Total path loss	164.57 dB
Performance			
Distance			**60.734 km**
Precision			30.4 m
Frequency			5875.000 MHz
Equivalent Isotropically Radiated Power			186.221 W
System gain			167.10 dB
Required reliability			94.000 %
Received Signal			-87.47 dBm
Received Signal			9.47 µV
Fade Margin			**2.53 dB**

ET's Easy Mode for Decibel Math

- **Step 1: Start with the Sign**
  - +: Move the decimal point to the **right**.
  - −: Move the decimal point to the **left**.
- **Step 2: Read the Tens**
  - Each 10 tells you how many places to move the decimal point.
- **Step 3: Handle the Ones**
  - Each +3 dB: Double the value.
  - Each −3 dB: Halve the value.
  - Each remaining +1 dB: Add 20
  - Each remaining −1 dB: Subtract 20
- **Why It Works:**
  - It's simple, quick, and close enough for RF work!

ET's easy mode

Calculating Power in Watts: 27 dBm

- **Step 1: Recall the Formula**

$$P_{watts} = 10^{\frac{P_{dBm}-30}{10}}$$

- **Step 2: Plug in 27 dBm**

$$P_{watts} = 10^{\frac{27-30}{10}}$$

- **Step 3: Simplify the Exponent**

$$P_{watts} = 10^{\frac{-3}{10}} = 10^{-0.3}$$

- **Step 4: Approximate the Value**

$$P_{watts} \approx 0.501\,\text{W}$$

- **Result:**
  - 27 dBm ≈ 0.501 W
  - Half a watt is a common power level for low-power transmitters!

Calculating Power in Watts: 27 dBm (ET's Easy Mode)

- Start with the sign: + means we're moving the decimal point to the **right**.
- Break it down:
  - Start with 1mw - because it's dBm, or dB relative to one milliwatt
  - 20 dBm = 0.1 W (move the decimal two places to the right).
  - Add +3 dB: Double it → 0.2 W.
  - Add another +3 dB: Double it again → 0.4 W.
  - Add the final +1 dB: Add 20% → 0.4 + 0.08 = 0.48 W.
- Result: 27 dBm ≈ 0.48 W
- Close enough for RF work!