PML ELECTRONICS FAQ

3/2/03

Onboard Electronic Devices (Altimeters, Timers, Etc.)

(See the Electronics page of our webstore for more details on each device and other devices that may not be covered here).

PML currently carries the Co-Pilot altimeter. The Co-Pilot altimeter was developed exclusively for PML by Missile Works Corp., and was designed specifically for PML's CPR3000 Recovery System (though it can also be used in other applications as well, such as scratch-built deployment systems). The Co-Pilot is based upon Missile Works' RRC^2 altimeter (though it differs in important ways such as location of electronic components, which allow it to fit CPR systems). The Co-Pilot provides two-stage barometrically-controlled (pressure-sensing) deployment of rocket recovery systems and equipment.

~~PML also carries the AccuFire Timer, made exclusively for PML by G-Wiz Partners. The AccuFire is an adjustable (0-25 sec.) post-motor-burnout timer. Like the G-Wiz LC, LC Deluxe, and MC, AccuFire uses a progressive launch detect algorithm. The timer must "see" either 2g for 0.5 seconds, or 4g for 0.25 seconds, or 8g for 0.125 seconds to determine that launch has occurred and begin monitoring for motor burnout. Accelerometer-based detection of motor burnout occurs upon detection of deceleration (negative g's) after launch detection; the timing to the firing event begins at motor burnout. The AccuFire uses a standard 9VDC battery as a power source, and provides an output current to the pyro channel of up to 1.25A. Also, the AccuFire is NOT affected by hybrid motor harmonics; it's completely safe to use with hybrids.~~

~~*IMPORTANT CUSTOMER ALERT:*~~

~~For the AccuFire to function as a 2nd stage ignition device, you MUST use:~~
~~1) BlackSky HiRMI Standard electric match (preferably dipped in pyrogen) or~~
~~2) DaveyFire N28F (preferably dipped in pyrogen).~~

~~For the AccuFire to function as an ejection charge initiator the following electric matches could also be used:~~
~~3) 1 or 2 above (without the pyrogen dip),~~
~~4) BlackSky HiRMI - Sensitive,~~
~~5) DaveyFire N28B, or~~
~~6) Oxral.~~

~~Other ignition devices *WILL NOT FUNCTION PROPERLY* with the AccuFire.~~

How Altimeters Work

The following is a generalized discussion of how the PML Co-Pilot and other barometric altimeters work. It is not intended to be absolutely or entirely accurate, just descriptive of basic operations as an educational tool.

The Co-Pilot, and all other barometric altimeters I know of, takes an air pressure sample when you first turn them on (and some like you to leave them on for a couple minutes so they can take multiple baseline readings). They then set themselves to say, "OK, this pressure reading I'll call zero". Doesn't matter what the actual launch site elevation is, it says, "OK, this is zero. I'll base everything I do from now on based on changes from this pressure reading". So, let's say your launch site is at 750 ASL (above sea level), and let's pick some arbitrary scale for altitude. Let's say it ranges from 0 at sea level to 10000 at 10 miles altitude. When you turn your altimeter on, it takes the pressure reading at your launch site, which being at 750' is, say, 15. It does it a few more times over the next few seconds...15, 15, 15. It says, "OK, I keep getting 15, so I'm now going to reset all my internal software to say "15 = 0". The next thing the Co-Pilot does is look for a pressure drop corresponding to 300' AGL to determine a launch has really taken place, so it should arm it's deployment circuits and look for apogee. So, now you launch, it sees 15-16-17-18- and up (let's say 17 equals 1050', or 300' above your launch site altitude). It says "OK, there's 17, that's 300' above the ground, so this is a real launch. I'm going to start running the software to monitor when to deploy my chutes now". OK, the rocket's still going up, is near the top of it's flight, and it sees 800-801-802 on our arbitrary scale. 802-803-804----804-803-802. "OK", it says, "I saw 804 as the highest reading I ever got, but now I see 803 and then 802. Must be I'm over apogee and falling back to earth. Deploy!"

Deployment Charge Igniter Selection

PML's Electronic Deployment Devices can work with flashbulbs, electric matches or igniters. Flashbulbs are not recommended, though, due to their much lower reliability and great variability in firing current requirements. Also, electric matches are preferred over igniters due to the relatively low current requirements compared to most igniters intended for motor ignition. The resistance reading of what you intend to use is important. Here's why:

E = I x R, where E is Voltage, I is Amperage, and R is resistance. We know the Voltage involved depending on the onboard battery. We also know from the specifications of the unit that the ignition device must fire with a certain amperage range. So, we need to find R, the Resistance, to determine which ignition device can work successfully with the device we intend to use. Below is an example of how to do the calculation, though if the manufacturer of the electronic device specifies requirements for the ignition devices connected to it, follow the manufacturer's specifications over the calculation.

> Co-Pilot Altimeter
> Battery = 9 volts
> Current = 1.25 amps
>
> E = I x R, 9 = 1.25 x R; rearranging, we get R = 9/1.25 or 7.2 ohms
> The ignition device must be 7.2 ohms or more to work properly with the Co-Pilot.

Igniter manufacturers will specify the electrical usability (ohms and volts) range for their devices; contact the igniter manufacturer for their specifications. We strongly recommend that you check each igniter you intend to use before flight to determine that it is good and within the ohm range needed. We also strongly recommend that you ground-test the electronic device you intend to use with the ignition device you intend to use before committing that combination for use in an actual flight. Ground testing instructions are included in our detailed instruction package provided with each of the Electronic Deployment Devices we sell.

Timer Ignition Device Selection

~~The AccuFire is designed to work with electric matches or igniters, and outputs up to 1.25 amps to the pyro circuit. Flashbulb-based igniters are not recommended due to their much lower reliability and great variability in firing current requirements. The AccuFire pyro channel (output circuit) is a closed-loop feedback amplifier with a limit of 1.25 amps current output.~~

~~***IMPORTANT CUSTOMER ALERT:***~~

~~For the AccuFire to function as a 2nd stage ignition device, you MUST use:~~
~~1) BlackSky HiRMI Standard electric match (preferably dipped in pyrogen) or~~
~~2) DaveyFire N28F (preferably dipped in pyrogen).~~

~~For the AccuFire to function as an ejection charge initiator the following electric matches could also be used:~~
~~3) 1 or 2 above (without the pyrogen dip),~~
~~4) BlackSky HiRMI - Sensitive,~~
~~5) DaveyFire N28B, or~~
~~6) Oxral.~~

~~Other ignition devices *WILL NOT FUNCTION PROPERLY* with the AccuFire.~~

Battery Testing is CRITICAL

One thing that is ***CRITICAL*** that many customers do not do is to test their battery before **EVERY FLIGHT**. Onboard electronics systems are very sensitive to appropriate voltage and current conditions; a just-slightly-weak battery can cause the electronics to fail. Given that you're flying hundreds of dollars of rocket, electronics, motor casing and motor reload, taking time to test your $1.89 battery makes sense (not only from a cost perspective, but from a safety perspective as well.) It always amazes me how someone can walk out to a launch pad carrying $500+ of rocket, motor and electronics but wants to "save money" on batteries or igniters/ematches on board! The short story is: make SURE you test your battery as noted in the manufacturer's instructions. Test a NEW battery when you get it as well (it doesn't happen often, but sometimes a battery is bad right out of the box), and test every battery before every flight. It's asking a lot of an inexpensive battery to run an onboard computer and fire two ematches every flight…make sure it can do it, and replace it often.

Ni-Cad Batteries for Electronic Systems
We recommend Radio Shack's Hi-Capacity Ni-Cad battery part# 23-299 as a good Ni-Cad for onboard electronic systems (unless specified otherwise by the instructions provided for the device).

Ematches vs. Igniters

The difference between ematches and igniters is that ematches are intended to ignite an easy-to-burn substance quickly, such as the BP used in rocket ejection charges. However, an igniter is intended and constructed to produce a large, hot ball of flame for an extended period (say, 0.5-0.75 seconds) to ignite a rocket motor. Ematches typically will not ignite motors unaided as they do not produce a hot enough flame for long enough, whereas igniters certainly could ignite BP. Another significant difference between them, which is critically important for onboard rocket electronic use, is their current requirements. Igniters typically require much more current than an e-match; the current requirements are usually more than altimeters can provide. Therefore, for onboard altimeters, which need to ignite deployment charges, ematches are needed. For staging timers, which need to ignite motors, igniters are needed. Be sure to always check to be sure an e-match or igniter will work with your onboard electronic device.

Our Magnelites are definitely igniters, and likely cannot be used in onboard systems due to the current requirements issue. The sample calculations above and manufacturer's recommendations can be used to determine if a particular e-match will work with your altimeter.

PML recommends that all flash bulbs and electric matches have the electrical wires twisted together until just before installation in the rocket system. This can help prevent accidental ignition of the device due to static discharge or radio frequency interference (RFI).

The Daveyfire N28BR Electric Match works perfectly with the CPR3000 system for parachute ejection charge ignition. The N28BR fits perfectly into the CPR3000 Ejection Charge Cylinder. Of course, the N28BR can also be used in scratchbuild ejection systems as well. (Not intended for motor ignition; our Igniters Page for Magnelite motor igniter kits).

The Daveyfire N28F Electric Match works perfectly with onboard staging timers for second stage ignition of G-80 single use motors. The N28F can also be used for ignition of other popular rocket motors. For best results for motor ignition, dip N28F one time into a Magnelite pyrogen mixture (sold on our Igniters page). (Electric matches will usually require extra pyrogen for successful motor ignition). CAUTION: When dipping take care so that resulting match head will pass easily into the motor grain hole. Blocking motor hole can cause over-pressurization of motor which can rupture motor.

Other Ignition Devices

- We also offer the Robby's Rockets Loadable Ejection System (LES) kit for those who prefer flashbulb ignition. This kit comes with everything you need for ten ejection charges using flashbulb ejection ignition, except the FFFFg ("4F") black powder, which can be purchased locally in sporting goods or gun shops, especially those that cater to antique firearms such as muzzleloaders. Everything but the prewired flashbulbs can be used over and over again. This kit is intended primarily for CPR2000-based rockets.
- However, we recommend use of electric matches over flashbulbs for onboard electronic systems. Flashbulbs are not recommended due to their much lower reliability and great variability in firing current requirements.

CPR2000 and CPR3000

A CPR-based rocket must always be flown with the electronics installed. A CPR-based rocket cannot be flown with motor-based ejection. This is because the fin section coupler/bulkplate assembly and the lower drogue piston block off the motor section from the rest of the rocket.

- PML doesn't sell an altimeter housing kit, but we do have an altimeter and LES tube mounting kit that goes along with our CPR2000-based systems. Many have used this system in their scratchbuild electronic-deployment rockets. Check out the website at www.publicmissiles.com in the CPR Systems section. Also, check out the Dec. 97 issue of High Power Rocketry Magazine. There's a good article on how to make a Self-Contained Altimeter Bay that'll make the altimeter easily removable to switch back and forth between rockets. However, you'll have to modify the HPR Magazine design slightly due to differences in altimeter layout from the ALTS2 altimeter used in the article design.

Fitting ST-2 Timer to IS3000

The PML AccuFire is the recommended staging timer for the IS3000 system; the two were designed together to complement each other. The Transolve ST-2b will also fit directly. The ST-2 can be used if the customer drills holes in three of the corners of the board. However, using an ST-2 can be potentially unsafe as it only has one set of two screw terminals, requiring the customer to install a switch in series with the electric match to safe the system from firing on the ground. Everything else uses off-board power and will not fit the IS3000 system.

Customer Q&A and Miscellaneous Co-Pilot Information

1. **Q:** "…there was a cold solder joint on one of the sensor leads..."
   A: Customers have noted that they think that some of the joints on the Co-Pilot are cold-soldered (i.e. bad connections). The sensor, terminals, and discharge capacitor are all hand-soldered so they will look different than the wave-soldered joints. Only the circuit side components can be placed for wave soldering, and the sensors cannot be washed, hence they are added post wave. The joints may appear cold, but they likely are not. Remember these are plated feed-thru holes,

so the surface pad condition in no way visually indicates the integrity of the joint.

2. **Q:** "I recently bought a Co-Pilot and powered it up for the first time today and seem to have a problem. It does not detect continuity on either the drogue or main outputs, when in input test mode it sees all five switches but not the main or drogue but when in the output test mode it works properly and fires both outputs, when first turned on with a e-match in both outputs the unit does not beep indicating no continuity. Am I doing something wrong or do I have a problem with my copilot?"
   A: Your battery voltage is too low. The continuity circuit bias voltage is unable to operate the circuit on a weak 9V battery (approximately 8V give or take). Your Co-Pilot is working exactly as designed; it's "trying to tell you something" by not going into certain operational modes properly. You need to read and follow the instructions about testing the battery, even if it's a brand new battery right out of the box. You MUST test your battery every single time you're going to use the Co-Pilot. Very cheap insurance considering a $2.50 battery can make the difference between getting your multiple-hundreds-of-dollars of rocket and hardware back.
3. **Q:** Reading through the manual, I was trying to find some sort of 'rule-of-thumb' for using the Mach Delay, and a description of what could likely happen in the following scenarios:
   a) transonic to sonic flight w/o Mach Delay
   b) transonic to sonic flight w/ Mach Delay but delay time too short
   c) transonic to sonic flight w/ Mach Delay but delay time too long
   A: a) You run the risk of mach pressure spiking.
   b) Same as a)
   c) Not a problem *unless* delay exceeds time to apogee
   One could also reverse these scenarios (sonic to transonic) and the same would still hold true.
4. **Q:** "When not using the Co-Pilot for deployment, is it best to fly with main and drogue connectors closed or open circuit? Does it have an impact on battery life?"
   A: It will work in either configuration. If the outputs are open then no audible chirping on the pad, if shorted then the unit will chirp. The battery will be used up a bit sooner if the outputs are shorted. Leave one output shorted and the other open for the best of both. The MosFET outputs of the Co-Pilot utilize an internal crowbar circuit to limit current flow, so it makes them immune to shorts. Opens are a "don't care" since no current flows.
5. **Q: "**Has PML considered using a RCA jack (normally closed) in place of the SPST switch? Using a RCA plug allows a measure of safety...(remove me prior to launch) and a pressure relief hole."
6. **A:** We've considered it, but the RCA plugs can be less durable over time than a "real" switch. Also, you need to mount the switch such that the movable "leaf" will be forced INTO contact by the G forces of launch (rather than 180 deg. from that where the launch will try to separate the switch). Also, the size of the altimeter pressure hole would determine the size of the plug needed, so you'd need to maybe use a "big" plug on a small rocket to get the size of the plug hole

you need. One other thing is that all altimeter manufacturers I'm aware of recommend that the pressure relief hole(s) be smooth and flush to the airframe. All RCA plugs I've seen use a threaded "ring" to tighten them on, which makes a turbulence-inducing obstruction right before the hole, and also by definition makes the hole not flush to the airframe.

7. **Q:** I just noticed browsing Missile Works web site that the Co Pilot is ~25 bucks more than an RRC2. What makes the Co-Pilot worth the extra bucks besides the PML brand name?

A: -- Designed specifically to interface with the CPR-3k system
-- Minor revision to apogee detection software
-- Better layout of terminals for easier connections.
-- Clear markings for all connections and switches.
-- Lower altitude main chute deployment range available.
-- Superior documentation (instructions).

8. **Q:** What is the Co-Pilot's altitude report-out accuracy?
A: The software interpolates and reports to the nearest foot. On a low flight it is easily within 5% (2K AGL) and the accuracy increases from there as peak altitude increases, then it rolls off again. Missile Works states that +/- 3% is a typical accuracy (3-5K AGL). No barometric unit we know of for HPR currently compensates for local ambient pressure conditions, so as that fluctuates you'll get some slight variance in readings (only for extreme fluctuations).