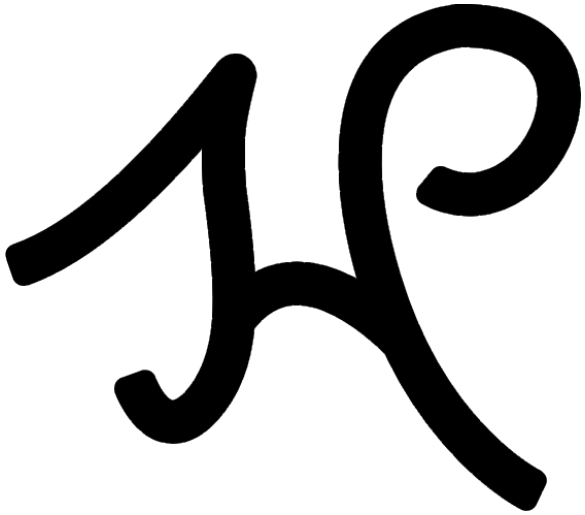
Cat Claw Cable Cutter

Component Guidebook

HCR-4100



Authored by **Austin Sennott** and **Charles Sharp**

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Rockets are dangerous! This publication is intended to provide information on the safe construction and operation of an amateur liquid rocket component, but it is no guarantee of safety. Always follow relevant safety guidelines and best practices when handling hazardous substances or situations – never assume that any situation is inherently safe. Half Cat Rocketry is not liable for the usage of this document, and the authors bear no responsibility for the usage of its content. Read the disclaimer on the next page before continuing.

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About **Half Cat Rocketry**

Half Cat Rocketry began as a project to build a liquid bipropellant rocket in our final undergraduate semester at the University of Central Florida. From September through December 2020, we constructed, iterated, and finally test fired *Half Cat Walking*. From participating in introductory rocket projects, to leading them, to producing solid motors, to designing hybrid systems, four years of learning culminated in four months of innovation and success.

We are Austin Sennott and Charles Sharp. For eight years, we have been relentlessly gaining experience in amateur rocketry, woven together with education and careers in aerospace engineering. Today, our focus is on pioneering simple, reliable liquid rocket motors and supporting students and individuals looking to build their own. Our goal is to demonstrate that they can be accomplished quickly and economically, for the benefit of both the hobby and the careers of students everywhere. We were once students ourselves, and still produce rockets with our own time and money, so we are well acquainted with the need to reduce scope and budget as much as possible.

Half Cat is the name of a meme, unique and recognizable. We do serious work, but we don't take ourselves too seriously - our brand and project names are a lighthearted nod to the industry, which can too often lack originality.

Half Cat Rocketry is ongoing, and we will continue to build rockets and publish information about them. Our hope is to redefine what's possible for students and amateurs to achieve with a little bit of creativity, leading the way for ever more awesome projects.

About the Authors

Austin Sennott is a rocket propulsion engineer and Level 2 certified in high-power rocketry. Since 2018, he has been building experimental solid, hybrid, and liquid motors, including the first liquid bipropellant rocket fired at UCF.

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Charles Sharp is Level 3 certified in high-power rocketry and employed as a rocket propulsion engineer. In over 10 years of building rockets, he has gained expertise in all types of rocket propulsion, including the first high-power rocket propelled by liquid CO_2.

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Version History

Revision	Description	Date
01	Initial Release	**14 Oct 2024**

The latest version may be found on both the Half Cat Rocketry website and GitHub repository:

Half Cat Rocketry Website

GitHub Repository

Scope

Cat Claw is a cable cutter mechanism made of modified off-the-shelf commercially available parts. It is designed to be a low-cost and easy to service solution for parachute release to make single-compartment dual deployment recovery widely accessible.

This guidebook covers:

- Background on the function of cable cutters
- Parts list and assembly instructions
- Manufacturing reference materials

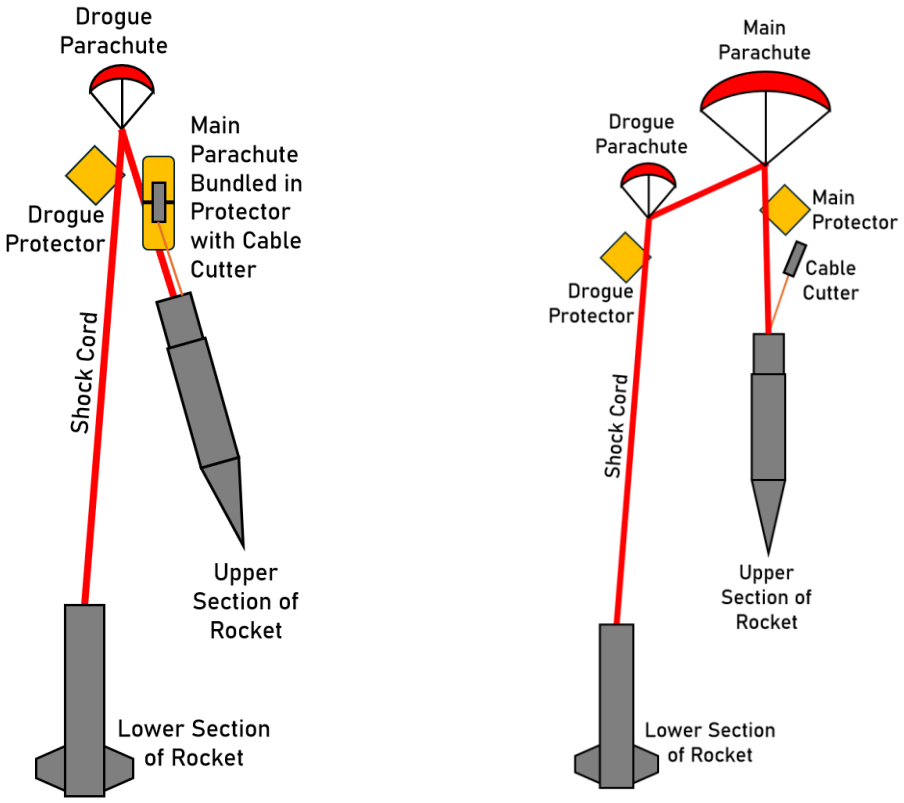
It is assumed that the reader is familiar with high-power rocketry and the use of basic hand tools.

Table of Contents

Introduction

What is a cable cutter and how does it work?

Cable cutters are used as an alternative to conventional dual deployment recovery in amateur rockets. Rather than deploying the drogue and main from separate compartments in the airframe, with cable cutters both the drogue and main parachute are ejected at apogee from a single airframe separation point. The main parachute is kept tightly bundled by a nylon cable tie, which the cable cutter severs to release at the desired deployment altitude during descent. This allows for a more compact airframe and recovery system, without the need for shear pins.



Cable cutters shear the cable tie which bundles the main parachute, using a metal piston propelled by a small pyrotechnic charge. The charge is ignited by an electronic match which receives current from an electronic deployment controller, just like a typical pyrotechnic deployment charge. When using cable cutters for main deployment, standard pyrotechnic deployment charges are used for the apogee separation event.

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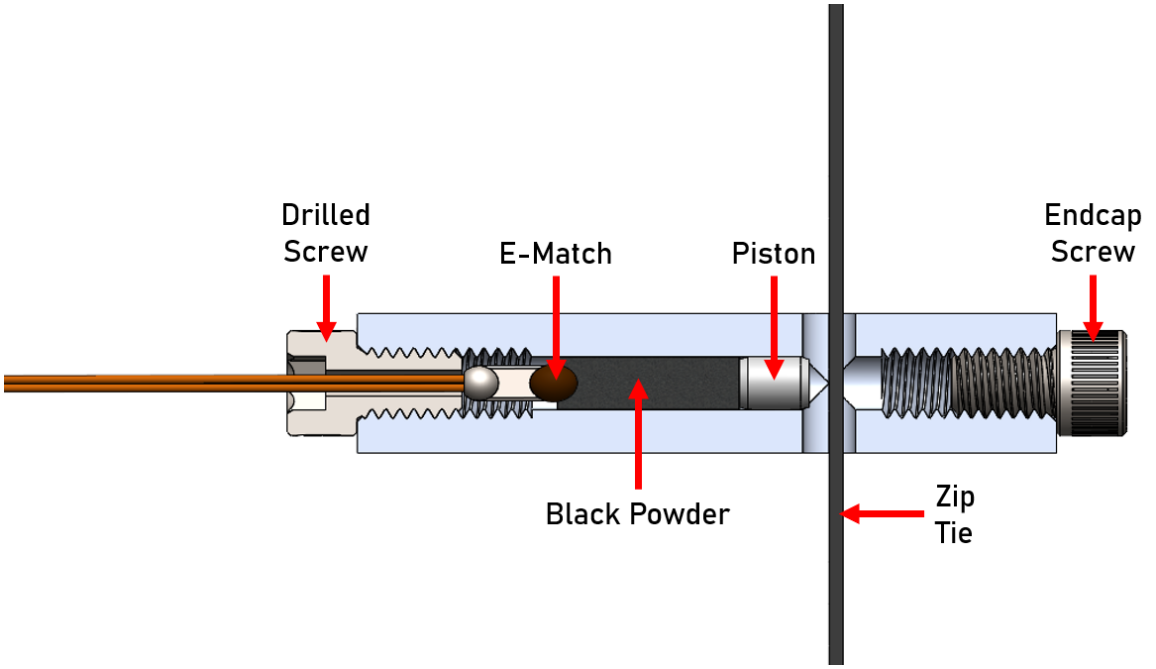
Cat Claw Cable Cutter

Cat Claw is not the most compact or lightweight cable cutter, but it is intended to be the most accessible option. There are other, smaller designs, but Cat Claw can be made very cheaply in-house by any hobbyist. Furthermore, it is easy to load and reuse quickly which minimizes the labor involved in preparing a rocket for flight. Cable cutters already find use in high-power rocketry, but this document is intended to make them a less difficult and more practical option for single-compartment dual deployment recovery on all but the most mass-optimized rockets.



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Bill of Materials

This Bill of Materials (BOM) produces a set of two Cat Claws at a cost of $17.13 each. However, some line items are multi-packs and producing additional cable cutters will reduce the per-unit cost. Additionally, the tools are a fixed cost and only need to be purchased once.

It is assumed that a standard consumer-grade 3D-printer is available for making the printed components. While they are not strictly necessary, the drill jig makes fabrication of the cable cutter body very easy and extremely quick, and the scoop and funnel makes loading a simple and deterministic process.

Components

Line	Item	Unit Price	QTY	Cost	Context
1	Female Threaded Hex Standoff, Aluminum, 1/2" Hex, 2-1/2" Long, 1/4"-20 Thread	$5.91	2	$11.82	Cable Cutter Body
2	18-8 Stainless Steel Dowel Pin, 3/16" Diameter, 1/4" Long, Pack of 20	$5.42	1	$5.42	Cable Cutter Piston
3	Vented Socket Head Screw, 1/4"-20 Thread Size, 3/8" Long, Pack of 5	$7.03	1	$7.03	Cable Cutter End Caps
		Subtotal		**$24.27**	

Note: If producing >2X units, 93235A534 (Line 3) may be substituted with 92185A535 for the non-e-match side

Line	Part Number	Vendor Description	Source
1	91780A363	Female Threaded Hex Standoff Aluminum, 1/2" Hex, 2-1/2" Long, 1/4"-20 Thread	https://www.mcmaster.com/91780A363/
2	90145A501	18-8 Stainless Steel Dowel Pin 3/16" Diameter, 1/4" Long	https://www.mcmaster.com/90145A501/
3	93235A534	Vented Socket Head Screw 1/4"-20 Thread Size, 3/8" Long	https://www.mcmaster.com/93235A534/
4	92185A535 *(if producing >2X units)*	Super-Corrosion-Resistant 316 Stainless Steel Socket Head Screw 1/4"-20 Thread Size, 3/8" Long	https://www.mcmaster.com/92185A535/

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Tools

Line	Item	Unit Price	QTY	Cost	Context
1	Short-Length Drill Bit, TiN-Coated High-Speed Steel, 3/32" Size, 1-3/4" Overall Length	$3.51	1	$3.51	Drill Bit for E-match Hole
2	Uncoated High-Speed Steel Drill Bit, 12 Gauge Size, 3-1/2" Overall Length	$2.35	1	$2.35	Drill Bit for Zip Tie & Piston Holes
3	Loop Handle Tube Brush, Low-Scratch Brass Bristles, 3/16" Diameter, 7" Overall Length	$3.30	1	$3.30	Cleaning Brush
4	Hex L-Key, with Standard Tip, 9/64" Size, 4-1/16" Overall Length	$0.41	1	$0.41	Piston Removal Tool
5	Hex L-Key, with Standard Tip, 3/16" Size, 2-15/16" Overall Length	$0.41	1	$0.41	Socket Screw Hex Key
		Subtotal		**$9.98**	

Line	Part Number	Vendor Description	Source
1	2908A33	Short-Length Drill Bit, TiN-Coated High-Speed Steel, 3/32" Size, 1-3/4" Overall Length	https://www.mcmaster.com/2908A33/
2	30585A23	Uncoated High-Speed Steel Drill Bit 12 Gauge Size, 3-1/2" Overall Length	https://www.mcmaster.com/30585A23/
3	7353T518	Loop Handle Tube Brush, Low-Scratch Brass Bristles, 3/16" Diameter, 7" Overall Length	https://www.mcmaster.com/7353T518/
4	7122A45	Hex L-Key with Standard Tip, 9/64" Size, 4-1/16" Overall Length	https://www.mcmaster.com/7122A45/
5	7122A22	Hex L-Key with Standard Tip, 3/16" Size, 2-15/16" Overall Length	https://www.mcmaster.com/7122A22/

Consumables

Line	Item	Unit Price	QTY	Cost	Context
1	Nylon Zip Ties, 3/16" Wide Max	Variable	-	-	Securing Parachute
2	3F Pyrodex Powder or 4F Black Powder	Variable	-	-	Pyrotechnic Charge
3	E-matches	Variable	1	-	Cable Cutter Initiation

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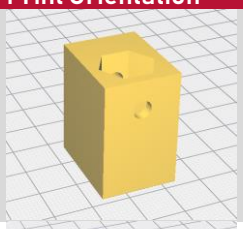
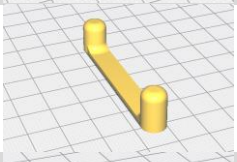
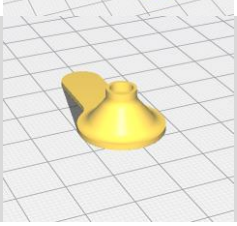
Printed Components

Line	Item	Unit Price	QTY	Cost	Context
1	McMaster Cable Cutter Drill Jig.STL	$0.00	1	$0.00	Printed
2	Cable Cutter Powder Scoop.STL	$0.00	1	$0.00	Printed
3	Cable Cutter Powder Funnel.STL	$0.00	1	$0.00	Printed

Print Orientation

Print components in the following orientations:

Part Number	Print Orientation
Cat Claw Drill Jig.STL	
Cable Cutter Powder Scoop.STL	
Cable Cutter Powder Funnel.STL	

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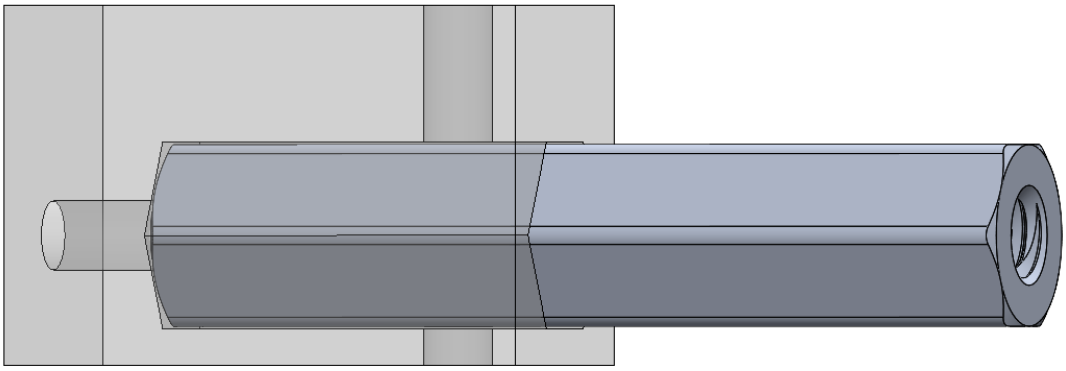
Fabrication Procedure

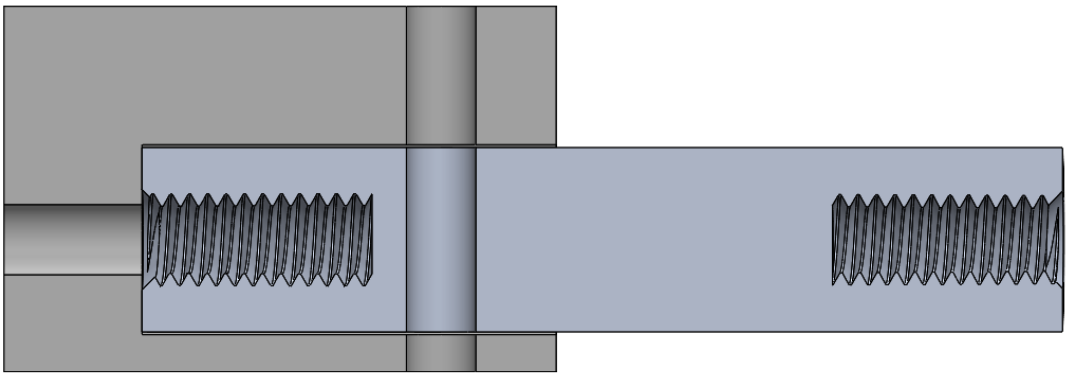
Required Tools

QTY	Tool
1	Power Drill
1	Bench Vise
1	3/32" Drill Bit
1	#12 Drill Bit
1	Cat Claw Drill Jig

1. Insert the 91780A363 hex standoff into the printed drill jig as shown, until it fully bottoms out. If it is a loose fit, apply tape to the hex standoff as needed until snug.



2. Clamp the drill jig in a bench vise with the longer side of the zip tie hole guide facing upwards. Using the #12 drill bit, drill the zip tie hole through the hex standoff as shown.



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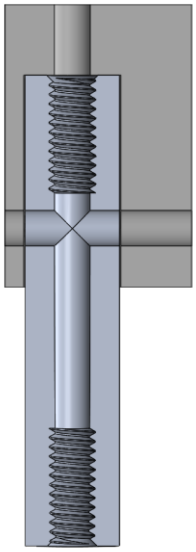
3. Clamp the hex standoff directly in the bench vise, with the piston bore end of the drill jig facing upwards. Using the #12 drill bit, drill the piston bore until it connects the two threaded holes as shown. Clean out any drill chips and/or cutting oil.

   Note: Do not clamp the printed drill jig for this step, or the hex standoff will be pushed out of the jig by the drill bit.



4. Remove the hex standoff from the printed drill jig, and install QTY 1 93235A534 vented screw hand-tight into the end farther from the zip tie hole as shown. Clamp the hex standoff in the bench vise with the head of the screw facing up. Apply WD-40 or cutting oil to the 3/32" drill bit, and drill out the existing vent hole as shown. This will allow the e-match wires to pass through the screw. Remove the screw and clean out any drill chips and/or cutting oil.

   Note: Only one screw needs to be drilled out per cable cutter. The screw on the opposite side may remain unmodified.

Assembly and Loading Procedure

1. Assemble and load the cable cutter:

   a. Test e-match for continuity, then insert twisted wire leads through the drilled-out 93235A534 screw from the end and out through the socket. A small strip of masking or electrical tape around the solder beads at the base of the e-match head is recommended to prevent shorting and/or powder leakage.

   b. Install un-modified 93235A534 (or 92185A535) screw into the threaded end closer to the zip tie hole and tighten to snug using the 3/16" hex key.

   c. Insert the zip tie (3/16" wide max.) through the zip tie hole. Place a small piece of masking tape on the tail of the zip tie to prevent it from falling out.

   d. Insert the 90145A501 piston into the bore from the end farther from the zip tie hole. Use the 9/32" hex key to ensure it is all the way down the bore, contacting the zip tie.

   e. Measure out 3F black powder replacement (Pyrodex P or equivalent) or 4F black powder (Goex FFFF or equivalent) using the appropriately labeled end of the printed powder scoop.

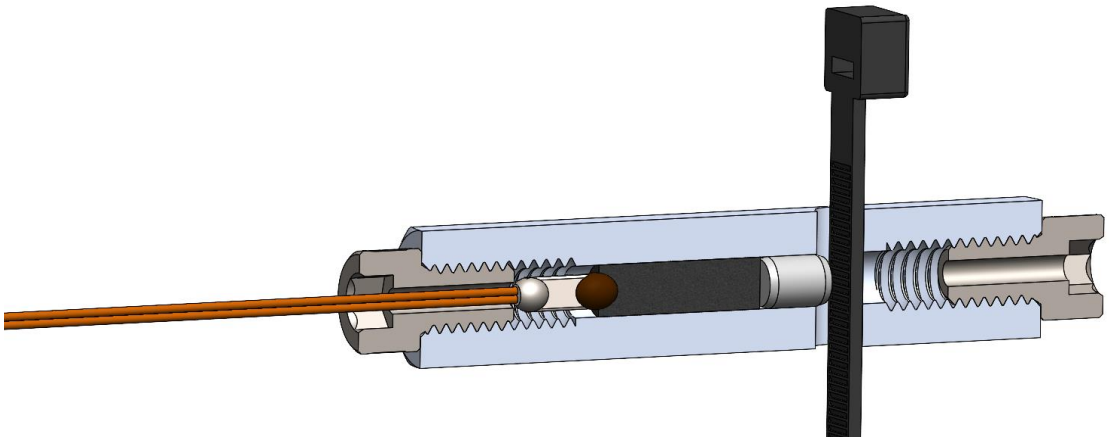
   f. Pour the powder into the cable cutter on top of the piston, using the printed powder loading funnel

   g. Install the drilled-out 93235A534 screw with e-match into the threaded end farther from the zip tie hole and tighten to snug.

      Optional: Tie a thin Kevlar cord around the base of the screw head before running down fully, to provide more secure retention of the table cutter than the wires alone.

   h. After folding the parachute and wrapping with a flame-proof protector, cinch the zip tie around the parachute bundle. For redundancy, it is recommended to use two cable cutters, which must either be on the same zip tie, or zip ties that are daisy chained together. Do not place multiple independent zip ties around the parachute.

   i. Connect the e-match wires to the Main charge leads from the deployment controller just as you would an ejection charge. Ensure the connections are mechanically secure and insulated from one another. The main parachute bundle is now ready to pack inside the rocket airframe.



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2. Post-Recovery Servicing:

    a. Remove both screws from the hex standoff and push out the piston using the 9/32" hex key. A small section of the zip tie may also remain inside the cable cutter, and must be removed.

    b. Remove the spent e-match from the drilled-out screw.

    c. Clean the piston bore and piston of residue using the 7353T518 brush. If using water or other solvents, ensure the interior of the cable cutter is fully dry before reloading.

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