

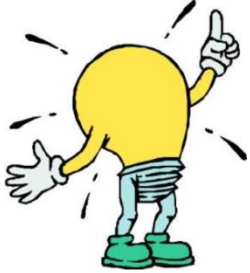


Pulse Test of Firing Capacitor Characteristics

NDIA Fuze Conference
Baltimore, MD
7-9 July 2015



Insight

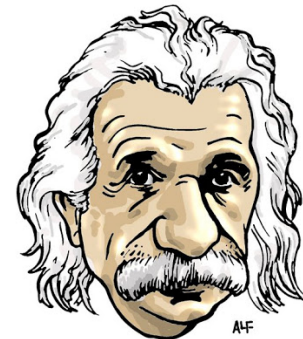


Generally I'm not known for being too bright,

But, a Google search can make you an instant genius !

Google

=





Source of Technique

**A Web search turned up a “Technical TidBit” on the referent web site
“Measuring Capacitor Self-Inductance and ESR”**

**The purpose was to measure inductance and ESR
with regards to the capacitors’ pulse performance as a
bypass capacitor in a digital circuit or its ability to
shunt current in an ESD role.**

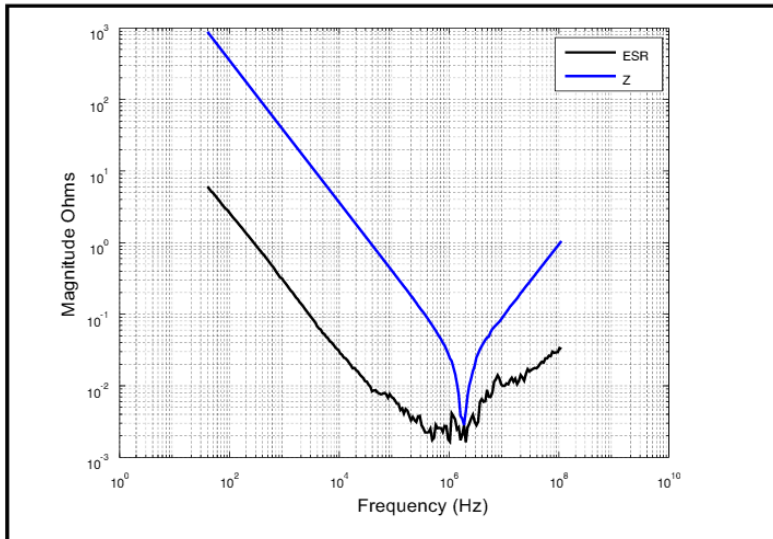
**High Frequency Measurements Web Page
Douglas C. Smith
URL: www.dsmith.org**





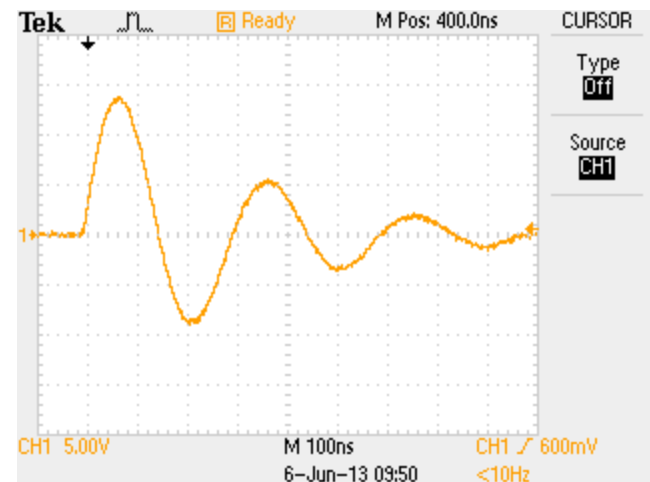
New Application

Z and ESR C1210C475M5R1C



**Most capacitor data is given at AC.
Some data is DC but not pulse.**

**When we perform a ringdown test,
We are looking for peak amperes,
inductance, and resistance.**

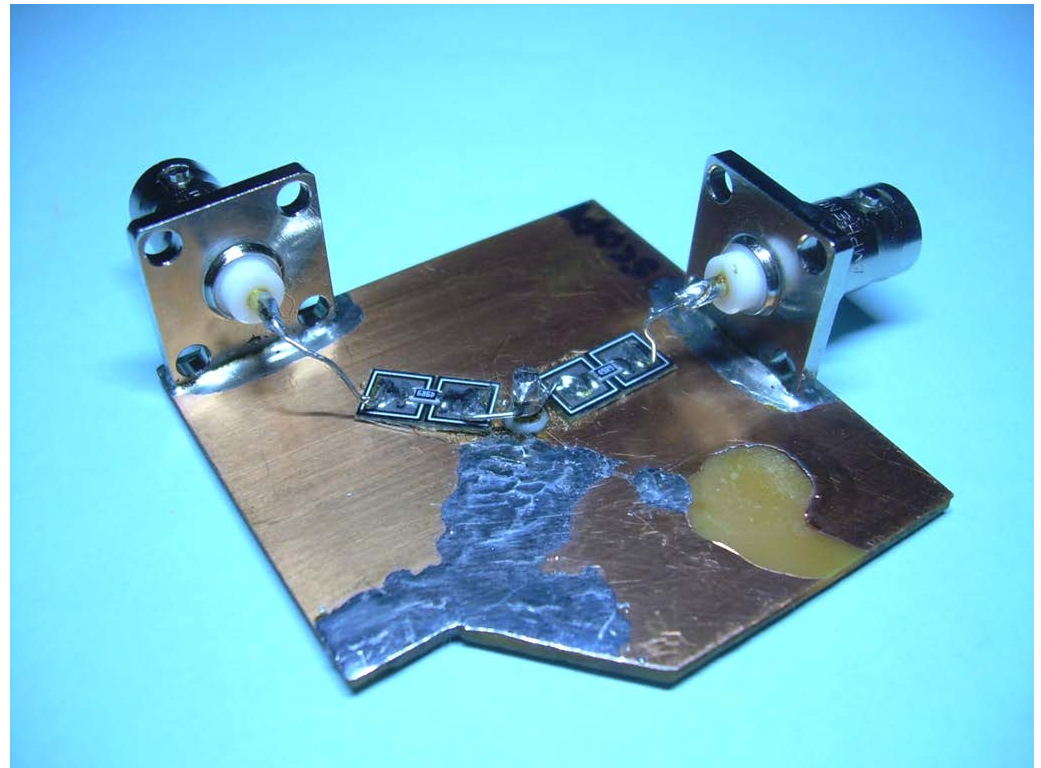




Pulse Testing

So, can we do pulse testing, and how does it relate to ringdown data?

Doug Smith Fixture



New Test Fixture

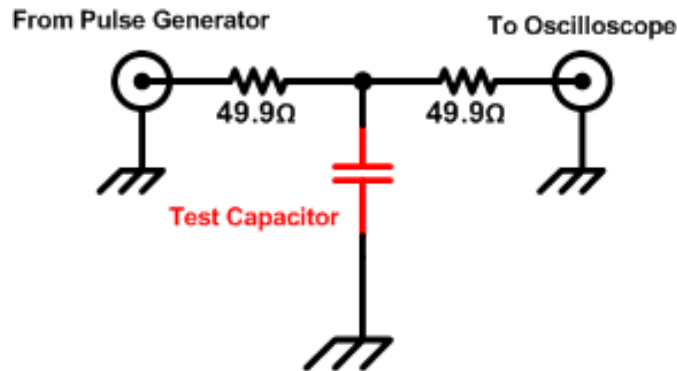


Test Set-Up

Pulse Generator
1 μ sec pulse
2.5 volt amplitude
50 Ω source



Oscilloscope 100 MHz or Better
5 mv / div, 10 nS / div-typical
Dependant on inductance, etc.

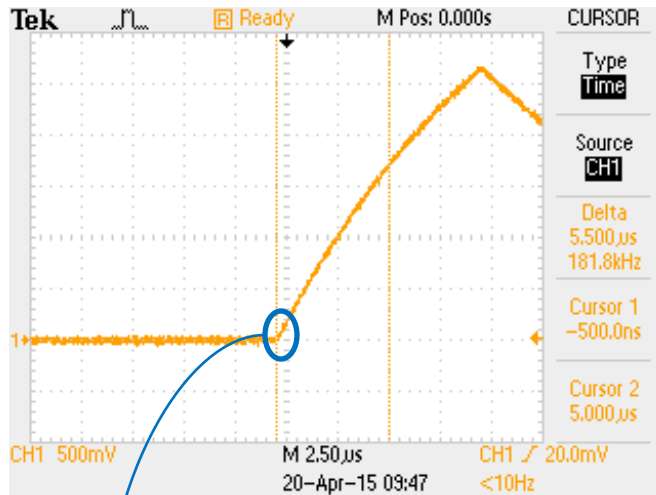


Use 50 ohm coax cables
with BNC connectors, ~ 2 Ft
and equal lengths.

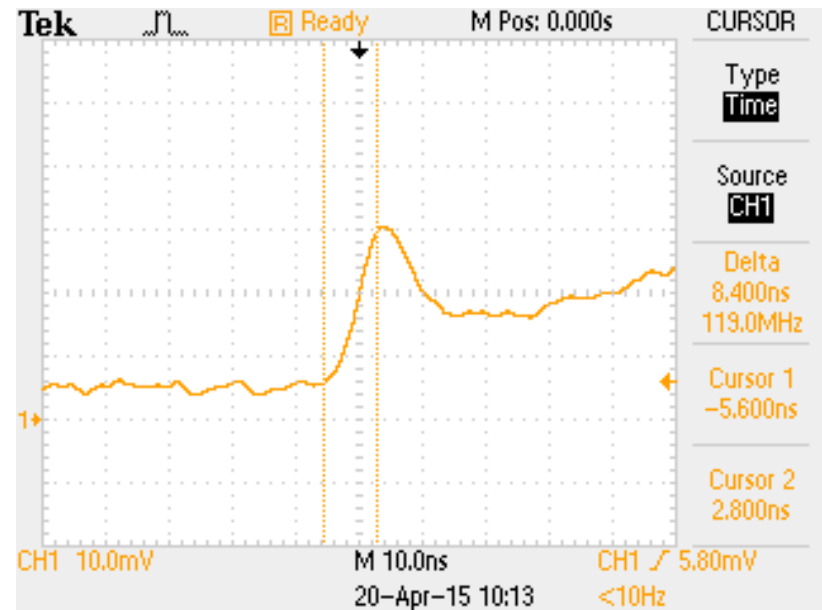


What Do We See?

Typical Capacitor Charge Waveform



If we zoom in, this is what we see !

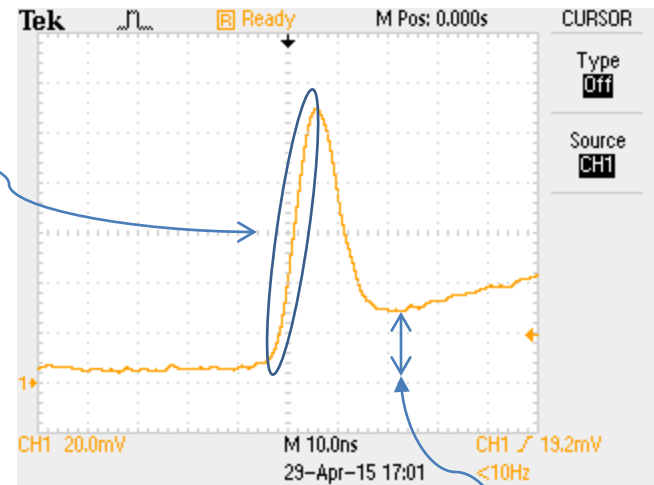
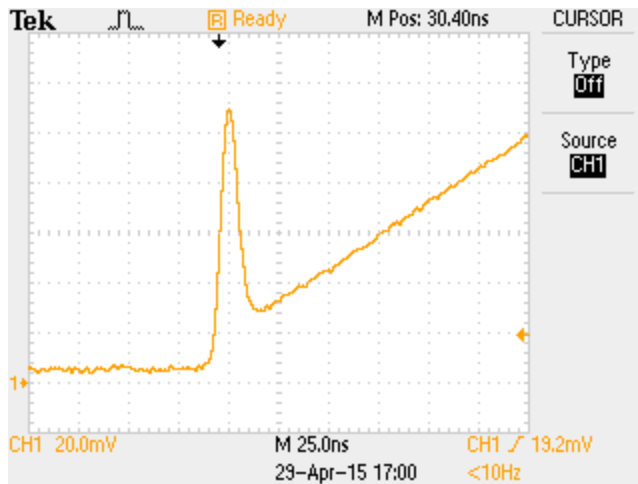




What Does That Waveform Represent?

Parasitic Inductance of Capacitor,

$$L = \frac{E}{\left(\frac{di}{dt}\right)}$$



ESR of Capacitor,

$$R = \frac{E}{I}$$

Since we use a 2.5 volt pulse into a 50 ohm resistor, current, I (di) is 50 mA



Testing

Like a Kid with a new toy, I started testing all kinds of stuff!



Capacitors

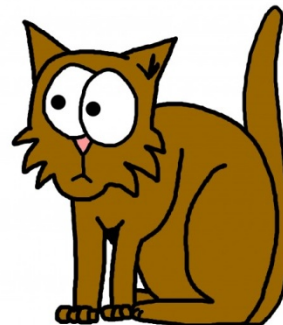
NovaCap
Wright
Poly Film
High voltage ceramic
Regular chip ceramic

CVRs

Barrel
Clamp (Stripline)

Resistors

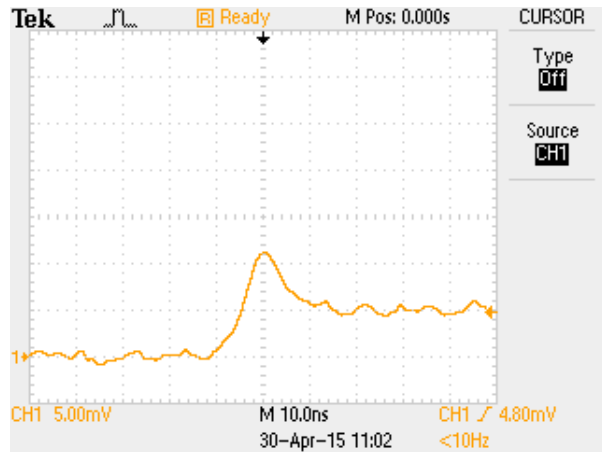
Inductors



But, not the cat

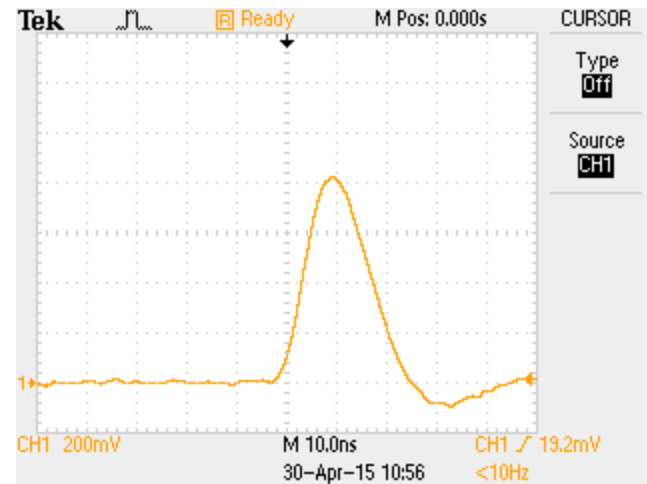


General Parts



**Surface Mount Resistor, .10 Ohms
Measured L=2.2 nH, R=100.73 mΩ**

**Molded RF Inductor 220 nH
Measured 186 nH**





Firing Capacitors

Summary of Pulse Test vs. Ring Down in Freddie Fireset

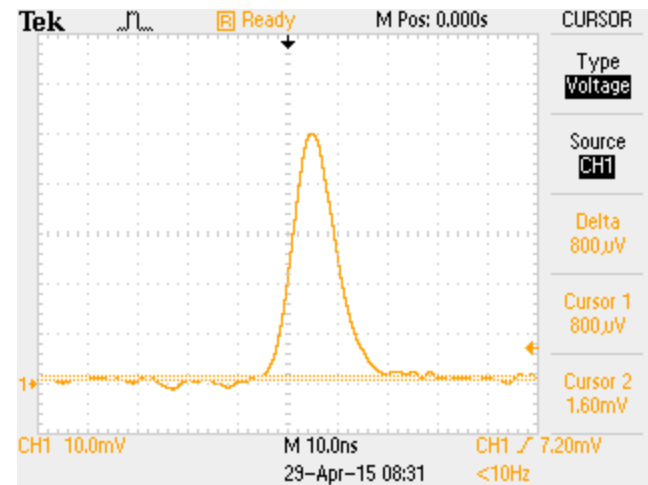
Pulse Test		Ring Down	
NovaCap 3640R144K152P		I_{PEAK}	2544 A
L=	1.530 nH	L=	13.72 nH
R=	126 mΩ	R=	42.31 mΩ
Wright SMN6964TR		I_{PEAK}	2035 A
L=	4.115 nH	L=	16.49 nH
R=	213 mΩ	R=	65.74 mΩ
Vishay PolyFilm ?		I_{PEAK}	1487 A
L=	13.65 nH	L=	35.52 nH
R=	237 mΩ	R=	65.74 mΩ



Barrel CVR Measurement



**Pulse Measurement Data:
L=9.259 nH, R=15.9 mΩ**



**CVR Resistance is .005087 Ω,
At 50 mA, E ≈ 258 µV.**

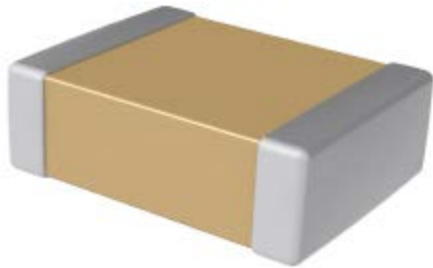
Not likely to measure that on my scope!

But, it could also imply 10 mΩ of Fixture Resistance.

Clamp CVR is ~ 2 nH less



A Potential Firing Cap ?



Kemet C2225C104KFRACTU

0.1 μ F, 1.5 KV

**High Voltage X7R Dielectric, 500 – 3,000 VDC
(Commercial & Automotive Grade)**

Pulse Data: L=1.49 nH, 130 m Ω

So I put two in parallel, must be twice as good, right?

2 in Parallel, Pulse Data: L=1.02 nH, 94 m Ω

Well, not quite!

Have not performed ring down yet. Most all data sheets say X7R material not suitable for pulse applications. Need to run that to ground.



Summary

- ▶ The test method may have value in testing potential capacitors and measuring other components
- ▶ There appears to be a correlation between pulse inductance and performance
- ▶ There is a weak correlation between pulse ESR and performance



Questions?

Fred E. Piering
Weacomm, Inc.
2585 Tuscaloosa Trl
Maitland, FL 32751-5149
weacomm@earthlink.net
Office: 407-645-1688
Cell: 321-356-0239