EMP Proof Communications in the Age of Putin

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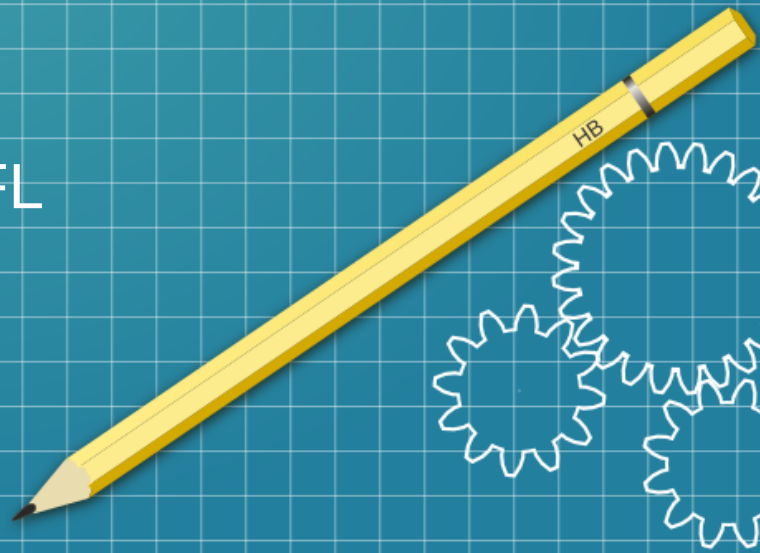

One dictator after another...

Forbes

North Korean EMP Attack Would Cause Mass U.S. Starvation, Says Congressional Report

Bruce Dorminey Senior Contributor ⓘ
I cover aerospace, astronomy and host The Cosmic Controversy Podcast.

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North Korea could even rig the warhead to detonate in the event that it was intercepted by our own missile defenses.

aircraft electronics would be fried, as well as electronics in air traffic control towers, and

Forbes

North Korean leader Kim Jong-Un (R) inspecting a launching drill of the medium-and-long range... [+]

Unlike a conventional ICBM which launches and then goes into a suborbital flight before re-entering Earth's atmosphere, an EMP warhead need not re-enter Earth's atmosphere before exploding hundreds of kilometers above its target. Super-EMP weapons are designed to produce a high level of gamma rays, which generate the sort of high-frequency electromagnetic pulse that is

Exclusive: Russia attempting to develop nuclear space weapon to destroy satellite with massive energy wave, sources familia with intel say

By Katie Bo Lillis, Jim Sciutto, Kristin Fisher and Natasha Bertrand, CNN

5 minute read · Updated 7:57 AM EST, Sat February 17, 2024

(CNN) — Russia is trying to develop a nuclear space weapon that would destroy satellites by creating a massive energy wave when detonated, potentially crippling a vast swath of the commercial and government satellites that the world below depends on to talk on cell phones, pay bills, and surf the internet, according to three sources familiar with US intelligence about the weapon.

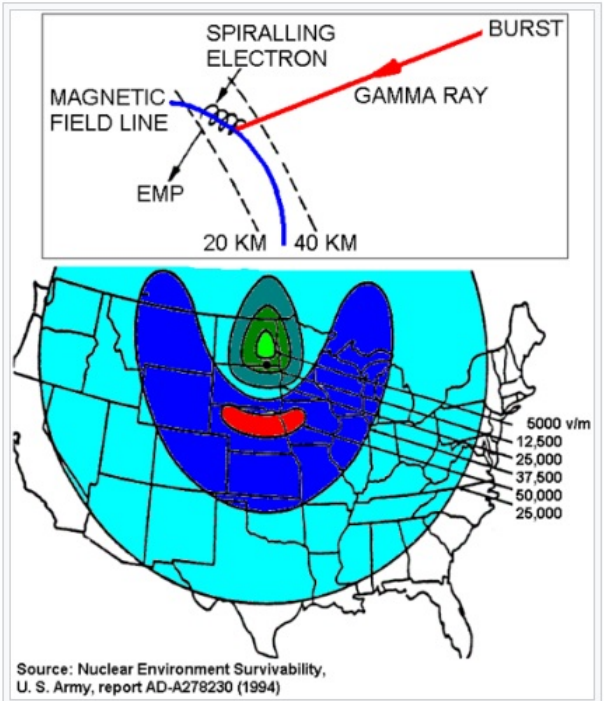
These sources gave CNN a more detailed understanding of what Russia is working on – and the threat it could pose – than the US government has previously disclosed.

Republican Rep. Mike Turner of Ohio, the chair of the House Intelligence Committee, set off a frenzy in Washington on Wednesday when he issued a statement saying his panel "had information concerning a serious national security threat." By Friday, President Joe Biden had publicly confirmed that Turner was referring to a new Russian nuclear anti-satellite capability — but officials have steadfastly refused to discuss it further, citing the highly classified nature of the intelligence.

The weapon is still under development and is not yet in orbit, Biden administration officials have emphasized publicly. But if used, officials say, it would cross a dangerous rubicon in the history of nuclear weapons and could cause extreme disruptions to everyday life in ways that are difficult to predict.

This kind of new weapon — known generally by military space experts as a nuclear EMP — would create a pulse of electromagnetic energy and a flood of highly charged particles that would tear through space to disrupt other satellites winging around

10-25 kV/m E Field (nano sec)



The mechanism for a 400-kilometre-high (250 mi; 1,300,000 ft) burst EMP: gamma rays hit the atmosphere between 20–40 km (66,000–131,000 ft) altitude, ejecting electrons which are then deflected sideways by the Earth's magnetic field. This makes the electrons radiate EMP over a large area. Because of the curvature and downward tilt of

REF:
https://en.wikipedia.org/wiki/Nuclear_electromagnetic_pulse

Test Waveforms

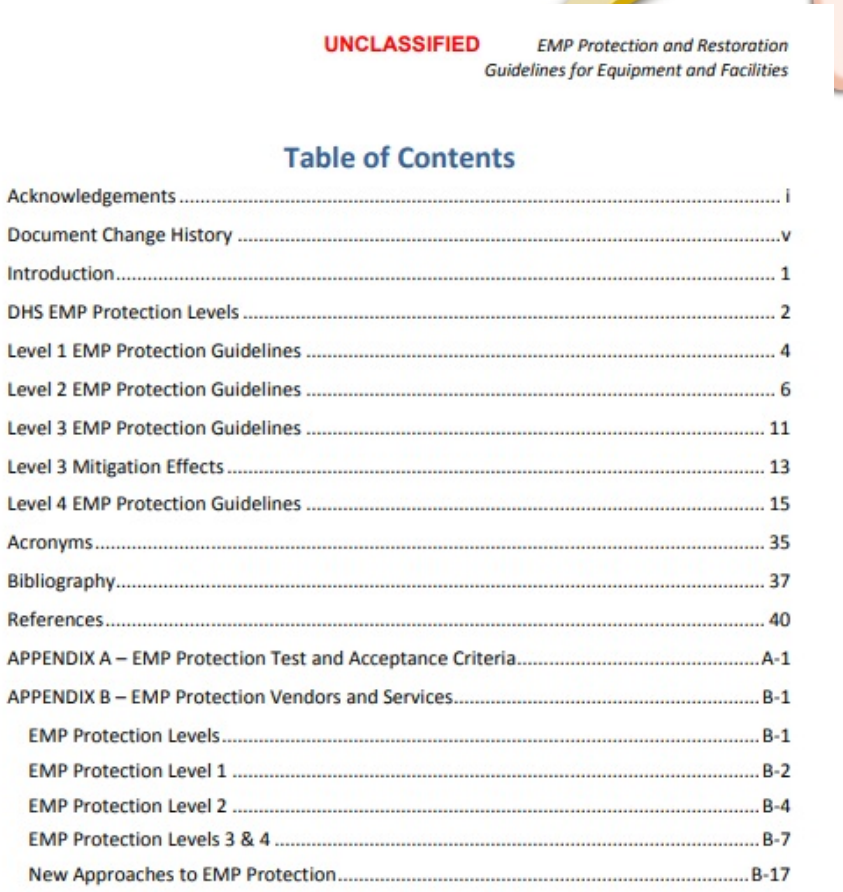
- “Advanced Fast Electromagnetic Pulse System (AFEMPS): A 3.5 MW pulser combined with a wire-spread antenna system provides system level testing and meets MIL-STD-2169B Early-Time HEMP Waveform”
- “Vertical EMP Facility (VEMP): A VEMP using a 2.0 MW pulser is being developed to provide the Early-Time HEMP Waveform and is scheduled to be operational no earlier than January 2013.”
- https://www.wsmr.army.mil/tc/test/svc/neee/eme.html

What role do community Hams play?

- Often Subject Matter Experts to assist community professionals.
- Recommend mitigation techniques commensurate with resources and balancing risks.
- (Rare but extremely damaging vs much more common storms)

Refer to 2016 DHS Recommendations

Graded series of “protection levels” – assist local authorities to recognize potential to get to higher levels.



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Defensive Strategies

1) Bandwidth limitation: by limiting bandwidth, total energy is limited. (Our antenna systems naturally do this)
2) Voltage Clamping: by gracefully arcing or active voltage clamping, limit the energy delivered to delicate circuits
3) Limit aperture exposed to E-field (shorten wires, or SHIELD; extreme example is Faraday Cage)

Voltage Clamping

- Coax cables will arc. ? re-usable?
- Lightning arresters may add protection, particularly if bandwidth limitations have slowed down the “pulse”
- Gas-discharge tubes (low pressure gas) are standard protection, available in multiple voltages. Standard device in ham radio lightning arrestors
- ESD diode protection
- Capacitive bandwidth limitation

Receiver Protection

- Large number of receivers, from homebrew QRP rigs to $$$ commercial radios include diode protection of receiver inputs
- Bandpass filters dramatically reduce incident energy (but may be damaged)

Accessory Protection

- CMOS device protection – example keyer chip
  - Utilize additional MOSFETs to absorb energy
  - LIMITED ability
- Consider adding additional protection. Zeners, diodes, etc

TRANSMITTERS

- Appear much more difficult to protect.
- Must produce significant AC voltages (e.g 50-400 VAC)
- SWR can raise voltages significantly
- Difficult to set protective level guaranteed to protect
- Solid State transistor design may be close to limits of device!
- Transistor finals susceptible even to SWR damage (excess voltage/current) – what will 25kV do to them???

Devices with natural protection

- VACUUM TUBES
- Arcs actually common in transmitting tubes.
- Actually remove unwanted gases.
- Tubes generally unharmed (worry more about power supplies)

QST published government study

Electromagnetic Pulse and the Radio Amateur

Part 1: Will your station survive the effects of lightning strikes or electromagnetic pulse (EMP) generated by nuclear explosions? The information in this series will help you harden your radio system.

By Dennis Bodson, W4PWF
Acting Assistant Manager, Technology and Standards
National Communications System
Washington, DC 20305-2010

Radio amateurs have long been concerned with protecting their radio installations against lightning. Many have applied lightning protection where required by local electrical codes. Traditionally, the installed protection is designed to combat "slow" lightning strikes (having rise times on the order of tens of microseconds) with protection from direct overhead strokes obtained by sheltering important conductors with a grounding system.

To address the transient threat, including lightning-voltage surges and electromagnetic pulse (EMP), it is necessary to protect installations against electromagnetic fields rising to a peak intensity of 50 kV/m in several nanoseconds. While some (ARES), the National Traffic System (NTS), the Radio Amateur Civil Emergency Service (RACES) and the Military Affiliate Radio System (MARS).[1]

Radio amateurs have provided communications during natural disasters such as tornadoes, hurricanes, floods and blizzards when other forms of communication have been inadequate. The amateur uses portable, mobile and fixed-station radio equipment that is not necessarily dependent on commercial power. In almost every community large and small, there is a cadre of experienced radio amateurs willing to respond to the need for emergency communications.

In addition to the role amateurs fill during natural disasters, the National Com-

as a result of an above-ground nuclear detonation. NEMP has an electric field strength of 50 kV/m horizontally and 20 kV/m vertically, with a pulse rise time to peak of 5 to 10 nanoseconds.

There are several different types of EMP resulting from a nuclear explosion. One of the more significant types is the High-altitude EMP (HEMP) that results from a nuclear explosion above 30 miles in altitude. The HEMP is created by the interaction of high-energy photons (gamma rays) with atmospheric molecules, producing Compton electrons. These electrons decay in the Earth's magnetic fields, emitting photons in the process.

System-Generated EMP (SGEMP) is produced by the direct interaction of high-

REF:
https://qsl.net/kx4z/QST-Electromagnetic_Pulse_and_the_Radio_Amateur.pdf

Resilience

Observations

Most of the solid-state, and all of the tube-type, radios were not susceptible to the simulator field pulses until long, external wires were attached. Short wires—microphone, power cord and internal wiring—did not generate sufficient transient pulse energy to produce observable damage to the radio equipment. When power lines and antennas are attached to radio equipment, however, protection must be provided. With long external wires attached and no protection provided, a single pulse could cause disruption of the microprocessor-controlled displays, cause frequency shifts and permanently damage the radio's internal components. Two notable exceptions are

The UHF coaxial T was the best assembled device; it provided transient protection and could pass the transmitted signal over the full range of test frequencies. Also, the SIOV AC Test Box repeatedly provided necessary power protection required by the radio equipment. These two devices will be discussed in more detail in the next installment.

Reasonable Protective Solutions

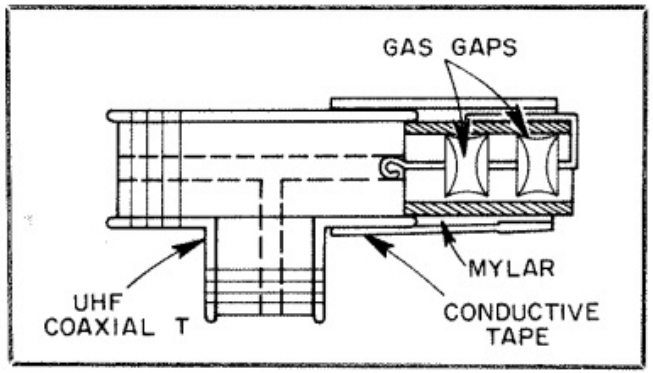


Fig 16—Pictorial diagram of an inexpensive, homemade transmission-line transient protector. See text for description of assembly.

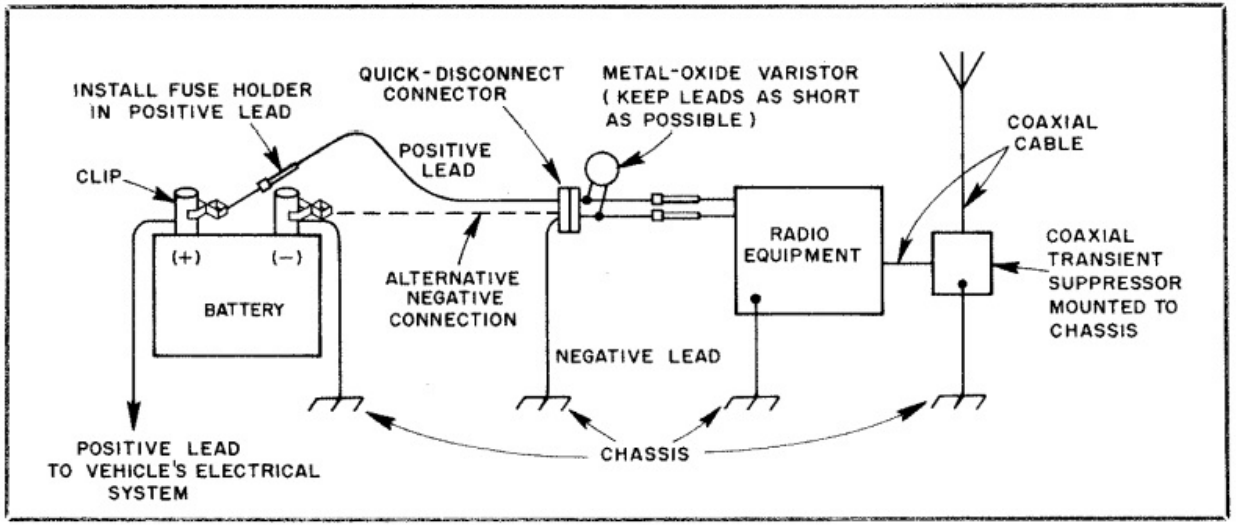


Fig 14—Recommended method of connecting mobile radio equipment to the vehicle battery and antenna.

Goal: Dissipate arriving energy

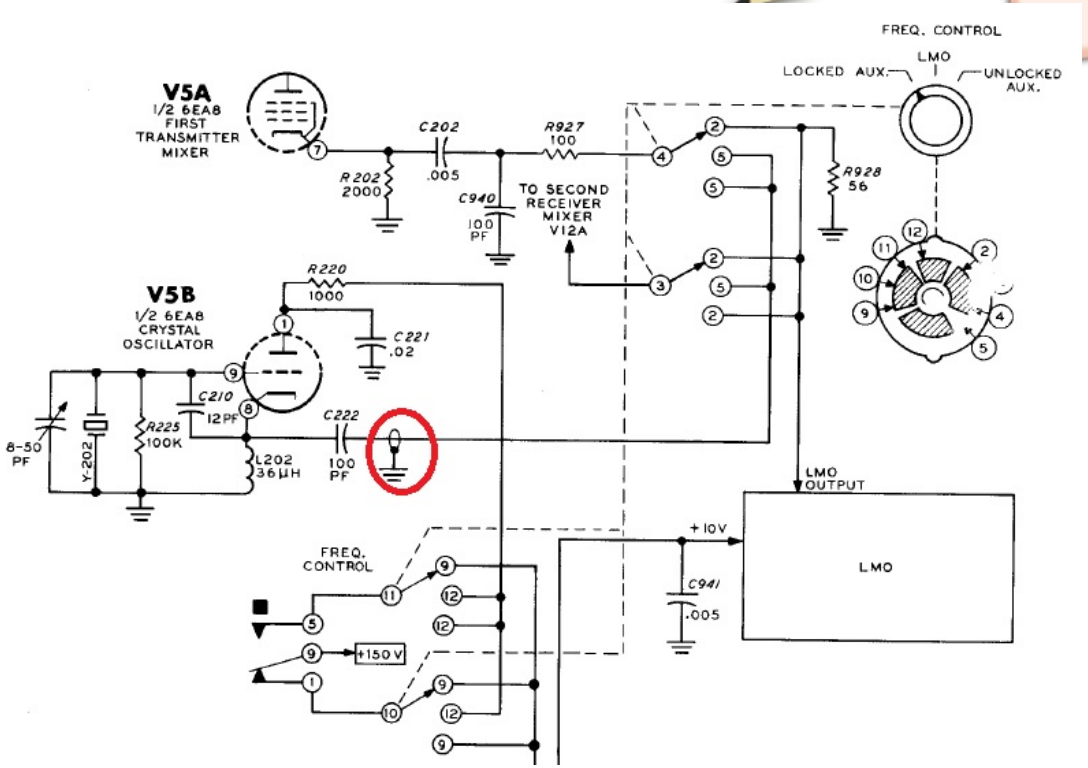
- EOC facilities provide some SHIELDING due to re-bar
- Main concern are arriving antenna cables and power cables
- Protect antenna lines with 1:1 chokes / gas discharge tubes
- Protect power cables with MOV / dual-stage UPS, voltage disconnect limits.

Resilient Gear

- Manual antenna tuners with air wound inductors (impervious)
- Manual antenna tuners with air-variable caps – voltage limiters!
- Vacuum tube amplifiers – resilient
- Vacuum tube transceivers – resilient
- Hybrid radios – can be made resilient with protection of receiver (Kenwood TS-520 etc)
- ***Not that difficult to protect gear if thought given.***

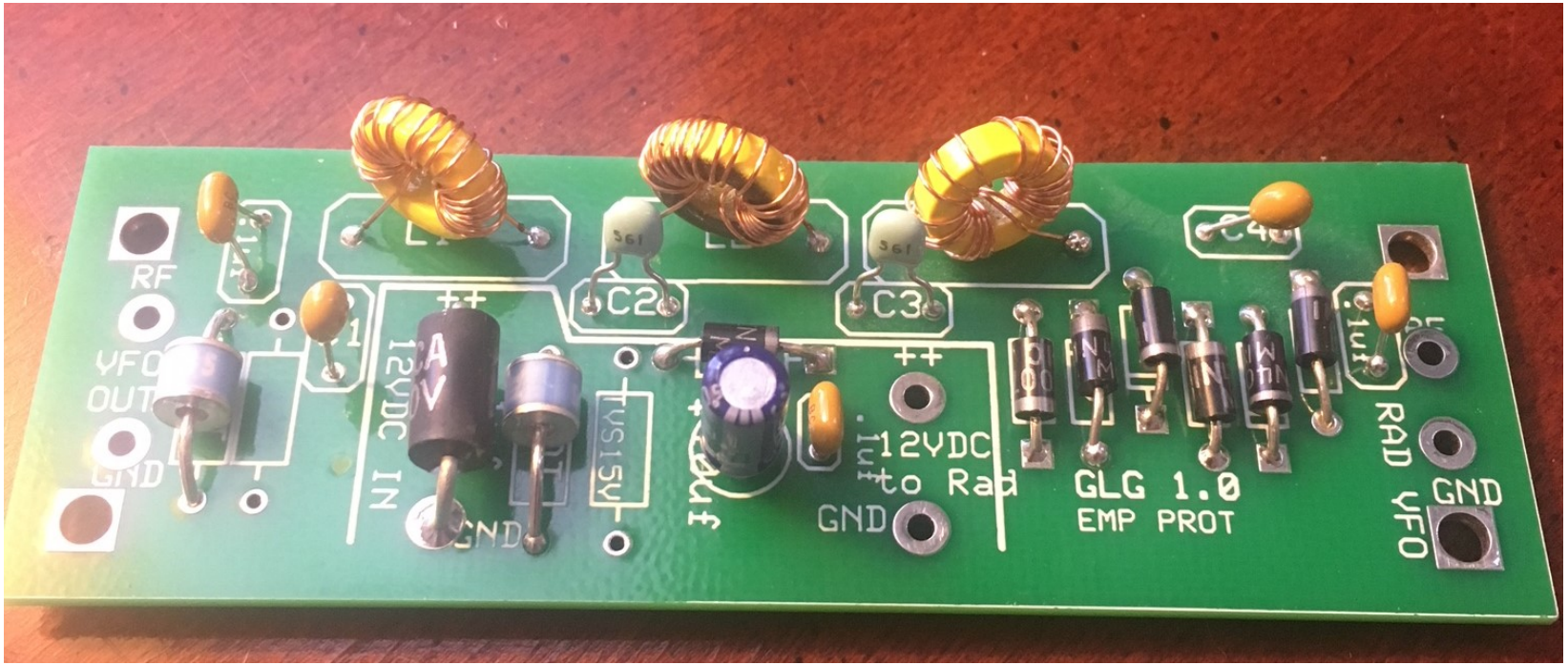
Easy to inject computer controlled signals

- External VFO into SB series
- (Similar solutions for HW series)



External digital VFO

EMP protection to accessory

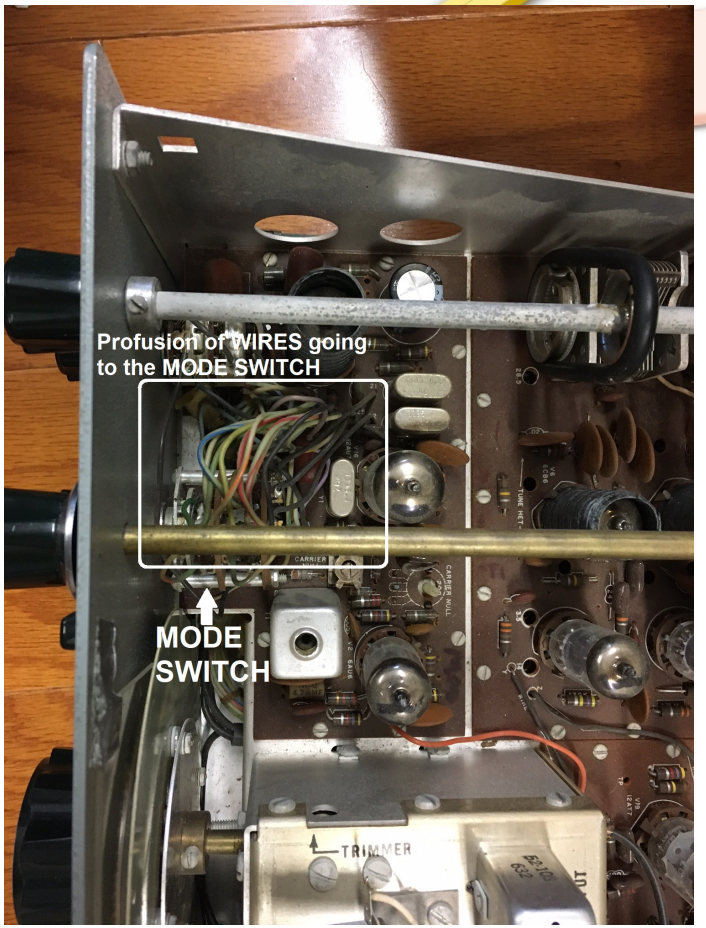


Irreplaceable Rotary Switch: MODE

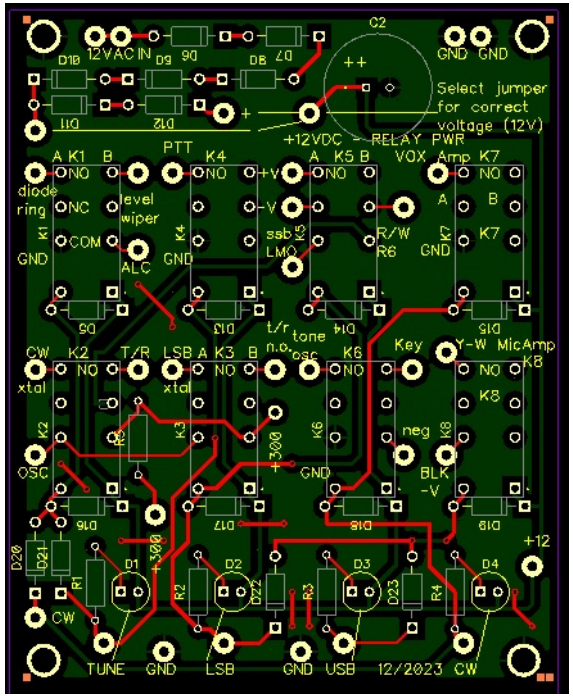
Modern microprocessor-controlled radios make multiple configuration changes via multiple microprocessor outputs, adjusting filters, connecting signal paths, switching power voltages.

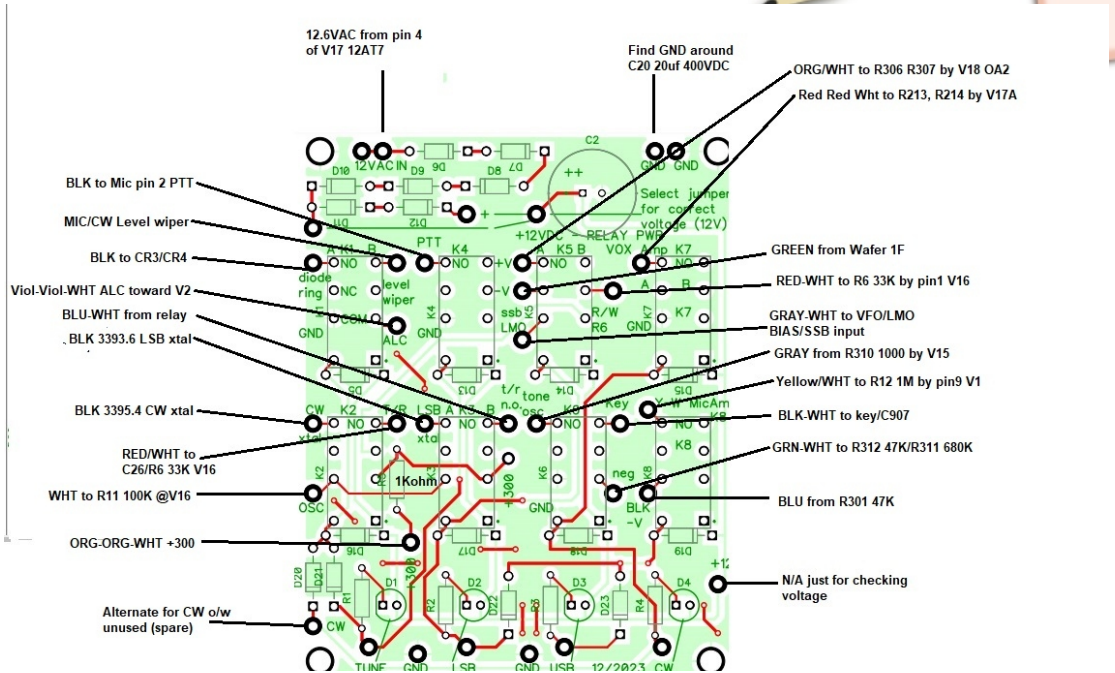
Older non-computer radios accomplished these type controls via complex rotary switches / relays.

The Heathkit MODE switch is irreplaceable, with multiple wafers, each front & rear, and complex custom logic. Corrosion and physical damage eventually make these switches unreliable.



Relay-Based Replacement

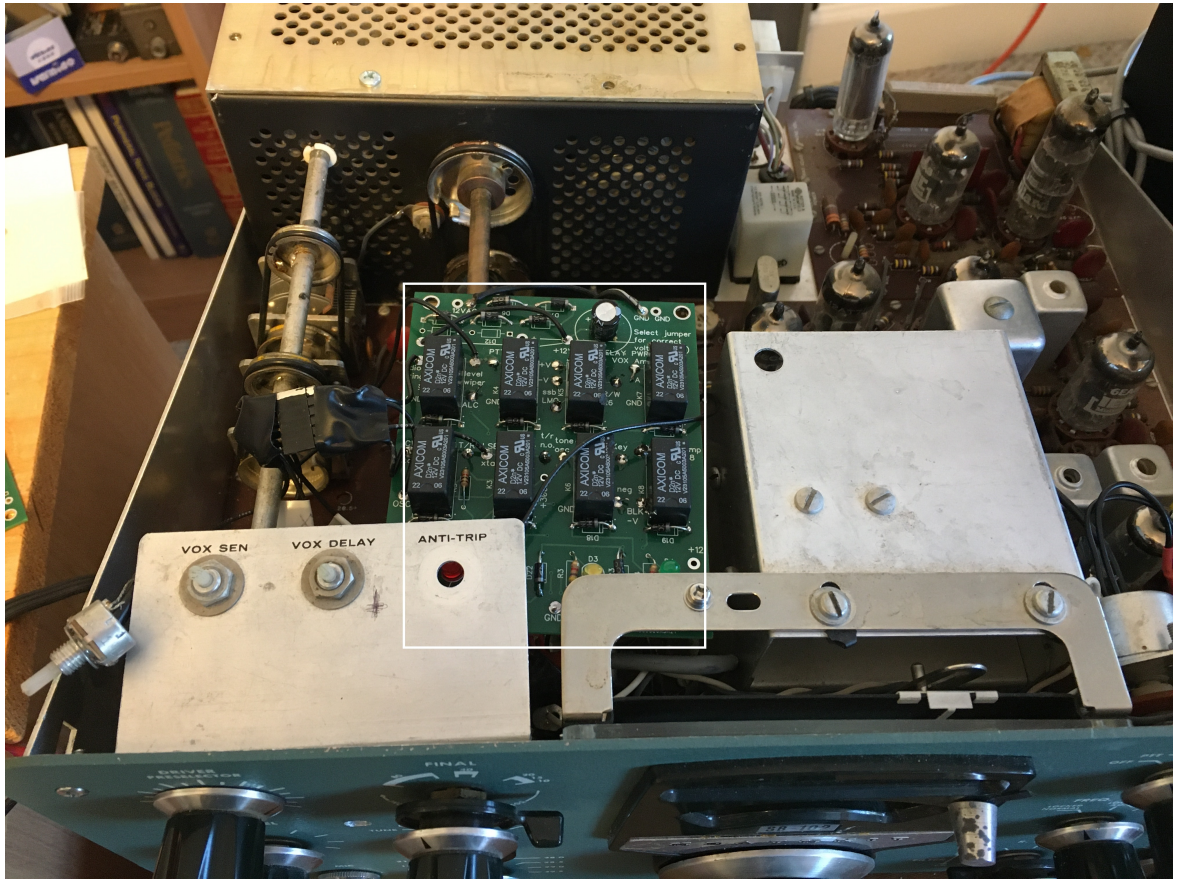




Avoided EMP-vulnerable control logic in favor of simple RELAYS. System could be controlled by solid state opto isolators if desired.

- Development identified 14+ logic connections made by the “mode” switch.
- Heathkit switched very few RF connections (primarily choosing between 3 carrier crystals).
- Almost all switched connections were DC or audio signals. Unfortunately, some were 200VDC.

Successful Prototype installation



Alternative EMP-hardened designs

- Relay-switched pi-networks and simple 6146 tube amplifiers can provide EMP-hardened end-amplifier exposed to antenna systems. With little need for heat sinks the volume difference isn’t that great and efficiency higher.
- A simple front-end vacuum tube preamp can shield the remainder of the receiver from EMP energy with modest design complexity.
- Fragile computer systems can use opto-isolators to isolate from much of the RF circuitry. Hybrid designs (such as the sBitx) that perform SDR in a 0-50kHz window can be operated via optically isolated devices.

Conclusion

- There ARE protective strategies that can be relatively easily employed and many are “dual use” – additionally protect against lightning or power line issues.
- Hams can assist in raising protective levels for critical systems, such as infrastructure-free HF communications
- Becoming subject matter expert adds value to experienced hams who can balance priorities.

Comments / Discussion?