A Basic Measurements Analysis of the Rosemary Ainslie Claimed COP=17 Heater Device

– Problems and Solutions Identified with the Ainslie Team's Measurements and Test Setup

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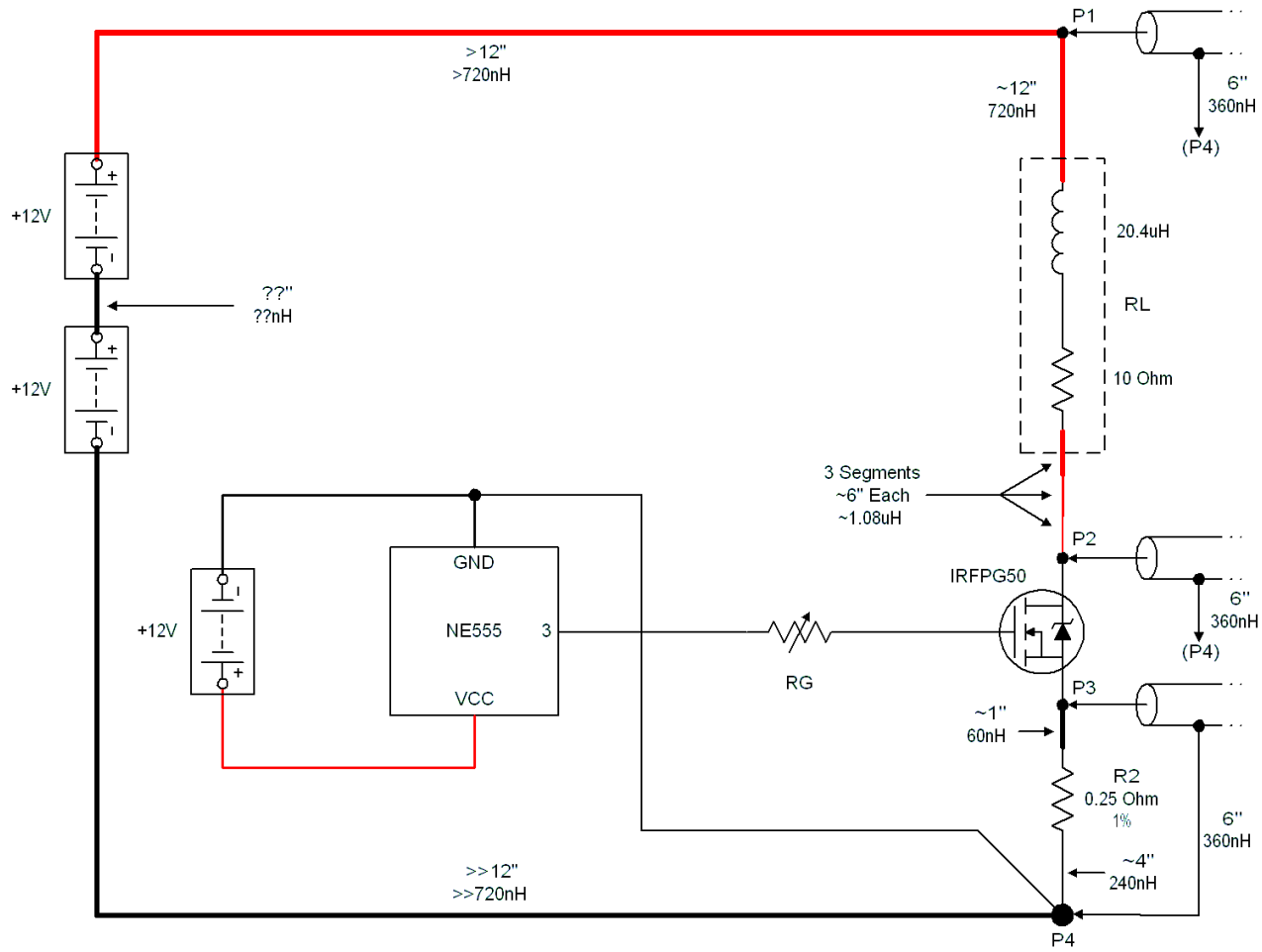
v02



Fuzzy's DUT Circuit - Probe Locations and ~Wire Lengths

Relative Wire Gauges used as per photographs provided by Fuzzy.

P6139A Probe with 6" ground lead.

- Inductance based on typical 60nH per inch of wire. Actual nH/inch may vary slightly with wire type.
- Shunt Inductance between probe tip and gnd lead ~ 300nH total; inductive reactance @ 7MHz ~ **13.2 Ohms**.
- Shunt probe gnd lead inductance ~360nH; inductive reactance @ 7MHz ~ **15.8 Ohms**.
- Inductance between battery terminals and scope probe >> 1.44uH; inductive reactance @ 7MHz >> **63 Ohms**.

Figure 1

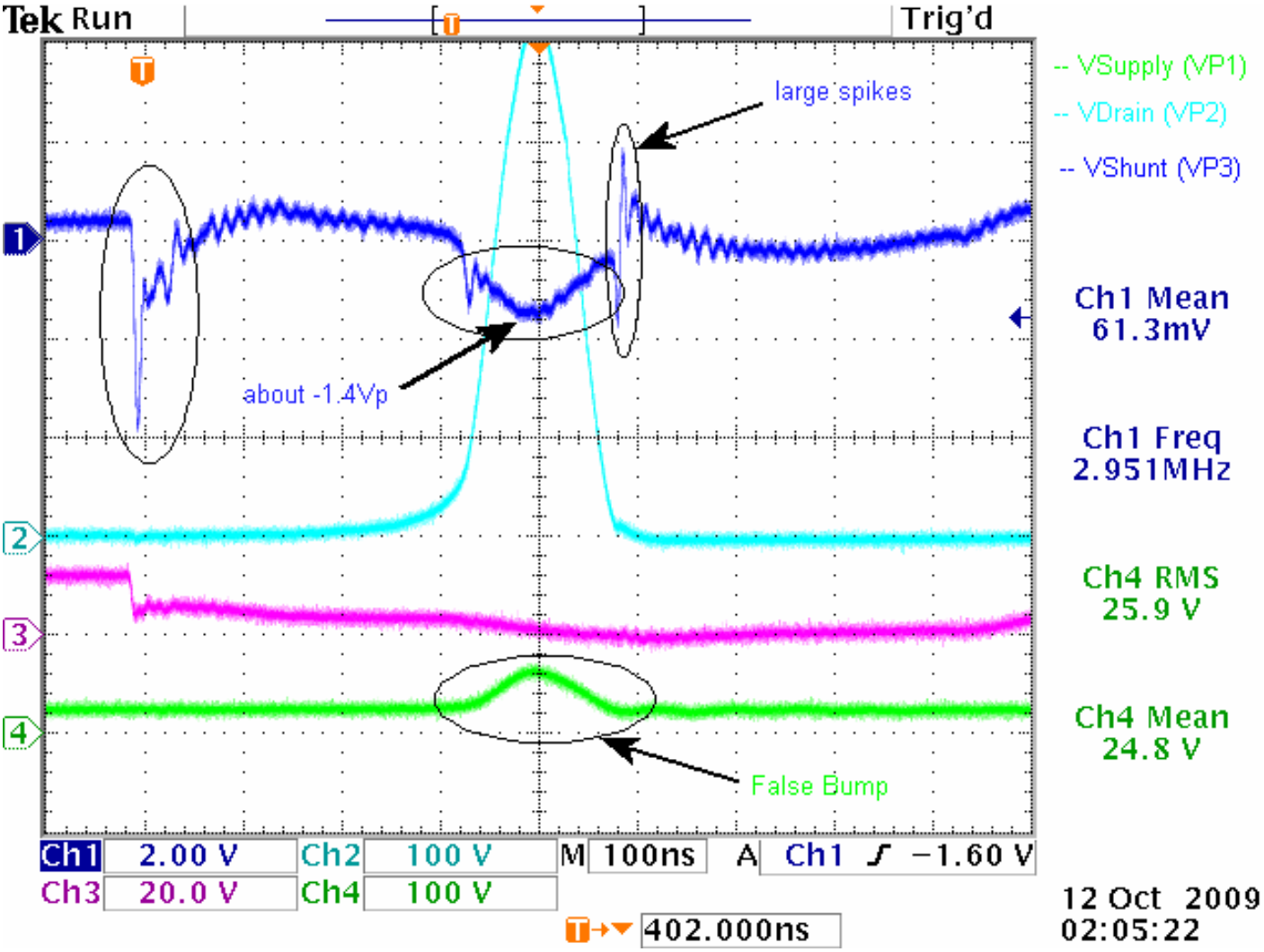
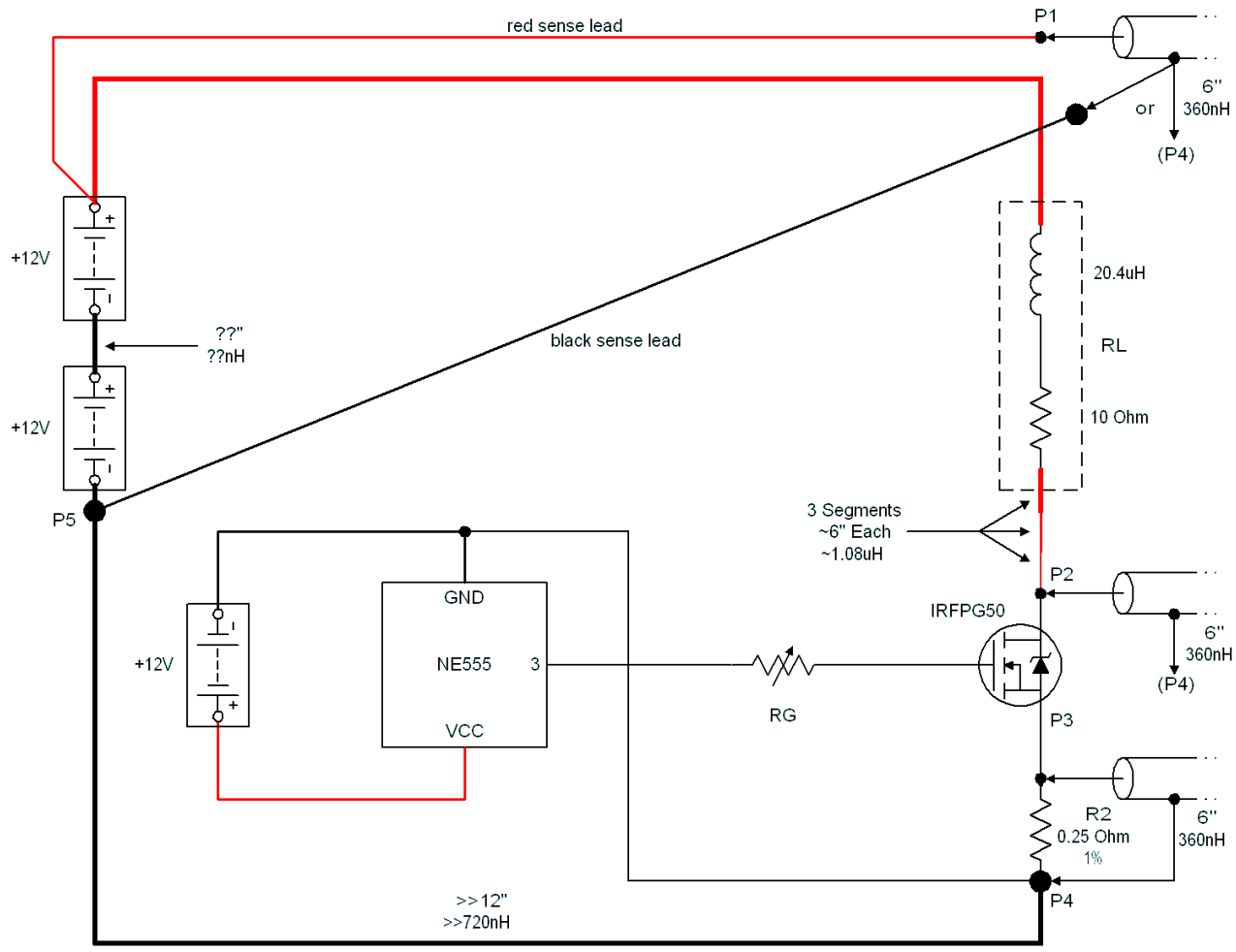


Figure 1a – Before "First Approach" Improvements

In this figure we clearly see the two problems plaguing the Ainslie Team with their power calculations. First, there is an elevated negative voltage excursion evident on the shunt resistor, and second, a falsely-elevated voltage "bump" on the battery voltage probe.

Both of these erroneous measurements are the result of excessive inductance between the measurement point where the probe leads are placed, and the desired measurement point. Figure 1 clearly illustrates what is causing this excessive inductance. There is about 300nH of inductance skewing the shunt voltage measurement, and greater than 720nH of inductance skewing the battery voltage measurement, as shown in Figure 1.



Fuzzy's DUT Circuit - Probe Locations and ~Wire Lengths
Proposed Improvements - First Approach

Relative Wire Gauges used as per photographs provided by Fuzzy.

P6139A Probe with 6" ground lead.

- Inductance based on typical 60nH per inch of wire. Actual nH/inch may vary slightly with wire type.
- Shunt Inductance between probe tip and gnd lead now reduced to near 0nH; negligable reactance.
- Shunt probe gnd lead inductance ~360nH; inductive reactance @ 7MHz ~ **15.8 Ohms**.
- Inductance between battery terminals and scope probe reduced by 720nH by introducing red sense lead. Almost complete elimination of the inductive effects can be realized by also using the black sense lead as shown, however a ground loop is introduced which may cause problems with the shunt measurement. Experiment with both P4 and P5 for the battery probe ground, but this clearly illustrates the limitations of using a single-ended probe for both measurement points.

Figure 2

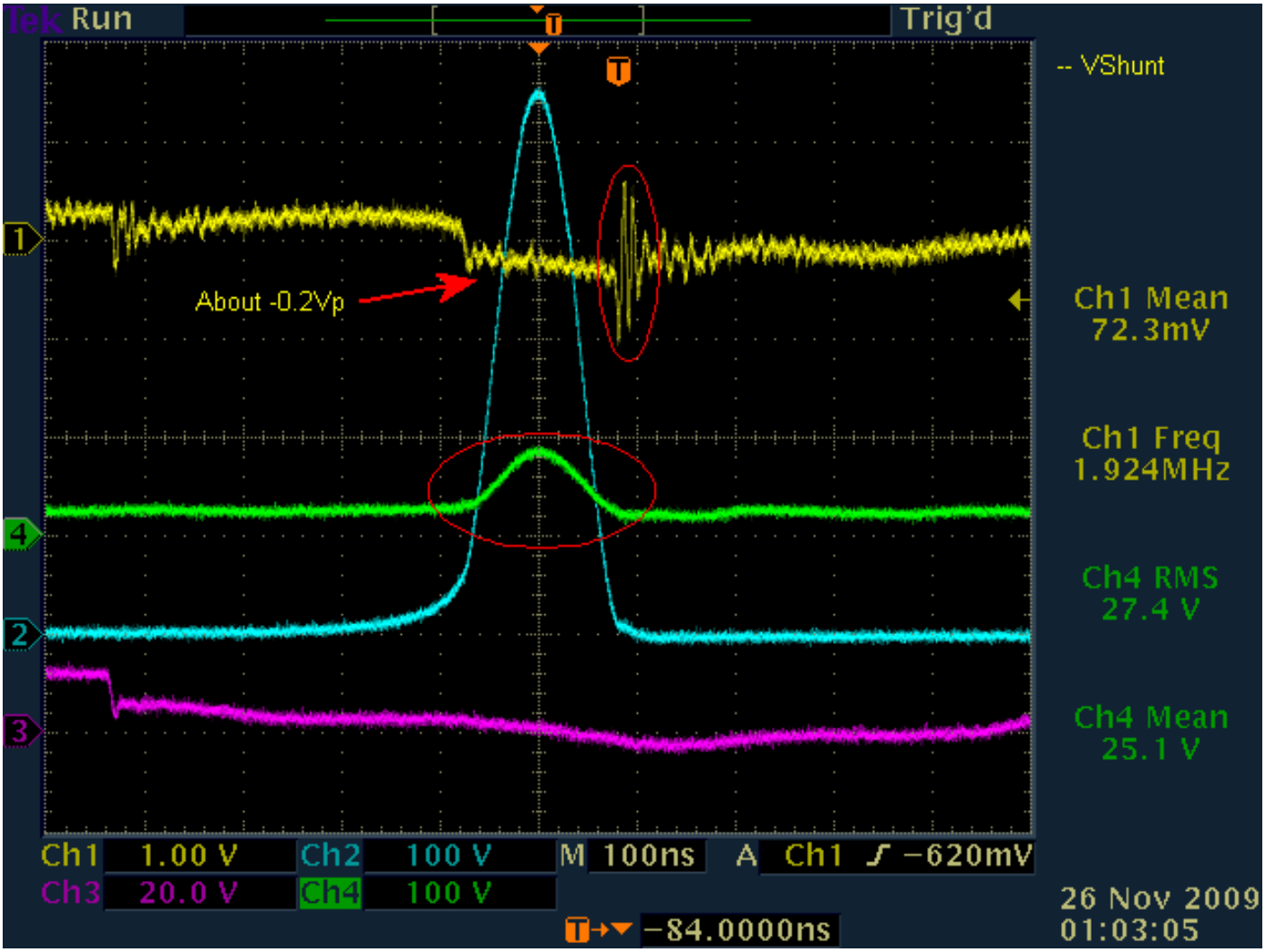


Figure 2a – After partial implementation of First Approach improvement

This figure from Fuzzy's test #12 illustrates what happens when part of the inductance in the shunt resistor measurement is eliminated, simply by repositioning where the probe ground leads are terminated. In this case the change was small but made a marked improvement on the spike and overall amplitude of the trace. The change involved moving the probe ground leads from the end of a 4 inch wire, directly to the bottom of the shunt resistor—a reduction of about 240nH worth of inductance. This is represented as P4 in Figure 2.

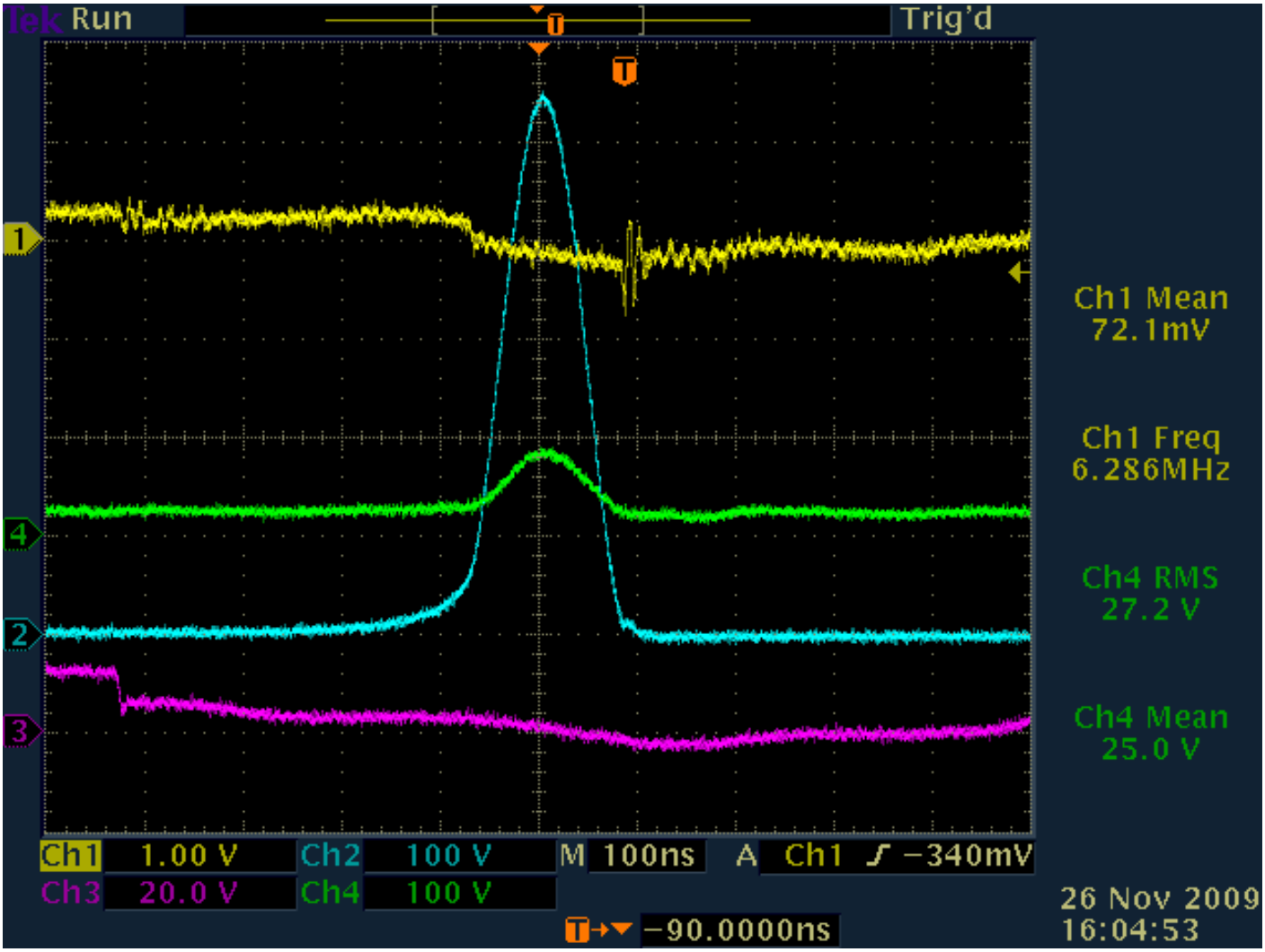


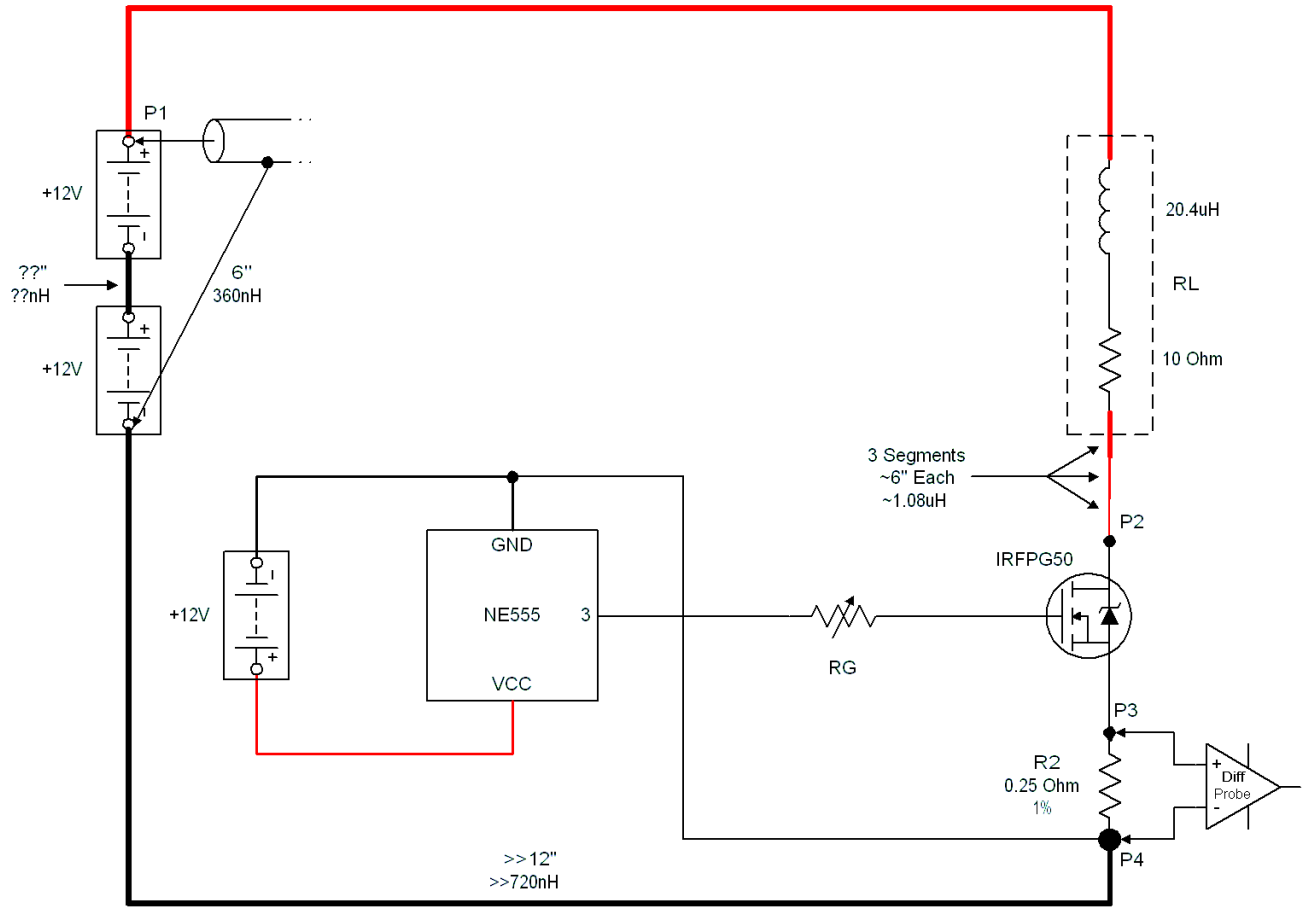
Figure 2b – After another partial improvement on the shunt resistor

From Fuzzy's test #13 we see the completion of the shunt resistor improvement from the "First Approach" diagram in Figure 2. The probe tip was relocated from the MOSFET source pin, directly to the top of the shunt resistor. Another marked improvement in the false negative voltage being measured across the shunt resistor, which is evident when compared with Figure 2a above. There is even less amplitude in the spike, and overall less amplitude in the negative excursion.

This small physical change represents the reduction of only about 60nH worth of inductance, but it was clearly contributing to the skewed measurement.

In both cases the battery voltage "bump" is still present, however by implementing the other part of the 'First Approach" improvement by utilizing the sense leads shown, this can also be substantially reduced.

The other improvements that follow require different scope probes, which apparently, the AT does not have, therefore are not able to implement. A quasi-differential measurement may be attempted in order to implement the "Second Approach" improvement shown in Figure 3 below, but for superior accuracy, it would be preferable to use a true differential probe.



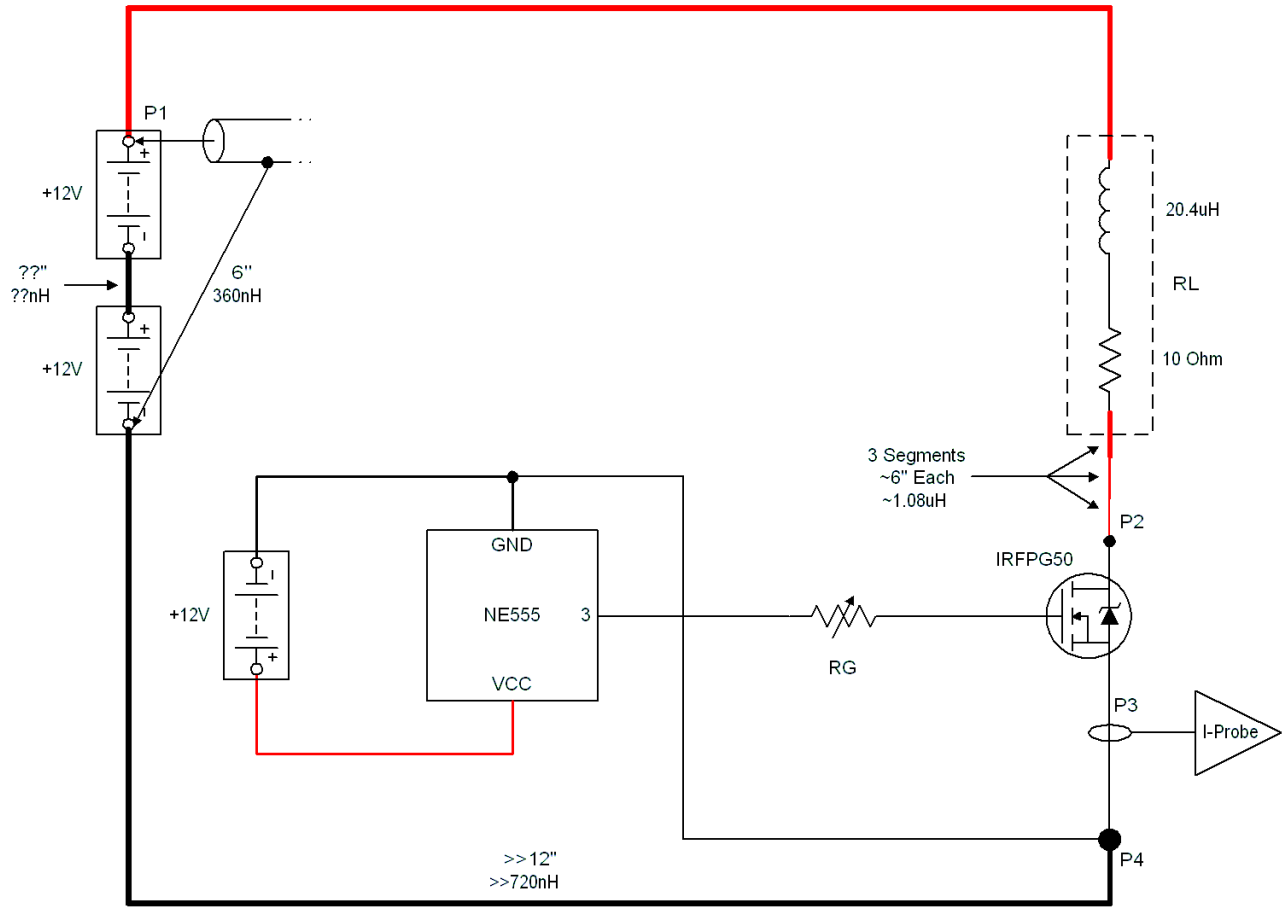
Fuzzy's DUT Circuit - Probe Locations and ~Wire Lengths
Proposed Improvements - Second Approach

Relative Wire Gauges used as per photographs provided by Fuzzy.

P6139A Probe with 6" ground lead.

- Inductance based on typical 60nH per inch of wire. Actual nH/inch may vary slightly with wire type.
- Shunt Inductance between probe tips reduced to near 0nH, Diff probe used, therefore no gnd issue.
- Battery probe gnd lead inductance ~360nH; inductive reactance @ 7MHz ~ **15.8 Ohms**.
- Inductance between battery terminals and scope probe almost completely eliminated. No ground loop issue if probe P2 is not used (not required to prove thesis per Rosemary Ainslie).

Figure 3



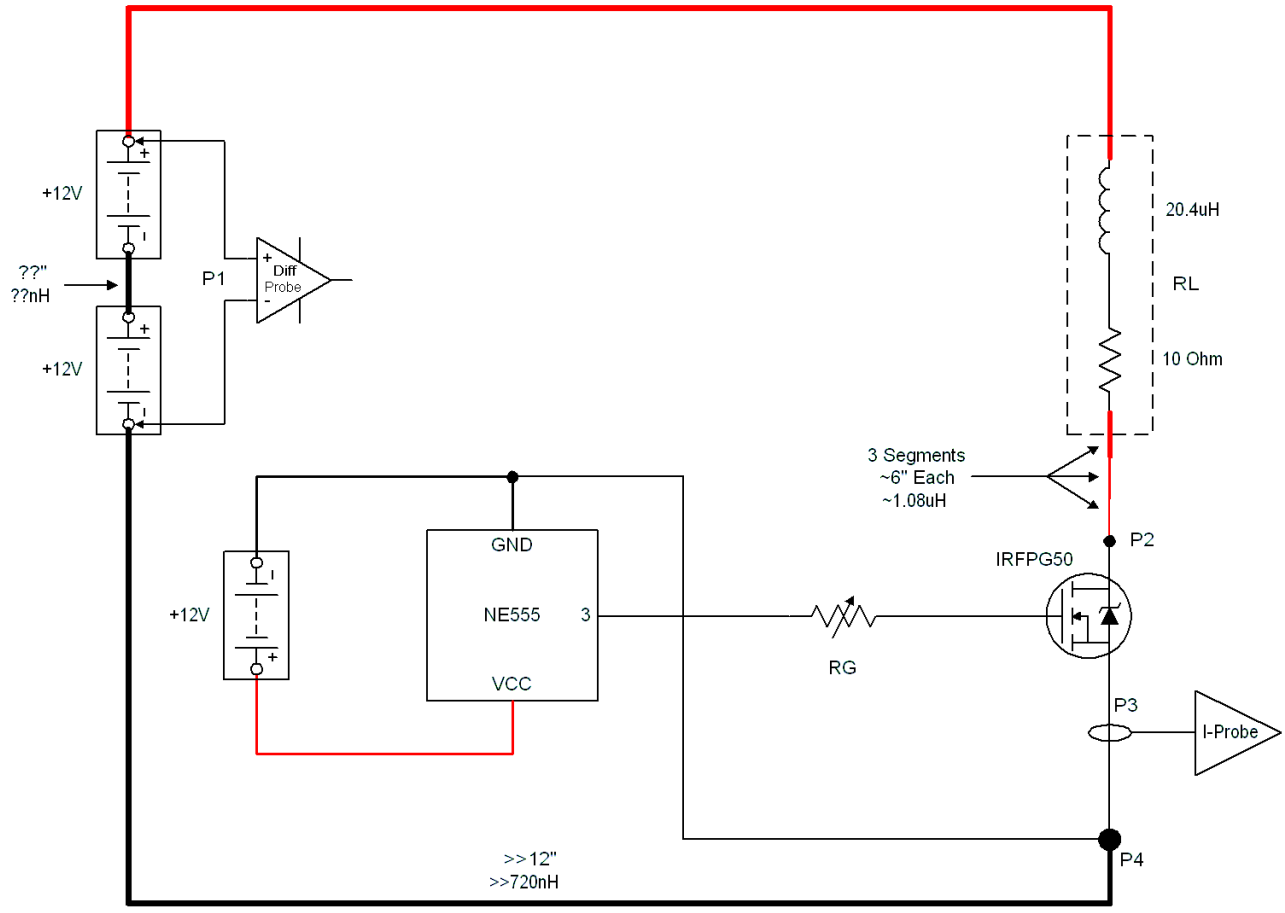
Fuzzy's DUT Circuit - Probe Locations and ~Wire Lengths
Proposed Improvements - Third Approach

Relative Wire Gauges used as per photographs provided by Fuzzy.

P6139A Probe with 6" ground lead.

- Inductance based on typical 60nH per inch of wire. Actual nH/inch may vary slightly with wire type.
- Shunt eliminated in favour of Current Probe (TCP202). No ground or minute inductance issues present.
- Battery probe gnd lead inductance ~360nH; inductive reactance @ 7MHz ~ **15.8 Ohms**.
- Inductance between battery terminals and scope probe almost completely eliminated. No ground loop issue if probe P2 is not used (not required to prove thesis per Rosemary Ainslie).

Figure 4



Fuzzy's DUT Circuit - Probe Locations and ~Wire Lengths
Proposed Improvements - Fourth (Best) Approach

Relative Wire Gauges used as per photographs provided by Fuzzy.

- Inductance based on typical 60nH per inch of wire. Actual nH/inch may vary slightly with wire type.
- Shunt eliminated in favour of Current Probe (TCP202). No ground or minute inductance issues present.
- Battery probe (singel-ended) replaced in favour of true differential probe (P5205). Gnd lead inductance/resonance issue eliminated.
- Inductance between battery terminals and scope probe almost completely eliminated. An additional single-ended probe may now be used if desired to measure point P2 on the MOSFET Drain with no compromise in the other measurements.

Figure 5