ROUSE-TECH

CD4 INSTRUCTION MANUAL

INTRODUCTION

The CD4 unit is designed for deploying parachutes and recovery items in high power and amateur rockets at any altitude. From sea level to space. The CD4 unit can be used in both "low altitude" and "high altitude" configurations. The low level application is for flights under 20,000 ft. where there are no problems with the burning of a pyrogen. For flights over 20,000 feet, the CD4unit can be prepared for high altitude flights by "potting" the electric match heads with epoxy into the electric match holder.
Either configuration accepts the two different sized of CO2 cartridges As in any type of ejection and recovery system, only after ground testing to confirm desired results, should you proceed with the flight.

Remember to always ground test the rocket to insure that the ejection of recovery items and separation of rocket components is adequate.
Another benefit of the CD4 system is the elimination of Nomex protection parachute cloths and recovery line protection sleeves. These items often consume valuable recovery volume and never completely protect the recovery items from the burning of the pyrogen- black powder. Your expensive parachutes and recovery items can now be used many years with no damages.
A year of research and testing went into the CD3 unit. From the initial tests conducted to determine exactly what was happening at high altitudes we discovered that not even a Davey Fire electric match would completely burn at altitudes of 55,000 ft. and above. Pyrogens placed in contact with the matches would not completely burn either, with noticeable drop offs in burn rates starting at 20,000 ft..
Many different types of pyrogens were tested including nitro-cellulose based, black powder, Pyrodex, Igniter Man pyrogen, potassium based pyrogens, Clear Shot, Red Dot, Blue Dot and "777 brand" pyrogens. Each exhibited different characteristics in their burning and burn rates. However, the common denominator was that none worked in vacuums of 3" Hg and lower. (Roughly 55,000 ft..) All of these compounds are pressure dependent for their burn characteristics. The lower the pressure, the slower the burn. (Burn rate co-efficient). There was a significant drop off in gasses produced at approximately 20,000 ft. (13" Hg). Incomplete combustion occurs at an alarming rate above this.
After some assistance from NASA, the units design could be finalized to incorporate both the needs of low altitude flights and high altitude flyers. At high altitudes, NASA pointed out that there can be no burn in a vacuum due to the lack of air molecules needed to transfer heat to sustain burning. (Heat transfer in both convection and conduction. Radiation plays little in the role of sustaining combustion). Anything that burns must maintain its individual ignition temperature to sustain the burn. At these high altitudes, the ignition temperature is not maintained, nor can it be transferred due to the lack of a medium to transfer (conduct) temperature- air molecules.
Another factor that contributes to the high altitude burn problem is that of cooling gasses. As altitude increases, so does the cooling of the expanding gasses due to the pressure differential. The expanding combustion gasses expand so fast that they cool, like that of a CO2 cartridge or air hose. This cooling effects the burning of the pyrogen. At high altitudes, the cooling extinguishes the burn as the cooling and expansion of gasses lowers the ignition temperature to below that of the ignition temperature of the pyrogen.
The physical characteristics of the pyrogen are also critical to the burn. The powders used in rocketry are granular and when they burn they "spray" the adjoining grains out. At low altitudes, the flame front and ignition temperature keeps up with the moving particles and a complete burn is accomplished. These ejection containers fail prior to all the pyrogen being burnt, with particles burning out side the canister. Keeping the granules in a confined area to insure complete combustion by maintaining pressure, is whats needed to produce the gasses needed to separate the rockets components for these canister types of applications.
It is the burn rate of pyrogen (BP) and the physical properties of atmosphere that make the design of a deployment device difficult. For these reasons, ROUSE-TECH recommends 20,000 ft.. as the cut-off altitude for successful deployment of any pyrogen based ejection system. Over 20,000 ft.. the lack of air drastically effects any compounds ability to burn. There is no magical altitude where things "don't work" as it is far more complicated than that, when dealing with different pyrogens, containers, air pressure etc.

Whether you are launching a rocket to 4,000 ft.. and wish to have a high tech system to compliment your rocket and electronic components, or if you are launching a rocket to high altitudes,you now have a system to do so safely and without damage to your expensive rocket and recovery components. And, never have to smell and clean the black powder residue from the rockets components.

ROUSE-TECH

PRODUCT DISCLAIMER AND LIMIT OF LIABILITY

Rouse-Tech, Inc. has designed the CD4 system for rocket parachute deployment in hobby rockets only.
Other uses and applications where gas generation is needed, using the CD4 unit have not been identified.

Do not use this device in any other application. Never place more pyrogen in the unit than specified.

Purchaser and user agrees to hold harmless Rouse-Tech, Inc. for any and all claims, debits, liabilities, judgements, costs and attorneys costs arising, claimed on accouunt of, or other action arising from use of this product, for property damages, injuries and death.

Rocket launching activities are a dangerous activity and acknowledged as so by purchaser.

Rouse-Tech, Inc. products have not been tested by any agency, organization or entity for certification, approval,rating or qualification.

Extent of liability will be limited to the cost of the product.

FLIGHT PREPARATION

CD4

POTTING THE ELECTRIC MATCH FOR HIGH ALTITUDE FLIGHTS

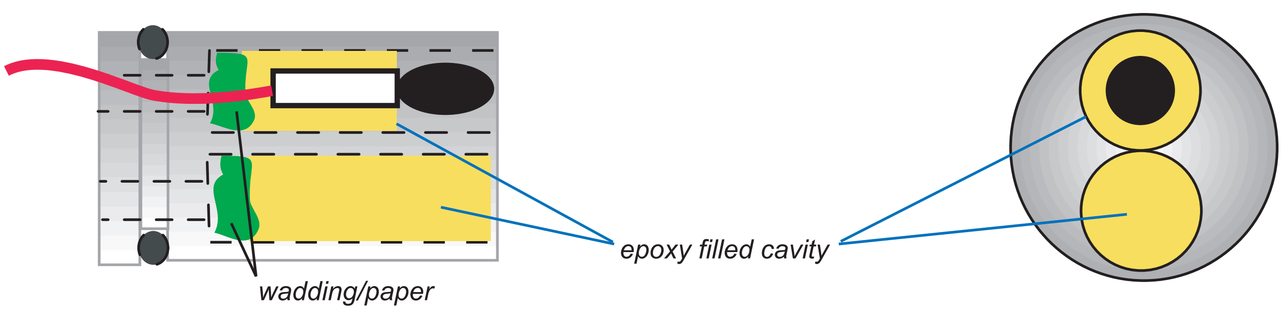
STEP 1- Place a generous coating of Teflon grease on the two o-rings, and inside the bore of the CD4 casing. You must fill the o-ring grooves in the plunger and holder with the sealant grease to insure a proper seal at the inside diameter of the o-ring too.
Install the o-rings. Slide the plunger into the casing bore approximately 1/8". You will feel a slight resistance when the o-ring contacts the casing.
Place the pyrogen inside the pyrogen cavity. Set aside and make sure not to tip over and spill the pyrogen.

STEP 2- Check the Ohm's resistance of the electric match(s) you will be using. Remove the plastic cap from the head of the electric match by sliding down the wire leads and discard. Push the wire leads into the electric match cavity and out the smaller hole on the bottom. Pull through all the way until only 1" of the match head is left sticking out of the end. Bend the wire over so you can pack wadding or paper towel into the hole around the wire at the bottom. Pack the bottom of the cavity only enough to seal wire so epoxy doesn't drip through. This serves two purposes. First it keeps the epoxy from dripping out of the cavity when potting. Second, when drilling out the cavity after the flight, the paper allows the point of the drill bit to hit the paper before it hits the flat bottom of the cavity. You will know when you hit the paper with the drill. Still, be careful not to hit the bottom!
If you wish to use the Delrin ematch holder only once, and wish to discard it, more can be purchased as they were made to be a low cost disposable item. Or, re-use should you prefer.

OPTION 1- POTTING

STEP 3- "POTTING THE ELECTRIC MATCH IN EPOXY". Mix a small amount of 5 minute epoxy and fill the cavity about 1/2 way. Straighten the match wire and pull the match head down into the cavity until its flush with the end of the stainless steel holder. Your epoxy should cover all of the electric match except the pyrogen dipped tip. (Usually black). Do not get epoxy on the tip. The goal here is to seal the cavity up to the match head and not get epoxy on the pyrogen on the match head.

STEP 4- If using one match in the flight, place wadding or paper towel inside the other cavity about 1/2 way and fill the remainder with epoxy to seal the cavity.



SINGLE MATCH CONFIGURATION SHOWN

FLIGHT PREPARATION

CD4

USING PUTTY TO SEAL ELECTRIC MATCH

STEP 1- Place a generous coating of Teflon grease on the two o-rings, and inside the bore of the CD4 casing. You must fill the o-ring grooves in the plunger and holder with the sealant grease to insure a proper seal at the inside diameter of the o-ring too.
Install the o-rings. Slide the plunger into the casing bore approximately 1/8". You will feel a slight resistance when the o-ring contacts the casing.
Place the pyrogen inside the pyrogen cavity. Set aside and make sure not to tip over and spill the pyrogen.

STEP 2- Check the Ohm's resistance of the electric match(s) you will be using. Remove the plastic cap from the head of the electric match by sliding down the wire leads and discard. Push the wire leads into the electric match cavity and out the smaller hole on the bottom. Pull through all the way until only 1" of the match head is left sticking out of the end. Bend the wire over so you can pack wadding or paper towel into the hole around the wire at the bottom. Pack the bottom of the cavity only enough to seal wire so epoxy doesn't drip through. This serves two purposes. First it keeps the epoxy from dripping out of the cavity when potting. Second, when drilling out the cavity after the flight, the paper allows the point of the drill bit to hit the paper before it hits the flat bottom of the cavity. You will know when you hit the paper with the drill. Still, be careful not to hit the bottom!
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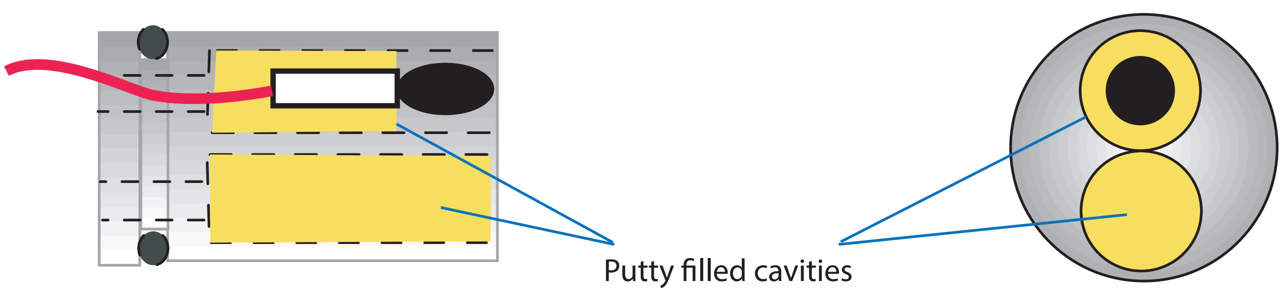
OPTION 2- PUTTY SEALANT

STEP 3- "Sealing the electric match with putty"
For flights under 30,000 feet, this method is preferred. Basically, what you want to do is roll a thin rope of putty and wrap it around the silver part of the match head. Then pull the match head into the electric match holder from the wire leads. The putty should remain below the tip of the match. Its easy, so give it a few tries to get it right.

STEP 4- If using one match in the flight, place the putty in the remaining electric match hole to seal it.

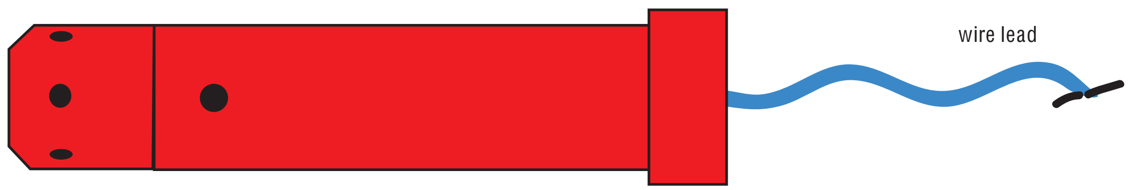


SINGLE MATCH CONFIGURATION SHOWN

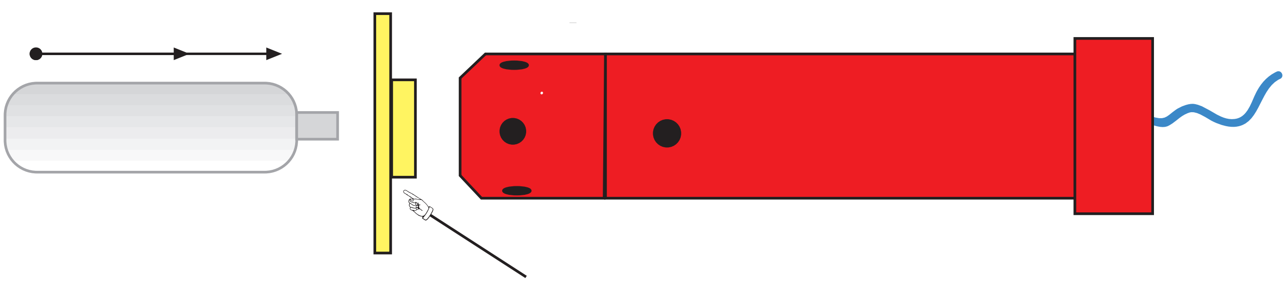
FLIGHT PREPARATION

Continued

YOUR CD4 UNIT SHOULD LOOK LIKE THIS, (Nomex sleeve not shown.)



Tightly screw the CO2 cartridge into the CD4 unit using the appropriate combination flange. Place the shoulder of the flange facing toward the CD4 unit!!!



USE APPROPRIATE FLANGE - GOLD FLANGE FOR 16 GRAM USE,
BLUE FLANGE FOR 38 GRAM USE

NOTES-

The CD4 unit should always be cleaned right after use. Black powder residue is harmful to aluminum and stainless steel if left uncleaned. Be careful not to use emery cloth or sandpaper to clean residue as these will scratch the protective anodizing inside bore of the unit.

Always take care when removing the plunger. Do not damage the point on the plunger. Push gently with a dowel or other object

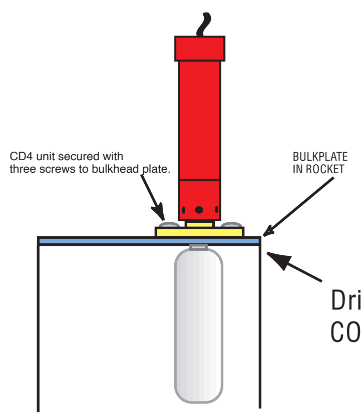
Always use Rouse-Tech CO2 cartridges. Other brands may use thicker caps or different thread dimensions! This can cause a failure due to an unacceptably small puncture size!!

MOUNTING DETAILS

Since there are so many different configurations of rockets and the way they separate at deployment, the CD4 combination flange was designed to have two methods of mounting in the rocket to accommodate as many design scenarios as possible. Like the black powder canister method, the CD4 should be placed below the recovery components- ie. parachute and recovery lines. Recovery components and parachutes should always be "above" the CD4 unit to insure they are pushed out by the gasses. Remember, using the CD4 eliminates the need for Nomex protection cloths, shock cord protection cloth and wadding. All components can be placed in the recovery area and rest against the CD4 unit without much concern for damages from burning.

Make sure that all electric match wire leads are secure so they don't tangle with recovery components.

RECESSED MOUNT



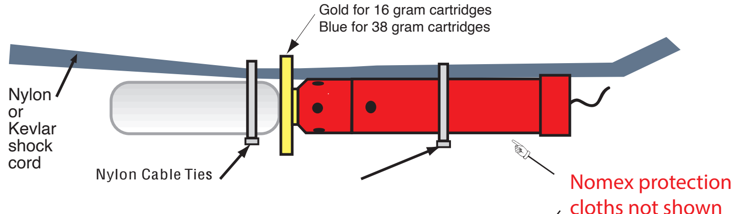
Drill hole in bulkhead plate slightly larger than the CO2 cartridge you are using.

The CD4 unit is designed to be mounted in a recessed configuration, using the round combination flange. Color coded with the following-
Gold is used with the 16 gram cartridge and red is used with the 38 gram cartridge. It's necessary to drill a hole in the bulkhead or coupler, the diameter of the cartridge so it can slide into the recessed area. Then, screw the combination flange to the bulkhead plate. Lay out the proper hole pattern to conform to your rocket, and either drill them or tap them.

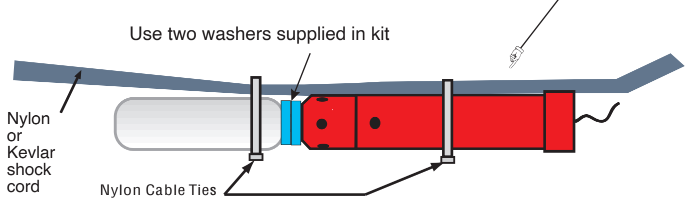
SHOCK CORD MOUNTING

The CD4 unit can also be used by mounting it directly to the bridle using cable ties (zip ties). When using this method, it is essential that the CO2 cartridge, when fully threaded into the case, is flush with the bottom of the bore. Adding two 3/8”
washers or using the colored flanges is what is needed and both are included with the kits. Not using the colored flanges
or washers will result in the CO2 cartridge protruding too far into the bore, effecting the release of CO2.

OPTION #1



OPTION #2
No flanges, only washers



SIZING GUIDE

John Rockdale

Introduction

The Rouse-Tech CD4 CO_2 deployment system is designed to replace black powder deployment systems in amateur rockets. The CD4 system has two advantages over black powder systems:

- No residue to clean up after recovery, and no risk of a burned or melted parachute or streamer.
- No decrease in efficiency or reliability at extreme altitudes, i.e. > 40,000 feet. Black powder systems tend to fail at extreme altitudes due to poor heat transfer and combustion efficiency at low atmospheric pressures. The CD3 system is immune to this problem.

Optimally sizing an ejection system from a purely theoretical basis is a deceptively complicated matter. The mass of the two components to be separated, airframe material, shear pins, component coefficient of friction, and vent hole sizes all factor in to the problem. As with any “ejection charge calculator” or calculation, there is no substitute for ground testing your system, and we do not recommend flying any system for the first time without a ground test.
The CD3 system provides for two different CO_2 cartridge sizes: 16 and 38 grams.
We will present two methods for determining the optimal CO_2 cartridge size for your rocket, in ascending order of complexity. No matter which method you choose, remember that you should *always* ground test your system before flying it for the first time.

Method 1: Rough guidelines by compartment size
This method is based solely on typical charge sizes for typical rockets. It’s a rough starting point for your ground testing. Simply use the table below to locate the recommended CO_2 cartridge size for the diameter and length of the recovery compartment.

Recommended Cartridge size by recovery compartment length and diameter (typical)

	Length (in)											
Diameter (in)	6"	10"	14"	18"	22"	26"	30"	34"	38"	42"	46"	50"
2"	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g
3"	16 g	16 g	16g	16 g	16 g	16 g	16g	16 g	16 g	16 g	16 g	16 g
4"	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	16 g	38 g
5"	16 g	16 g	16 g	16g	16 g	16 g	16 g	16 g	38 g	38 g	38 g	38 g
6"	16g	16 g	16 g	16 g	16 g	16 g	16 g	38 g	38 g	38 g	38 G	38 g
8"	16 g	16g	16 g	16 g	16 g	38 g	38 g	38 g	38 g	38 g	NR	NR
10"	16g	16 g	16 g	38g	38	38 g	38 g	38 g	NR	NR	NR	NR
12"	16 g	16 g	38g	38	38 g	38 g	NR	NR	NR	NR	NR	NR

NR = Not recommended

Method 2: Sizing by Black Powder Equivalence

This method might be preferred for those experienced flyers who are comfortable with their own or published black powder "ejection charge calculators" or techniques. This method is also suitable for those retrofitting previously flown rockets with a successful base of experience.

Step 1: Determine the black powder charge (in grams) using the method you prefer. A widely used black powder charge calculator is available on the web at Rocketry Online's INFOcentral web page. Rocketry Online's URL is **www.rocketryonline.com**. You can find the calculator by going to the INFOcentral page and finding the "recovery" section. The "recovery" section's index has a "black powder use" page where the calculator resides. Note: There is no need to add in "extra" black powder charge for flights expected to exceed 20,000 feet.

Step 2: Multiply the black powder charge size (grams) by 5.0 to determine the amount of CO_2 (also in grams) required to achieve the same compartment pressure.

Step 3: Round *up* to the nearest sized CO_2 cartridge. Use this as the starting point for your ground testing.

Example: My previous rocket has flown and successfully deployed at 12,000 feet three times using a 2.5 gram black powder charge. What size CO_2 cartridge should I use to replace the black powder charge system?

2.5 x 5.0 = 12.5 grams CO_2. Round up to the nearest sized CO_2 cartridge: 16.0 grams.

Use a 16 gram CO_2 cartridge as the starting point for my ground testing.

Here's a brief description of the underpinnings of this "conversion factor" method (the black powder pressure calculation is borrowed from Ted Apke's "Ejection Charge Calculator" page on ROL's INFOcentral web page):

Quoting from Ted:

The ejection charge equation is:

$$Wp = dP*V/R*T$$

Where:

- dP is the ejection charge pressure in psi.
- R is the combustion gas constant, 22.16 (ft-lbf/lbm R) for FFFF black powder. (Multiply by 12 in/ft to get in terms of inches)
- T is the combustion gas temperature, 3307 degrees R for black powder
- V is the free volume in cubic inches. Volume of a cylinder is cross section area times length L, or from diameter D, $V=L*\pi*D^2/4$
- Wp is the charge weight (mass, actually) in pounds. (Multiply by 454 g/lb to get grams.)

Here's an example calculation. Suppose you want to generate 15 psi inside a 4" diameter rocket in a parachute compartment 18" long. That makes a volume of 226 in^3. The amount of powder you need will be:

$$Wp = 15*226(454)/12(22.16)\ 3307$$

$$Wp = 1.75 \text{ grams}$$

Continuing with the example provided by Ted Apke above, here's how to solve the same problem using CO2 instead of black powder:

Start with the ideal gas law: $n= PV/RT$

n= number of moles CO_2 required.
P= ejection pressure desired in atmospheres (1 atm = 14.7 psi)
V= volume of parachute compartment in liters (1 liter = 61 in^3)
R= universal gas constant (=0.08206)
T= Temperature of expelled CO_2 gas at deployment in degrees Kelvin (273K)

In this example:

P= 15psi = 1.02 atm
V= 226 in^3 = 3.70 liters
T= 273K

Number of moles CO_2 = (1.02*3.70)/(0.08206*273) = 0.168 moles.

Lastly, one mole of CO_2 = 44 grams, so 0.168 moles * 44g/mole = **7.41 grams CO_2**.

Thus, we have the result that 7.41 grams CO2 produces the same ejection pressure as 1.75 grams Black powder.

Dividing these results gives a ratio of 7.41 g CO2/1.75 g BP = 4.24. We recommend adding a safety factor of approximately 20%, resulting in a "conversion factor" of 5.0 grams CO_2 per gram of black powder.