

MAKING LOW CURRENT ROCKET MOTOR IGNITERS

High quality custom rocket motor igniters can be made quickly, easily, and inexpensively. You can make tiny igniters that will fit in the nozzle of small composite motors (e.g. 24mm E15, E30) up to massive igniters suitable for the largest motors. And best of all, they won't take a lot of current for firing, which means that they can be used for staging and airstarts with a timer (e.g. PerfectFlite MT4) and a small, lightweight battery.

If you want to ignite a large cluster of motors, keeping the current requirement of each igniter low is important, because the firing system (ground launch or onboard electronics for airstart) needs to supply the igniter current multiplied by the number of igniters wired in parallel. Using the techniques described in this document you will be able to fire dozens of igniters simultaneously for a really impressive airstart using a timer and battery that together weigh less than one ounce.

Igniters take electrical energy and convert it to heat. They have a "heating element" that gets hot when power is applied, and a flammable coating ("pyrogen") that produces the intense flame required to ignite modern composite motors. The heating element is typically constructed in one of two ways: the "bridgewire" or the "conductive dip".

A bridgewire consists of a small length of very thin nichrome or copper wire that glows red hot when power is applied to it (like the heating element of a toaster, but much smaller). The red-hot glow then ignites the pyrogen coating.

Conductive Dip igniters replace the bridgewire with a flammable chemical composition that includes a quantity of conductive particles (e.g. Graphite) that allow current to pass through it. When sufficient current passes through the composition, it self-heats to the point of combustion, igniting the pyrogen overcoat.

Conductive Dip

Pros

- Very easy to make
- Inexpensive
- Relatively low current requirement
- Able to make any size igniter, from very small to very large

Cons

- More fragile than bridgewire
- Electrical resistance varies more than bridgewire
- Firing current requirement varies more than bridgewire

Bridgewire

Pros

- Easy to make
- Inexpensive
- Low current requirement
- Best reliability and consistency

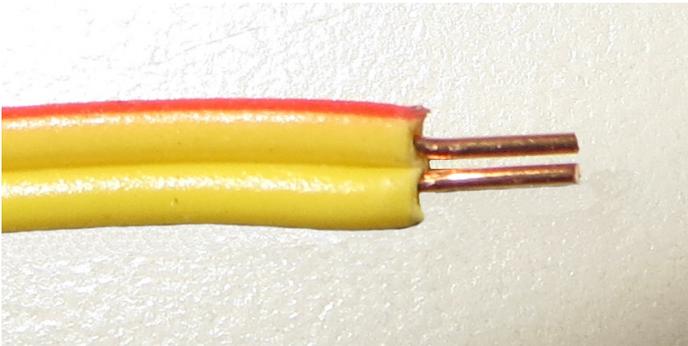
Cons

- Harder to make very small igniters for 24mm motors
- Requires soldering skills and equipment
- Igniter quality more dependant on assembly skill

MAKING CONDUCTIVE DIP IGNITERS

You will need:

- Conductive primer dip chemical
- Non-sparking (e.g. brass) stirring rod
- 26 gauge to 22 gauge solid duplex leadwire
- Pyrogen overcoat chemical
- Wire stripper
- or 2 pcs of 30 gauge wirewrap wire, twisted



Cut leadwire to desired length (*for tiny igniters, use two pieces of 30 gauge wire-wrap wire twisted together in a drill instead of normal 2 conductor wire*).

Strip back 1/8" of insulation from one end of leadwire. Position the bare wire ends close to each other (but not touching!) with a gap of about 1/32" (*picture #1*). The longer and closer the bare wire ends are, the lower the resistance of the finished igniter. After you have made and tested a few igniters, you will get a feel for the gap vs. the resistance and current requirements of the igniter.

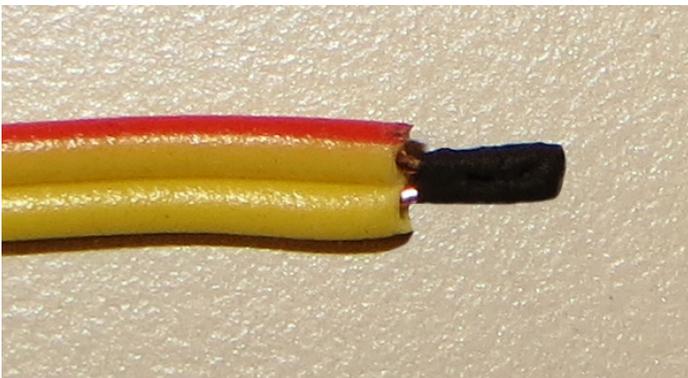
Stir conductive primer chemical mix thoroughly. Then stir it some more. You want the conductive particles spread evenly throughout the mixture.

Dip the bare wire ends in the conductive primer mixture, covering just the bare wire ends (*picture #2*). Do not overdo it! A thick coating will only increase the current required to fire the igniter without any benefit. Moving the wire end back and forth as you draw it back up and out of the chemical mix will help minimize the amount of primer deposited on the ends.

Allow the primer to dry thoroughly before proceeding to the next step.

Stir the pyrogen mixture thoroughly. Dip the primer-covered end of the igniter in the pyrogen such that about 3/4" to 1" of the end is covered with pyrogen (*picture #3*). If you are making a small igniter for a narrow-throat rocket motor, be careful as you remove the igniter from the pyrogen mixture to avoid a heavy buildup. For larger igniters, do not dip a second time. Instead you can use thicker leadwire for more pyrogen buildup, or attach a small sliver of Blue Thunder propellant to the end of the igniter.

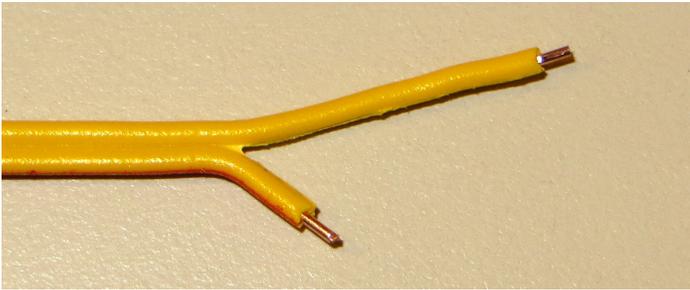
After your igniter is thoroughly dry (overnight at minimum), check the resistance of the igniter. You may have other specific needs, but 5Ω to 10Ω resistance is good for most applications. If the resistance isn't what you expected, don't use the igniter for demanding applications like staging and airstarts, but it will probably work just fine for ground ignition.



MAKING BRIDGEWIRE IGNITERS

You will need:

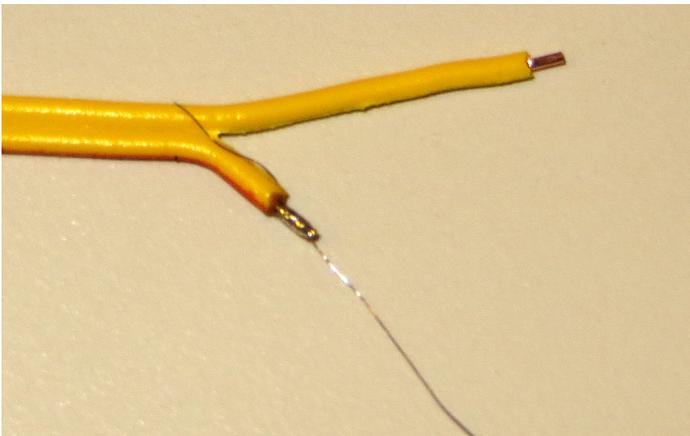
- 40 gauge bare nichrome wire
- Pyrogen overcoat chemical
- Wire stripper
- 26 gauge to 22 gauge solid duplex leadwire
- Non-sparking (e.g. brass) stirring rod
- Solder, liquid flux, soldering iron



Cut leadwire to desired length.

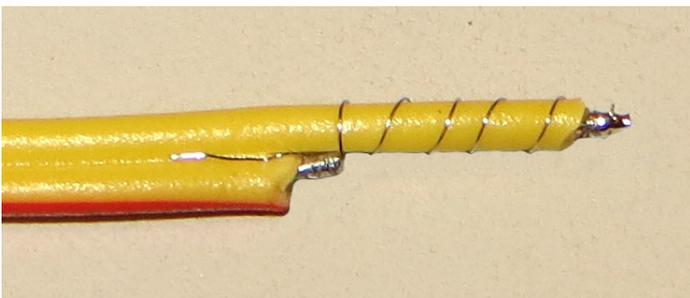
Separate individual conductors on twinlead, cut one to 1/4" and other to 5/8". Strip 1/8" insulation from each end. Bend ends slightly in a "Y" formation to make next step easier (*picture #1*).

Hold the 40 gauge bridgewire parallel to shorter prepared end and wrap several turns around stripped end, leading the extra bridgewire away from the leadwire.. Solder bridgewire to stripped leadwire end (*picture #2*). You *must* use a suitable liquid flux to solder nichrome bridgewire properly.



Straighten both leadwires and wind four to five turns of bridgewire around the insulation on the longer leadwire end. Do not allow the thin 40 gauge bridgewire to develop kinks. You should also avoid sharp bends in the bridgewire where it meets the leadwire. When you get to the end of the leadwire, continue wrapping several turns of bridgewire onto the stripped end of the leadwire (*picture #3*).

Solder and trim excess bridgewire. Make sure you clean all flux residue from the joints and allow the assembly to dry. Use a magnifier to inspect the finished wire ends for breaks and poor solder joints.



Stir the pyrogen mixture thoroughly. Dip the spiral bridgewire end of the igniter in the pyrogen such that about 3/4" to 1" of the end is covered with pyrogen (*picture #4*). If you are making a small igniter for a narrow-throat rocket motor, be careful as you remove the igniter from the pyrogen mixture to avoid a heavy buildup. For larger igniters, do not dip a second time. Instead you can use thicker leadwire for more pyrogen buildup, or attach a small sliver of Blue Thunder propellant to the end of the igniter.

The igniter should be allowed to dry thoroughly before use. Unlike the conductive dip igniters, the igniter's resistance can be checked at any time after soldering. Igniters made with 40 gauge nichrome wrapped on 26 gauge leadwire will yield approximately one ohm of resistance per turn of nichrome coil..



Current, Voltage, and Resistance

In order to guarantee success with your igniters you need to consider a number of inter-related variables. Your igniter will require a certain amount of current to heat up (quickly) to the ignition point. For 40 gauge nichrome bridgewire, you should figure on about 1.5 amps of current for rapid ignition. If you have a sensitive pyrogen, using bridgewire thicker than 40 gauge (i.e. 38 gauge to 30 gauge) will require more current with no significant benefit. Igniters made with conductive dip vary according to a number of parameters – the formulation of the dip, the size of the bead of conductive material on the end of the leadwires, the amount of heat drawn away by the copper leadwires, etc. 1 to 3 amps of current is a typical range, but you can narrow it down further by testing a batch of igniters and recording the results.

If you will be firing multiple igniters in parallel (e.g. multi-engine cluster) your battery will have to supply the current required for a single igniter multiplied by the number of igniters used. Once you have determined the total current requirement for the igniter(s) you can proceed to calculating the battery and igniter resistance requirements.

A battery's voltage will drop significantly when a heavy load is applied. You cannot assume that a 9V battery will put out 9 volts when you're trying to pull several amps (or more) of current out of it! Check to see how many volts your battery will put out *when loaded with the equivalent current draw of the total number of igniters*. Then you can determine the resistance that each *individual* igniter should be by dividing the battery voltage (under *total* load) by the current for the *individual* igniter.

Examples:

9V alkaline battery, one 1.5 amp nichrome igniter:

Battery voltage under 1.5 amp load is 6.9 volts, igniter current is 1.5 amp, igniter resistance should be 4.6Ω. Adjust number of turns of nichrome bridgewire to achieve this resistance.

9V alkaline battery, two 1.5 amp nichrome igniters:

Battery voltage under total 3 amp load is 4.8 volts, each igniter current is 1.5 amp, each igniter's resistance should be 3.2Ω. Adjust number of turns of nichrome bridgewire to achieve this resistance.

PerfectFlite L225 LiPo battery, twenty 1.5 amp nichrome igniters:

Battery voltage under total 30 amp load is 4.6 volts, each igniter current is 1.5 amp, each igniter's resistance should be 3.1Ω. Adjust number of turns of nichrome bridgewire to achieve this resistance.

Sample Battery Data:

Duracell 9V Alkaline

<i>Current</i>	<i>Voltage</i>	<i>Power</i>
0A	9.3V	0.0W
1A	7.6V	7.6W
2A	6.2V	12.4W
3A	4.8V	14.4W
4A	4.4V	17.6W
5A	1.8V	9.0W
6A	0.7V	4.2W

PerfectFlite L225 7.4V 250mah LiPo

<i>Current</i>	<i>Voltage</i>	<i>Power</i>
0A	8.4V	0.0W
5A	7.8V	39.0W
10A	7.2V	72.0W
15A	6.6V	99.0W
20A	6.0V	120.0W
25A	5.3V	132.5W
30A	4.6V	138.0W
35A	3.9V	136.5W

Note that maximum power transfer occurs when the battery is loaded to approximately ½ of its open-circuit (unloaded) voltage. For best efficiency, do not load the battery beyond that point.

Sources

Chemicals:

FireFox FX

<http://www.firefox-fx.com>

(208) 237-1976

Conductive Dip: "ELV Conductive Primer"

Pyrogen: "Pyromag"

Wire, etc.:

PerfectFlite

<http://www.perfectflitedirect.com>

(603) 735-5994

Nichrome Kit: "IEKN"

Solder & Flux: "SFLX"

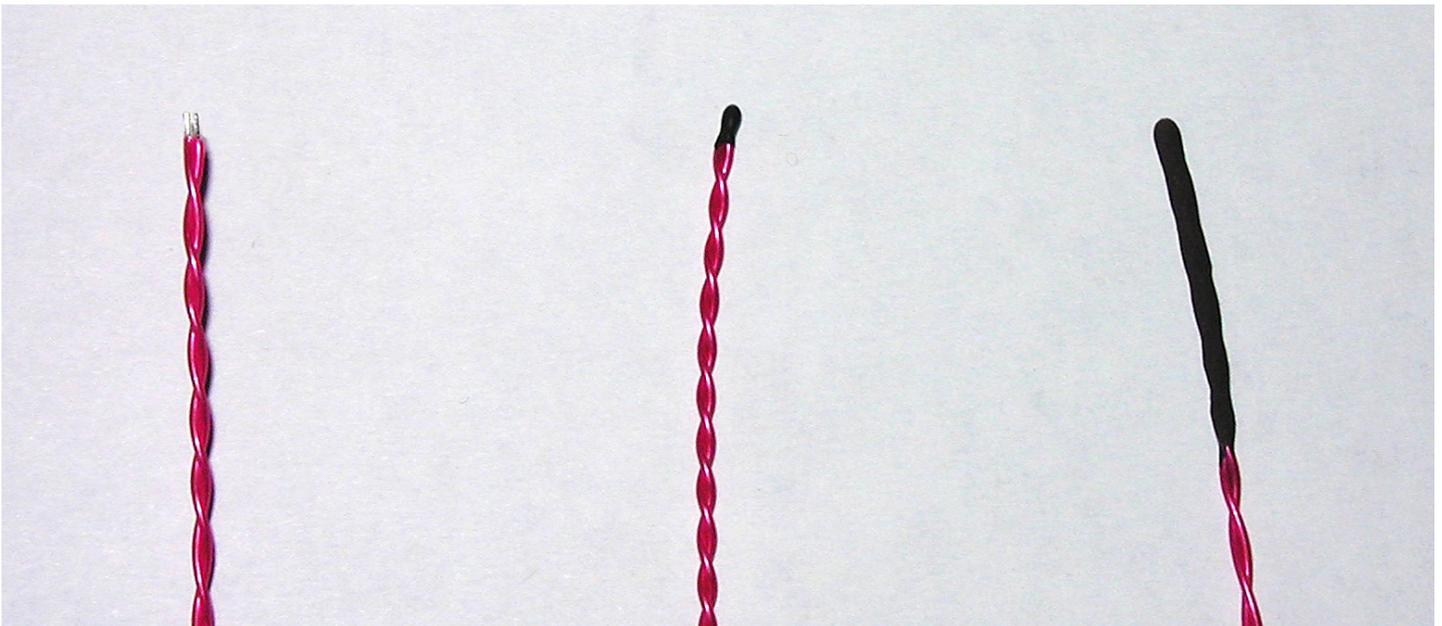
Note:

Most of the chemical mixes (primer and pyrogen) use acetone, a fast drying solvent, as a thinner. Even when you keep the mixes bottled and well capped, they thicken and dry out over time. In virtually all cases they can be reconstituted by adding a small amount of acetone or MEK and stirring to regain the proper consistency. We have used the same bottles of primer and pyrogen from FireFox FX for nearly 10 years in this manner.

Cautions

- Always wear safety glasses when stirring and working with flammable chemicals.
- Keep chemical mixes and solvents away from heat and open flame. Do not smoke while working with flammable chemicals and solvents.
- Hold chemical bottles away from you and do not look into bottle while stirring.
- Wear gloves and wash hands after handling chemicals.
- Follow any additional safety and handling instructions provided by chemical mix manufacturers.

A very thin conductive dip igniter suitable for 24mm composite motors:



Wire Prepped

Conductive Dip

Pyrogen Overcoat (finished!)