

Electrical Current Requirements of Model Rocket Igniters

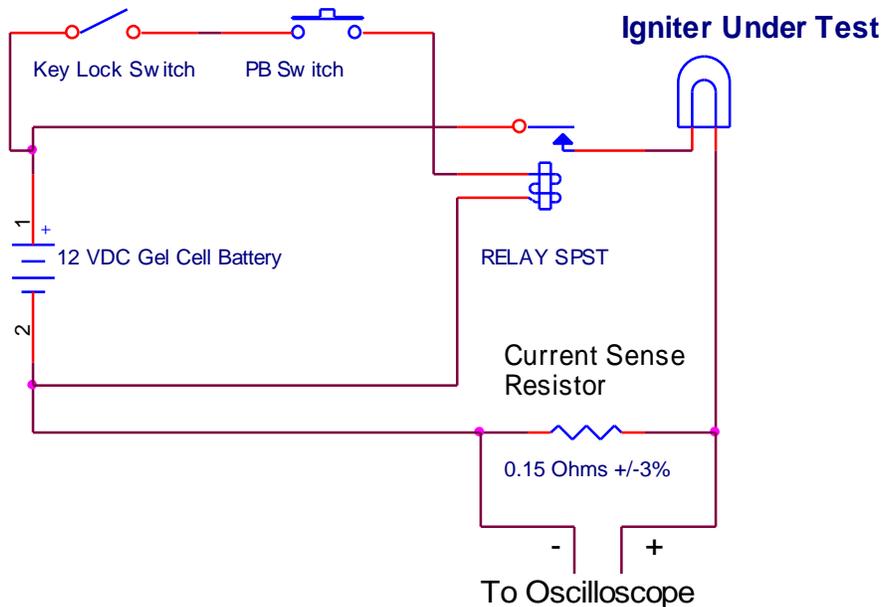
By: Robert Briody ©2000

Overview

Every model or high power rocket flight begins with a single event. An igniter or electric match is electrically initiated which in turn ignites the blackpowder or composite propellant. For such a critical role, little technical information is available regarding the electrical characteristics of these devices. Some manufacturers of electric matches provide "no fire" and "all fire" current. Ratings for their devices. While important from a safety perspective, this information conveys nothing as to the devices true electrical characteristics. This document will shed some much needed light on the electrical characteristics of electric matches. The waveforms shown through out this document were take using a Hewlett-Packard 2Gs digitizing oscilloscope.

Test Setup

Battery Type: 12 Volt Sealed Lead-acid Gel Cell
Battery Capacity: 7 AHr
Battery Voltage: 13.04 VDC
Current Sense Resistor: 0.15 Ohm +/-3%
All high current wiring uses #16 stranded copper wire.
Oscilloscope: Hewlett-Packard 554520A digitizing oscilloscope



Test Process

Three igniters of each type were test fired. The current waveform of each igniter was plotted. A "typical" waveform from each igniter set tested was selected for this article. The waveforms shown in this article represent the voltage drop across a 0.15 Ohm resistor. Though the waveforms are voltage, from Ohm's law, $I=E/R$, we can convert the waveforms to current. The plots showing a scale of 500mVper division are actually 3.33 Amps/division.

Test Results

The first electric match tested was the DaveyFire N28F (black wire). The waveform shown in Figure 1, below represents the current consumed by the igniter. From Ohms law ($I=E/R$) we see the peak voltage to be 2.125 volts across a 0.15 ohm resistor or 14.16 amps! The manufacturer's data sheet specifies the current as "2 amps for 40 milliseconds". The "no fire" current is specified at 0.4 amp and "all fire" current at 1.00 amp. Depending on the application, the manufacturer's specification can be misleading and lead to less than desirable results for the unsuspecting rocketeer.

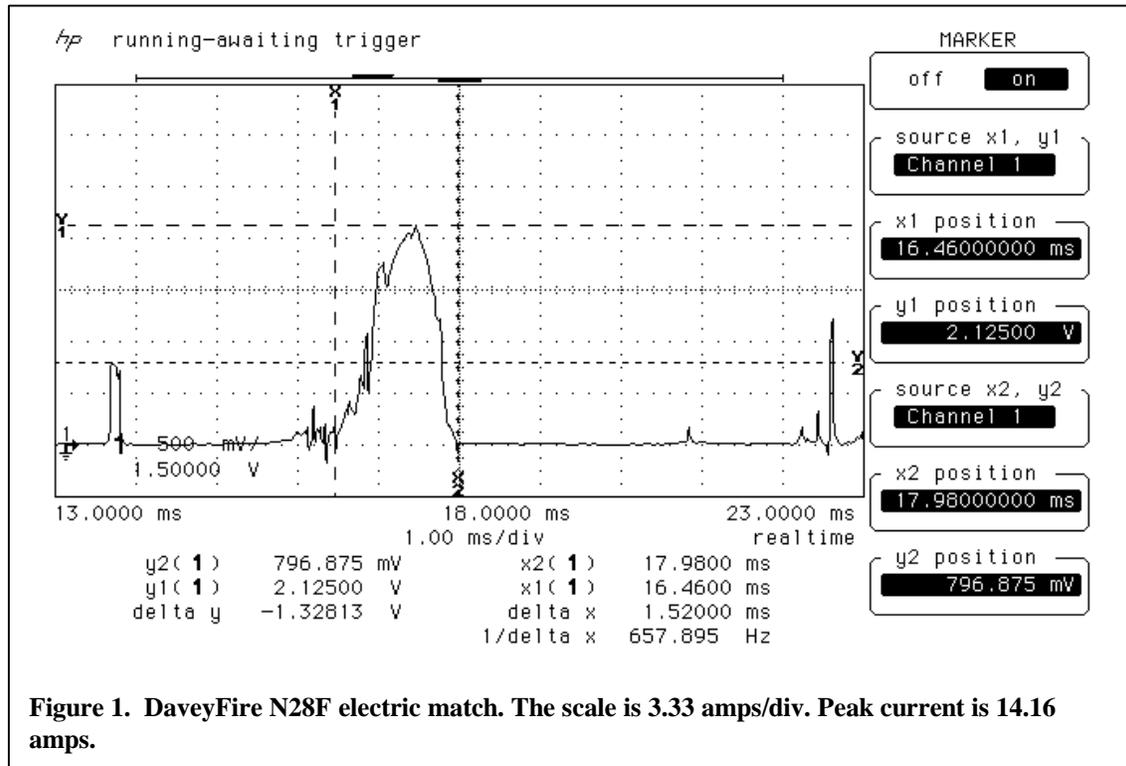
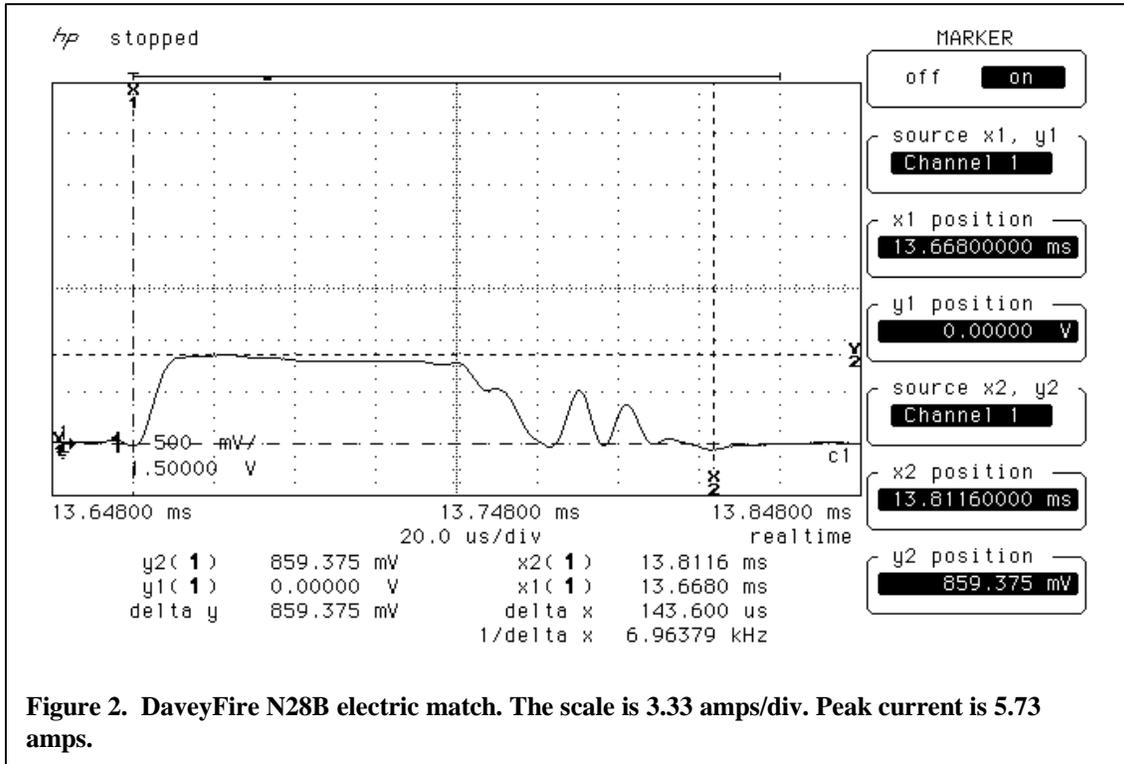
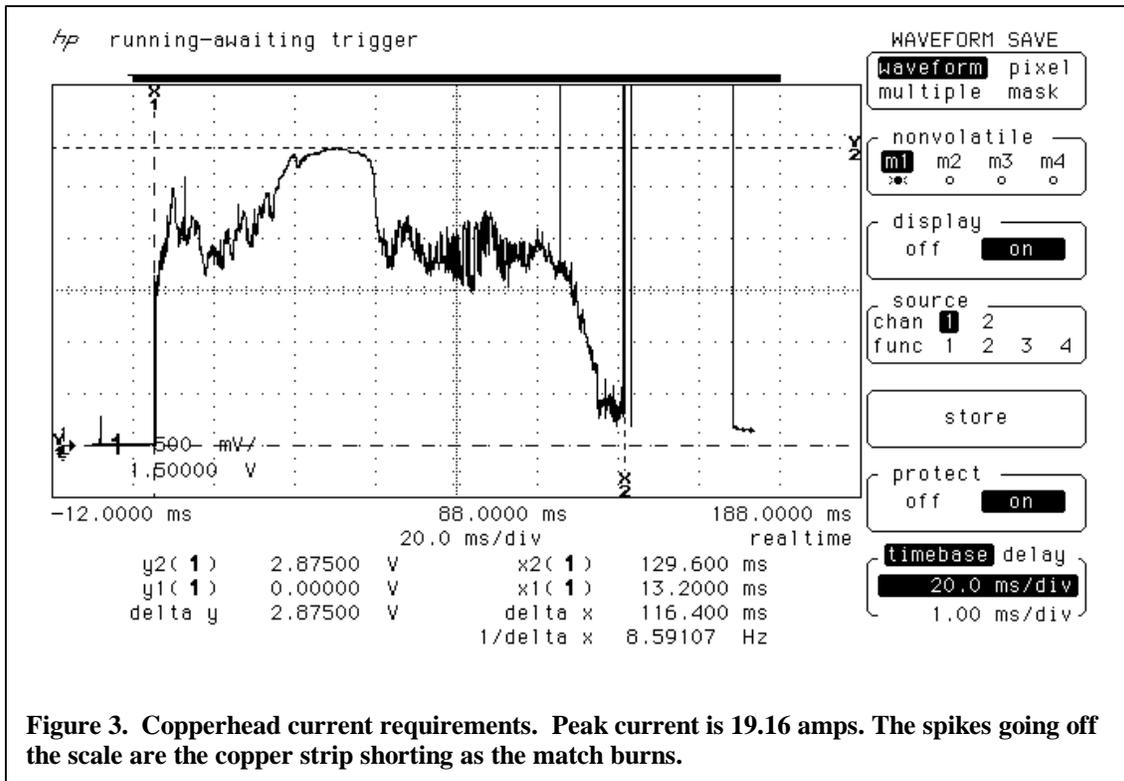


Figure 2 shows the relatively low current requirements of the DaveyFire N28B electric match. Peak current required is 5.73 amps. The manufacturer's literature says 1 amp for 2 milliseconds.



The next electric match tested was the Aerotech Copperhead from a G64 RMS motor. To make it reliable and compatible with alligator clips, I delaminated the entire length, except for the last 2 inches.



After the Copperhead, I tested the IgniterMan Igniter (#24 wire electric match). Figure 4 shows the current demands of an IgniterMan Igniter. Notice the ramp up in current from 6.04 amps to the peak of 18.02 amps. This current rise represents the conduction current of the gas plasma produced by the burning pyrogen.

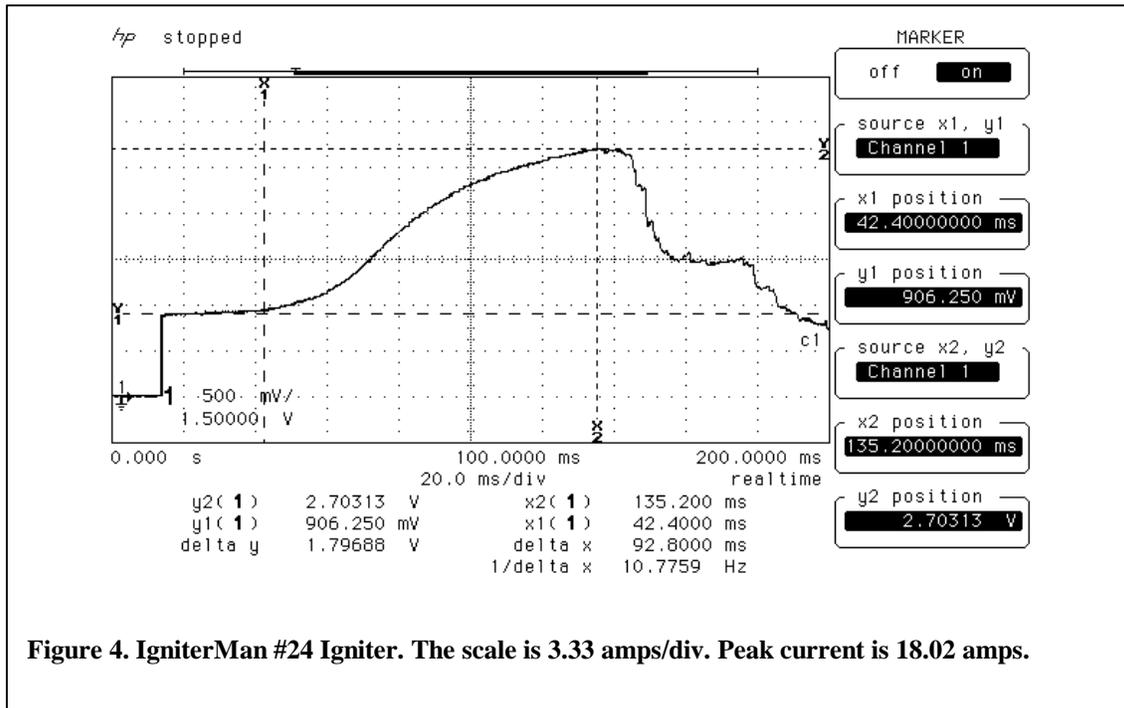


Figure 4. IgniterMan #24 Igniter. The scale is 3.33 amps/div. Peak current is 18.02 amps.

Figure 5 shows the electric current demands for an Oxral electric match. Note the extremely low current, compared to all of the other electric matches tested. With out a doubt, this is the best electric match to use for ejection charges when avionics are used. It's relatively low current and short duration are exceptional. The Oxral match does have one detraction when used as an ejection charge initiator. The protective plastic sheath consumes a large percentage of the internal volume of a microcentrifuge tube. This in turn limits the total amount of blackpowder that can be loaded into the tube. This is easily solved by purchasing larger containers or tubes. No manufacturers data sheet was available for this electric match.

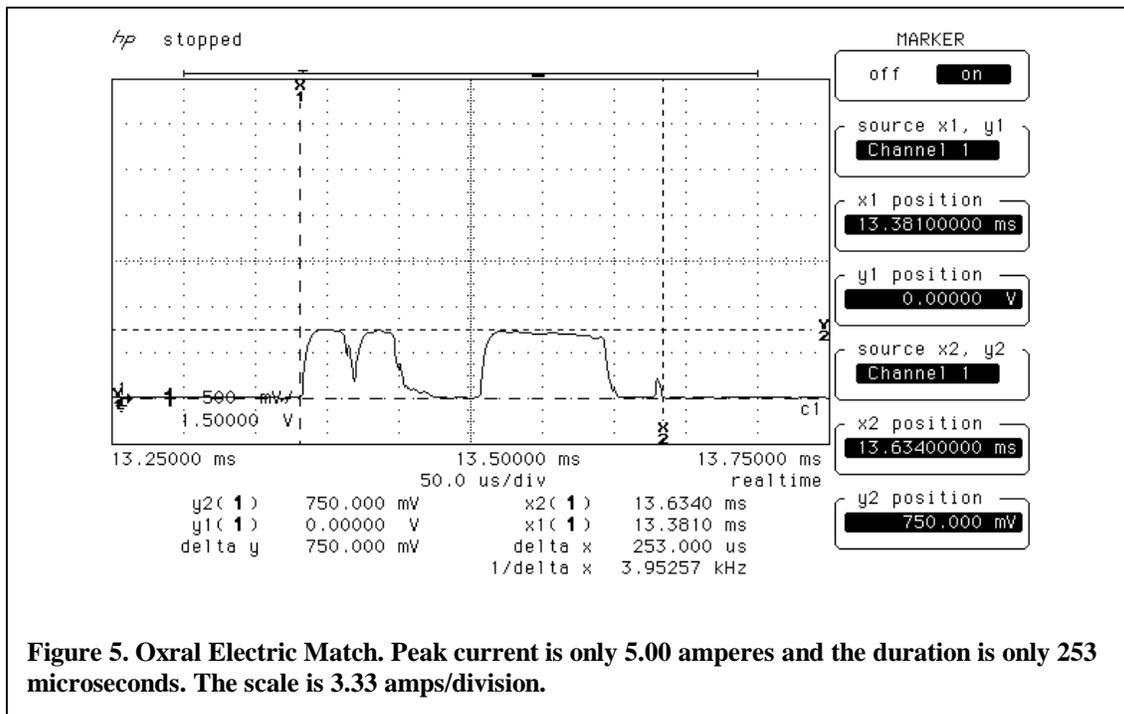


Figure 5. Oxral Electric Match. Peak current is only 5.00 amperes and the duration is only 253 microseconds. The scale is 3.33 amps/division.

Next, we'll take a look at the peak current requirements of an AG-1 Flashbulb. Figures 6 and 7 show the long term and short term current requirements, respectively. Flashbulbs are perceived to be "low current" devices. The peak current here is 9.89 amps!

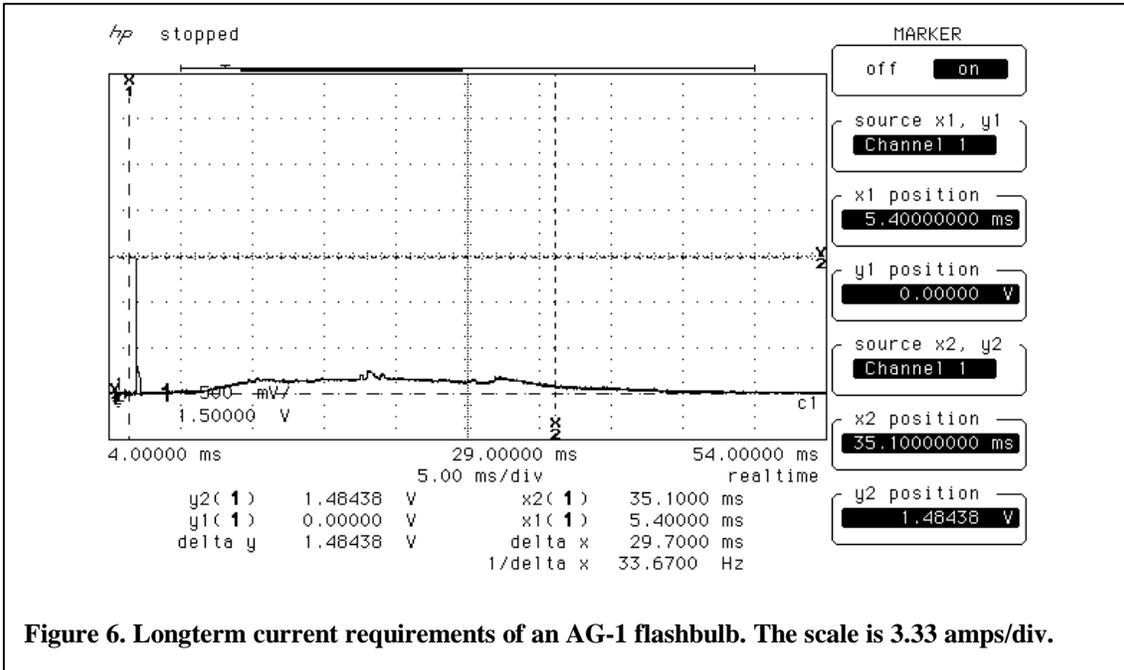


Figure 6. Longterm current requirements of an AG-1 flashbulb. The scale is 3.33 amps/div.

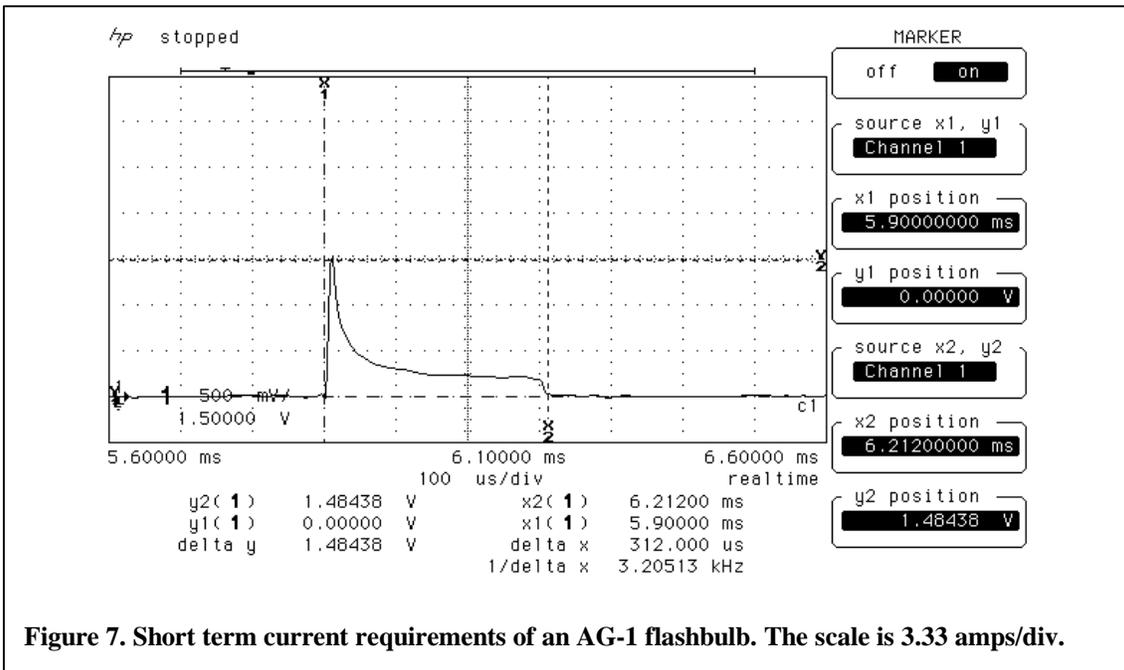


Figure 7. Short term current requirements of an AG-1 flashbulb. The scale is 3.33 amps/div.

Shown below is the current requirements for a Firestar FS-36 igniter. This is a bridge wire based device. The base wire is #24 insulated solid copper wire.

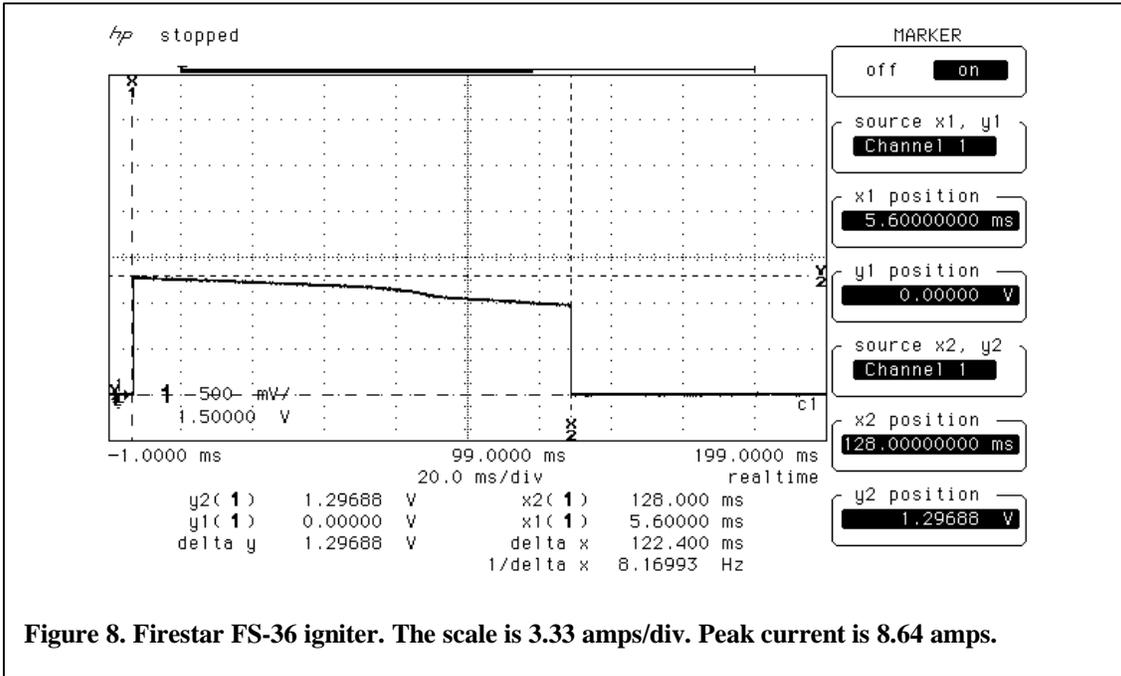


Figure 8. Firestar FS-36 igniter. The scale is 3.33 amps/div. Peak current is 8.64 amps.

Next is the Magnelite ML-32 dipped in their pyrogen. The ML32 is also a bridge wire based igniter. The base wire is #26 insulated solid copper wire.

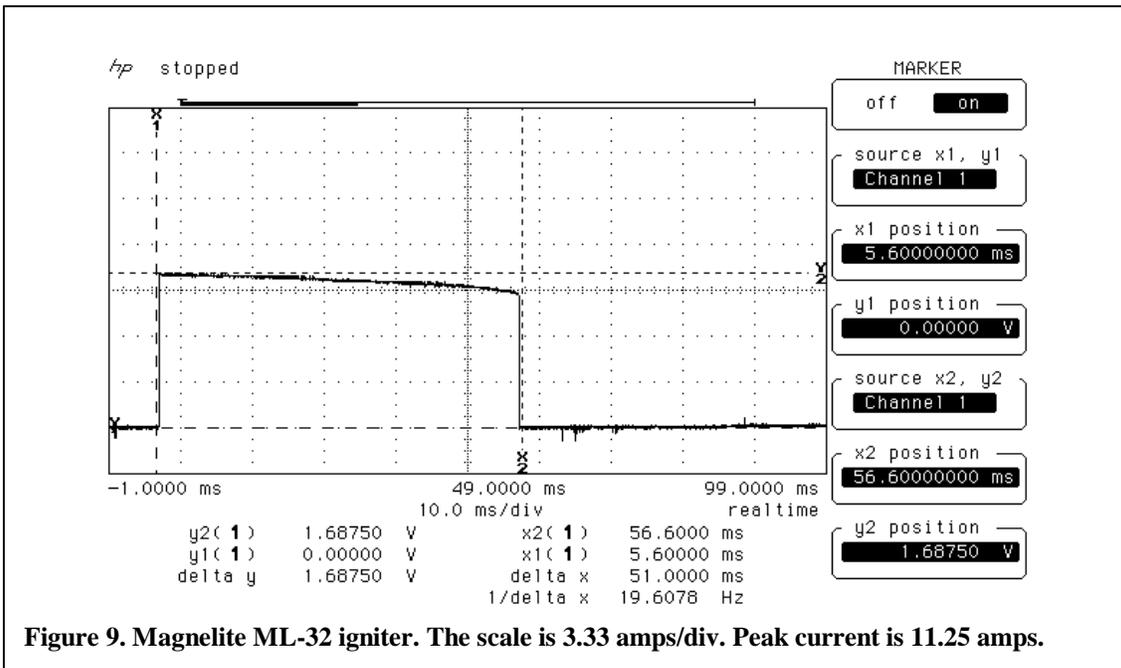


Figure 9. Magnelite ML-32 igniter. The scale is 3.33 amps/div. Peak current is 11.25 amps.

Shown in Figure 10 is a hybrid igniter. The bridge heating element is formed using IgniterMan's Conductive Primer. The pyrogen used is Magnelite.

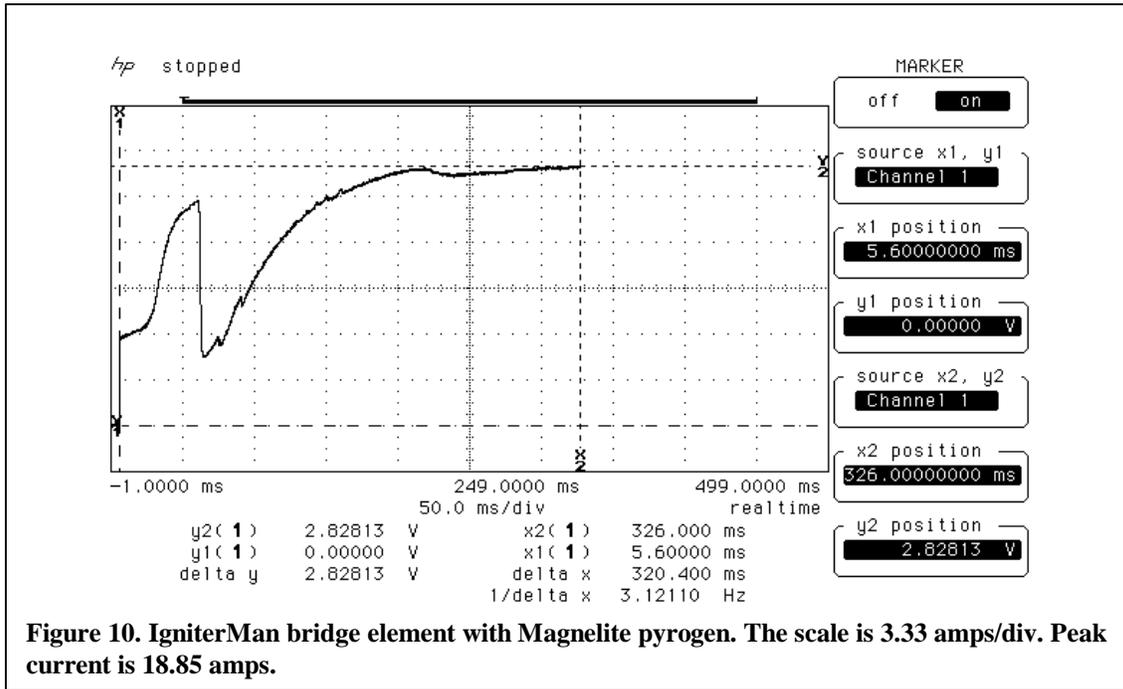


Figure 10. IgniterMan bridge element with Magnelite pyrogen. The scale is 3.33 amps/div. Peak current is 18.85 amps.

Figure 11 shows the current draw of a standard Estes igniter when connected to a 12 VDC lead-acid battery.

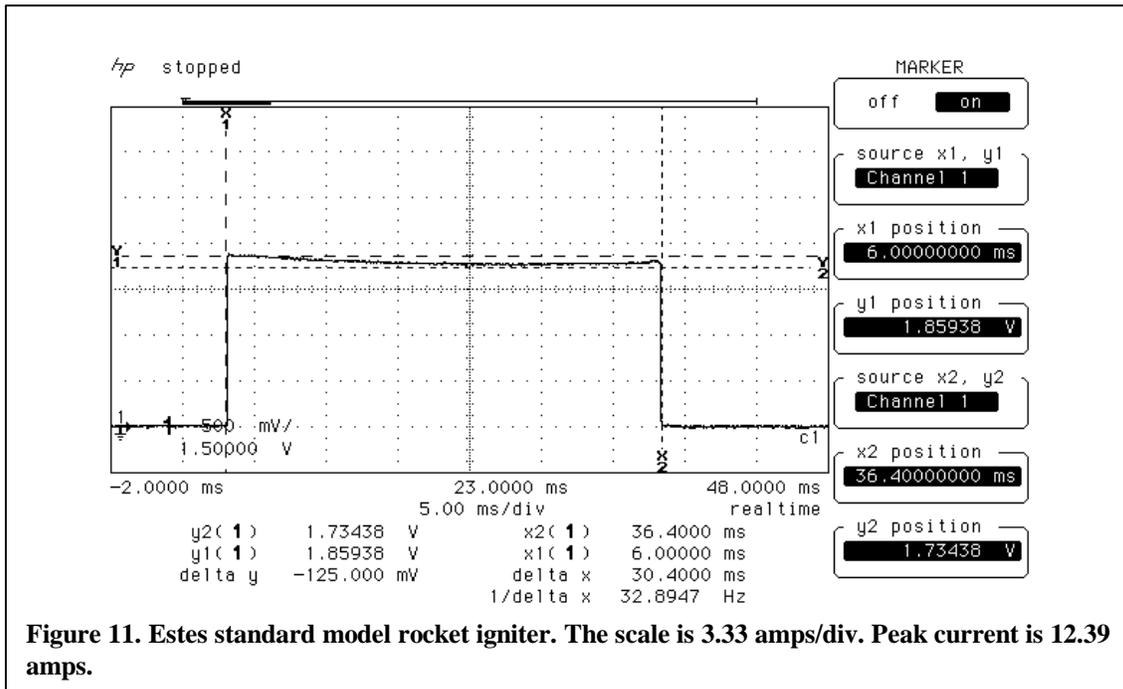
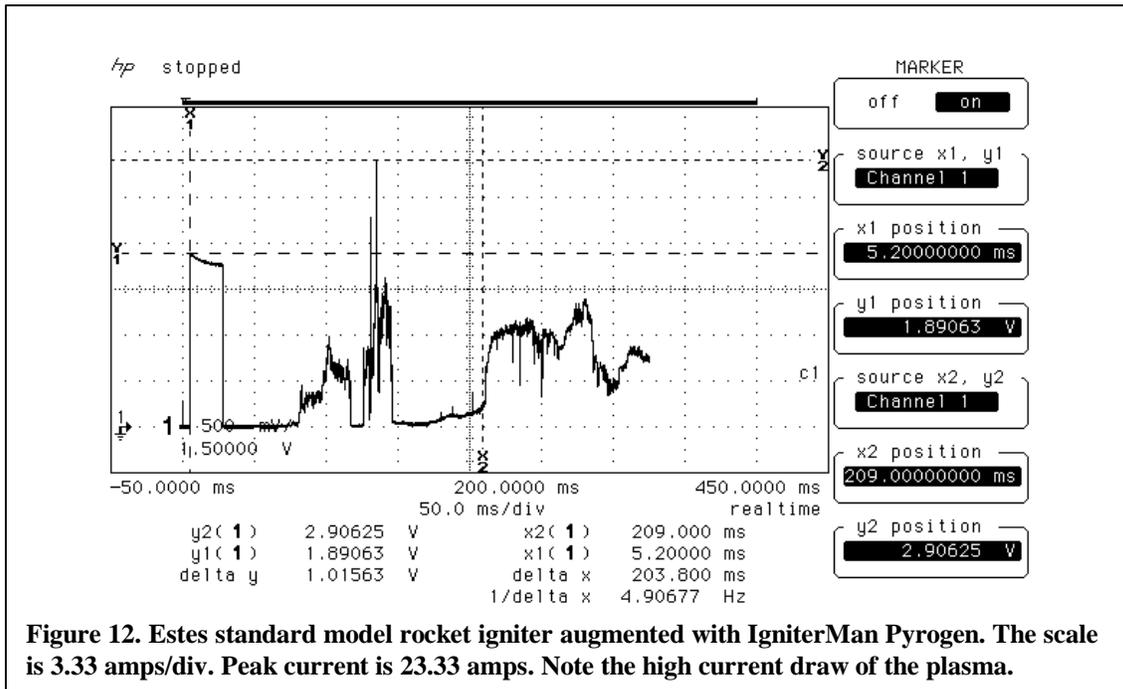


Figure 11. Estes standard model rocket igniter. The scale is 3.33 amps/div. Peak current is 12.39 amps.

Figure 12 shows the current draw of a standard Estes igniter when augmented with IgniterMan Pyrogen. Again, the igniter is connected to a 12 VDC lead-acid battery.



Electric Match Compatibility with 9 VDC Batteries

Most Altimeters and Accelerometers used for air-starting motors and recovery initiation use the standard 9VDC transistor battery. As you'll see from the following waveforms, you'll probably want to switch to using a dual battery system. In a dual battery system, one battery is used to power the computer or electronics and a second battery is used to power electric matches and the associated firing circuitry. The battery grounds are common but the Plus (+) terminal are separate and isolated. This configuration prevents power spikes or glitches, produced by firing electric matches, from causing erratic or erroneous flight computer or timer operation.

Figure 13 shows what happens when a DaveyFire N28F is placed directly across the terminals of a Standard Duracell Copper Top 9VDC alkaline battery. The battery is fresh with an open circuit voltage of 9.68 VDC. The current demands of the electric match are such the battery voltage dips to 2.56 VDC! This has serious potential for glitching or causing anomalous behavior for most ANY flight computers on the market.

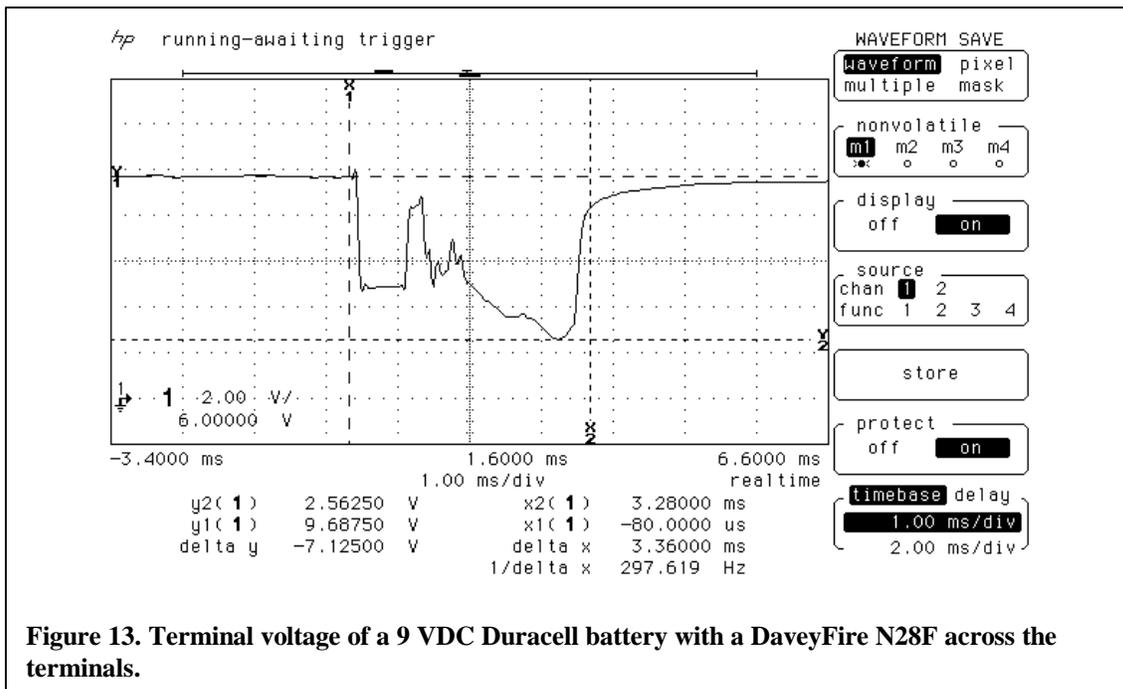


Figure 13. Terminal voltage of a 9 VDC Duracell battery with a DaveyFire N28F across the terminals.

Figure 14 shows a DaveyFire N28F across the terminal of a Duracell ULTRA 9VDC transistor battery. Though the results were improved, there is little to no room for electric match variance.

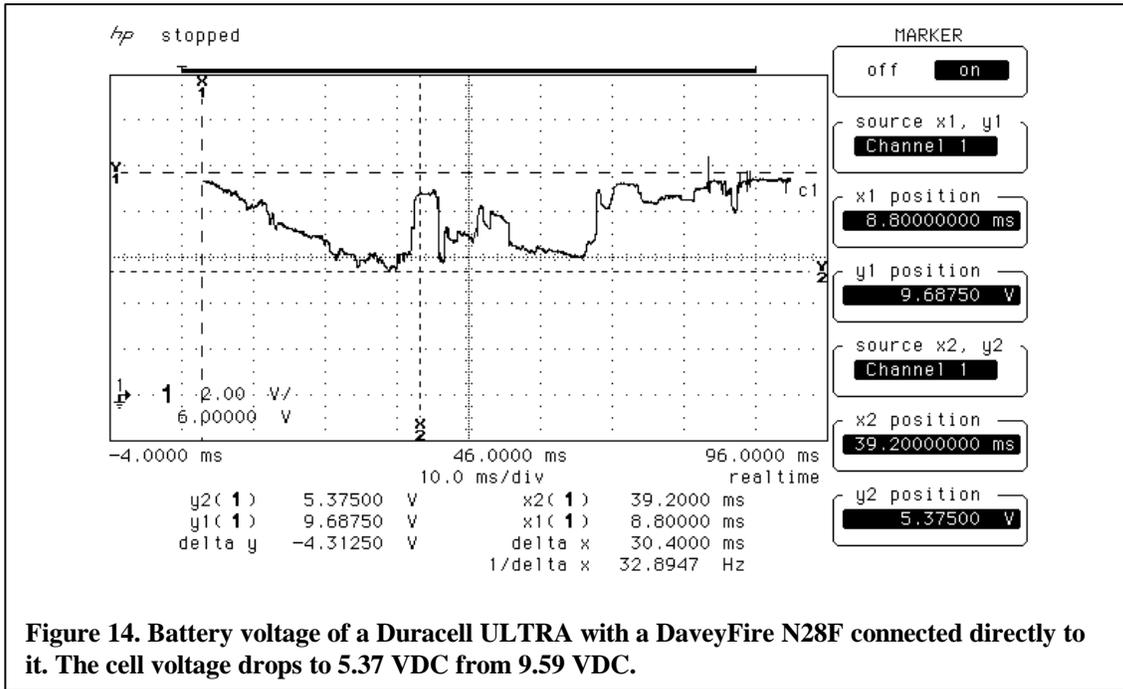


Figure 14. Battery voltage of a Duracell ULTRA with a DaveyFire N28F connected directly to it. The cell voltage drops to 5.37 VDC from 9.59 VDC.

In the next test I connect a DaveyFire N28B (white wire) directly across the terminals of a Duracell Copper Top 9VDC transistor battery. Figure 15 shows the superior electrical performance of the N28B over the N28F. This electric match requires the least amount of current and is excellent for recovery initiation. **WARNING:** The N28B is incapable of reliably firing composite propellant motors. It's burn temperature is too low and burn rate too fast. Reliable motor ignition is best achieved through Firestar, IgniterMan, Magelrite or dipped/augmented Daveyfire N28F igniters.

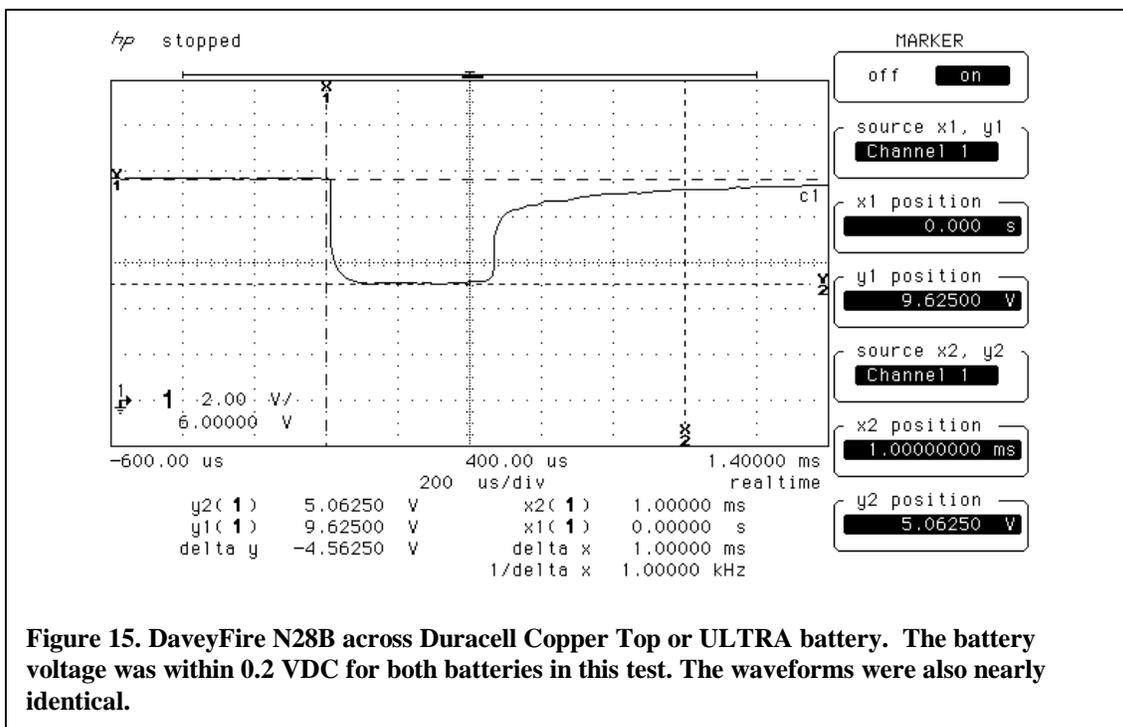


Figure 15. DaveyFire N28B across Duracell Copper Top or ULTRA battery. The battery voltage was within 0.2 VDC for both batteries in this test. The waveforms were also nearly identical.

Last, we test the loading effects of a Robby's Rockets AG-1 Flashbulb-based ejection charge on a Duracell 9 VDC battery. The results are shown in figure 15. Notice how the voltage dips instantaneously from 9.65 VDC to 4.312 VDC. Depend on the avionics, this low voltage could cause anomalous behavior in some systems.

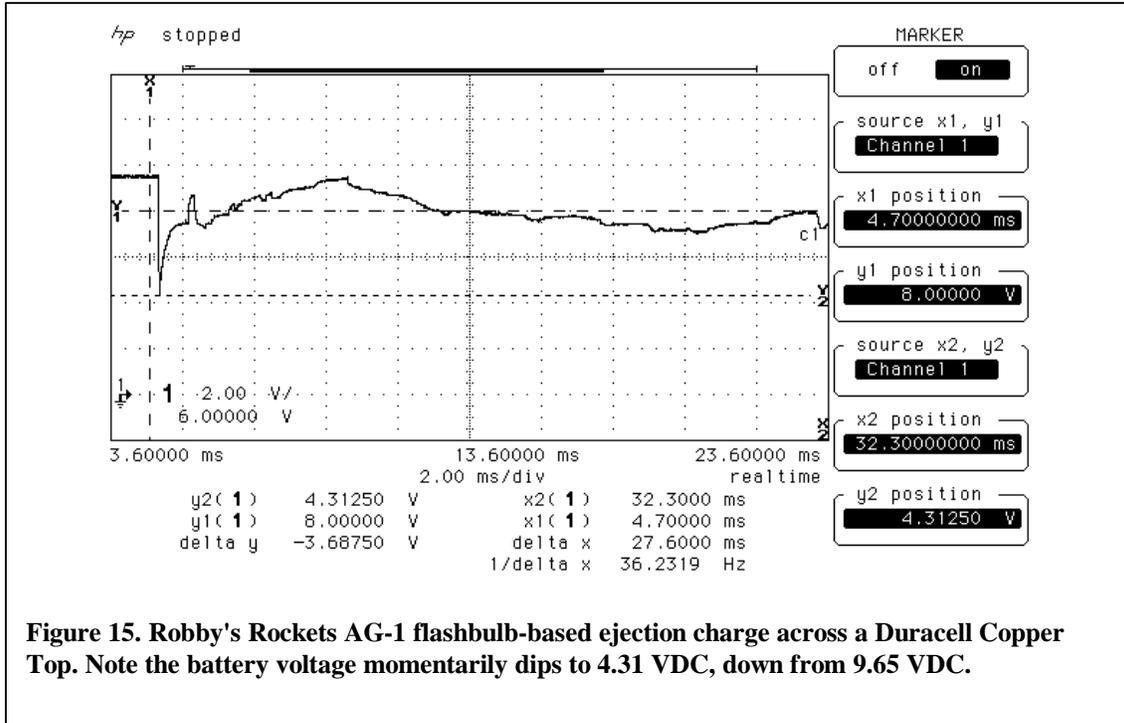


Figure 15. Robby's Rockets AG-1 flashbulb-based ejection charge across a Duracell Copper Top. Note the battery voltage momentarily dips to 4.31 VDC, down from 9.65 VDC.

Summary

Igniter/electric match electrical current demands vary widely, as can be seen from the above information. The above waveforms **must not** be considered “worst case” as I have no manufacturing process information from any of the manufacturers. As only three igniters or electric matches were tested from each manufacturer, the tests results are only a ‘snap shot in time’.

The “all fire / no fire” current ratings, though useful, don’t adequately show the igniters true electrical characteristics. When choosing an electric match, you must understand the target application. If connected to computer-controlled electronics or digital logic, you must design the system to handle the PEAK current demand of the igniter/match. Failure to perform either one of these steps can cause serious malfunction or momentary failure of the electronics. This could cause your prized rocket to “lawn dart” or “core sample”. Remember, this is rocket SCIENCE.

Acknowledgments

Thank you Doug Pratt of Pratt Hobbies for providing the DaveyFire N28B electric matches without charge for this test. Thank you Pius Morozumi for providing several varieties of electric matches, flashbulbs and for convincing me to expand the scope of this document to include nearly all of the common igniters used in model and high power rocketry. Thanks also goes to my son, Scott Briody, for helping me perform the tests.