High Powered Microwave Wideband Interference on Electronics

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Motivation

Recent developments in the:

- Physical downscaling of integrated circuits
- Proliferation of microwave sources
- Growing importance of electronic warfare
- Nonlinear dynamics in circuits due to chaotic signals

have led to the investigation of high powered microwave (HPM) wideband interference on electronics.

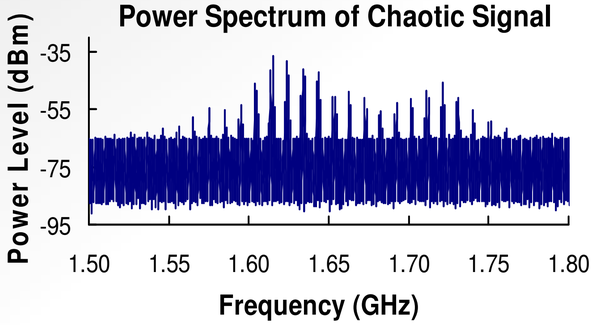
Is there a difference between using chaotic and coherent signals to cause disruptions in electronics?

A power supply and a high speed digital inverter were injected with chaotic and coherent HPM pulses and the effects on their outputs were compared.

TWT Oscillator

A traveling wave tube (TWT) amplifier was configured as a pulsed oscillator to generate chaotic wideband signals

Power Spectrum of Chaotic Signal

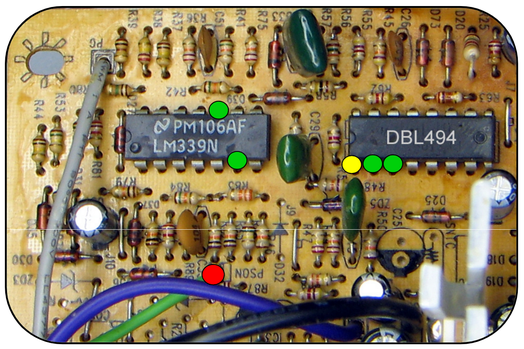


The chaotic signal had a center frequency of 1.65 GHz and a 200 MHz bandwidth, which is 4 times the bandwidth needed for 'wideband' designation.

Coherent refers to a single frequency pulsed carrier.

Power Supply Circuitry

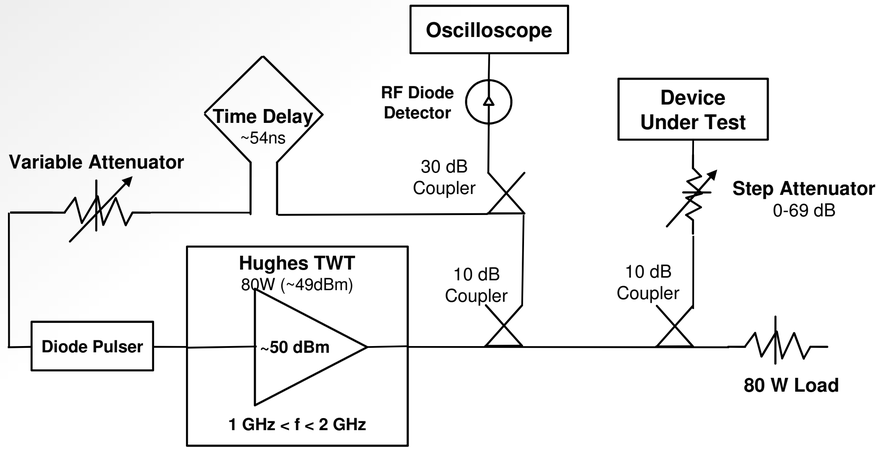
Locations of susceptibility to HPM interference were identified in the circuitry of a standard ATX computer power supply.



- Shutdown
- Output Disturbances
- No effect

A RF cable was soldered to these locations.

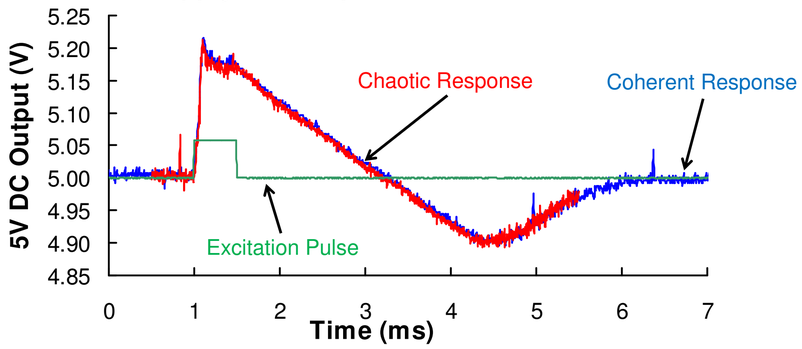
Experimental Setup



Disturbance Results

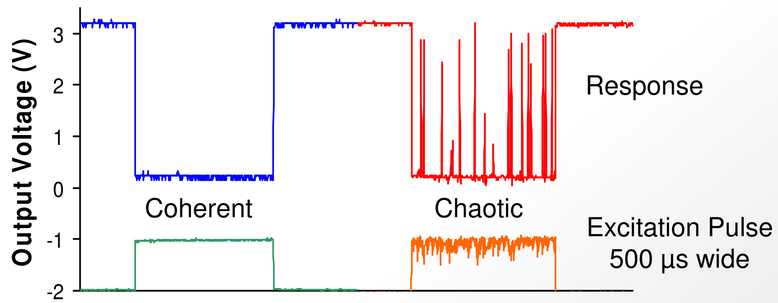
- HPM pulses of varying pulse width and power were directly injected into a power supply while monitoring DC output voltages.

Power Supply +5V Output Deviation due to HPM Pulses



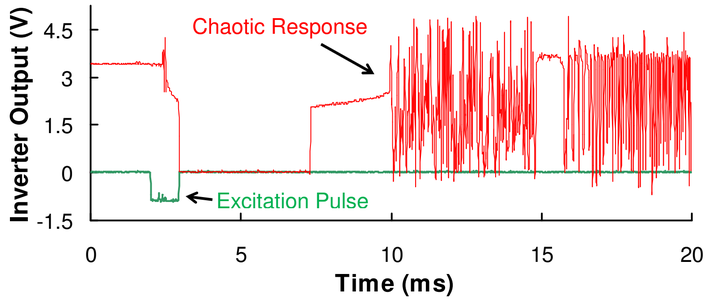
- The disturbance response is the same for a chaotic or coherent pulse.
- Injection into the voltage feedback path caused output voltage disturbances large enough to violate ATX specifications.

High Speed Inverter Response to HPM Pulses



- The short parasitic RC time constants that make the inverter 'high speed' also leave it highly susceptible to chaotically modulated HPM pulses. The slower power supply circuitry is not significantly affected by the chaotic modulation.

Massive Disruptions in Inverter from HPM Pulse

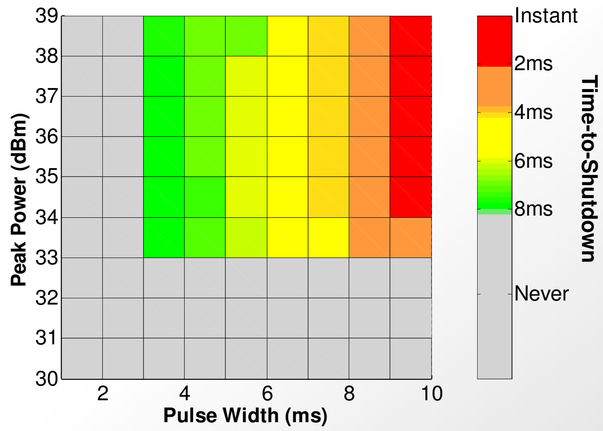


- Chaotic pulses can cause prolonged erratic behavior lasting more than 20 times the excitation pulse width.

Shutdown Results

- HPM injection into the Power Supply ON wire disrupted the 'power-on' command from the motherboard, causing the power supply to shut down.

Time-to-Shutdown After Excitation HPM Pulse



- The time-to-shutdown after pulse excitation is not linearly related to pulse width and peak power – there are distinct thresholds before effects are observed.

Conclusions

- Chaotic HPM pulses are **more effective** than coherent pulses at causing massive disruptions in high speed digital circuits, resulting in **corrupted data.**
- HPM pulses can cause output voltage fluctuations and even **shutdown states** in standard power supplies – a **catastrophic** system wide failure.
- The wideband nature of chaotic signals enable them to disrupt a **wide variety** of circuits – detailed **prior knowledge** of targeted electronics **not needed**.

Acknowledgements

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