DC to AC Across the Spectrum

Power Inverters, Ham Radio Transmitters, Audio, Light & Beyond

A Unified Guide to Frequencies, Terminology, Interference & Relationships — From Sub-Hertz to Daylight

Why This Guide Exists — The Spark of Curiosity

If you've ever looked at a 12-volt battery powering a coffee maker through an inverter and then at the transmitter in your ham radio (an IC-705, FT-891, or similar) and thought, *"Both of these are doing DC to AC conversion… how are they related?"* — this document is for you. That simple observation is the seed of this entire exploration. A power inverter takes DC from a battery and creates 60 Hz AC to run household loads. A ham radio transmitter takes DC from the same kind of battery (or power supply) and creates precisely controlled, modulated AC at millions of cycles per second to carry your voice or data across the planet. Both are fundamentally "DC to AC" processes, yet they live in completely different engineering worlds.

This naturally leads to deeper questions: At what point does the terminology change from "inverter" to "RF power amplifier"? How do these different frequency regimes interact and interfere with each other in the real world? What other devices and natural phenomena convert or generate AC across the spectrum — from car alternators to dog whistles to the light from the sun? And in an infinite universe, is there any true upper or lower bound to frequency or oscillation? **The purpose of this guide** is to provide a single, clear map of the frequency spectrum that answers these questions. It is designed for ham radio operators, engineers, makers, and curious minds who want to understand:

- Where terminology shifts and why (power engineering vs. RF vs. photonics vs. acoustics)
- How different bands can interfere with or interact with each other in the real world (60 Hz hum in audio, inverter hash on HF bands, audio modulating RF carriers, ultrasonic devices affecting animals)
- The continuity of vibration and energy from the slowest waves to visible light ("DC to daylight")
- Practical implications for troubleshooting, system design, and appreciating how the universe organizes energy

Whether you're trying to eliminate RFI from a power inverter in your shack, understand why your mobile ham setup picks up alternator whine, or simply pondering the infinite spectrum on SolveTheUniverse.com, this chart gives you a unified framework — both a practical reference and a reminder that everything — power, sound, radio, light, and even spacetime itself — is connected through frequency and oscillation.

AC Generators & AC-AC Converters — The Other Side of Line-Frequency Power

In addition to DC-to-AC inverters, humanity produces and transforms AC power through **AC Generators (Alternators, Gensets)** and **AC-AC Converters** / **Frequency Changers**. These sit alongside the 50/60 Hz power-inverter rows in the spectrum below and are a major source of harmonics and conducted emissions that interfere with sensitive electronics and radios — understanding where each process lives on the spectrum helps predict, diagnose, and mitigate these interactions.

Utility-scale generators (large synchronous generators at power plants, and many wind turbines) convert mechanical rotation directly into AC via electromagnetic induction and feed it straight to the grid at grid frequency — genuinely no DC stage involved. **Vehicle alternators** are a real, common exception worth being precise about: they do generate three-phase AC internally via electromagnetic induction, but that AC never actually leaves the unit — it's immediately rectified to DC by a built-in diode bridge before reaching the battery or the vehicle's DC electrical system, because a vehicle's electrical system runs on DC. *(Corrected from an earlier draft, which described all "traditional alternators" as having no DC stage at all — true for utility generators, but not for vehicle alternators specifically.)* Modern variable-speed wind turbines often add their own power electronics with a DC link for grid synchronization, unlike simpler fixed-speed designs. Separately, modern "inverter generators" (portable gensets) deliberately rectify to DC and then re-invert, specifically for cleaner, more stable output. **AC-AC converters** (cycloconverters, matrix converters) transform fixed AC mains into a different frequency or voltage directly, with no DC link at all. They collectively explain real-world interference like alternator whine in mobile HF setups and harmonics from variable-frequency drives.

Interference & Relationships — Why the Full Map Matters

One of the main reasons for mapping the full spectrum is to understand how different frequency regimes **interfere with or interact with each other** in real life:

- 60 Hz power-line hum in audio equipment and phone lines
- Inverter hash / RFI from switch-mode supplies appearing as broadband noise across HF ham bands (very common for portable/POTA operators)
- Alternator whine in mobile HF radio setups
- Your voice (80 Hz–8 kHz audio) modulating a much higher RF carrier in your transceiver
- Ultrasonic dog repellers affecting pets while silent to humans
- Harmonics from nonlinear devices landing in other bands

Understanding where each process lives on the spectrum helps predict, diagnose, and mitigate these interactions — whether you're designing a clean shack power system or trying to hear a weak DX station through the noise.

DC-to-AC Conversion Comparison

Power Inverters, Signal Generators, Acoustic Waves & the Full Electromagnetic Spectrum — Sorted from Lowest to Highest Frequency

Both a DC-to-AC power inverter and a signal generator convert direct current into alternating current. However, they operate in fundamentally different engineering domains. Power inverters deliver significant real power to loads (appliances, tools, motors) and are optimized around utility frequencies (50/60 Hz). Signal generators are precision test instruments that produce low-power, highly controllable waveforms across a wide frequency range. This document expands the comparison to include **acoustic phenomena** (human voice, audio amplifiers/speakers, infrasound, ultrasonics including dog whistles), **biological oscillations**, the full electromagnetic spectrum up to visible light ("DC to daylight"), and even **gravitational waves** — providing a complete picture of frequency and terminology across domains. Theoretical baseline: 12 V DC at 20 A (240 W input).

Baseline Input & Key Calculations

DC Input: 12 V × 20 A = **240 W** available
Realistic inverter efficiency ~90% → **~216 W AC** output available (good pure-sine units: 85–95%)
At 120 V RMS: ~1.8 A RMS (sine-wave peak voltage ~170 V) | At 230 V RMS: ~0.94 A RMS

Frequency Spectrum — From Infrasound to Visible Light (and Beyond)

Frequency	Terminology	Output Characteristics	Power Level	Notes on Terminology & Design
< 20 Hz (down to ~0.001 Hz)	Infrasound (Acoustic Pressure Waves)	Mechanical sound pressure waves in air, ground, or water. Felt as vibration at high intensity.	Varies widely (natural: very low; industrial: high)	Natural phenomena: earthquakes, volcanoes, elephants, whales, wind turbines, atmospheric events. Sonic booms and large explosions produce intense broadband shock waves whose dominant energy often peaks in the 1–200 Hz range — the shock's own broadband energy extends up into the audible range even though the classification "infrasound" strictly means below 20 Hz. Overlaps Schumann frequencies but is **acoustic/mechanical**, not electromagnetic. Can cause unease or physical effects at sufficient intensity.
0.01 Hz – ~10 Hz (extends to 200 kHz)	Low-Frequency / Schumann Resonance Signal Generator	Clean sine wave, adjustable amplitude (typically line-level or low-power audio drive)	Very Low (mW range)	Consumer and lab devices for Schumann resonance experiments (~7.83 Hz fundamental — the real, measured resonance of the Earth-ionosphere cavity), relaxation, grounding, or general low-frequency signal generation. These produce **electrical EM** signals, not acoustic sound pressure.
0–400 Hz (variable)	Variable Frequency Drive	Variable voltage/frequency AC to control motor speed	High (motor-rated, kW scale)	Industrial motor speed control. At very low frequencies, transformers become large/inefficient. Modern VFDs

	(VFD) / Frequency Inverter	and torque. Can operate near DC (0 Hz hold).		use high-frequency PWM internally but output low-frequency AC or DC-like hold for motors.
~80 Hz – 8 kHz	Human Voice (Acoustic) + Brain Waves (Biological)	Complex acoustic pressure waves from vocal cords. Brain waves are electrical oscillations in neural tissue.	Very Low (acoustic); Biological signals: µV–mV	**Voice:** Adult male fundamentals ~85–180 Hz; female ~165–255 Hz. Clarity requires harmonics up to 4–8 kHz. **Brain waves:** Delta (0.5–4 Hz), Theta (4–8 Hz), Alpha (8–12 Hz), Beta (12–30 Hz), Gamma (30–100+ Hz). These electrical signals overlap voice and Schumann ranges numerically but are a different physical phenomenon. When speaking into a ham radio mic, voice modulates the much higher RF carrier in the HF/VHF rows.
20 Hz – 20 kHz (full audible spectrum)	Audio Power Amplifiers & Loudspeakers (Speech, Music, PA Systems)	Electrical AC audio signal (typically 4–8 Ω speaker load) converted to acoustic sound pressure waves.	Low–Medium (amplifier output watts)	The electrical signal driving speakers is true AC in the audible band. Amplifiers boost low-level signals (mic, instrument, phone) to drive voice coils. In ham radio (IC-705, FT-891, etc.), this audio stage modulates the much higher RF carrier. **Wine glass shattering demo:** a glass resonates and shatters when driven at its natural frequency (typically 500–2000 Hz, commonly ~800–1200 Hz) with sufficient sustained amplitude — classic acoustic resonance. The 240 W baseline does **not** directly apply here — these are signal/power amplification systems for sound reproduction.
50 Hz	Power Inverter (Standard Utility Frequency)	~230 V RMS sine (or modified sine) for household/industrial loads in most of the world.	High (hundreds of W to MW)	Regional standard (Europe, most of Asia, Africa, Australia). Same design family as 60 Hz inverters — optimized for efficiency, surge handling, and clean output to real loads. (Japan is a real, notable exception, running both 50 Hz in its eastern grid and 60 Hz in its western grid.)
60 Hz	Power Inverter (Pure Sine — Household / Vehicle / Shack)	120 V RMS (or 240 V) clean sine wave for appliances, tools, radios, and backup power.	High (hundreds of W to several kW typical)	The classic consumer/industrial inverter. Most common term when people say "inverter." The 240 W baseline example (12 V × 20 A) is typical for portable units in this category.
400 Hz	Aerospace / Aircraft Inverter	115 V RMS at 400 Hz — the higher frequency allows much smaller, lighter transformers and magnetics.	High (weight-critical designs)	Used in aircraft where every gram matters. The higher frequency dramatically reduces the size and weight of magnetic components compared to 50/60 Hz designs.
~1 kHz	High-Frequency Inverter or Audio-Range Power Amplifier	AC output in the low-kilohertz range, often for specialized loads or as an intermediate stage.	Medium–High	Overlap/transition zone. Some specialized power conversion or high-power audio amplification still uses this terminology. Most general audio now has its own dedicated row above.
10–100 kHz	High-Frequency Inverter / Resonant Converter (Induction Heating, SMPS, etc.)	High-frequency AC, often used internally or for specialized heating/wireless power applications.	Medium–High (application dependent)	"High frequency" here usually refers to internal switching or resonant link frequency, allowing tiny transformers. Output may be filtered back to lower frequencies or tailored to the load (induction cooktops, wireless chargers, compact power supplies).
20 kHz – several MHz	Ultrasonics / Ultrasound (Acoustic)	Mechanical pressure waves above human hearing. Used for imaging, cleaning, welding, and animal deterrence.	Low–Medium (acoustic power)	Includes **dog whistles** (typically 23–54 kHz, often ~35 kHz) and **ultrasonic dog repellers** / **bark deterrents** (~20–40 kHz). These are acoustic ultrasonic pressure waves — inaudible to humans but well within dogs' hearing range (up to ~45–65 kHz). Also medical imaging (1–20 MHz), industrial cleaning, and non-destructive testing. Distinct from EM RF at similar frequencies.
≥ 1 MHz	RF Power Amplifier or RF Signal Generator + Amplifier	RF electromagnetic waves, typically into 50 Ω systems. Used for communication, broadcasting, and testing.	Low–High (mW to kW+ in transmitters)	True radio-frequency domain. Design shifts to transmission lines, matching networks, antennas, and consideration of radiation. No large iron-core

				transformers. Efficiency, harmonics, and EMI become critical.
HF (3–30 MHz) / VHF (30–300 MHz)	HF / VHF Ham Radio Transceiver (e.g. IC-705, FT-891, FT-857D)	Modulated RF carrier (SSB, CW, FM, digital) at operating frequency. 5–100+ W typical output.	Medium–High (transmit)	Specialized communication equipment. **Transmitter** = modulated RF power amplifier chain. **Receiver** = sensitive RF front-end. Usually powered directly from 12–13.8 V DC (or internal DC-DC converters). Signal generators are commonly used for receiver testing and alignment. Your radios live here.
1 GHz – 100+ GHz (incl. 5G sub-6 GHz & mmWave)	Microwave / mmWave / 5G Transceivers & Phased Arrays	Extremely high-frequency EM waves using waveguides, microstrip, phased-array antennas, and beamforming.	Low–Medium per element (arrays scale up)	Modern wireless (5G phones/base stations), radar, satellite links, and high-speed data. Design is heavily transmission-line and antenna-focused. 5G spans "traditional" RF sub-6 GHz bands with very different engineering challenges than true mmWave.
mHz – GHz (wide tunable range, high precision)	Function / Arbitrary Waveform Generator (AWG) or RF/Microwave Signal Generator	Extremely precise, low-distortion waveforms with sweep, modulation, arbitrary shapes, and DC offset. Usually into 50 Ω or high-Z.	Very Low (typically < 1 W)	Instrumentation / test & measurement. Precision frequency (ppm accuracy), waveform shape, and features are the focus — **not** power delivery. These devices do **not** convert the 240 W baseline; they are low-power by design. Essential for circuit development, receiver testing, and research.
~300 GHz – 400 THz	Infrared (IR) (Near, Mid, Far IR)	EM radiation felt as heat. Generated by IR LEDs, lasers, thermal sources, or blackbody radiation.	Low–High (LEDs: mW; heaters: kW)	The "heat" you feel from the sun, a heater, or another person is mostly infrared. IR LEDs in remotes, night-vision, thermal cameras, fiber optics, and some heating applications. Still fundamentally turning electrical energy into oscillating EM fields — just at optical-adjacent frequencies. Bridges microwave and visible light.
400–790 THz (visible light)	Visible Light / Photonics (LEDs, Lasers, Incandescent)	Electromagnetic waves at optical frequencies. LEDs convert DC directly via electroluminescence; lasers via stimulated emission.	Low–High (LEDs: mW–W; lasers: mW–kW+)	This is the "daylight" in the classic engineering phrase **"DC to daylight."** The ultimate high-frequency end of practical human-generated EM waves. Photons at these frequencies carry enough energy to interact with chemistry and biology (vision, photosynthesis, sunburn). In an infinite universe, even higher-energy gamma rays exist from cosmic events.

Acoustic vs. Electromagnetic Distinction

Several rows in the chart (Infrasound, Human Voice, Audio Amplifiers & Speakers, Ultrasonics including dog whistles) describe **acoustic** (mechanical pressure) waves traveling through air, water, or solids — not electromagnetic waves. They are included because they represent the same fundamental concept of oscillation and frequency, and they fit naturally in the spectrum. The 240 W baseline calculations apply primarily to the true power-conversion rows (VFDs, 50/60 Hz inverters, etc.). Acoustic and biological systems are shown for conceptual completeness.

Dog Whistles & Ultrasonic Repellers

These practical consumer devices fit cleanly in the Ultrasonics / Ultrasound row (20 kHz – several MHz). Classic dog whistles operate at 23–54 kHz (often ~35 kHz). Ultrasonic bark deterrents and dog repellers typically use 20–40 kHz irregular or pulsed tones. They are inaudible to most humans but well within a dog's hearing range (up to ~45–65 kHz). This is a real-world example of acoustic waves at frequencies far above the human voice row.

Negative Frequencies & Cancelling Waves

In frequency-domain analysis (Fourier transforms), **negative frequencies** are the mathematical complex-conjugate counterparts to positive frequencies — they complete the symmetric spectrum. In the physical world, two waves of identical frequency but 180° out of phase undergo destructive interference (cancellation). This is the operating principle behind active noise-cancelling headphones, many audio filters, and phased-array beam steering. It shows how "negative" or opposing phases are essential to understanding real wave behavior.

The Infinite Universe — No Upper or Lower Bound

If the universe is truly infinite, there is no fundamental reason the electromagnetic (or acoustic) spectrum must have an upper or lower bound. Waves could exist with frequencies so low that a single cycle takes longer than the current age of the universe, or so high that a single photon would collapse into a black hole. Our chart only shows the narrow slice humans have learned to generate, detect, and use. Nature has been playing with this spectrum since the beginning of time — from Earth's natural Schumann resonances (~7.83 Hz) to the highest-energy gamma rays from distant cosmic events. That is exactly why SolveTheUniverse.com exists: to explore these connections across all scales.

Beyond Electromagnetic Waves — Gravitational Waves: Ripples in spacetime itself (nanohertz to kilohertz range). Detected by LIGO (roughly 10–1000 Hz, ironically in the audio band) from black hole and neutron star mergers, and by pulsar timing arrays at nanohertz frequencies from supermassive black hole binaries across galaxies. These are not EM at all, yet they are "waves" in the most fundamental sense. In an infinite universe, such phenomena remind us that the chart above, vast as it is, is still only a tiny slice of reality.

Glossary of Abbreviations Used in This Guide

RMS	Root Mean Square — the effective, equivalent-heating-power value of an AC voltage or current; what a multimeter reads by default.
PWM	Pulse-Width Modulation — rapidly switching a DC source on and off at varying duty cycle to synthesize an AC-like or variable-voltage output.
SMPS	Switch-Mode Power Supply — a power supply that converts using high-frequency switching (often 10–100+ kHz) rather than a heavy line-frequency transformer; a common RFI source.
RFI / **EMI**	Radio-Frequency / Electromagnetic Interference — unwanted signals that couple into a receiver or nearby equipment.
POTA	Parks on the Air — a popular ham radio activity operating portable stations from parks, often battery/inverter powered.
DX	Ham radio shorthand for distant stations/long-distance contacts.
Q (factor)	Quality factor — how sharply "tuned" a resonant circuit or antenna is; high Q means a narrow bandwidth and strong resonance.
SSB / **CW** / **FM**	Single-Sideband, Continuous Wave (Morse code), Frequency Modulation — common ham radio voice/data modulation modes.

Related on SolveTheUniverse.com

This guide's acoustic rows (infrasound, human voice, audio amplifiers, ultrasonics) connect directly to the site's **Sound** section, which covers the underlying wave mathematics (wave speed, intensity, decibels, resonance, and the Doppler effect) in more depth. The power-inverter and AC-generator rows connect to the site's ongoing **Grounding and Bonding** practical guide, and the whole "DC to daylight" continuity theme connects to the site's own **Why Pressure** article, on why so much of physics keeps reaching for the same handful of underlying concepts to explain very different phenomena.

Document for SolveTheUniverse.com • Theoretical comparison only — real devices vary widely in efficiency, design, and application. Created to explore the beautiful continuity of frequency and oscillation across power, radio, sound, light, and the cosmos. Revised 2026-07-22: corrected the vehicle-alternator DC-stage claim, added the Japan 50/60 Hz grid split, clarified the infrasound/audible-band boundary for explosive shock waves, and added a glossary of abbreviations.