PML STAGING FAQ

3/17/04

Interstage Couplers

Interstage Couplers are used to house staging timers and to connect the upper and lower stages together. The Interstage 3000, the latest version from PML, is used in our two-stage rocket kits, but is now available for scratchbuilders designing their own staged rockets. Using an IS3000 system from PML is a quick, simple solution to an often-difficult design problem. Interstage 3000 kits are ready to ship in 2.1, 2.5, 3.0 and 3.9" diameters.

To use an IS-3000 system, the booster needs 3" (regardless of diameter) at the top, just like a regular rocket would for a payload coupler or nosecone shoulder. The sustainer (upper stage) also requires 3" clear at the bottom. The Staging page of the website has a PDF file that illustrates design requirements for the upper stage if you are designing a scratchbuilt two-stage rocket. There is also a PDF file that shows design requirements for the Terrier IS3000 system.

IS3000 Specifications

Weight

The weights given below are without the timer. See the Electronics Page on the PML website for timer weight information.

- IS-3000-2.1 = 5.5 oz.
- IS-3000-2.5 = 6.8 oz.
- IS-3000-3.0 = 7.0 oz.
- IS-3000-3.9 = 9.3 oz.
- IS-3000-Terrier = 7.5 oz. (The urethane transition piece weighs 1.3oz. with the rest of the system weighing 6.2 oz.)

Length

The timer enclosure tube, which comprises the entire length of the IS-3000, is 5” for all systems except the IS-3000-TERR Terrier system, in which it is 8” long.

Electronics/Staging Timer

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.

Two-Stage Rocket Booster Delay Timing

Shortly after the release of our Terrier Booster for our Mini-BBX kit, a customer wrote with the following question: *"What motor delay times do you recommend for the Mini-BBX Terrier booster? Short medium or long? Does it matter which upper stage motor?"*

ANSWER:
I think what you're asking is more correctly not what delay time is necessary for the booster (but we'll talk about that, too), but when the upper stage motor should be ignited. Well, as in lots of rocketry, it really depends. The general rule or situation you need to look for is: if at booster motor burnout the rocket is not moving quickly, i.e. doesn't have a lot of kinetic energy to keep it coasting, you want to get the upper stage motor lit NOW. If it has a lot of velocity and can coast for a second or two, you can set your sustainer stage ignition to be a little later. The idea is that you don't want the rocket slowing down to the point where the fins aren't providing good guidance for it before the upper stage gets lit and gets everything under power again. When considering when to ignite the sustainer motor, also don't forget that the motor may require a bit of time to come up to pressure and really begin a thrusting burn. You have to figure that into it too, which depends upon the upper stage motor you've selected. Also take into consideration the composition of the second-stage motor and account for that in the timing as well. For example, a Blue Thunder motor will ignite and come up to pressure far quicker than will a Blackjack. It also depends on what you're trying to achieve: the absolute maximum altitude of a certain kit? A successful two-stage flight but staying under a certain waiver? Etc. It all depends on what you're trying to do. Honestly your best bet would be to simulate a number of different delay scenarios to see which one provides the flight profile you're looking for (but always keeping in mind a generous safety factor of timing to account for problems like a slow-pressurizing motor, etc.). Sometimes an immediate ignition of the second-stage motor is best, but other times that can actually decrease the ultimate altitude due to pushing the flight profile into a higher-drag situation. "It depends" is the honest answer.

You really need a simulation program to help determine what you want/need to do depending upon what motor combos you're using since of course the power level of the booster motor, and the weight of the entire rocket, which of course depends upon what motors are installed, play a big factor in it. We'd suggest RockSim, available at http://www.apogeerockets.com/index.asp since we already have the data files for the MiniBBX/Terrier available for RockSim on our RockSim Data page in our website.

Now, regarding actual booster motor ejection times, that of course depends somewhat on the above now that you understand that, but there's more to it than just igniting the sustainer stage and immediately ejecting the booster recovery system. The booster itself will coast fairly well on it's own after separation, so you need to figure that out, too. A good way to approximate what delay time you should use for the booster is to calculate the coast time to apogee for the entire rocket as though there were no upper stage motor. Basically use the entire two-stage rocket in your sim, but install only a booster motor and

no sustainer motor, run your simulation, and look for when the rocket reaches apogee. That time is a pretty good estimate of what delay to select for the booster motor, because the booster itself will coast about that long after separation. Let's do a hypothetical example: let's say you're going to use an I284W as your booster motor. Load your simulation with an I284 in the booster, and no motor in the sustainer stage. Run the sim, and see when it says the rocket will reach apogee. Let's say it's about 10 seconds. So, you'll want to use about a 10-second delay in your booster motor for your real two-stage flight, since the booster will tend to coast about that long. If you use anything too terribly much shorter than that you run the risk of stripping the chute off the booster section. It doesn't seem to make sense that the booster would coast that long without a nice aerodynamic nosecone on it, but it will.

Two-stage rockets are a complex thing, and do definitely require special considerations, experience, and lots of "what if" thinking and simulation.