

# Nuclear High Altitude EMP

Dave Casler

KEØOG

# Sources

- DHS, *Strategy for Protecting the Homeland Against Threats of EMP and GMD*, Appendix A, “Technical Background,” 27 Jan 2022
- DOE, *U.S Department of Energy Electromagnetic Pulse Resilience Action Plan*, Jan, 2017
- MIL-STD-464A, *Electromagnetic Environmental Effects: Requirements for Systems*, Section A5.5, 24 Dec 2020
- Perotoni et al, “Generation of Double-Exponential EMC Pulses with Software-Defined Radios,” *Advanced Electromagnetics*, Vol 11, No. 3, Sept 2022.
- Wikipedia: numerous articles on High Altitude Nuclear EMP
- A Source I wish I had: MIL-STD-2169C, Notice 1, (Secret), *High-Altitude Electromagnetic Pulse Environment*, 31 Mar 2020
- <https://www.empshield.com/emp-report/> (many sources included)

# Original Question

- David Martin (no call given, 143 David Martins in QRZ)
- “Are there any transceivers on the market today that would survive high-altitude nuclear electromagnetic pulse from an atom bomb? Or, can a vacuum tube radio survive that?”
- Short answer: like lightning resiliency, the entire system (antenna, transmission line, grounding, and electronic equipment) can help provide protection



Hardtack 1 Teak  
1 Aug 1958  
3.8 Mt, 34 km  
Operation Newsreel



# Teak Side Effects

- EMP observed at the Apia Observatory at Samoa was 4x any solar storm

Hardtack 1 Orange  
12 Aug 1958  
3.8 Mt, 76.8 km  
Operation Newsreel





Starfish Prime  
20 Jun 1962  
1.4 Mt, 400 km  
Operation Fishbowl





# Starfish Prime Side Effects

- Damaged electronics in Honolulu and New Zealand
  - Fused 300 street lights on Oahu
  - Set off about 100 burglar alarms
  - Failure of a microwave repeater on Kauai
- Produced an artificial radiation belt
  - Destroyed 3 satellites: Ariel, TRAAC, and Transit 4B
  - Damaged 3 satellites: Cosmos V, Injun I and Telstar 1
  - NASA concerned because 4 months after, radiation dose was  $>0.6$  Gy/day for a well-shielded capsule in polar orbit (for comparison, a pelvic CT scan is 0.006 Gy)
- Effective satellite kill radius about 80 km



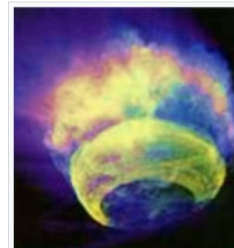
# Soviet Test Side Effects

- EMP fused 570 km of overhead telephone lines with a measured current of 2,500 A
- Started a fire that burned down the Karagande power plant
- Shut down 1,000 km of shallow buried power cables between Tselinograd and Alma-Ata

## List of high-altitude nuclear explosions [[edit](#)]

See also: *List of artificial radiation belts*

Mission	Date	Yield	Altitude
<span><span><span></span></span><span> </span></span> USA <b>Hardtack I</b> – (Operation Newsreel) – <a href="#">Johnston Atoll</a> , Pacific Ocean			
<i>Yucca</i>	28 April 1958	1.7 kt	26.2 km
<i>Teak</i>	1 August 1958	3.8 Mt	76.8 km
<i>Orange</i>	12 August 1958	3.8 Mt	34 km
<span><span><span></span></span><span> </span></span> USA <b>Argus</b> – South Atlantic Ocean			
<i>Argus I</i>	27 August 1958	1.7 kt	200 km
<i>Argus II</i>	30 August 1958	1.7 kt	240 km
<i>Argus III</i>	6 September 1958	1.7 kt	540 km
<span><span><span></span></span><span> </span></span> Soviet Union – 1961 tests – <a href="#">Kapustin Yar</a>			
Test #88	6 September 1961	10.5 kt	22.7 km
Test #115	6 October 1961	40 kt	41.3 km
Test #127	27 October 1961	1.2 kt	150 km
Test #128	27 October 1961	1.2 kt	300 km
<span><span><span></span></span><span> </span></span> USA – <b>Dominic I</b> – ( <a href="#">Operation Fishbowl</a> ) – <a href="#">Johnston Atoll</a> , Pacific Ocean			
<i>Bluegill</i>	3 June 1962	failed	
<i>Bluegill Prime</i>	25 July 1962	failed	
<i>Bluegill Double Prime</i>	15 October 1962	failed	
<i>Bluegill Triple Prime</i>	26 October 1962	410 kt	50 km
<i>Starfish</i>	20 June 1962	failed	
<i>Starfish Prime</i>	9 July 1962	1.4 Mt	400 km
<i>Checkmate</i>	20 October 1962	7 kt	147 km
<i>Kingfish</i>	1 November 1962	410 kt	97 km
<i>Tightrope</i>	4 November 1962	<5 kt	30–80 km
<span><span><span></span></span><span> </span></span> Soviet Union – <b>Project K</b> – <a href="#">Kapustin Yar</a>			
Test #184	22 October 1962	300 kt	290 km
Test #187	28 October 1962	300 kt	150 km
Test #195	1 November 1962	300 kt	59 km



Hardtack I Orange  



View of *Starfish Prime* through thin cloud, as seen from [Honolulu](#), 1,300 km away.  



The debris fireball and aurora created by the *Starfish Prime* test, as seen from a KC-135 aircraft at 3 minutes.



# So What Happened That October?



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## Cuban Missile Crisis

82 languages

Article Talk

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From Wikipedia, the free encyclopedia



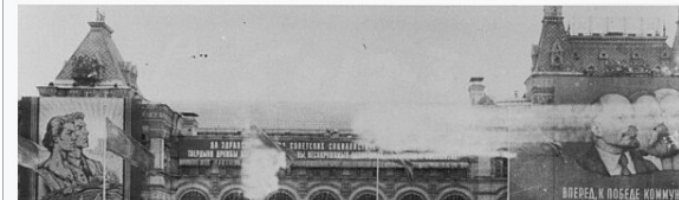
*"Missile Crisis" redirects here. For the missile crisis in Cyprus, see [Cypriot S-300 crisis](#).*

*"Cuban Missile" redirects here. For the baseball player, see [Aroldis Chapman](#).*

The **Cuban Missile Crisis**, also known as the **October Crisis (of 1962)** (Spanish: *Crisis de Octubre*) in Cuba, the **Caribbean Crisis** (Russian: Карибский кризис, tr. *Karibsky krizis*, IPA: [kəˈrʲipskʲɪj ˈkrʲizʲɪs]) in Russia, or the **Missile Scare**, was a 13-day (October 16 – October 29, 1962) confrontation between the United States and the Soviet Union, which escalated into an [international crisis](#) when American deployments of missiles in Italy and Turkey were matched by Soviet deployments of similar [ballistic missiles](#) in Cuba. Despite the short time frame, the Cuban Missile Crisis remains a defining moment in American national security and nuclear war

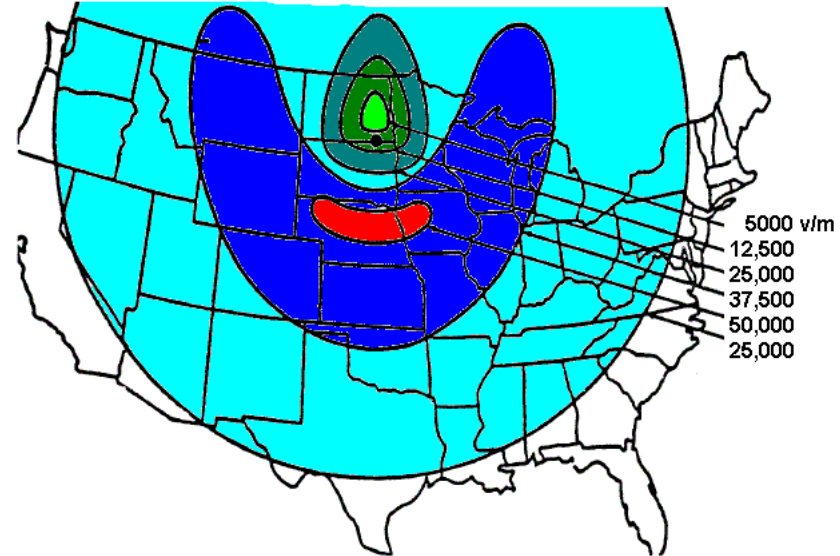
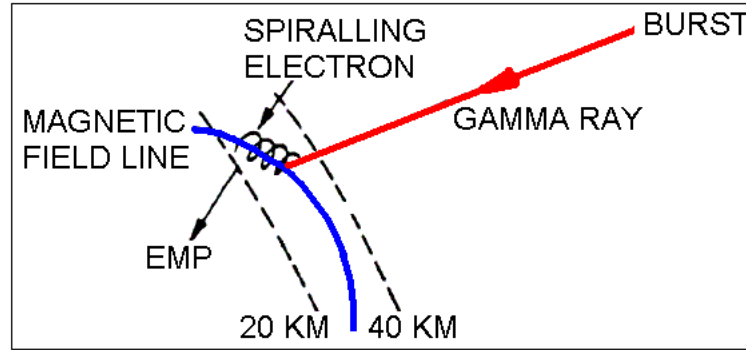
### Cuban Missile Crisis

Part of the [Cold War](#)



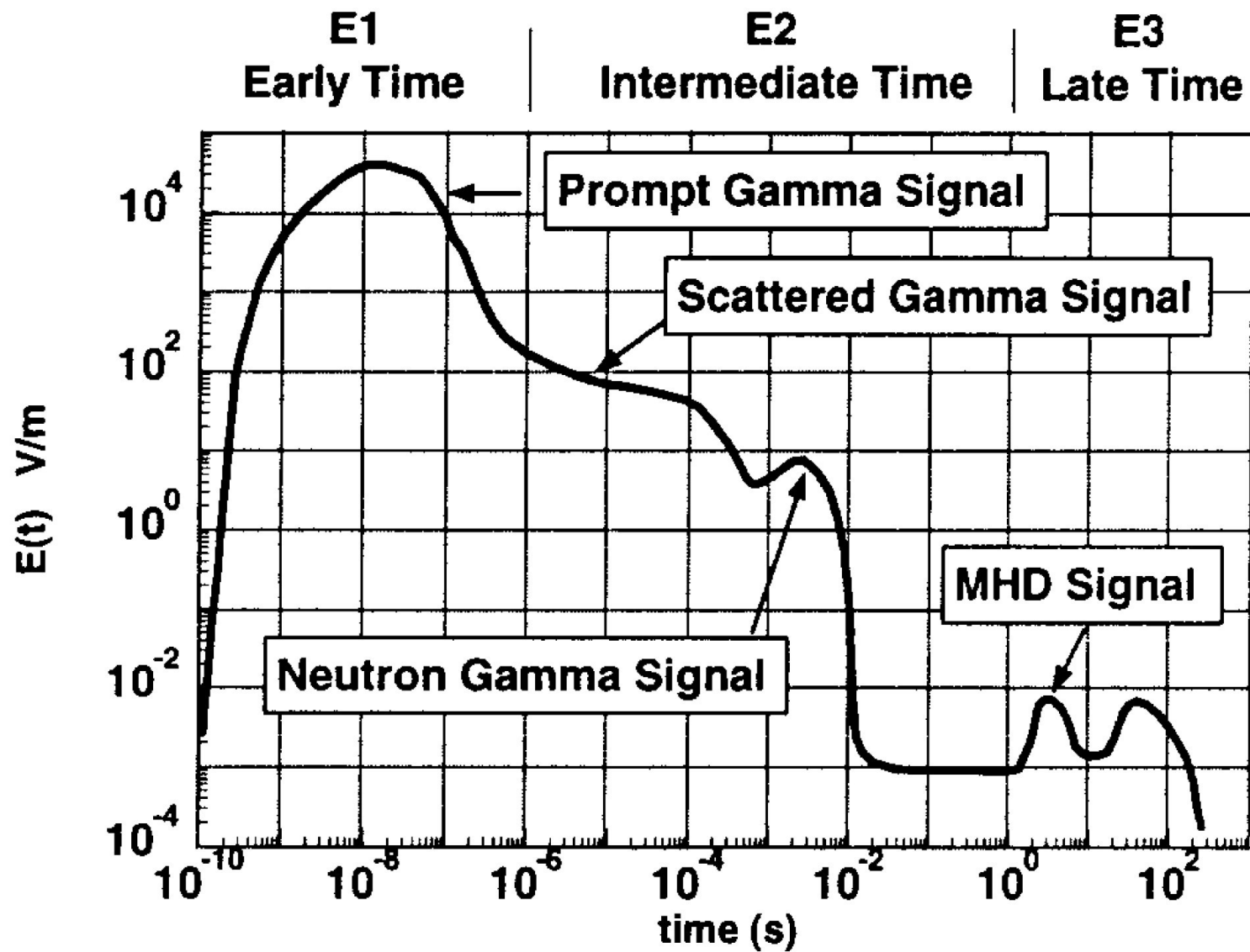
# So What is HAEMP Really?

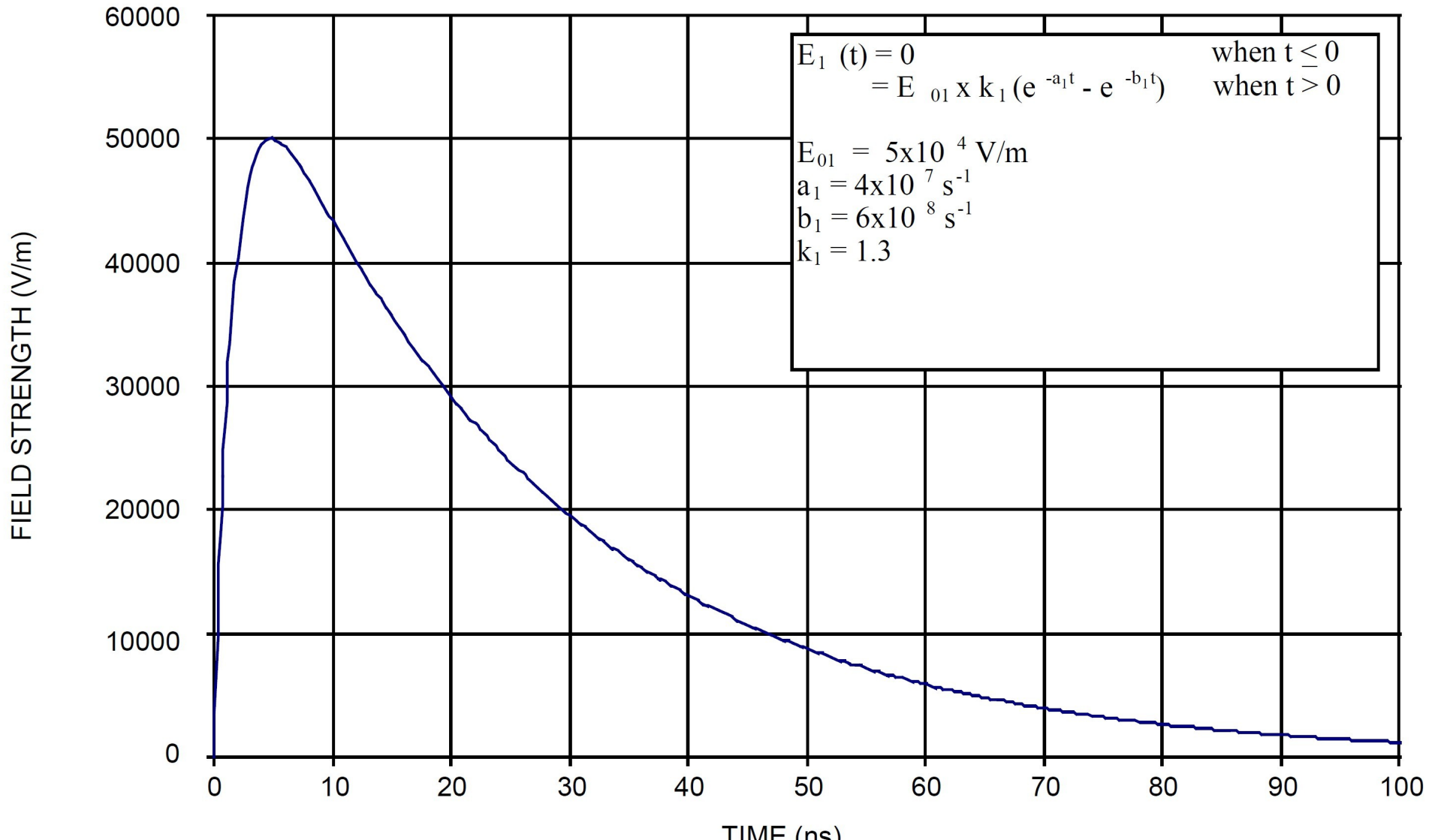
- Nuclear scientists have been aware of EMP from very early days
- Extensive test data was gathered during space tests
- The summation of all of this is distilled in the threat document MIL-STD-2169 (Classified)
- Lots of generalized info readily available (Wikipedia and much more)
- Lots of folklore out there too, some of it truly imaginative



Source: Nuclear Environment Survivability,  
U. S. Army, report AD-A278230 (1994)

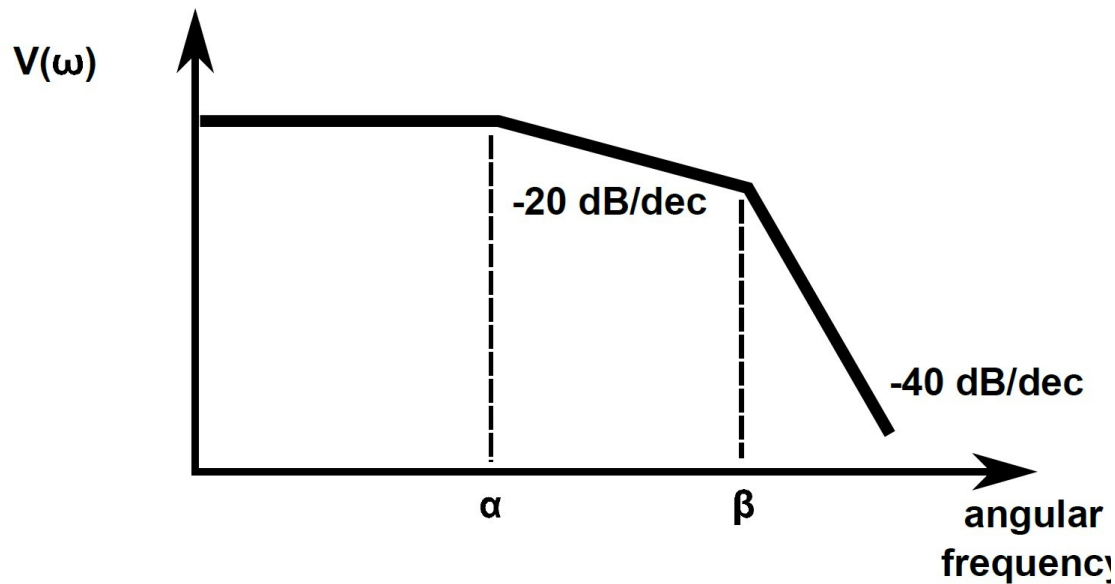
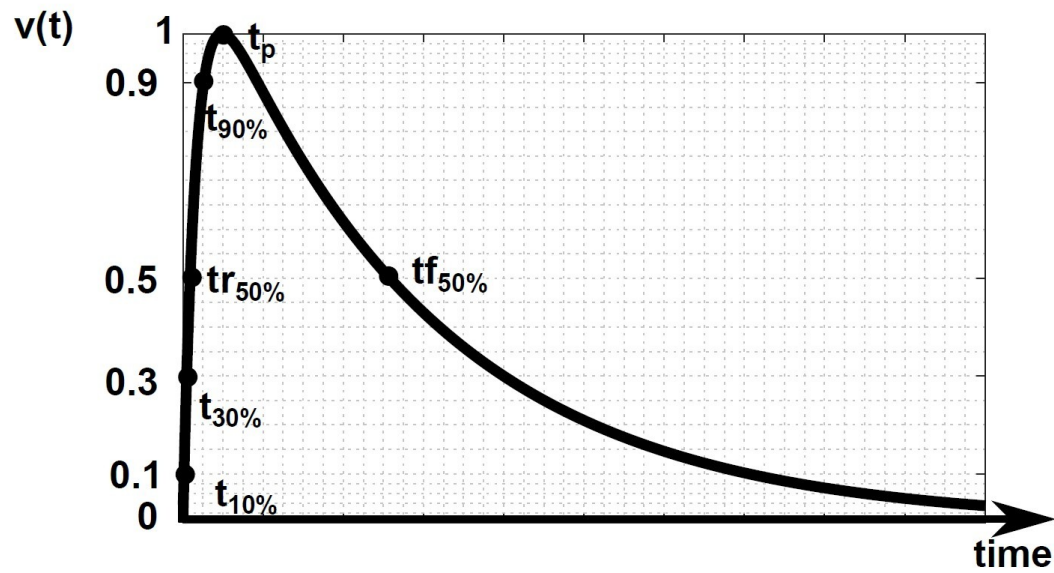






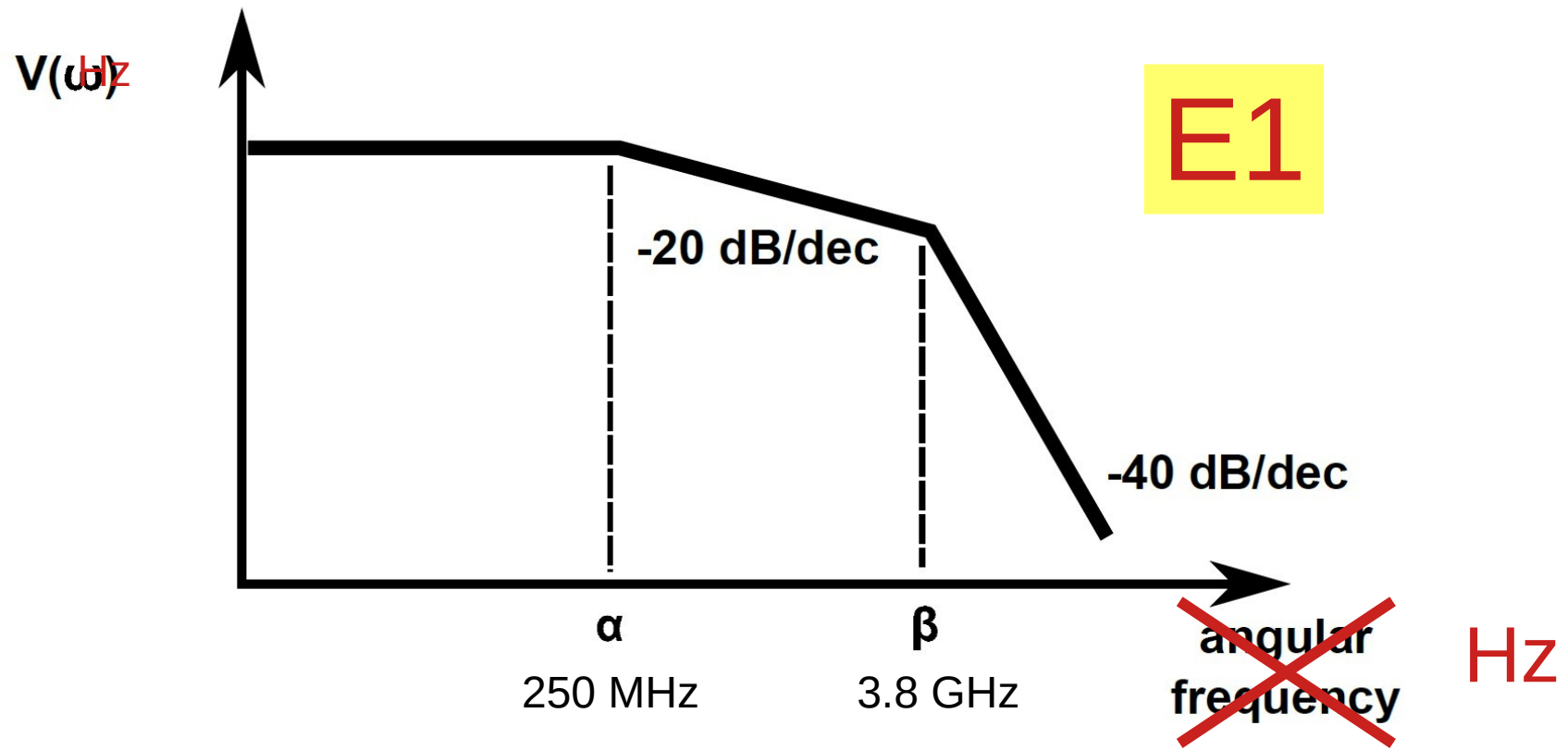
# Dare I Ask How Much Energy is in E1?

- Let's say 50 kV/m, 377  $\Omega$  for air impedance, gives  $E^2/R = 6.6E6$  watts/meter<sup>2</sup>
- Or  $6.6E6 \text{ W/m}^2 \times 30E-9 \text{ s} = 0.198 \text{ mWs/m}^2$
- And then the E1 pulse is gone!
- So we need to protect against a high voltage for a very short period of time with not enough energy to destroy discrete components
- Over what frequency range?



**TABLE 1.** Parameters for some Double Exponential Functions in EMC - normalized amplitude.

Application	$\alpha$ [1/s]	$\beta$ [1/s]	Rising time	Falling time
Lightning DO160 and MIL-STD-464 [22] [23]	11,354	647,265	$t_r = 6.4 \mu\text{s}$	$t_f = 69 \mu\text{s}$
NEMP E1 [14]	4E7	6E8	$t_r = 4.88 \text{ ns}$	21.97 ns
NEMP E2 [14]	1E3	6E8	$t_r = 0.24 \mu\text{s}$	0.69 ms
NEMP Bell [16]	4E6	4.76E8	$t_r = 0.01 \mu$	$t_f = 0.17$
Lightning Type 1 IEC 60060 [21]	14E3	25e5	$T1 = 1.2 \mu\text{s}$	$T2 = 50 \mu\text{s}$
Lightning Type 2 IEC 60060 [21]	5E4	17.3E4	$T1 = 8$	$T2 = 20$
EFT [19]	1.8E7	3.1E8	$t_{r10to90} = 5 \text{ ns}$	$t_{f50} = 50 \text{ ns}$
ESD fast wave [17] [24]	8.3E10	5E10	$t_{r10to90} = 1.2 \text{ ns}$	$t_{f50} = 2 \text{ ns}$
ESD slow wave [17] [24]	4.5E11	5E11	$t_{r10to90} = 22 \text{ ns}$	$t_{f50} = 20 \text{ ns}$
This study	15,354	647,265	$t_r = 5.90 \mu\text{s}$	$t_f = 51.7 \mu\text{s}$



# So How Can We Protect Our Stuff?

- Can't rely on ordinary Gas Discharge Tube (GDT) technology —GDTs take 100 ns to conduct—by then the pulse is gone
- But: there are several devices that can conduct down to sub-nanosecond range
  - Some types of GDTs using different gasses, e.g, krypton in glass
  - Transient voltage suppression (TVS) diodes (avalanche TVS is 50 ps)
  - Metal-oxide varistor (MOV) (some are sub-nanosecond)
- Does anyone put all this in a package? Yes.

# What Does EMP Shield Do?

With EMP Shield you will have:



## **EMP Protection**

All Phases an EMP (E1, E2, & E3)



## **Lightning Protection**

100% Lightning Guarantee  
Backed By a \$25,000 Insurance  
Policy



## **Solar Flare Protection**

Up to 228,000 Amps





## HF/VHF/UHF Radio EMP Protection up to 1500 Watts with N-Connectors (ANT-1500-N)



Next Generation EMP Protection With Military Certified Testing.

Listed by the Department of Homeland Security.



(DC-pass)

\$379.00

[Freedom Sale!](#) - Save an extra 10% Off this EMP Shield in Your Cart

1

ADD TO CART

If you order, use discount code KE00G

**Model: ANT-S1500**

Patented



**EMP**  
SHIELD

**NEMA Rating:**

**NEMA 4**

**IP Rating Met:**

**IP65**

**Maximum Continuing Operating Wattage:**

**1500 Watts**

**Specification Met:**

**UL 1449; CE; MIL-STD-188-125-1**

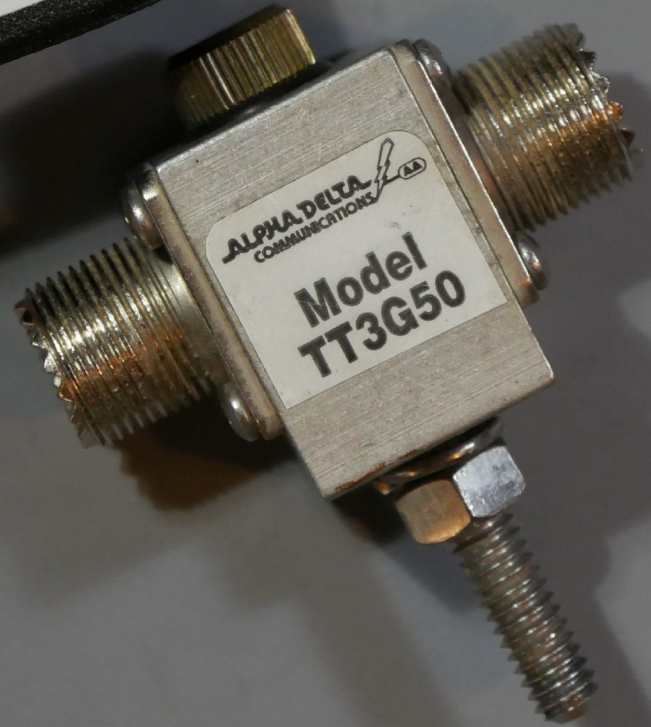
**Voltage Protection Rating:**

**Ant-G 1200 Vpp (3600 watts)**

**Response Time:**

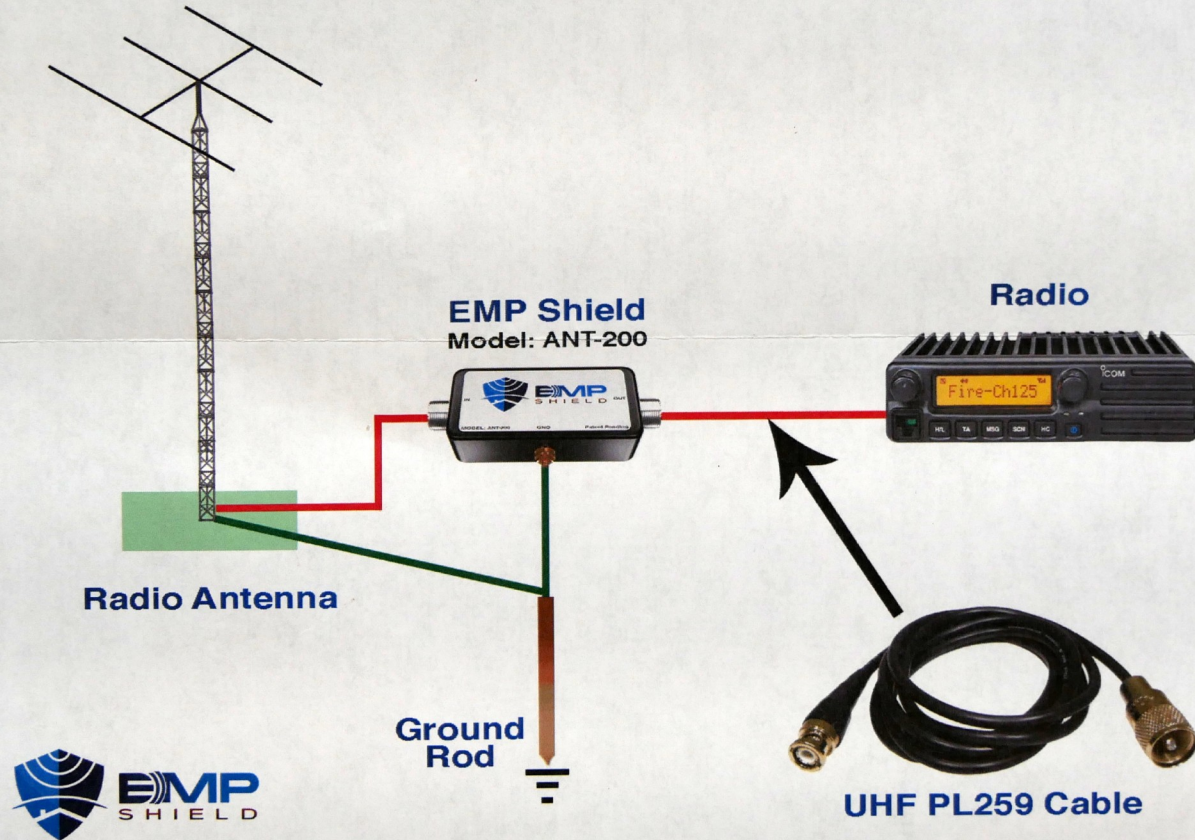
**< 1 nanoseconds**





# EMP Shield

## Ham Radio Installation Instructions





# If You Like to Look Up Patents

- US 10,530,151, 7 Jan 2020
- AUS 2019206390, 10 Jun 2021
- Application 2023/0147803
- CA 3,088,002, 18 Oct 2022
- US 10,742,025 11 Aug 2020
- AUS 2020361439, 28 Jul 2022
- US 10,938,204, 2 Mar 2021
- US 11,451,051, 20 Sep 2022
- US 11469,592, 11 Oct 2022



# Things Dr. Carty Told Me

- Pointed me at different GDTs
- Vacuum tubes are unaffected by E1
- In an EMP event, the magnetosphere bulges and there are serious ground currents
- Takes hours for ionosphere to settle; until it does there can't be another E1 pulse
- Devices with clamshell covers, such as my IC-7300, will not admit E1—has to come in via power or antenna
- He makes EMP equipment for everything from ham radio to homes and vehicles as well as commercial grid stations, etc.

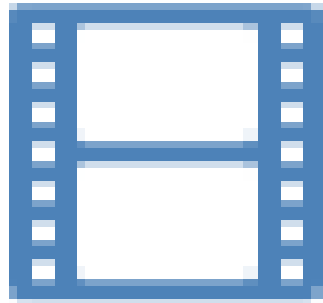
# EMP (E1) Protection Hot Area of Interest

- Department of Homeland Security, working with other departments including DoD, is moving with the due speed of government to assess threat, make plans, set up testing regimes, and so on.
- EMP Systems has been involved during the process and has developed numerous products across many areas
- Other companies are getting interested
  - Faraday Defense has something for sale for every one of your worries (whether your worry is based on science or gossip)



# Will HAEMP Ever Happen Again?

- In the 1960s, only US and USSR had the capability and both nations tested exoatmospheric nuclear weapons
- Now several other nations have this capability but none have tested
- It is in nobody's interest to create a HAEMP event because they're shooting themselves in the foot by doing so
- Just take a look at satellites
  - In 1962, there were ~100 satellites
  - In 2023, there were >7,000 satellites, and some companies are adding to that number regularly



# Finishing Thoughts

- I've got lightning arrestors on everything and have added one EMP Shield ANT-1500
- If there is a HAEMP event, we have much bigger problems (we're at war—nuclear war!)
- Let's worry about disasters that already happen all too frequently (fires, floods, tornadoes, hurricanes, drought...the list goes on)
- I, for one, plan to sleep soundly tonight!