Practical A.E.G Upgrade

Methods, Tricks and Myths

THE AirSoft PRESS

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Preface

Airsoft has been well established in Asia for over 20 years, but only in recent years has there been much interest in the Western world. Most professional literature on Airsoft were written in Japanese, with very few translated works available. Even though we are seeing more and more tech tips (in English) popping up on the internet these days, too many of them were written by newcomers who don't really know what they are talking about. If you upgrade your AEG based on their advices, you may risk running into unexpected troubles.

At AirsoftPRESS, we produce technical information based on input from practicing engineers, technicians and field operators who have been with Airsoft since the era of S.S. 9000. Because we are part of the industry, we know what information is really needed, and we make sure our e-books tell what people really need to know. We do not mind to criticize thing that doesn't work, and we will not hesitate to give you hacks and workarounds to difficult problems. Reading this e-book should be like having an airsoft professional by your side, passing on useful hints whenever you get stuck.

Introduction

Short for automatic electric gun, AEG is a type of battery powered air gun capable of full & semi auto firing. An electric motor inside the AEG rotates a series of gears sequentially to drive the piston, which in turn compresses the spring. When the spring is released, the piston is being pushed forward to produce compressed air and propel the bullets. Due to such a complex internal structure, power upgrade is never easy.

There is no substitute for good old fashioned know how. By upgrading the gun yourself, you are knocking out the hardest part of it first, knowing what goes where.

Before kick starting an upgrade project, it is suggested that you first define your upgrade objective(s). What do you want to achieve? High FPS? High ROF? High accuracy? And how high is high by the way?

This e-book is organized based on the primary upgrade objectives of high FPS, high ROF and high accuracy. In addition, a section on troubleshooting is included. Rather than going the cumbersome step-by-step way, we will teach you the essentials through an easy-to-read Q&A format. We do assume that you have the basic ability to disassemble and reassemble your gun and the mechbox. In case you do not, refer to the many step-by-step free tutorial web pages available on the internet (here are some suggested links: http://www.airsoftguns.com/articles/skyfire/mechbox/index.htm, http://www.teamairsoft.com/downloads/v2mech.pdf, http://www.airsoftplayers.com/mechbox/tutorial.asp).

After trying out the tricks and tips suggested in this e-book, never hesitate to contact us should you believe there are mistakes waiting to be corrected (there are always better ways of doing things…).

Abbreviations used in this book that need clarifications:

- AEG: Automatic Electric Gun
- ACM: All China-Made
- TM: Tokyo Marui
- CA: Classic Army
- ICS: I Chih Shivan Enterprises
- SRC: The brand name used by STTi to market its M4 replicas
- UTG: Under the Gun (an ACM manufacturer)
- WELLS: another ACM manufacturer
- BE Tech: an ACM manufacturer that specializes in producing plastic internals
- rpm: revolutions per minute
- mah: milli amp hour
- NiCD: Nickel Cadmium
- NiMH: Nickel Metal Hydride
- QC: Quality Control
- QA: Quality Assurance

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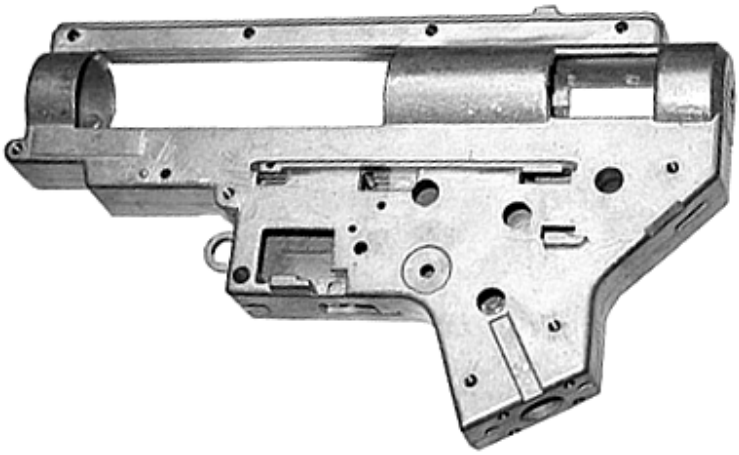
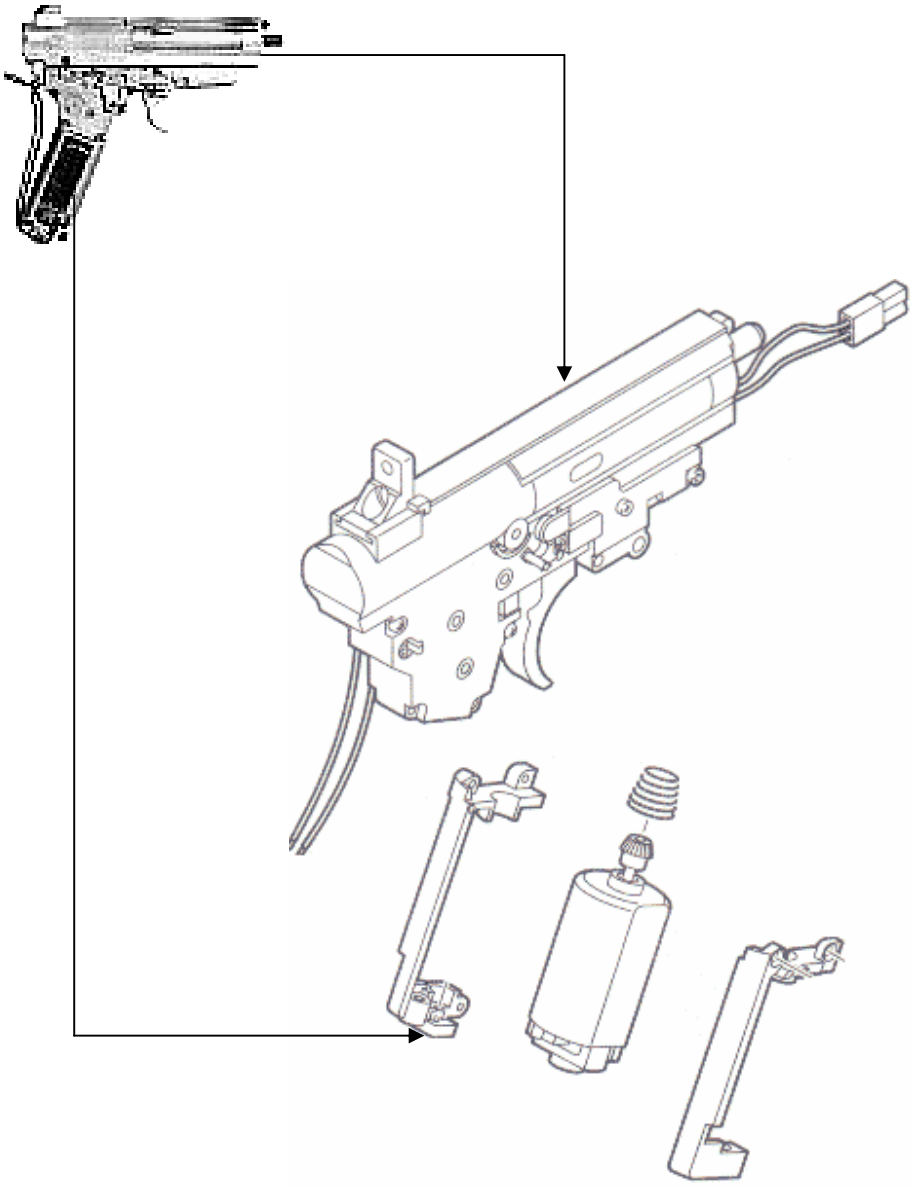
Getting Ready

Below are the components that deserve your attention. These components are often named differently by different authorities. Although it does not really matter how they are named, for illustrative purpose we use the “most popular” names whenever possible.

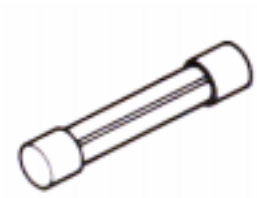
Mechbox shells
Version 2:  Version 3: 

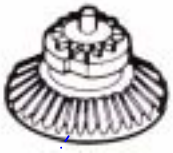
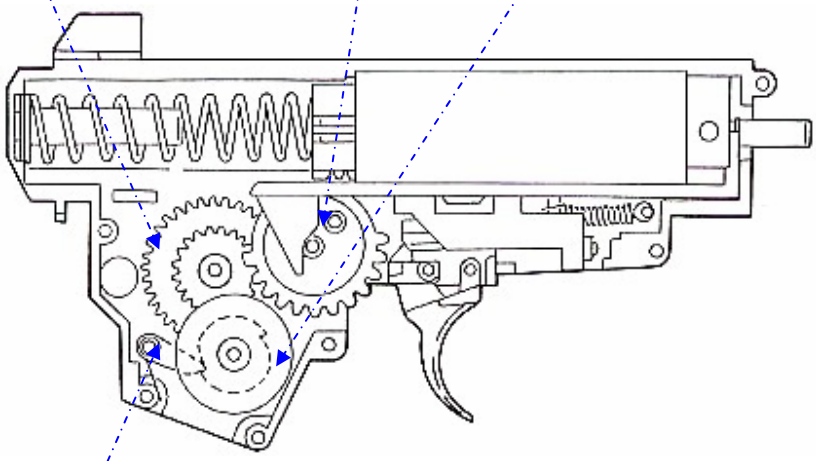
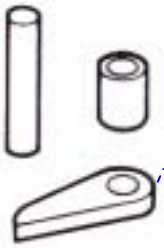
Different ways of "holding" the motor

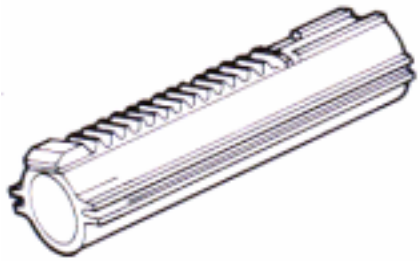
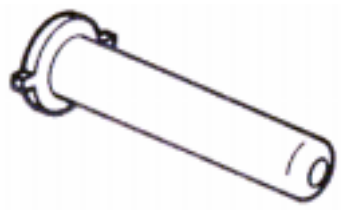
Holding the motor via a detachable metal frame (available only for version 3 mechbox or above, examples: G36, AK, and AUG):

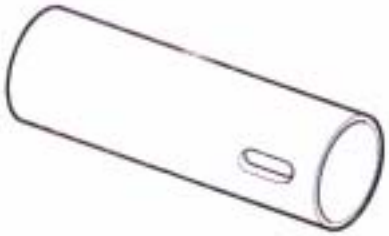
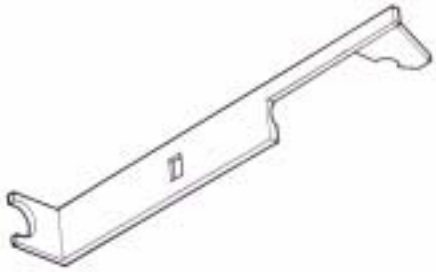


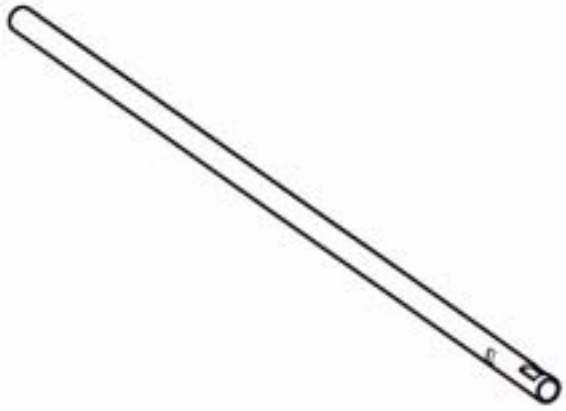
Holding the motor via the grip and the bottom motor plate (MP5, G3, SIG, M4 …etc):

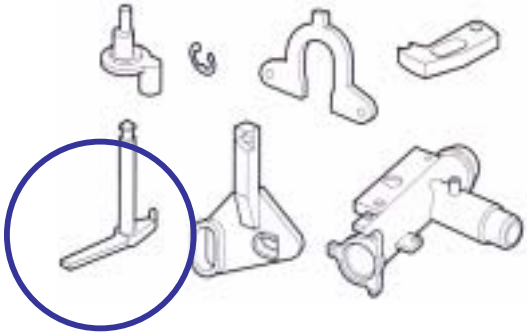
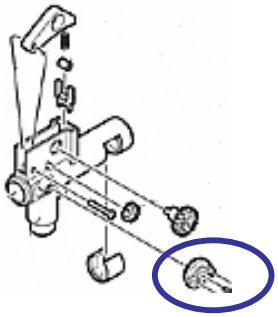
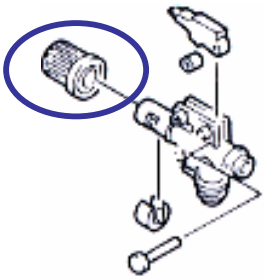
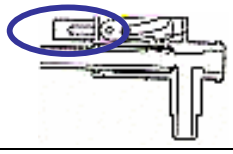
Wiring (and fuse holder)	15A Fuse
	

Spur Gear	Sector Gear	Bevel Gear
	 Back:  Front:	
		
Anti-reversal latch kit	Bushings	Shim washers
		

Piston Head Assembly	Nozzle
 The TM type Piston Head uses the following metal spacer unit to affix the head to the piston. The stock spring is also attached to this unit. 	
Piston	**Piston Gear**
	
Spring Guide	**Spring**
Version 2 (stock):  Version 3 (w/ ball bearing): 	A “regular” type spring:  A Systema type spring (notice the length and the pitch):

* Notice the difference between a V2 spring guide and a V3 spring guide.	
Cylinder	Tappet Plate
	

Hop Up Rubber and Spacer	Inner Barrel
	

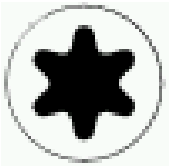
Hop Up Units
Lever style (MP5 excluding the K) :  Dialer style (M4):  Rotary style (G36, G3, SIG, AUG …etc):  Push Lever style (MP5K, AK): 

Tools you're going to need

The two basic types of screwdrivers are standard (slot / flat head) screwdrivers and Philips screwdrivers. Do note that using a screwdriver of the wrong type or size may damage the screw, which may give you unexpected troubles.

TM mechboxes use plenty of Torx screws. Torx is the trademark for a type of screw head characterized by a 6-point star-shaped pattern. Torx head screws generally resist slipping better than Phillips Head or Slot Head screws. Torx head size is typically described using the capital letter "T" followed by a number, such

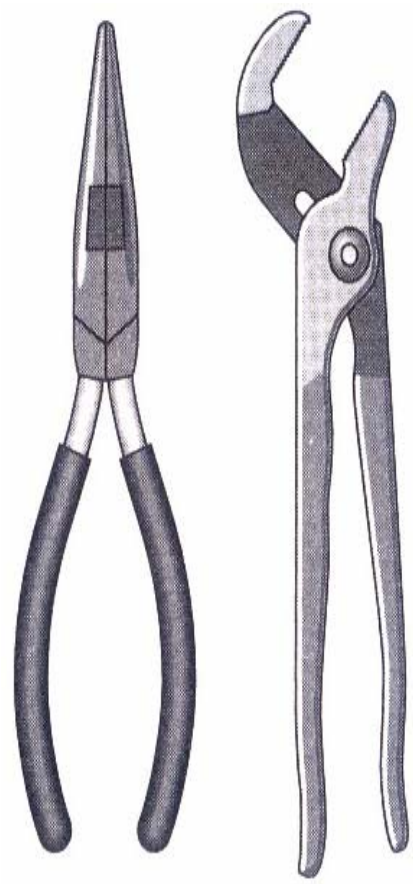
as T5, T10, T15 and T25. TM mechboxes use T10 screws. You therefore need to have the corresponding driver handy.



You may consider to use screwholders for hanging onto screws that have to fit into tiny space. Many screwholders have magnets to hold the screw. Some special screwholders have a little gizmo built-in for grabbing the screw.

Screws with a centre hole that is hexagonal require the use of Allen wrenches or Hex drivers.

You shall need needle-nosed pliers (the one on the left) when handling smaller screws and nuts. Combination slip-joint pliers (the one on the right) are usually needed for handling relatively larger screws and nuts, even though they can be adjusted to several widths with a sliding pin.

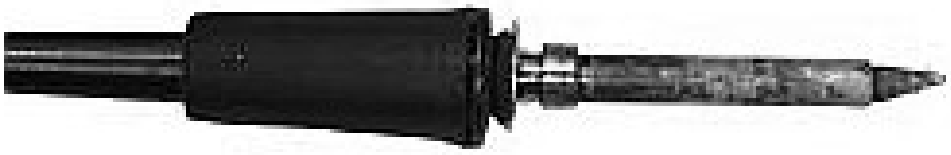


You use the razor knife for task that needs a very sharp edge, such as trimming plastic and decals, cutting wire and stripping wire ends.

You use the "E" Ring Clip Tool to effortlessly remove or insert "E" Rings. Some AEGs use "E" rings a lot while some do not.

You may need to use nut drivers to set or remove hexheaded shaped screws, nuts and bolts.

You may need to use a pen shape soldering iron for rewiring the mechbox and the battery connection. Of course, you are expected to know the basics of soldering.



Proper handling of the screws

Most amateurs tend to screw things very tightly in hopes that the parts will not fly off later. This is in fact a deadly mistake because some screws, bolts and nuts are NOT supposed to be tightened too securely or the threads would be stripped.

If you find yourself confronted with a screw that is extremely difficult to get unscrewed, don't use brute force (or you risk stripping the threads). Instead, give the screw a slight twist in the opposite direction and then loose it again. If this does not help, tap the screwdriver on the head with a small hammer (but don't tap it too hard). If it still fails to make it, try to squirt the screw with penetrating oil or WD-40 and retry.

Stripping screws that go into places like the connection points between the mechbox and the pistol grip can be frustrating. If unfortunately you strip a screw, the 2 easy ways to remove it are:

- Fill the stripped screw hole with J.B. Weld (which is a type of glue specially for use with metal parts), and then put your screwdriver into the old hole to create a new fitting. Give it 10 to15 minutes to set and dry completely, then unscrew it.

- Drill a hole in the screw, then scoop out the old screw.

On the other hand, to prevent certain critical screws from getting loose, apply threadlock/locktite - a glue type of compound that makes screws more secure. Loctite usually won't bite into plastic very well. It can sometimes soften the plastic, but most of the time it won't really be permanently stuck on there. Most of the time you can get a locked screw loose via the use of a decent screwdriver (by the way, heat is what is used to release excessively strong locktite).

Anywhere screws thread into metal, apply a dab of locktite for preventing all the vibration from loosening the screws.

There are locktites of different strength available. You may want to check out the proper type to use through this URL:
http://www.loctiteproducts.com/glue.asp

The proper ways of taking things apart and putting them back together

To avoid getting into chaotic situation when doing your assembly and disassembly works, try to be as organized as possible. Do your work on a clean, dry and flat surface which is close enough to reach without having to walk back and forth to access the necessary tools.

In fact, it is best to work things out on a big white towel. The towel provides a color contrast, thus making it easy to see the parts as you lay them down.

Before you remove each part, ask yourself the following questions and take notes if possible:

1. What is this, and what is it for?
2. Why is it made the way it is?
3. How tightly is it screwed on out-of-the-box? How hard is it to remove?

As you remove each part, lay it down on a clean flat surface in clockwise order, with each part pointing in the direction it laid when it was in place. Assign each part a number indicating the order in which it was removed. When you are ready to put them back together, start with the last part you removed and then go counterclockwise through the rest of the parts. If possible, go to your manufacturer's website (or any other web site) and look for any documentation files (mostly in PDF format) they offer for free download. Many of them include very detailed fly-out diagrams, a complete list of all parts as well as where they fit. This will greatly lessen any confusion you might have when putting things back together.

Your Upgrade Objectives

Friends in the US ever heard of the rumor that the 55 miles-per-hour freeway speed limit was set partly for energy conservation? At this speed level, maximum fuel economy and engine lifespan can be achieved. If you go faster, however, the gas mileage will become un-proportionately poorer and your engine will require maintenance work much sooner.

In the world of airsoft, it is now possible to push the limit to well over 500 fps. And, it has been heard that people in Japan can achieve a ROF well over 35 shots per second. Does it sound too good to be true? The thing is, there are always trade-offs between energy consumption, lifespan, power and $$$. If you have load of $ to spend then you don't need to read this book at all – just ask for the most expensive guns and you're ready to rock n' roll. If, however, you want to spend less and keep cost-effectiveness in mind, then it is recommended that you first figure out your upgrade objectives and the associated trade-offs before making a decision.

Before you tackle any upgrade job, ask yourself the following questions:

1. *Do you really want to do this yourself? Do understand that airsoft upgrade can be either fun OR horrendous.*
2. *Do you really know how to do it? Do you have the tools to do it?*
3. *If you goof, can something be seriously damaged? And, are replacement parts readily available?*
4. *How long will it take, and how much $ will you save by doing it yourself?*
5. *In case something goes seriously wrong, is helping hand easily available?*

Proceed only if you are positive on all of the above. As a suggestion, know the locations and hours of your local airsoft stores as they are most likely the closest sources of help during emergency.

Your number one weapon in getting free help from the airsoft store guys is Pizza :> The guys at the local airsoft stores are often at the center of the airsoft scene in your town. Since you are going to be making lots of trips down there, you should get to know these guys and treat them well. Most of the time a free pizza is good enough to make them happy. You will be thrilled at how much a little kindness and a pizza can do for you at the store.

TM AEG: a baseline for measurement

If the FPS performance of a stock TM gun is used as the baseline for measurement (let's say 100%):

- a SRC AEG is roughly at 105% due to the use of a harder spring.
- a CA AEG is roughly at 110% due to the use of a harder spring.
- an ICS AEG is also roughly at 110% due to the use of a harder spring.
- an AE AEG is roughly at 115% due to small improvement over the ICS AEG.
- an ACX AEG is roughly between 50%~60% due to the use of a very soft and short spring.
- a Cybergun AEG (which is ACX OEM) is roughly at 85% due to the use of a spring softer than the TM one and a poorer HopUp unit which allows air to easily escape (ACX has never managed to get the HopUp correctly done on their previous generation of AEGs). The story may change with the release of the new Cybergun M4, which is not yet available as of the time of this writing.
- an ACM AEG (such as the UTG MP5 and the WELLS M4) is roughly at 85% due to serious air leakage in the piston set and along the inner barrel.

If your Airsoft battlefield has a limit of 350 FPS or below, a stock ICS or CA weapon will just do fine. If your weapon is a stock TM, a Cybergun or an ACM, some minor upgrades will also do the job. Of course, when we say "it will do fine", it is based on the assumption that your gun is always under proper usage.

ACX versus Cybergun

ICS versus AE

SRC Guns

ACM Guns

Since ACX has been out of the market equation for quite awhile already, we are not going to waste time on its' products. Technical information provided in this book does apply to Cybergun's AEG. In fact, Cybergun uses ACX to custom make the DPMS AR15 (which is based on the ACX XM177 with improvements in parts, finishing and workmanship), which shows quite a significant improvement over the ACX counterparts. Internally, the mechboxes and the gears are of metallic construct. Externally, most of the parts are made of plastic.

The AE MP5s, on the other hand, are upgraded ICS MP5s. The earlier releases of the ICS MP5 series have many internal quality related problems, and AE had fixed most of them. Nowadays the two lines are almost identical in terms of power (approx. 310~320). Strictly speaking, AE is more a reseller than a manufacturer.

SRC is basically STTi with a new name. The major selling point is cost – the SRCs are on average 20% cheaper than the TMs. Parts are 100% TM compatible, although quality is not as good.

ACM AEGs used to be the low power alternatives to full blown AEGs. With the introduction of new AEGs from UTG and WELLs, ACM AEGs are now capable of challenging the status quo. By duplicating the architecture of the TM AEGs, many ACMs can achieve performance close to the TM counterparts. Still, due to poor QC and other factors, these ACMs usually have the following problems:

- air leakage - this is especially true with the piston set due to poor design

of the o-ring and the o-ring space in the piston head.

- imprecise inner barrel – the relatively lower level of manufacturing capability makes it generally more difficult for the Chinese manufacturers to produce tighter inner barrels.
- relatively unstable hopup - gap between parts and poor rubber used in the bucking can loosen the hopup mechanism
- easy thread stripping- this often happens on the plastic parts - remember, the majority of parts found in the ACM AEGs are plastic based.
- poor wires – the plastic shielding of the wires tend to melt under high heat.

The good news is, since these ACMs are almost identical to the TMs, parts are 100% TM compatible. Therefore, you won't have difficulties finding replacement parts.

Warning – stock mechbox lubing is often insufficient

TM and AE have been doing okay in terms of mechbox lubing. ACM internals tend to be over-lubed. Other AEG internals such as those from CA, ICS and Cybergun are often poorly lubed. If you open up their mechboxes you will be shocked by how dry their gears and pistons are. Get them properly lubed with grease can significantly lengthen their lifespan. However, don't use the WD40 type of lubricants inside your mechbox. WD40 fails to stick on the gears, thus producing no cushioning effect at all.

What is proper usage?

Proper usage means when you pull the trigger in full auto mode, you don't release it until after 2 to 3 seconds, and that you don't hold it till the entire high cap magazine is emptied. We have heard people complaining that a stock TM gun can break within 3000 shots. Frankly, when a stock TM gun can be ruined this fast, it has to be a serious user problem. TM has the best QA and QC practice in the airsoft industry so there is no way for its' AEG to quickly break by itself.

At the end of the day, an AEG is an electro-mechanical equipment. It needs proper usage and care to stay alive:

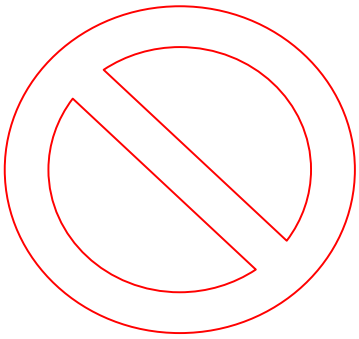
- Don't take your AEG outdoor in rainy days.
- Give your AEG enough time to cool down when the weather is hot.
- Handle your AEG with care – don't drop it on the ground.
- Clean the inner barrel every time after outdoor use.

High FPS Upgrade

What are the key elements of a high FPS setup?

High FPS is achieved when:

- enough air is being sucked into the cylinder.
- the cylinder is large enough to accommodate the required amount of air.
- the spring can move forward fast and powerful enough to create the necessary air pressure.
- the compressed air does not escape.
- the hopup unit does not introduce too much friction on the bullets.



Please consult your local law enforcement agency on your country's legal FPS limit. Exceeding such limit can be a serious legal offense. Proceed to the High FPS section of this book only if you agree to abide by the law!

Version 2 mechbox versus Version 3 mechbox: any difference in stock performance?

TM metal mechbox versus Cybergun plastic mechbox?

We have heard people saying that due to a better design, guns running on the Version 3 mechbox (such as the AK and the SIG) can offer better FPS by default. Frankly, this is quite untrue. Both mechboxes share the same internals (gears, piston, cylinder and spring), therefore it is not likely that one can outperform the other without modifications. The true reason why V3 guns offer better stock performance is that these guns are based on better overall gun design so that air leakage is kept to the minimum. TM AK is an obvious example – sometimes it can shoot at a FPS well over 300 under purely stock configuration.

Most V3 mechboxes do come with more reliable select fire mechanisms (such as those gear based mechanisms in use by the AK and the G36). Also, because some V3 mechboxes include a motor mounting frame for mounting the motor, mechbox testing can be done almost on the fly without the need to first assemble the lower receiver part of the gun.

We have heard people saying that the Cybergun's DPMS AR15 is crappy due to the use of plastic internals. These people obviously have no clue on what they are talking about. All ACX and Cybergun' AEGs are based on the metallic Version 2 mechbox. The primary difference is that the ACX/Cybergun mechbox has an EG-560 compatible motor affixed by two screws. Its' diecast is also less solid when being compared with a TM, but based on our test result it can still survive a M120 (with NO spacer on either end of the spring) + 9.6V combo.

Plastic mechboxes do not have to be bad. In fact, some recently marketed made-in-China AEGs (such as the BE Tech AUG/XM8) can shoot at around 330 FPS perfectly fine using plastic mechbox and gears.

Are CA/ICS guns crappy for upgrade?

Although it is believed by many that AEGs produced by CA and ICS are crap, based on our experience and observation this is not really the case. Most importantly, their mechboxes and gears are built strong and solid material (even stronger than the TMs). Their stock mechboxes and gears can sustain M130 ~ M140 without problem when under proper usage.

However, they do have certain problems in their lineups. The plastic nozzle, tappet plate and safety cover found in the ICS MP5s are very easy to break even at M120 + 9.6V. On the other hand, it has been reported by many airsoft technicians that the positioning of gears are inconsistent and inaccurate in many CA mechboxes.

FPS increase in meter readings VS performance increase in a practical sense: the law of diminishing marginal gain in performance.

Generally speaking, FPS in between 360~380 and ROF in between 22~25 should keep your AEG very usable and durable for years without the need for major expensive maintenance. This can be achieved with the use of a M110 spring + ball bearing spring guide as spacer, or a M120 spring without spacer on either end (refer to the section on the use of spacer for further information). If you want to go over these limits, be prepared to spend lots of $ on subsequent maintenance.

You are encouraged to think about the significance of performance difference brought about by an upgrade. Based on our experience and observation, a FPS increase of approx. 40~50 does make a visible difference when the total FPS before upgrade is under 300. That is, an AEG running at 340 does give better result in a visible manner then a stock TM. However, the marginal gain tends to fall as you move up the FPS curve (you cannot really tell a practical difference between 440 and 480 UNLESS you are also moving up to 0.3g or 0.4g BBs). Frankly, difference in meter reading does not always translate into difference in real world effectiveness.

When you do your upgrade, there is really no need to go for a certain FPS level very precisely (unless you are selling your services). Someone 80 feet away will tell you that he feels the same when being shot at 350 and 400.

* For your reference, a M100 spring can produce FPS of up to around 350, while a M120 can take you to the 400 level. M130 can push the limit to around 450. And you shouldn't want to talk about a M140 (and beyond) unless you want to do some bloody killing. In most countries on earth, a M140 should allow you to break the law and get yourself to jail.

0.20g BBs versus 0.25g BBs versus 0.30g BBs: the heavier the better?

Does FPS always go hand in hand with Joule?

What is the difference between the FPS system and the Joule system?

How do you use FPS to measure Joule?

How do you use FPS to give an estimate of the range?

If you plan to upgrade to 400FPS+, you may better also move to 0.25g BBs. 0.20g BBs are way too light at this power level and will not deliver the accuracy you need. If you plan to go over 450FPS+, consider the use of 0.30g BBs for maximum flight path stability. Marushin has some very nice 0.30g BBs (USD$18 something per bag of 1800… ☹).

By the way, heavy BBs do drag down FPS quite a bit (due to the heavier weight) but may produce higher impact (also due to the heavier weight). They are VERY expensive though… you should really take this cost element into consideration when defining your desired upgrade level.

As previously stated, heavier BBs may produce higher impact. What this indicates is that FPS rating alone may not truly reflect how powerful an AEG is. While FPS measurement (feet per second) looks primarily at the “speed” of the flying bullet (i.e. the muzzle velocity)(!), Joule measurement (a system commonly in use in the UK) does take bullet weight into the equation to more accurately measure the force generated (i.e. the impact energy). In fact, we at The AirsoftPRESS prefer Joule measurement over FPS. However, it seems like the market in North America is biased totally towards the FPS system.

(!) For FPS measurement to deliver fairer results, one should REQUIRE all participating guns to use BBs of the same class (eg. 0.2g) and have hopup completely released.

BTW, the formula for calculating Joules uses MPS (meters per second) rather than FPS as the unit for representing velocity - as you know, the US uses non-SI (Système Internationale) units such as feet, gallons and miles, while most other parts of the world use SI units such as meters, liters and kilometers. To translate FPS into Joule, you will need to first convert FPS to MPS. The conversion rate is (roughly) 3.28, so you may do the math accordingly:

$$E = \frac{1}{2} * m * Vx^2$$

where E= the impact energy in Joules; m= the mass in kilograms, which is the weight of the bullet; and Vx= velocity in MPS.

FPS - MPS conversion:

1 m/s = 3.281 ft/s
1 ft/s = 0.3048 m/s

If you don't want to do the calculation by hand, refer to the following online calculator for help:

http://zephir.dk/articles/CIG/Height decreaseJS.html

In fact, this calculator offers functions for calculating the effective range and the drop distance of a bullet. You will, however, likely see different results in the real world (due to the many different outdoor conditions and the sometimes-unpredictable back-spinning effect created by the hopup function).

Higher FPS = lower ROF?

Softer spring = Higher ROF?

Harder spring = Lower ROF?

In many cases, the answer is YES. The harder the spring, the more horsepower it takes for the motor to pull the gears, which may reduce the ROF. However, this problem can usually be solved by using a higher voltage battery. Remember, a higher voltage battery is dangerous only if your spring is too soft for it. With an upgraded spring, a higher voltage battery doesn't hurt as much.

When you put a load on a spring (which means making it "shorter"), it pushes back against the load and tries to get back to its original length.

In theory, a softer spring costs less energy to compress and is therefore facilitating a higher ROF. However, one must also consider the fact that a softer spring is usually less responsive in its return journey (i.e. the "pushing back" movement). A harder spring is harder to compress, but when it is released it extends much faster. This explains why many powerful AEGs can also shoot at an amazing ROF.

You may want to refer to the High ROF section for information on how we achieve higher ROF without increasing much FPS through the use of a "harder spring".

BTW, how soft is "SOFT"? A stock TM spring is soft, and a Cybergun stock spring is way too soft (that is why a stock Cybergun AR15 can run fine even with 6V power). By using a spring that is too soft you risk having the gear timing mechanism disrupted (which may result in serious double feeding).

Is 8.4V insufficient for an upgraded mechbox?

Does battery size matter?

Is battery power important for semi-auto firing?

The correct voltage on which a motor is required to operate is critical. Every motor model is unique. Different models have different operating characteristics. In general, a 5% decrease in voltage can often translate into a 10% decrease in motor torque.

When you equip your mechbox with a harder spring, you want to ensure that the motor has sufficient power to start the load. We cannot, however, just look at the voltage level. Battery size (and its corresponding mah value) is another major factor to consider. A real life example: a 8.4V GP 3300mah battery can easily beat a 10.8V Sanyo 600mah battery in terms of power output.

We will talk about battery in further details later, for now you need to know that a 8.4V high mah battery (such as a GP 3300) is more than enough to drive a M120 upgraded mechbox (unless you are using EG560 ... refer to the next section for more information).

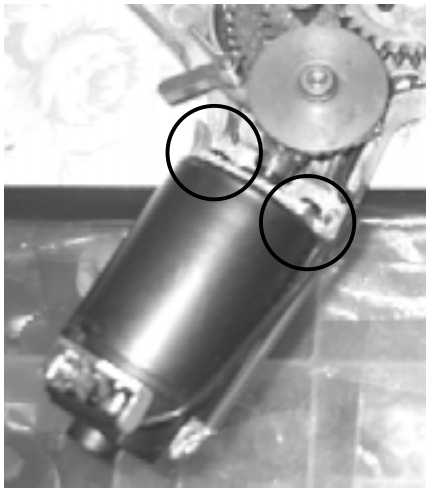
Many people believe that battery power does not matter in semi-auto, that as long as the motor has enough power to pull the piston then a shot can be satisfactorily completed. This concept is totally wrong. As said before, a gun's FPS is partly determined by how fast and powerful the piston is moving forward. With enough battery power, the motor can afford to pull the piston and the spring fast and hard. In return, the spring will be much more powerful in its "return movement" and will push the piston much harder. **High FPS in semi-auto requires significant horse power from the motor (and the battery).**

Is EG560 too weak and fragile to power an upgraded mechbox?

Can I use EG560 on my MP5?

EG560 offers very high speed and is one of the most durable motors we have seen. The thing is, it needs higher voltage to efficiently drive an upgraded mechbox (one that has a stiff spring). When an EG1000 works fine with 8.4V 2000 mah for a M120, an EG560 needs 9.6V 3000mah. However, at this power level it rocks. We have a FAMAS under this configuration for over 2 years without any problem. Based on our past experience, EG1000 is more fragile when comparing to EG560 (we had a small war game field with approx 50 upgraded FAMAS and 100 upgraded MP5K PDWs for hire. Last summer alone we got 8 overheated EG1000. The EG560 were all fine though).

Currently only the TM FAMAS, the entire line of ACX AEGs (including the MP5s and the L85) and the Cybergun DPMS AR15 use EG560 / EG560 compatible motors*. Although you may attach an EG560 to the MP5 V2 mechbox, the stock MP5 lower receiver is too small to accommodate it.



*** Remarks:**
ACX (Cybergun) named its EG560 compatible motor as AC1000. Although both the EG560 and the AC1000 are manufactured by Sagami and are sharing the same look, we cannot confirm if they are 100% identical. Based on our experience, two out of four AC1000s were dead after about 12000 shots (using PDI 120% spring). The EG560s had no problem at all.

More about EG-560, EG-700, EG-1000 and ICS Turbo 2000:

It is quite true that a properly shimmed mechbox can run perfectly fine with 7.2V. We upgraded a MP5 (we put in a spring which is almost one inch shorter but a little harder than the TM stock one) and have it driven by an EG1000 + a non-name branded 1800mah 7.2V battery and managed to achieve a consistent ROF of 24~26 at FPS of 298~302.

However, there is one exception - if you are using EG-560, the "7.2V test" may not give valid results. EG560 needs at least 8.4V to pull a stiffer spring. With proper power input, EG560 can produce ROF as great as that offered by EG1000.

EG1000 can give relatively high ROF even with low power input. However, it is also fairly easy to get over-heated. On stock gun using high mah (those with 2500mah or above) NIMH battery, stay at 7.2V in summer time - you don't want to cook your motor within an hour.

The ICS Turbo 2000 motor is kinda on par with the EG700 in terms of performance. They are less likely to get over-heated and are therefore more 8.4V friendly on stock guns.

However, because of the slightly different shape of the pinion gear, the Turbo 2000 may produce some strange metallic noise on non-ICS guns. Frankly, many parts from ICS are NOT truly TM compatible.

More about the UTG MP5 motor and the SRC M4 motor:

The EG700-like motor used by UTG in their MP5s is perfectly okay for up to 325~340 fps. Don’t go over this limit or the life of the motor will be significantly shortened. Don’t use Systema springs with this motor. Use softer springs such as the PDI 120% or the Guarder SP90.

The SRC M4 motor is slightly better than the UTG one. Still, it is not designed to handle real stiff spring and your best bet is to stay within the 350 FPS limit.

More about the new Cybergun GPX 5000 motor

The new Cybergun GPX 5000 motor (which comes with the A15 Evolution, available in long form only) has two ball bearings and based on our test results it gives a 8~10% ROF improvement over a EG1000 on a M100 equipped TM MP5K PDW. Torque-wise, it works fine up to M130 but at this level the ROF advantage seems to have diminished.

Why (and why not) should I buy the high torque gear set?

Why (and why not) should I use helical gears?

In its simplest form, the term "gear ratio" in the context of AEG mechbox defines the relationship between the pinion gear and the spur gear. It addresses the concern of how many times the pinion gear has to turn in order to make the spur gear turn once. Therefore, gear ratio equals the number of teeth on the spur gear divided by the number of teeth on the pinion gear.

So the gearing in the mechbox actually reduces the speed transmitted to the piston, not increases it. Such a speed reduction, however, is considered necessary as it adds torque. A low gear ratio slows things down but produces more torque, and vice versa. The higher the gear ratio, the hotter the batteries (and the motor) get as they induce more current to supply the same amount of torque. To illustrate, refer to the example illustration below:

The above shows a 3:1 gear ratio. The gear with 10 teeth (the right one) will have rotated completely when the 30-tooth gear (the left one) has rotated a third of its way. A gear ratio closer to 1:1 will allow both gears to turn at closer speed rates, thus producing higher RPM but less torque. **Less torque means more stress imposed on the motor when there is a need to pull a stronger spring.**

The TM FAMAS, the ACX MP5/L85 and the Cybergun A15 R1 all share the same

gear ratio, which is capable of delivering higher ROF (but less torque) than the standard TM gear ratio. Because at this gear ratio the gears are quite easy to break, Cybergun has switched to the standard ratio in the A15 R2 and in the forthcoming M4.

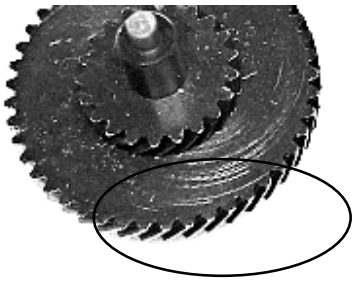
The high torque gear set has a different gear ratio than the stock gear set. It does produce higher torque without increasing the burden of the motor, but ROF is jeopardized.

You should consider the use of high torque gears if:

- you want to go significantly beyond M120, and
- you are in an environment where temperature is constantly high.

High torque gears make the life of your motor easier. However, if you push your motor with a 12V high mah battery, this benefit is lost.

Helical gears have their teeth cut at an angle such that more teeth are in contact at any given moment.



This approach is supposed to be good as any one tooth is facing less force upon it at any given time. The problem is that of fitting. You need to have mechbox, bushings and piston that fit properly with the helical gear set, and based on our painful experience it is better off to buy a complete Systema FTK rather than just the gear set alone.

Note that most FTKs are simply collections of improvement parts which allow

better compression (enhanced air sealing through more precise part sizing and the use of better O rings) and higher air flow volume (through enlarging the inner size of parts such as cylinder head and air nozzle). Since most FTK parts have their unique customized features, it is NOT a good idea to mix and match certain FTK parts with other parts from a different manufacturer.

Why (and why not) should I keep the stock plastic bushings?

Why (and why not) should I replace the stock plastic bushings with metal bushings?

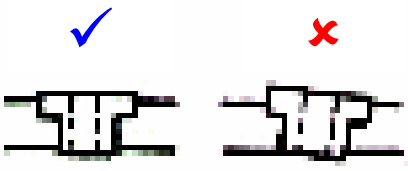
The plastic bushings should do just fine under the following conditions:

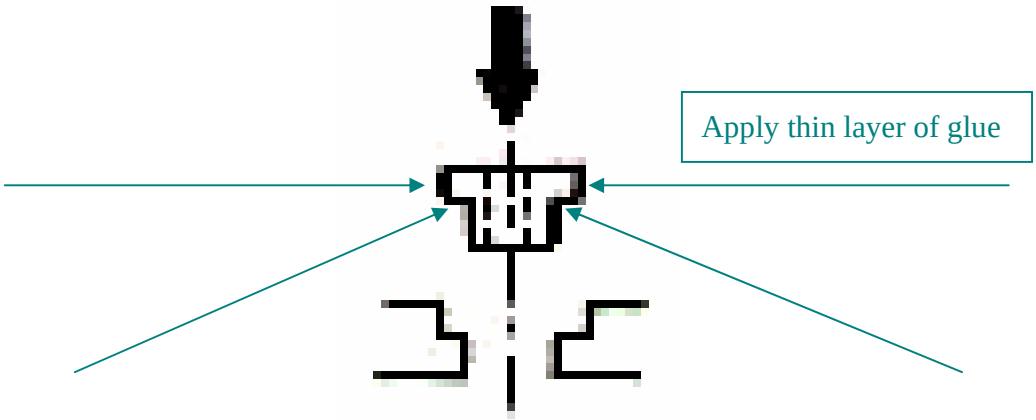
- they are adequately lubed
- your gun runs at less than 330~340FPS
- the spring in use is not the hard & short type
- you do not push the gun with high power battery (a GP 3300 8.4V or a Sanyo 1300 9.6V may be too much)
- you often keep your gun under proper usage

Even without upgrade, you should in any case replace the stock plastic bushings after around 13000~15000 shots.

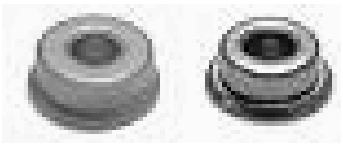
You should use metal bushings whenever you want to go beyond 350FPS or beyond (meaning anything stronger than a M100). If you use a hard and short spring, you should switch to metal bushings. Note that shimming must be done all over again when you install new bushings.

When installing new bushings, make sure you have them properly aligned with the place holders. Additionally, we recommend that you glue them in place, or otherwise they may go loose and spin together with the gears after prolonged use.





FYI, on the left is a 7mm bushing, on the right is a standard 6mm bushing:



7mm VS 6mm

In theory, a 7mm bushing due to its larger diameter allows the spreading of radial loads out on a slightly larger area of the mechbox shell. Simply put, it offers a relatively higher level of tolerance for radial and axial loads.

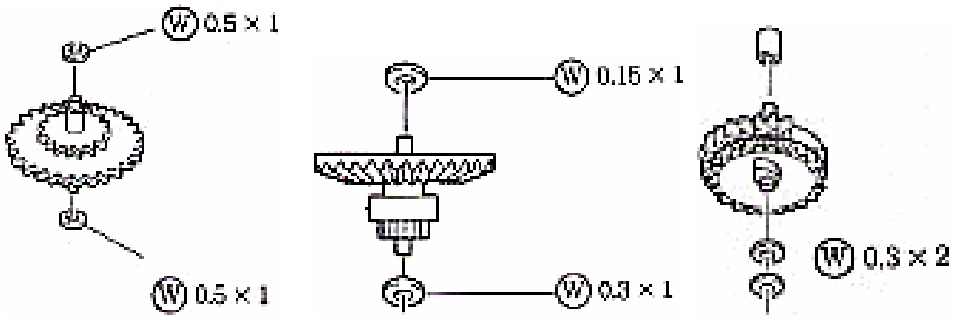
Going 7mm does not seem to be necessary unless you are using a very hard spring or that you want to use ball bearings in a high FPS setup. Certain new AEG models from CA are 7mm based. TM and ICS seem to stick with 6mm as of the time of this writing.

Warning:

Not all 6mm metal bushings share the same inner diameter. If you are using stock gears, the safest bet is the Area 1000 metal bushings (Area 1000 is a sub-product line of Systema).

What is an easy way to (more accurately) shim?

The goal of shimming is to keep the spacing of gears correct. Marui has a set of "official shimming standards" for the V3 mechbox:



These "standards" were devised based on the assumption that you use solely TM stock gears with stock plastic bushings inside a V3 mechbox. Therefore, they serve as good references but NOT absolute standards.

Most shim washers in the market have sizes of 0.2mm, 0.3mm and 0.5mm. There are 0.15mm and 0.1mm available from some Japanese manufacturers too. Use the SMALLEST possible shim washers to make the finest possible adjustment.

Start with the least number of shims. What you may want to do is to test fit the gears one by one incrementally. The test fitting process requires that you insert the gear in question and put the mechbox back together, then check for 'slop' from BOTH sides. Keep adding shim washers (or changing to a larger one) as long as 'slop' exists (but don't add too many or the gear will have a hard time spinning).

Order of gear installation: first is the spur gear. Next is the sector gear. Finally are the anti-reversal latch and the bevel gear. Don't forget to apply grease when installing the gears!

When inserting the “next gear”, always make sure that it aligns correctly with the previous one. Keep in mind that:

- the teeth of the piston must be correctly aligned with the teeth of the sector gear, or the piston teeth will be unevenly stripped.
- there should **almost** be no gap between the sector gear and the spur gear, or the teeth of the sector gear will break within 600 rounds at the time the spring is compressed.
- the anti-reversal latch must be properly positioned relative to the bevel gear, or the latch will worn out prematurely.

One good approach is to reference the way shimming has been originally done. The logic is simple – we need to re-shim because the stock bushing has a size (thickness in particular) slightly different from that of a metal bushing. Since the metal bushings share one same size between themselves (as long as they are name branded bushings from the same pack), chance is that you simply need to do minor adjustment at each location to compensate for the difference in thickness between the stock bushing and the metal one. Do note that this approach assumes that you do not replace the gears at the same time. Gears from different manufacturers do vary slightly in sizes and dimensions.

Go through several rounds of trial fire until there is **almost** no gap between the gears and at the same time they can spin smoothly without much resistance. * When we say **almost**, we mean the gap should be minimized but NOT completely eliminated. If the two gears are touching each other, you will run into problem too (due to excessive friction).

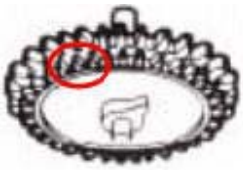
Spur gear breakage:

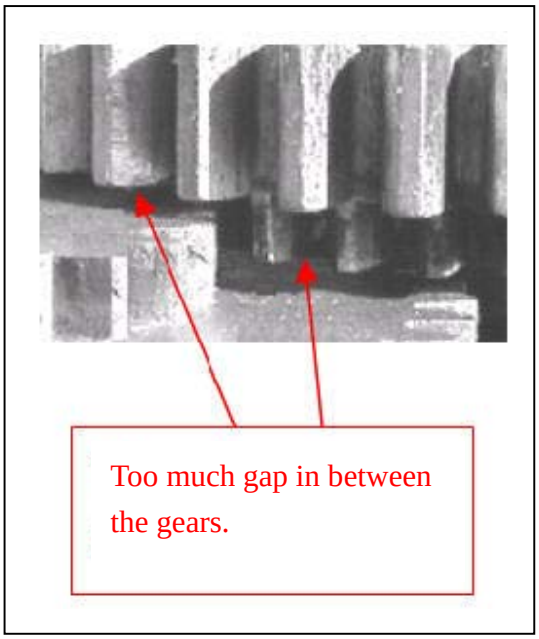
If your spur gear breaks, it is NOT necessarily due to poor shimming. If several teeth were broken together on the spur gear, chance is that the spring that you

use is too hard (the impact generated on the gears is too high) or too soft (the gears run way too fast) for your configuration.

Sector gear breakage:

If two of the inner teeth on the sector gear break in a row, do whatever you can to minimize the gap between the spur gear and the replacement sector gear. One quick and easy way is to swap one or two shim washer(s) (depending on their thicknesses) from the bottom side of the sector gear to the top.





How do I tell if shimming has been done correctly?

Anything special about shimming the AR-15 mechbox?

What is the recommended order of gear insertion?

If you have difficulties putting the two halves of the mechbox back together, chance is that you have put too many shims somewhere. One extra needless shim on either side of any one gear will usually make it impossible for the two halves to perfectly close.

On a mechbox with a stock spring installed, correct shimming should allow full-auto firing without problems at 7.2V. On a mechbox with an upgraded spring installed, correct shimming should enable full-auto firing (speed doesn't matter at this point) under regular 8.4V power.

In any case, test fire at least 600 shots – if nothing goes wrong after the test, you may safely assume that shimming has been quite properly done.

If you have a Cybergun DPMS AR-15 (Ver. 1), we strongly advise that you double check the factory default shimming – with its default shimming the sector gear can break in less than 600 shots even with a stock TM spring (we heard that there is a version 2 release of the AR15 with significantly improved internals. We haven't have a chance to play with one yet).

Again, the recommended order for gear insertion:
First is the spur gear. Next is the sector gear. Finally are the anti-reversal latch and the bevel gear.

Longer spring versus shorter spring: the longer the better?

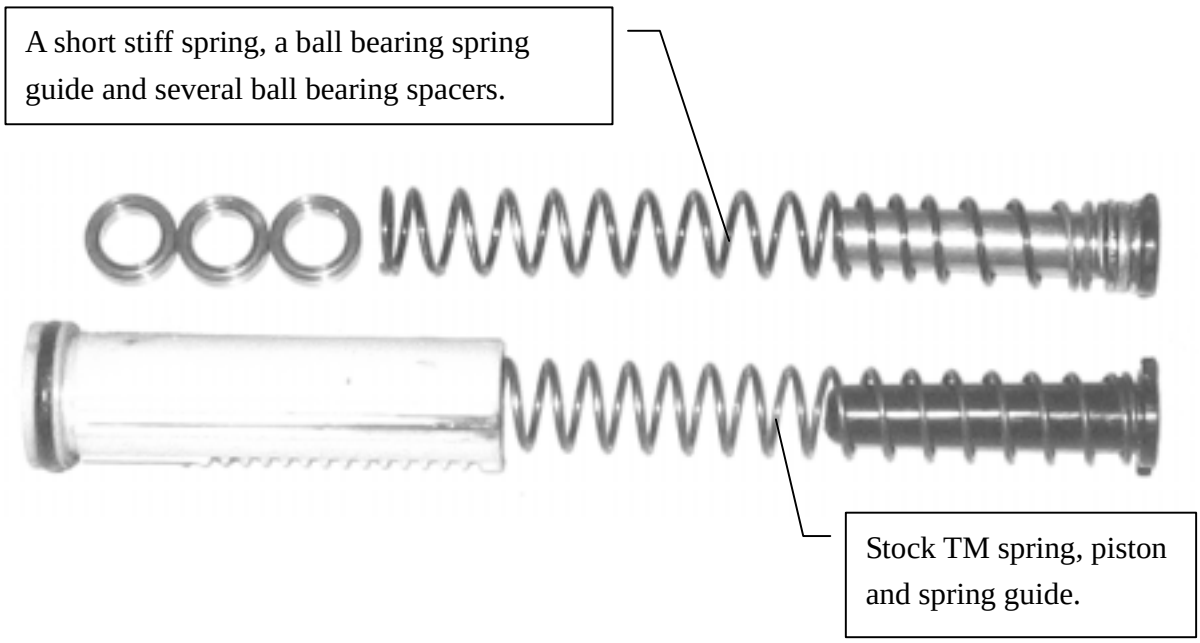
What are the major parameters of a spring?

Is a harder spring more harmful for the internals?

There has been a myth around saying that a very long spring is needed for delivering higher FPS. No, that is not always true. As an example, a PDI 130% spring is about an inch longer than the 140% one.

On every compression spring there are several parameters. The “free length” is the length of a spring with no load applied. “Length before set” can be thought of as near the maximum compressed length of a spring (let’s refer to this as the compressed length). The number of coils also plays a role in determining the strength of a spring. Generally speaking, the more coils a spring has the more powerful it is. However, the material that is used for producing the spring and the corresponding heat treatment process are even more critical. Put it this way, a soft spring with 10 coils may well be “weaker” than a hard spring with 5 coils. Also, not all coils are active (this apply especially to variable-pitch springs). And, installation-wise, a spring that is too long (a high free-length parameter) is much harder to fit into the mechbox.

To demonstrate the use of a short spring, let’s refer to the example below:



The shorter spring shown above is basically a M120 with one third of it chopped away. It is now much shorter than the “normal” TM spring. 3 ball bearing spacers are to be placed in the piston – the inner diameter of these bearings is large enough to avoid crashing with the spring guide.

This “short setting” is very easy to install, and is capable of offering a FPS of approximately 325~335 (compare to the TM default of 290~300) with a higher ROF (as the stiff nature of the spring allows faster decompression).

Based on our experience, the “short setting” also produces much less stress on the first several teeth of the piston, meaning the piston can last longer.

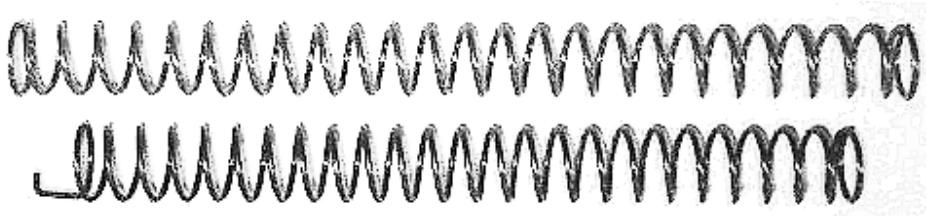
A softer but longer spring does have an advantage over a shorter but harder spring. A softer spring imposes less initial load on the motor and should work gently at 8.4V most of the time. A harder spring may require a very powerful battery (such as a GP 3300 8.4V or a Sanyo 2000 9.6V) just to get started.

A very hard spring has the potential of breaking the internals. However, based on our experience, as long as it doesn't go over 400FPS (meaning the spring should be hard but relatively short), even stock gears will survive (under proper usage of course).

Installing a long spring: tricks and potential danger.

Installing a short spring: tricks and potential danger.

A M100 spring is considerably longer than a stock TM spring:



Let's refer to the picture below. The sector gear keeps rotating anti-clockwise, and the piston is being driven to (almost) the leftmost position. If the spring is too long (meaning the compressed length exceeds what can be accommodated by the piston at the leftmost position), something will break (refer to the Troubleshooting section) or the gun will get locked up. And, according to a professional spring manufacturer, it is always NOT recommended that a spring be operated near "length before set" due to inaccurate loads resulting from the non-linearity of the spring rate when approaching maximum compression.

To minimize the chance of running into problems, when installing a long spring you should remove any spacer on the spring guide (OR inside the piston). While a ball bearing spring guide is a good idea, it itself is also a spacer with significant thickness.

On the other hand, if you are to install a spring that is significantly shorter than

the stock one, keep in mind that:

- when installed, both ends of the spring (without compression) should not have any gap left. If there are gaps on either side, you may need to use spacers. HOWEVER, the need for many spacers may simply indicate that the spring you selected is too short. Refer to the section on the use of spacers for further information.
- note the diameter of the spring wire. If the spring wire has a large diameter, the compressed length may still be too long.
- note the number of coils. A short spring with MANY coils can be very lengthy even at full compression.

Why (and why not) should the spring be ground?

How to facilitate spring spinning?

Grinding is the process of grounding the ends of a spring. Springs found in TM / ICS / Cybergun AEGs are properly grounded, which look highly professional. It is a bit disappointing to see that many of the springs found in the CA guns have not been grounded.

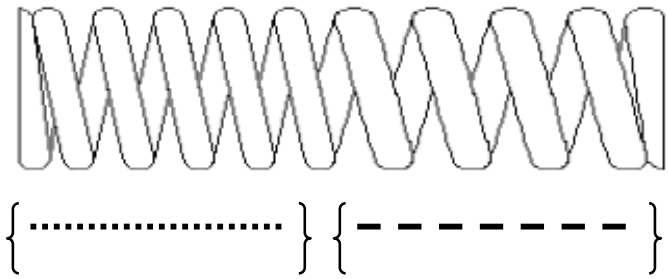
Generally speaking, when a spring is ground on both ends, it can spin more freely during compression. **Do it yourself grounding:** It is very easy. Just take the spring to the kitchen, turn on the fire, have the end of the spring heated, and then ground it by force.

When using a stock TM Piston / Piston head set, you will for sure want at least one end of the spring to be grounded unless you don't want the spring to spin. The TM type Piston Head uses the following metal spacer unit to affix the head to the piston:

There is huge space gap between the inside of the piston and this metal spacer unit. If your spring is not properly ground on this end, sooner or later its' tail will get trapped into the gap, thus stopping the spring from spinning. To solve this problem, you may either put a big-enough metal washer on top of this unit to cover the gap, or replace this spacer unit with a simple nut (refer to the simple bolt and nut mechanism deployed by the ICS piston head set).

What is a variable pitch spring? Is it always better for AEG?

The pitch of a spring refers to the distance, center to center, between two coils. A variable-pitch spring is one that starts out "soft" and after a certain load is placed on it, becomes stiffer. This kind of design is good when you do not have the horse power to start the initial load. Refer to the illustration below (note the small difference in pitch on the left and on the right):



The technology involved in creating such a spring is not rocket-science. When you've wound what you want at the first pitch, simply stop the lathe and change the lead screw speed setting to the second position. Continue winding at the second pitch until you want to change the pitch again.

A long variable-pitched spring:

When looking at a variable pitch spring, also pay attention to the number of active coils. Active coils are coils which contribute to the motive force of the spring. Only the coils which show daylight between them are active coils. Non-active coils usually act as spacer and nothing else.

Installing the variable-pitch spring:

As recommended by the manufacturer, the tighter coils are to be fitted to the rear of the mechbox (i.e. the side of the spring guide) for the best possible performance.

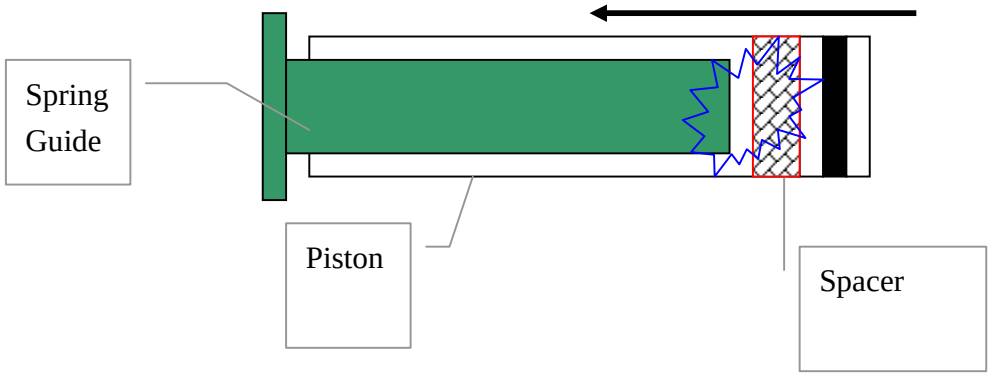
Use of spacers for spring compression: tricks and potential danger.

When you want to put spacer on the spring guide to increase the compression effect, first look for spacer of suitable diameter. Referring back to this picture:

The sector gear keeps rotating anti-clockwise, and the piston is being driven all the way to the leftmost position. If your spacer has an outside diameter exceeding the inside diameter of the piston and that the spacer is too thick (anything getting close to half an inch is considered too thick here), the piston's leftward movement will be blocked and the gun will get locked up.

Even if your spacer has a piston-safe diameter, use it very carefully with stock TM piston set. Referring back to the TM type Piston Head we talked about, the metal spacer unit itself is already a thick spacer. The use of additional spacer is no different from using a spring that is too long – something will break inside the mechbox (refer to our Troubleshooting section).

If spacer is used inside the piston (rather than with the spring guide), make sure the spring guide won't hit the spacer during full compression:



We found that using spacer for better FPS is effective and safe only for harder and shorter springs. On softer springs (like the default TM ones) the small increase in FPS has no real world significance at all. We have had a case where a G36C was equipped with a very hard but short (about one third shorter than a stock TM spring) custom-made spring capable of 450 FPS. By removing the 0.5 inch spacer from the piston we saw an instant drop of 50+ FPS. By adding a ball bearing spring guide the FPS went back to 450~460 again.

Be very careful when using spacer with PDI springs. PDI springs have many active coils, meaning the compressed length is quite close to the maximum. Additional spacers may cause gun lock-up.

Different piston models have different inner diameters. You need to choose spacers that are of a proper size – there shouldn't be room for these spacers to wobble inside the piston.

What is wrong with a custom made spring?

Systema Springs versus PDI Springs

Many people believe that custom made springs are no good for AEGs. In fact, the quality of a spring depends largely on the built material as well as the workmanship of the spring shop. If you go to a good spring shop, chance is that you can get a tailor made spring as good as those offered by Systema and PDI.

If you buy a Systema (or PDI) spring, you know at the time of purchase what FPS can be achieved. Their products are proven. With a custom made spring, you must measure the FPS and may have to do fine tuning on your own.

Systema springs are in general longer and harder, while PDI springs are shorter and a little softer. Both of them are from Japan and are of similar prices. People prefer PDI springs because PDI springs are thought to be less stressful for the gears. Do note that PDI springs are wider than Systema springs and are therefore not compatible with certain pistons (such as the Prometheus Hard pistons). The harder Systema springs tend to fracture, thus causing disintegration and mechbox lockup. PDI springs, on the other hand, are more reliable in this regard.

Based on our experience, installation-wise PDI springs are much easier to deal with. Below is a table for your reference:

Systema	PDI approx. equivalence	FPS with 0.20g BBs
M90	100%	295~300
M100	120%	325~340
M110	150%	365~380
M120	170%	390~400
M130	210%	425~440

M140	240%	455~470

Can stainless steel spring offer better FPS?

Can Telfon Coated spring offer better FPS?

Stainless steels will not rust, making them ideal for environments containing water or steam. Power-wise, being stainless or not doesn't seem to be relevant.

Telfon Coated finishing provides a smoother surface and can avoid electric shortening that causes sparks. One argument supporting the use of Telfon coated spring is that with a smoother surface the friction between the spring and the inner side of the piston can be reduced. Power-wise, being Telfon Coated or not does not seem to be relevant.

The long variable-pitch spring is very difficult to install. What should I do?

What can I do to reduce stress on the gears?

On most Version 2 mechboxes you can find a hole at the back of the mechbox which allows you to see through to the spring guide. You may insert a long and thin screwdriver, through the hole, into the butt of the spring guide. Just push downwards on the front of the screwdriver to keep the long spring in check while you close the mechbox. Most version 3 mechboxes do not have such a hole at the back :<

Spring rotation can reduce stress for the gears only if both ends of the spring are free for spinning. As a cheap way to facilitate free spinning of the spring, you may use a ball bearing spring guide as well as a ball bearing inside the piston. Take your piston to a local bearing shop and get a bearing that can fit into the inside of the piston perfectly. When both ends of the spring have ball bearings, free spinning can be significantly facilitated. Do remember that:

- a 400fps+ spring may be too tough for most ball bearings – they may be cracked.
- ball bearings do act as a sort of thick spacer – if you have them on BOTH ends of the spring you may experience gun lock-up. We recommend this configuration only for the hard and short type upgrade spring.

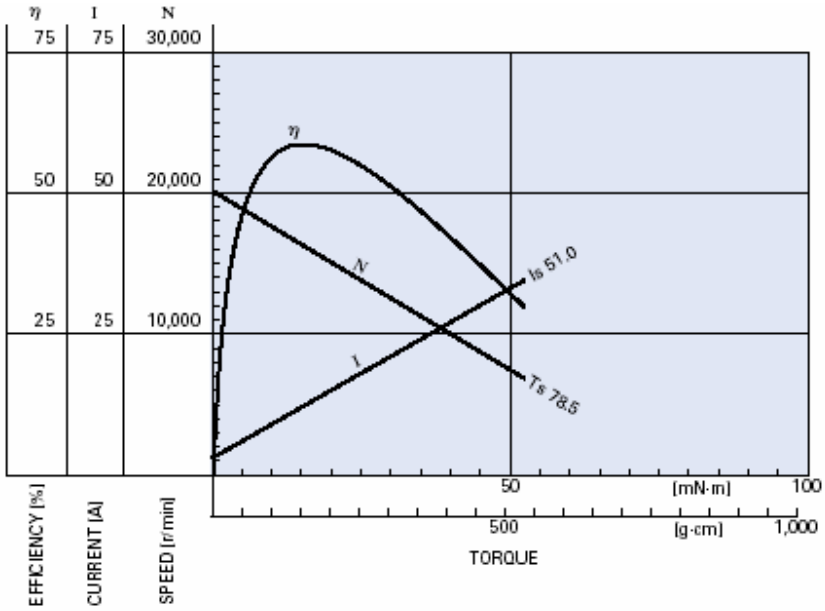
Can an EG1000 increase FPS (through higher torgue) over an EG700?

EG1000 offers higher throughput than EG700 on paper. In reality, there are many factors to consider for determining the actual throughput, and the difference on paper may produce benefits that are too marginal to be of any significance.

Below is a table extracted from a technical motor spec sheet:

VOLTAGE		NO LOAD		AT MAXIMUM EFFICIENCY					STALL		
OPERATING RANGE	NOMINAL	SPEED	CURRENT	SPEED	CURRENT	TORQUE		OUTPUT	TORQUE		CURRENT
		r/min	A	r/min	A	mN-m	g-cm	W	mN-m	g-cm	A

As you can see, different motors have different operating characteristics, that with different power source they may produce different RPM and different toque at different loads. And the efficiency does not have to be linear:



We do not want to go into details on motor technology. What we want to say is that, visual difference is minimal between the different TM motor models currently being offered in the market. If you want to see significant difference in torque or ROF, changing the gear ratio is the best thing to do.

Why (and why not) should I use a Bore-Up Cylinder?

Why should I replace the stock cylinder on my MP5K / G3 SAS?

A Bore-Up cylinder is a cylinder with extra capacity for storing pre-compressed air. You may consider the use of a Bore-Up cylinder if:

- you have switched to a very long barrel (refer to the high accuracy upgrade section).
- you are going way beyond 400FPS. The marginal gain in performance brought by the use of Bore-Up cylinder is less significant when you go below 400FPS.
- you are ready to shell out extra $ for buying a new piston set that can work with the bore-up cylinder.

If you are upgrading your MP5K / MP5K PDW or G3 SAS with a longer barrel, you will want to change the stock cylinder because the stock one was designed in such a way that just-enough compressed air is produced to get the bullets out of the short barrel. If you install a longer barrel, the amount of air held by the stock cylinder will become insufficient. The type of replacement cylinder to use depends on the length of the new barrel (refer to the next section).

When you use a Bore-Up Cylinder, you may also need to use a widened air nozzle in order to take full advantage of the extra air volume accommodated by the cylinder. The problem is that a widened nozzle is usually built with thinner plastic, which is very easy to break.

Different guns use different cylinders that have different number and position of openings. Why's that?

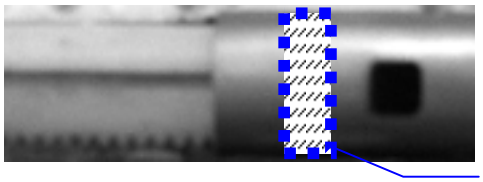
Is it useful to block the cylinder opening altogether?

Let's look into the number and position issues separately. Talking about the number of openings (also known as **auxiliary ports**), there are many arguments supporting the use of multiple evenly distributed openings (such as smoother compression, stabilized air flow …etc).

Frankly, the difference between one bigger opening versus multiple smaller openings isn't that significant in a real world context. We do see a direct relationship between the position of an opening (how far it is from the cylinder head) and the barrel length. Ever wonder why all TM AEG models can achieve almost-identical muzzle velocity even with different barrels? The key is the positioning of the cylinder opening.

A proper cylinder configuration should be able to accommodate sufficient air (and enable efficient compression) so the bullets can be successfully propelled out of the barrel while maintaining the targeted velocity.

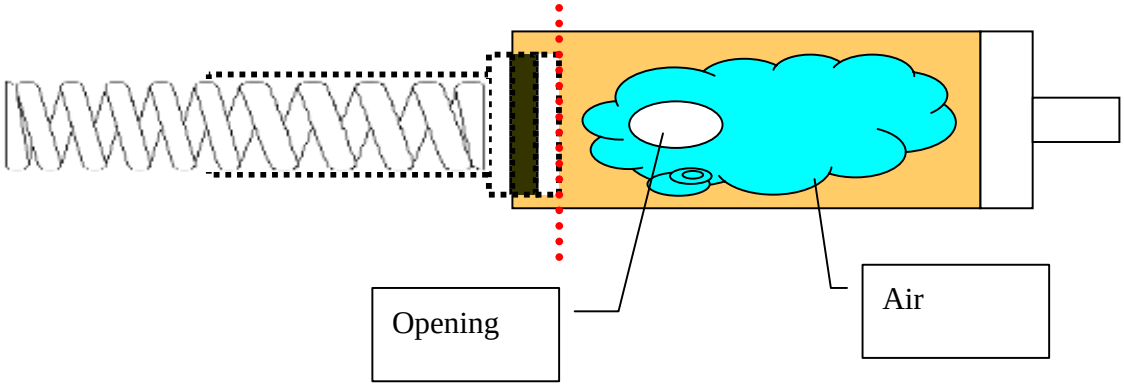
When the piston is driven backward, air is sucked into the cylinder. When spring compression is completed, the piston head is in a position before the cylinder opening:

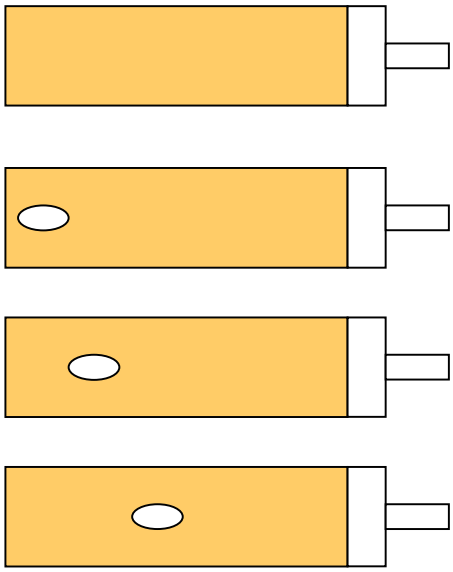


The piston head position. Also refer to the illustration below.

Upon releasing the compressed spring, the piston immediately moves forward –

this is when compressed air is produced. With an opening available, certain amount of air actually escapes out of the cylinder. The closer the opening towards the cylinder head, the easier it is for air to escape. Shorter barrel requires less compressed air to move the bullets away; therefore it does not hurt to have a cylinder opening closer to the cylinder head. Longer barrel needs greater power to kick out the bullets; therefore it cannot afford severe air leakage. Of course, with a bigger mass of air remaining inside the cylinder (waiting for compression), the workload will be higher for the system (meaning possible tradeoffs between FPS, ROF and power consumption).





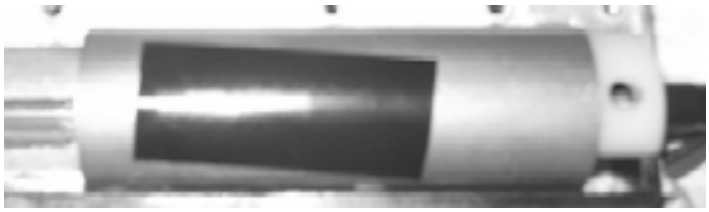
Recommendation: with a very long barrel (450mm+-), you want a cylinder with no opening at all. With a medium length barrel (350mm+-), an opening located further apart from the cylinder head is recommended. With a short barrel (250mm+-, like those in use by the MP5), an opening slightly closer to the middle of the cylinder is sufficient. With a very short barrel (150mm+-, like those in use by the MP5K and the G3 SAS), an opening in the middle of the cylinder is good enough.

In fact, there have been debates all over the airsoft communities regarding the issue of air volume balancing. It is believed by many that the volume of the barrel should not exceed the volume of the cylinder if FPS drop is to be avoided. It has also been said that the more appropriate cylinder-volume-to-barrel-volume ratio is around 1.5:1 (or 2:1 for type-0 cylinder). Even though different setups can produce totally different results (thus making it difficult to make accurate and precise judgment on the argued topic), generally speaking you should stick with the rule that the cylinder volume HAS TO BE LARGER than the barrel volume. You may reference the configuration information provided by Systema or the like when judging the correct “ratio” to deploy.

What is a quick and easy way to determine the cylinder to use for an extended barrel? Refer to the barrel length table below. If, let’s say, you want your MP5K to use a 229~230mm inner barrel, then simply put in a cylinder for the MP5 A4 model.

110 mm - used by MP5K
141 mm - used by MP5KPDW
229 mm - used by MP5A4/A5/SD5/SD6
245 mm - used by UZI
247 mm - used by CAR15, P90, G36C, SIG552, AK B-S
285 mm - used by MC51
300 mm - used by Thompson, M733
363 mm - used by M4/RIS, SR16, XM177, SIG551
369 mm - used by HK51
455 mm - used by AK47, AK47S
469 mm - used by G3A3/A4/SG1
472 mm - used by FAMAS
509 mm - used by M16A1/A2/VN, AUG
534 mm - used by SIG550
590 mm - used by PSG-1

We have also heard from someone on the internet saying that by blocking the opening with a tape one can increase FPS by 10% or so. We tried this out on a stock XM177 and found that the FPS actually drops. It is suspected that the performance gain is really on a case-by-case basis. BTW, it doesn't hurt for you to test it out on your gun as it costs you almost nothing.



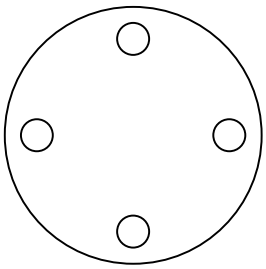
Why is it useful to put holes on the piston head? Any alternative?

Why (and why not) should I use a metallic piston head?

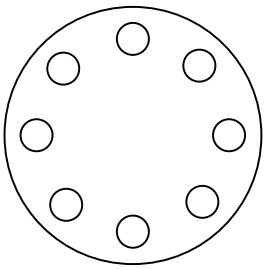
How about a silent head set?

Upgraded piston heads usually have holes on the front face of the head. When the piston is moving forward, air goes through these holes and forces the surrounding O-ring outwards to create a seal for preventing air leakage.
On a stock TM piston, it is quite difficult to take the piston head apart. However, as long as you are careful enough, there is no need to take it apart. Just remove the O-ring temporarily and then drill the holes directly (use a small battery-powered drill only – a drill that is too powerful will break the piston head). The holes do not have to be big. A diameter of 0.18~0.2 inch will do just fine. Do make sure that the face of the piston head remains completely flat.

The number and position of the holes do matter. You want to have at least 4 holes, and based on our experience there is no need to have more than 8 holes:

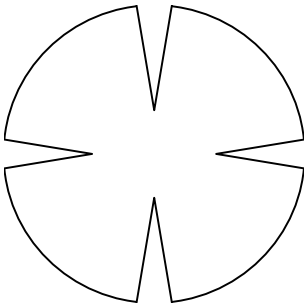


4 holes are good enough for gentle performance improvement.



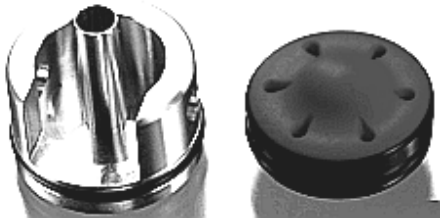
A 8-hole configuration offers slightly more performance improvement over the 4-hole configuration.

Some people prefer to cut the piston head into slices instead, which is not recommended as this approach will make the piston head more fragile then it should be:



We do not see any reason why you should use a “metallic” piston head. The stock piston head is good at absorbing much of the impact generated by the spring on the mechbox shell. You should not need to replace the piston head unless the stock one breaks or that a bore-up cylinder is to be used. The replacement piston head does not have to be a metallic one though.

A silent head set has a bumper-rubber installed in both the cylinder head and piston head. While it can reduce noise a little bit, beware that noise also come from the other parts of the mechbox and also from the motor. You need custom works on the gun to achieve total noise reducton. The Japanese are very good at doing this, but the cost involved is very high.



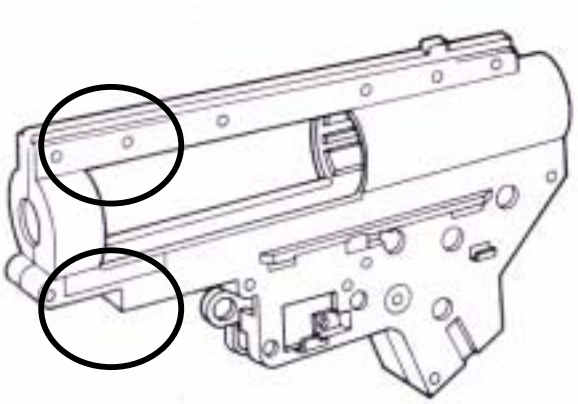
Is aluminum piston more durable?

Is version 2 mechbox too fragile for M130 or above?

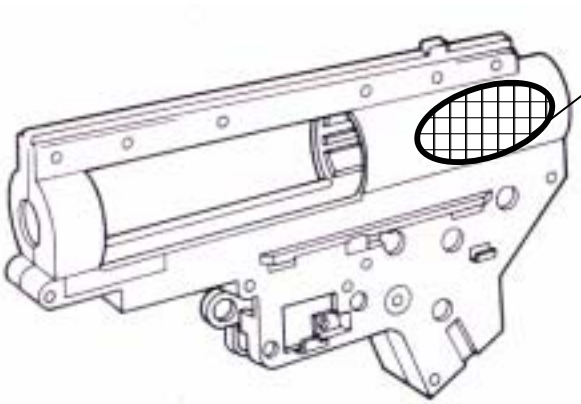
Aluminum is a light elemental metal notable for its relative lightness and resistance to corrosion. It is a soft metal which is easy to shape and is highly susceptible to impact damage. Therefore, even though it is stronger than resin, it is not of a mighty strength.

Frankly, if you do not go beyond 400FPS, an aluminum piston doesn't make any significant difference in durability. In fact, with improper shimming and under constant improper usage, its teeth will still get striped anyway. And because the aluminum piston is heavy (at least heavier than a resin piston), it is going to suck up more battery power.

It is believed by many that an aluminum piston (when comparing to a resin piston) can impart more force on the mechbox shell and get it cracking up near the nozzle. While this is technically possible, our experience shows that this can happen even without an aluminum piston if you are using M130 or beyond with 9.6V+ AND with constant improper usage (such as non-stop full auto firing for 10 seconds or so). This can also happen on a Cybergun DPMS AR15 if you are using M120 or beyond with GP 3300 8.4V+ as the material construct of its' mechbox is less solid than the TM one. In fact, even a reinforced gearbox will get cracked up under constant improper usage. The design of the Version 2 mechbox makes the area near the nozzle more fragile when comparing with the rest of the shell.



Some newer V2 mechbox implementations have wide openings near the butt of the mechbox (such as the Cybergun M4 mechbox). These openings will NOT bring you any performance benefit. They do make your life easier during mechbox assembly – you may now directly press down the spring with one of your fingers when the other fingers are working hard to close the mechbox halves together.



Aluminum piston and mechbox shell breakage:

It is the metallic piston head, NOT the metallic piston that produces the problem. The elastic deformation of plastic (polycarbonate) piston head helps dissipating the impact energy generated during spring decompression. Metallic piston head

is highly inelastic in this regard.

As a side note, it appears that the CA Version 2 mechboxes have been reinforced and are stronger than the TM counterparts. Stock version 3 mechbox does have a more intact design and can afford higher impact (all the way up to M140 if kept under proper usage, as experienced by some of the experienced technicians).

If you are to replace your stock mechbox with a third-party-made reinforced one, be prepared for parts incompatibility – the cylinder, the tappet plate, and the electrical unit in particular. Although you MAY BE able to get them fit through simple cutting and drilling, to reduce troubles the best thing to do is to verify with the manufacturer directly before purchase.

Do I need a heatsink motor plate on upgrade that involves M140 or above?

How do I effectively reduce heat on the motor?

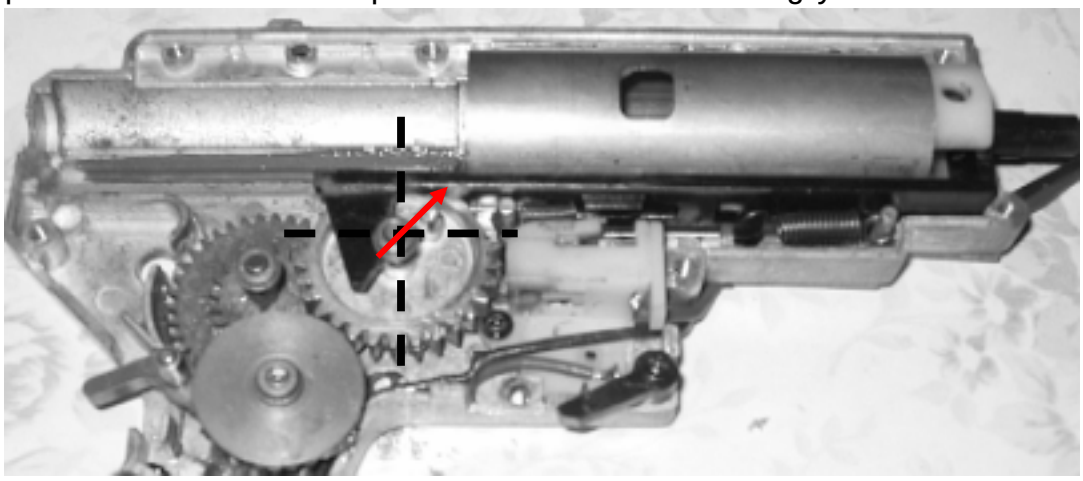
ICS offers so-called heat sink motor plates. As we all know, heat is one thing that can kill the motor easily.

Heat gets accumulated mostly on the metal frame of the motor, but it is the plastic cap of the motor which is in direct contact with the motor plate. Without direct contact the usefulness of the heat sink is doubtful. Frankly, by the time this heat sink is heated up, your motor has been severely over-heated already...

To reduce heat without forgoing power, you are advised to switch to the high torque gear set. The high torque gear set has a different gear ratio that makes high workload truly affordable.

Why (and why not) is the one o'clock gear timing an issue?

It is widely believed that you need to set your sector gear with the tappet plate post at the one o'clock position when reassembling your mechbox.



Although doing it this way doesn't hurt, it does not have to be strictly "one o'clocked". Think about it, the sector gear is a half-toothed gear which has multiple teeth partially formed on the periphery and an idle area formed on the remainder of the periphery. This design is supposed to provide an optimal means for pulling the piston into a compressed position when needed. When idle, the teeth formed on the periphery are not in touch with the piston. When you pull the trigger, the sector gear is driven anti-clockwise, which eventually will have its teeth getting in touch with the piston. This is when all the actions get started. Effectively, this mean the gear system will time the gears properly by itself.

What we are trying to say is that as long as the sector gear is in a position where all the teeth are facing downward (a position anywhere between 12:30 and 3:00, such that no tooth is in touch with the piston at the time of installation), it will do fine. Still, by having the gear "one o'clocked", you can enjoy a slightly faster initial response time (and peace of mind too). That's all.

Can I still use the smaller batteries to power my upgraded mechbox?

I want to hide my battery inside the grip and the stock but the battery cells are too big. What should I do?

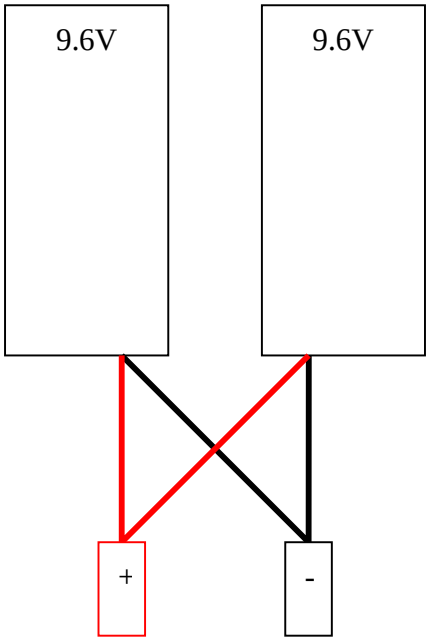
Chaining up your batteries: Parallel VS Serial configurations.

Smaller batteries have higher internal resistance and can get heated up easily. If you really want to use smaller batteries for fitting into the grip or the stock, you may need to go up to 10.8V or 12V. Practically speaking, the output of a 12V Sanyo 600mah is roughly on par with that of a 9.6V GP 2000 mah. And 600mah is way too insufficient. If you really need to go small, consider the GP 1100mah NiMHs instead.

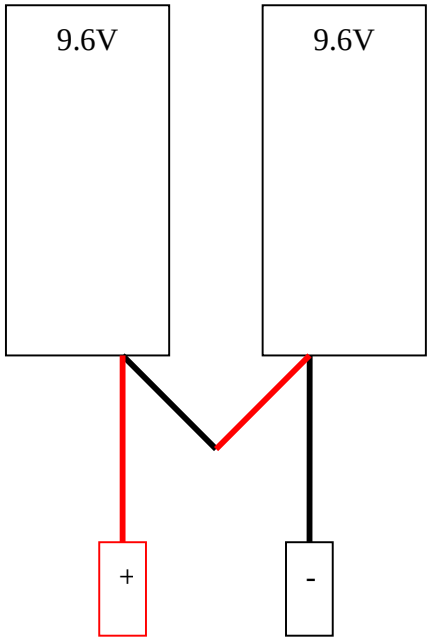
As said before, the small batteries are no longer sufficient for powering an upgraded gun. However, the bigger batteries have to be housed externally, which is not convenient at all.

If the grip and the stock have space to house the smaller cells, one thing you might want to do is to use a parallel configuration. That is, you can have two sets of 9.6V small batteries chaining up together to double the capacity. The connection must be parallel, NOT serial:

Parallel Connection
(doubled capacity)



Serial Connection
(doubled voltage)



Wiring can become complicated, but the power of two joining forces together can produce the horse power required by an upgraded mechbox. Do note that once they are connected together, you should never have them charged and discharged separately. Always treat them as a single entity.

Should I use Sanyo battery cells for maximum performance?

How safe is it to remove the fuse? Any alternative?

Based on our experience, Sanyo and Panasonic have good Nicds, while GP has good NiMHs. Be very careful when buying Sanyo cells, as there are many fake Sanyo cells in the market nowadays. Frankly, it is not easy to tell from the outside whether a Sanyo cell is authentic or not.

Although many shops suggest fuse removal, we recommend that you change the fuse to a 20A (or 30A) one instead. Most stock fuse is 15A. With an upgraded mechbox, more power is drawn from the battery and the default 15A fuse may not survive the increased power flow. On the other hand, without a fuse you risk damaging your motor in case of accident (in the electrical world there are often surprises). One common scenario - the fuse blows when something jams the gun thus causing the motor to be under excessive strain and not able to turn.

If you are using a regular battery (something with 1300mah or less), a 20A fuse may be sufficient. If you are operating on a more powerful battery (such as a 2000mah or a 3300mah), a 30A one is what you should go for.

Do I need a metal body to sustain the upgraded power?

No you do not. In fact, we have heard too many complaints about the various metal body kits being offered in the market. Most complaints were about proper fitting with the internals. If you want to switch to a metal body, be prepared to also change the hopup unit and some other internal parts.

Why (and why not) is it necessary to replace the stock wires?

Why is it necessary to shorten the wires?

Can I use stereo wires instead?

Yes and no. The stock wires found in most TM guns are of very high quality in terms of shielding – they are very difficult to tear. However, they are also very thin, meaning their ability to dissipate heat (generated due to current flow) is not as good. Always remember, the larger the wire cross section the better able it is to dissipate heat. The problem with excessive heat is that the wire shielding will eventually get melted down. Our experience shows that the stock TM wires are good enough under smaller mah battery (voltage is not the primary concern while the current is). If you are using high mah battery to drive an upgraded mechbox, consider replacing all the stock wires.

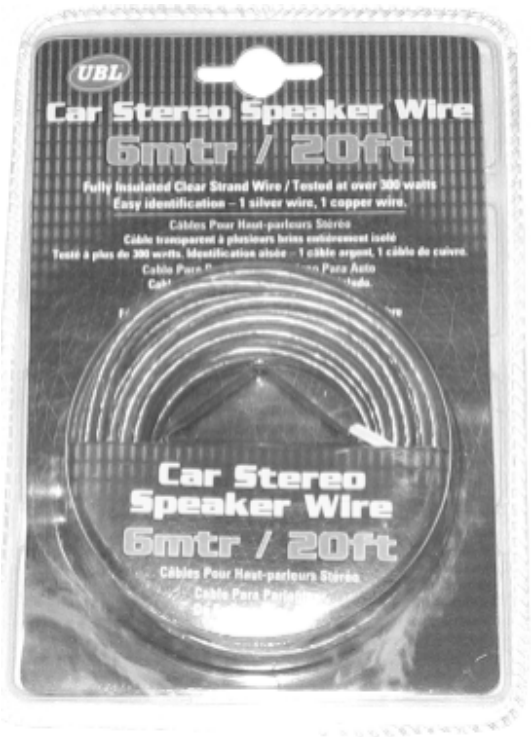
When selecting the proper wire, pay attention to the American Wire Gauge (AWG) system. An AWG gauge of 14 or 15 can sustain higher amps for power transmission than the standard 16 or 18 wires.

All wires have inherent resistance and that the best way to minimize resistance is to minimize the wire length (resistance is measured by having the resistance per unit of distance multiplied by the distance you are using). To do so you will have to trade off resistance and load with size and flexibility. One thing – if the wires that go to the motor are too short, you will have difficulty connecting them back to the motor that resides in the small grip.

We found that most non-stock wires are easy to tear and are highly susceptible to shorting. You may want to use additional shrink wrap or protective shield to protect them – believe us, it is very easy to tear the wires along the process of fitting the mechbox back into the gun body.

We have replaced all stock wires with stereo wires on a TM M4. The M4 did not

come with any power upgrade, and there has been no problem running with he stereo wires so far. However, we have been warned that stereo wires were not designed to sustain high current draw and therefore should be avoided on upgraded guns.



Why (and why not) is it necessary to replace the stock Tamiya connector?

The Tamiya connector is a popular connector for battery packs. Since it can afford at the max 15 amp, it may not work for high power configuration. We have seen these connectors being melted down by excessive heat from a 12V M140 combo.

If you want connectors that can sustain high current, use Deans connector instead (see the picture below).

With Deans connector, the Female side is usually connected to the battery pack. Visit http://www.wsdeans.com/ for more information.

Are NiCd batteries superior to NiMH batteries for driving upgraded AEG?

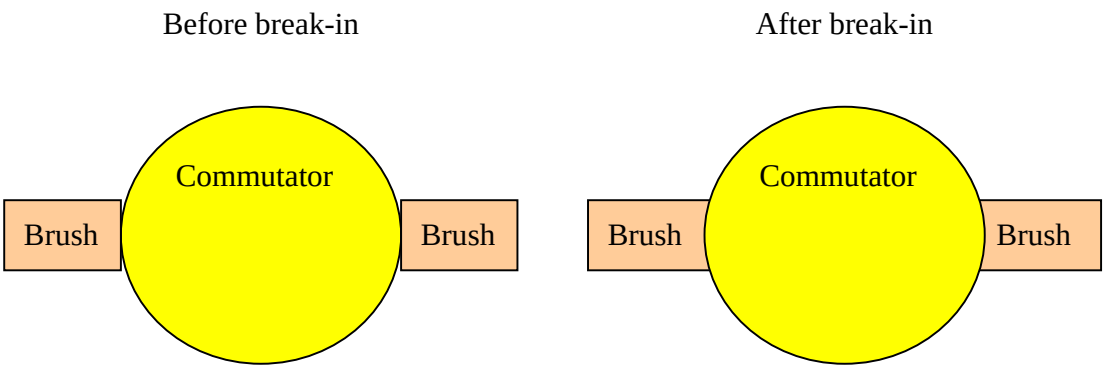
Ni-Cds have good performance in high-discharge and low-temperature applications, but are subject to the problem of “memory effect” (the cell remembers and maintains the characteristics of the previous cycle). They will also self-discharge at a rate of about 1% a day. Sanyo and Panasonic offer good quality NiCds.

NiMHs closely resemble the NiCds in construction but can offer 30% more capacity and about 25% more power than the NiCd counterparts. The problem is that they have poorer service life, tend to self discharge faster, and in certain cases are subject to “memory effect” (refer to the troubleshooting section for further information). GP offers very good quality NiMH cells.

How do I optimize the overall performance of the stock motor?

The best way to gain power from your stock motor is to properly break-in the motor brushes and the bronze bushings (all TM/ICS/CA motors use bronze bushings rather than ball bearings).

You want to first break-in the brush/commutator interface so that the brushes can conform better to the shape of the commutator. To do so is easy – just run the motor on 4 cells (1.2V on each cell) for several minutes until the full brush face is conformed to the commutator.



Breaking in bushings is necessary if the motor bushings are too tight. To do a quick check, just spin the motor (by hand) with the brushes removed and fell the resistance to turning (you may want to have some other motors here for comparison purpose).

To perform bushing break-in, just put a little valve of grinding compound into the bushing and spin the motor until you feel a reduction in resistance.

Is it possible to increase the torque of the stock motor? If so, how?

One quick and cheap way to increase the torque of your stock motor is to replace the stock motor springs (the springs that hold the brushes up against the commutator). Harder springs produce more tension and more amp draw, thus resulting in more torque but less RPM. On the other hand, if you want less torque but more RPM, a pair of softer spring is the way to go. Take the motor to a local electronic shop and find springs that work for you. Do keep in mind that very hard springs are no good as they impose too much pressure on the commutator. Very soft springs are no good as well, since they allow the brushes to bounce on the commutator. Some trial and error may be necessary to get this done properly.

What else should I buy for a high FPS configuration?

The stock tappet plate can break easily if you go over 400FPS. A reinforced tappet plate is worth the $.

An air seal nozzle is also a good option. It has an o'ring inside to prevent air leakage. Although it can improve the FPS a bit, to save $ we suggest that you buy one as a replacement only after the stock one is broken (yes, the stock nozzle can break under a high FPS / ROF configuration).

What is wrong with the soda can test?

What is right with the soda can test?

The soda can test is not for measuring muzzle velocity in an accurate manner. It may produce inconsistent results under the use of different BBs and different hopup settings. If you really use it, keep in mind that the degree of error is about +- 25~30 FPS.

In fact, the soda can test is best for measuring the impact energy generated by a gun. Being highly popular in Asia for estimating the Joule rating of AEGs, one should use this test to measure relative strength – that is, for comparing the power of one gun to another. The guns to be tested should be equipped with the same brand BBs and with hopup completely released. Single shot on the soda can should be made with the barrel being one inch apart from the surface of the can.

We also recommend that you use the soda can test for measuring the quality of an upgrade work. Proper upgrade should allow an AEG to deliver CONSISTENT performance in semi-auto. A dozen rounds of single shot should tell whether an upgrade is satisfactorily done.

What is the most accurate way to measure FPS?

Frankly, there is no single best way to measure FPS. It is believed by many that the more accurate yet cheap way to measure FPS is through the use of a chronograph. The problem with this method is that rarely will the chronographed speed correlate to the actual bullet velocities of your setup. Without proper calibration, no two chronographs will clock the same velocity.

Oehler Research offers a really fancy (and expensive) Chronograph known as the Model 35 Proof Chronograph. It has a built-in printer included. Visit http://www.oehler-research.com/ for more information.

We also want to remind you that there are several ways to “cheat” the velocity testing mechanism:

- use heavy BBs such as 0.30g or 0.40g
- use a weak battery (with a weak battery, your AEG will deliver less FPS even on single shot)
- adjust the hopup to the fullest possible extent (increased back spinning can lead to poorer velocity)

As said before, always REQUIRE all participating guns to use BBs of the same class (eg. 0.2g) and have hopup completely released. If possible, use a battery supplied by yourself to do the tests.

High ROF Upgrade

What are the key elements of a high ROF setup?

Generally speaking, a high ROF setup features fast piston movement as facilitated by:

- a powerful motor.
- an appropriate spring.
- smooth surfaces of the internal moving parts.
- light weight material used by the internal moving parts.

Additionally, a smooth running bullet feeding mechanism makes a high ROF setup usable and practical.

* Since smoother piston movement can facilitate the pushing forward action of the piston (and thus leading to more powerful output), a high ROF configuration in a way does contribute to higher FPS. This relationship, however, does not have to be linear. At a certain point along the growth path a high ROF setup may hinder the achievement of further FPS improvement.

Can I increase the ROF while keeping the FPS at the stock level by using 9.6V battery?

Voltage VS mah – which one matters the most?

Many people prefer to classify batteries based on voltage and mah. They like to look into these two factors separately. Without going into the complicated dynamics of battery and electric motor, we wanna tell you that battery performance is a function of both voltage AND mah COMBINED. When we say 9.6V is dangerous, we usually mean 9.6V large battery which has both high voltage and high mah output.

Although mah and resistance are not necessarily linked, large batteries tend to have higher mah value and at the same time less internal resistance, meaning they can sustain higher current draw at any given time. Simply put, higher mah means higher capacity AND ALSO the ability to sustain current draw at a higher rate. Effectively the motor can demand more from the battery at any given moment.

Based on our experience, for a stock gun a 8.4V 3300mah pack can be way more “dangerous” than a 9.6V 600mah pack.

Can I increase the ROF by replacing the mechanical contact switch with a solid state switching mechanism based on MOSFET?

The rationale behind the use of metal-oxide semiconductor field effect transistors (MOSFETs) is straight forward. The open contact switch used in the AEG mechbox is itself a major source of resistance along the current flow path. It is also subject to arcing, which leads to the gradual degradation of contact surfaces and the reduction of current carring capacity. With MOSFETs, the contact switch is isolated from the primary current flow path, meaning the current can flow directly to the motor without passing through the mechanical contacts.

If you have experience in R/C models you should have experienced the difference between the stock mechanical speed controller and the optional MOSFET based electronic speed controller.

Should you use MOSFET in your AEG? The primary concern is heat. Most MOSFET based electronic speed controllers for R/C cars are equipped with large heatsinks for heat dissipation (the MOSFET can get cooked under high voltage current). To ensure that the new mechanism doesn't stop working you may have to use a very high grade MOSFET (which can be very expensive) and find out a way to allow effective heat dissipation. You will also need to do major re-wiring in order to take advantage of this mechanism.

Why add a potential point of failure to the existing architecture?

Can I increase the ROF by using capacitors at the power source?

The rationale behind the use of capacitors is simple. Along the process of spring compression, there is an uneven load demand on the motor and on the current supply. This can result in voltage fluctuations and may affect motor performance quite negatively.

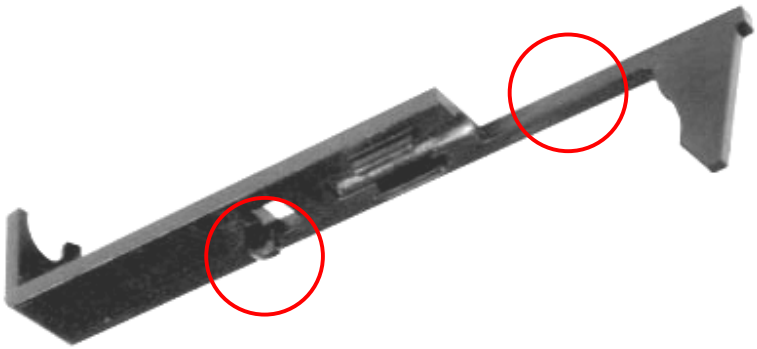
A capacitor is like a temporary storage buffer for electric power. When connected, the current first goes into the capacitor and then to the motor. When the load is less heavy, a certain amount of energy resides in the capacitor, waiting to be "withdrawn" by the motor when the load turns heavy. This mechanism in theory can produce a more stable current flow and increase the ROF.

Should you increase the ROF this way? There are several factors to consider:

- Size - to sustain high voltage level like 8.4V or 9.6V, you will need to chain up several capacitors. The combined size can be quite large - where do you plan to fit them in?
- Heat - can these capacitors survive the heat generated? When you go full auto all the way in summer the heat can be deadly to many electrical components.
- Benefit - according to a study conducted by an Airsoft web site out there, the ROF gain is less than 5%. Is this practical?

Is high ROF a major cause of tappet plate breakage?

With a stock spring, a mechbox that runs too fast will lead to tappet plate breakage:



If you want to increase ROF a bit, using a 9.6V small battery (600 ~ 1100mah) shouldn't hurt. Stock ICS / CA guns have higher tolerance on battery power due to the harder springs they use, so 9.6V is less threatening for them.

ROF-wise, why (and why not) should I replace the stock plastic bushings with ball bearings?

A bushing is simply a round tube that reduces sliding friction. The shaft rotates by sliding on the inside of the tube. On the other hand, a ball bearing allows the shaft to rotate by rolling.

Ball bearings allow smoother gear rotation and can save energy (15% better energy efficiency). You will also see a small increase in ROF. However, they are almost as fragile as plastic bushings when under high load and are in general not recommended for anything over a PDI 120%.

Use ball bearings primarily for energy saving purpose. They do allow the gears to spin smoother and "easier".

Mixing and matching ball bearings with metal bushings do NOT hurt (UNLESS you have them mixed and use in pair – it is NO GOOD if you use ball bearing on one side of a gear and metal bushing on the other side). For example, it is OKAY if you use metal bushings on the bevel gear and ball bearings on the spur gear. Doing so, however, does not really give you any benefit (also, you are restricted to using a weaker spring).

Some new mechboxes allow the use of 7mm ball bearings, which are larger and stronger (can sustain M120, but are also more expensive).

7mm bearing: 

ROF-wise, why (and why not) should I replace the stock plastic bushings with metal bushings?

How about oil channel bushings?

If you plan to significantly increase the ROF (such as a 25~30% improvement), the stock plastic bushings may get worn out very fast. Switching to metal bushings is therefore recommended.

Metal bushings by themselves won't improve the ROF. They will make your gun last longer though.

* The stock bushings used by the ACX/Cybergun AEGs are slightly smaller in diameter, meaning you will need to manually enlarge the bushing space holders on the mechbox if you are to replace them with TM compatible metal bushings.

Oil Channel Bushings are metal bushings with oil channels molded into them. They do no deliver any observable performance benefits, and it has been reported that they can lead to uneven wear on the gear axle.

Why (and why not) should I buy the high speed gear set?

Changing the gear ratio is the most effective way to increase ROF. However, the load on your motor will increase, and the gears will get striped easily (gear stripping happens when they run too fast). You must keep in mind that the risk of gear striping often grows hand in hand with ROF improvement. There is nothing you can do about this sad relationship.

The high speed gear set is never intended for springs stronger than M100. At the same time, any spring softer than the TM stock one is also not recommended. The stock ICS/CA springs are the ideal candidates for this gear set.

Should I upgrade to a Teflon Cylinder?

How about a high speed cylinder set?

Teflon coated cylinder has a smoother internal surface and is thought to be good for a high speed configuration due to less friction with the piston head. Although small performance gain is possible, we would recommend that you spend the money on something else. A Teflon Cylinder is, frankly, quite expensive.

Do keep in mind that you don't want to use it with an aluminum piston, or the coating will get worn out easily.

A High Speed Cylinder Set may also worth your consideration (provided that you have a deep pocket). The design goal of the high speed cylinder set is to achieve CONSTANT and CONSISTANT velocity through the use of parts that are precisely weighted. Installation-wise the set is simple to install and shouldn't introduce any difficulties.

We recommend that you buy a complete set rather than just the high speed cylinder alone. There are problems mixing and matching piston and cylinder from different makes, and you don't want to risk spending more for nothing.

What makes a ball bearing spring guide meaningless for a stock TM gun? How to work around?

Remember we talked about the metal spacer unit that is used to attach the piston head to the piston? With a stock TM piston set, the spring is fixed to the piston through that metal spacer unit. What this means is that free spinning of the spring is made impossible.

Spring rotation can increase ROF, but is possible only if both ends of the spring are free for spinning. The quick work around is to disassemble the stock piston head set, take out the spring and cut its' tail so that it can no longer be affixed to the piston head.

A better approach is to replace the stock metal spacer unit with a simple nut so that the spring can spin on a flatter surface.

Is there any cheaper alternative to ball bearing spring guide?

Why a ball bearing spring guide alone may not increase the ROF?

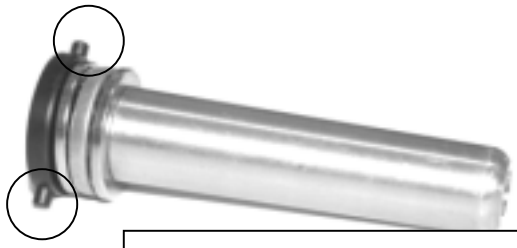
Take your stock spring guide and the piston to a local bearing shop and find a ball bearing that is large enough to fit into the spring guide without blocking the movement of the piston. This kind of larger ball bearing can be found in R/C hobby shops or professional bearing shops. Do remember to measure the spacing of this setup (for information on the potential danger, refer to the section on the use of longer spring and spacer). Also, if the spring is too stiff (M120 or above), the ball bearing may break after several hundred rounds of fire.

As stated before, free spinning on both ends of the spring is necessary for ROF improvement. The ball bearing spring guide is the solution for one end of the spring only. A ball bearing piston head is the solution for the other end, but is very expensive. As a recommendation, you may get a ball bearing that fits into the piston so that both ends of the spring can spin via rolling. Below shows a Japan-made ball bearing (part # JA 6700 ZZ) that can fit into the ICS black aluminum piston perfectly.

Note that different piston makes have slightly different inner diameters. You need to get a ball bearing that fits almost perfectly into your piston. There should not be room for the bearing to wobble inside the piston.

Can I use a Version 2 spring guide in a Version 3 mechbox?

It depends. We have been using the ICS version 2 ball bearing spring guides on a TM MP5 PDW and a G36C for years without problems.



They can fit into the Ver. 3 mechbox space holders without problems.

One thing for sure though – a Version 3 spring guide won't fit into a Version 2 mechbox.

Should I upgrade to an EG1000 for higher ROF?

How do I optimize the stock motor's RPM without spending major $?

Frankly, the difference in speed between an EG700 and an EG1000 is not significant. If you really want to see some visible differences, spend more $ on a Systema high speed motor, which has much higher RPM (37,400) than an EG1000 (27,552).

As mentioned earlier, you may replace the stock motor springs (the springs that hold the brushes up against the commutator) in order to achieve higher RPM. Softer springs produce less tension and less amp draw, thus resulting in higher RPM. Take the motor to a local electronic shop and find a pair of springs that work for you. Do keep in mind that very soft springs are no good as they allow the brushes to bounce on the commutator. Some trial and error may be necessary to get this done properly.

How can I increase the ROF while keeping the FPS at near-the-stock-level? What is the right type of spring and battery to use for this purpose?

As previously mentioned, a softer spring is usually less responsive in terms of its “pushing back” movement. A harder spring is harder to compress, but when it is released it extends much faster. High ROF is possible only when movement in BOTH directions is fast.

One way to raise ROF while maintaining the current FPS is to use a harder yet shorter spring. Roughly speaking, a harder spring that has 2/3 the length of a stock spring as well as 2/3 the amount of active coils should make it. Another way of doing this is to get a M110 or M120 spring and cut away three to four rounds of the tighter coils.

Do remember that a harder spring in any case will increase the current draw, so you may need a battery with a higher mah value (a small 600mah Sanyo may not cut it).

A teflon coated cylinder has a smoother inner surface to allow speedier and smoother piston movement, therefore making it possible to achieve a higher ROF without increasing the FPS. Do keep in mind that you don’t want to use it with an aluminum piston, or the coating will get worn out easily.

Is ROF over 30/sec possible?

What is the major ROF bottleneck?

The true bottle neck on ROF is not the mechbox, but the BBs feeding mechanism. Fast firing needs a fast and reliable bullet feeding mechanism. How fast can your magazine feed? Our experience shows that low-cap mags feed very fast but can be easily emptied in less than two seconds. Hi-cap mags feed slower and tend to be less reliable.

One recommended way to improve the feeding mechanism is to replace the stock plastic hopup unit with a one-piece metal hopup. Field reports show that the one-piece type of hopup tends to allow significant ROF improvement and almost-complete elimination of mis-firing (refer to the High Accuracy section for other benefits of the one-piece hopup unit).

A one-piece metal hopup unit for M4: 

Frequent cleaning and lubing (with Silicon Spray, NOT WD-40) of the magazines are essential too. This is especially true for MP5, which is best known for its poor bullet feeding performance (the shape of the magazine being too long and too narrow is one major constraint).

Some shops claim that their custom guns can achieve a ROF of up to 30/sec. Be prepared to pay a price for a high ROF like this (the upfront cost plus ongoing maintenance and trouble shooting …etc). Refer to the next section on teeth removal for further information.

Is aluminum piston better off for a high ROF configuration?

Are lighter gears better off for a high ROF configuration?

What else should I buy for a high ROF configuration?

Can I increase ROF by cutting off some teeth from the piston and the gears?

An aluminum piston, which is made of light metal (aluminum alloy), is about 1.5 to 2 times the weight of a regular resin piston. Heavier weight means higher work load for both the motor (pulling the piston) and the spring (pushing the piston), which will drag down the ROF a bit. However, with strong battery power and an upgraded spring, using aluminum piston shouldn't hurt much.

Lighter gears such as those made by zinc alloy can reduce the work load of the motor and can in theory contribute to higher ROF. HOWEVER, zinc alloy is a material too weak to handle the extra stress caused by the upgrade. Zinc alloy gears (such as the stock TM gears) are suitable only for stock guns or for guns with very mild upgrades.

A reinforced tappet plate is always recommended for upgraded mechbox. The stock tappet plate can break easily under high ROF. Apply grease on the two sides of the tappet plate (you want it to slide smoothly)!

One tactic for pushing the ROF limit is teeth removal. If you remove a tooth from the piston, the piston traveling distance can be shortened. If you remove a tooth from the sector gear, the sector gear can release the piston sooner, which can effectively shorten the piston traveling distance as well. This tactic has been used by many airsoft shops in Hong Kong and Japan.

We do not recommend that you do this. Firstly, you may not have the tools necessary to perform flawless teeth removal. Secondly, deciding which tooth to

remove involves professional judgment based on years of gun-smithing experience. You do not want to risk disrupting the gear timing. Thirdly, you lose some FPS for each tooth removed.

High Accuracy Upgrade

What are the key elements of a high accuracy setup?

Does a V-HopUp help?

High accuracy in semi-auto mode requires that you have a long and tight barrel plus a good hopup unit (!) for stabilizing the bullet's flight path.

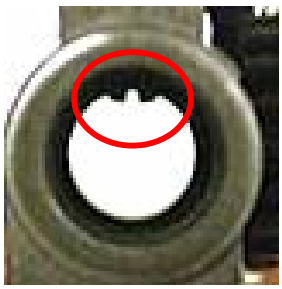
High accuracy in full-auto mode ALSO requires that the FPS and ROF performance of the gun be highly CONSISTENT. A good quality spring driven with stable horse power and the resulting smooth piston movement are essential.

(!) Strictly speaking, the back spinning effect created by the hopup function often produce uncertainty and can lead to poorer accuracy. However, we have to face the reality - without back spinning the bullets will not fly far enough.

The behavior of a poorly designed hopup unit tends to be unpredictable and unfixable. Test your hopup unit with 0.20g or 0.25g BBs (!!). If you find poor accuracy, be ready to shell out extra $ to get the unit replaced.

(!!) In any case don't expect accuracy with 0.12g BBs. They are way too light.

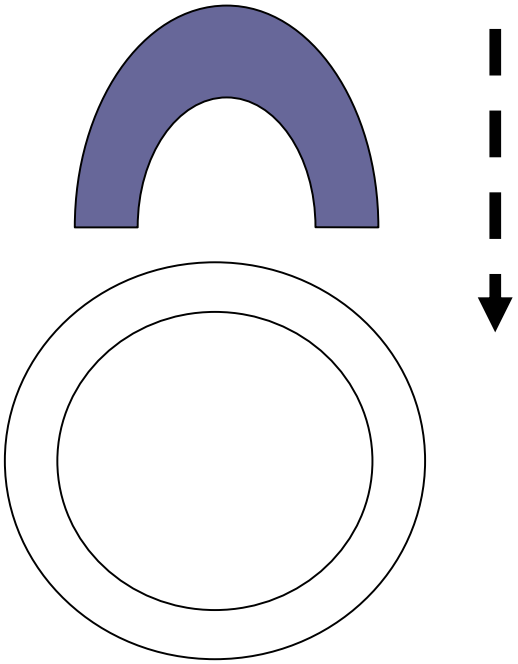
The TM M4A1 BOYS version, the Cybergun A15 R2 and the TM AKs use a hop up rubber which has two points of contact with the BB. Such a structure produces a cut in the middle to facilitate V-hop up, which is believed to produce less power loss through the hop up process and can allow for more stable BB flight.



However, sometimes a poorly built V-Hop Up unit can produce unexpected left spinning or right spinning effect.

V-Hop Implementation Type I (The Cybergun A15 Evolution AEG uses this kind of V-Hop):

Refer to the illustration below:

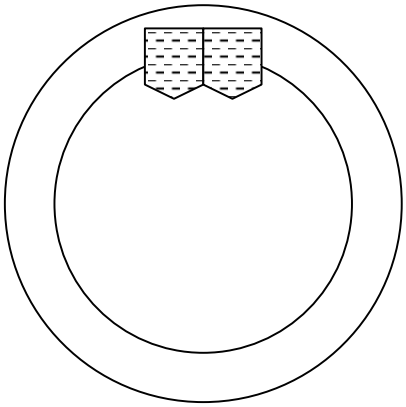


The “cut” in the middle is produced by pressing down the arc shaped spacer onto

the hop up rubber. If for some reasons the two ends of the spacer are not evenly worn out (or if one end breaks while the other one remains intact), unexpected spinning effect will be produced. Regularly perform visual check (by looking through the barrel) to ensure that the spacer is in good shape.

V-Hop Implementation Type II (The TM AK uses this kind of V-Hop):

Refer to the illustration below:



This type of V-Hop has a screw head shape knob inside the rubber tube (manufactured as one-piece) for use with the regular-type bucking. Again, if for some reasons the two sides of the knob are not evenly worn out (or if one end breaks while the other one remains intact), unexpected spinning effect will be produced. Regularly visual check is therefore necessary.

How to improve accuracy with short barrel?

Can a long barrel deliver higher accuracy and range?

Why (and why not) should I replace the stock cylinder when using a longer inner barrel?

With a short inner barrel, the only way to achieve better bullet stability is to use heavier BBs such as 0.25g. At the stock power level, you should not use anything heavier than this. You will also need to use a slightly stronger spring to compensate for the drop in FPS due to the heavier BBs. A M120 spring can sustain 0.30g perfectly, while a M130 (or above) spring can drive 0.4g and produce great impact.

In terms of accuracy, a long inner barrel can always make a visible difference. In terms of range, at the stock level the difference is minimal, while at 400FPS or above you will start to see greater differences.

Every time the piston is pulled backward by the sector gear, air is being sucked into the cylinder. When the piston is pushed forward by the spring, air inside the cylinder is compressed for propelling the bullet. The amount of air available for compression is essential. With a longer barrel, more compressed air is required to move the bullet out of the barrel. This is why you may need extra capacity within the cylinder for accommodating a greater amount of air.

The **suck-back** problem?
If you upgrade to a longer barrel without installing a matching cylinder, suck-back MAY occur.

It is believed by some airsofters that suck-back can occur if the piston retracts before the bullet has completely left the barrel (the so called “vacuum effect”

caused by having a barrel volume that exceeds the cylinder volume). There are other people who think that suck-back is simply BS.

Think about it, if the piston is pulled back before the bullet is out of the barrel, there is a possibility for a “drag-back” effect to occur. The degree and extent to which the FPS of the current bullet is affected is something we cannot tell without going through a lab experiment.

Another potential problem is, if the bullet is in the barrel while the piston is pulling back, the bullet may serve as an obstacle that blocks incoming air passage. If the cylinder fails to receive sufficient air from other channels (such as from the auxiliary ports), the FPS of the NEXT bullet may be affected. Again, we can’t tell the exact effect without carrying out an in-depth lab assessment.

Frankly, whether or not suck-back is a myth doesn’t really matter. Since suck-back is believed to occur due to an improper air volume balance, all that you need to do is to follow the rule of thumb – that is, ensure that the cylinder volume exceeds the barrel volume. It doesn’t hurt in any case to have larger cylinder volume, does it?

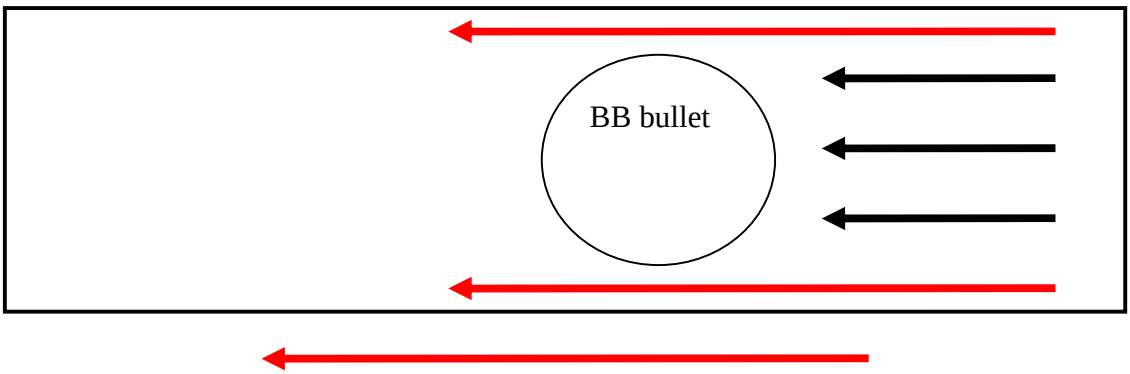
What is good about a high precision barrel?

How to maximize the effectiveness of a high precision barrel?

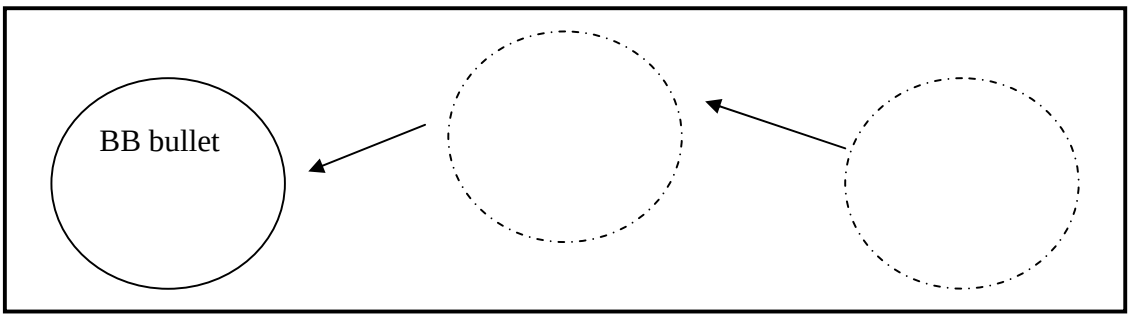
What is the drawback of using a high precision barrel?

High precision barrel helps increase both the muzzle velocity and the accuracy of an AEG by downsizing the inner diameter from the stock 6.08mm to 6.04mm or less. Most high precision barrels are highly polished on the inside (nickel-plated and teflon coated) for minimizing wear and tear.

Potential problems with a larger diameter barrel (like the stock one):



Energy that has been wasted.



Based on our experience, upgrading to a high precision barrel can deliver an

approximately 10% gain in performance. Improvement in accuracy is also visible.

The 6.03mm Prometheus tightbore barrel is way too tight – absolutely no tolerance on dust and dirt, and is not recommended for outdoor use. In fact, high precision barrel in general has an inner diameter too small to accommodate dirt and poor quality BBs. To avoid jamming, you must do whatever you can do to keep the barrel completely clean and properly lubed. You must use the best BBs, and must keep the magazine very clean (so that no dirt can ever get attached to the BBs). Be expected to face lots of hassles when operating your AEG in this manner.

Can the one-piece type hopup increase accuracy? Does it worth the $?

According to the Bernoulli's principle, if a bullet is given a backspin an overpressure is formed under the bullet and an underpressure is formed on the top of the bullet. The bullet is therefore sucked up - this is why it can fly farther.

In theory, the hopup back spinning mechanism adds instability to the bullet flight path as different bullet surfaces may react differently with different hopup rubbers, thus making the back spinning behavior highly unpredictable. A poor quality hopup unit with a shaky bucking mechanism can also produce problems.

Based on our experience, a high quality one-piece metal hopup unit does seem to reduce such uncertainty and increase accuracy significantly when being used with a high precision inner barrel. Accuracy is greatly improved when this combo is loaded with the heavier 0.25g BBs.

A one-piece metal hopup unit for M4: 

How do I hide the longer inner barrel?

The easiest way is to use a mock suppressor to hide the extended barrel.

Do remember that with a longer barrel, you need an inner barrel alignment adaptor to reinforce the setup. The Q Project was well known for supplying custom made barrel alignment adaptors.

Troubleshooting

My stock TM gun is dead after 3000 shots. Why?

TM has the best QA and QC practice, so if your stock TM gun breaks in 3000 shots, it has to be a user problem.

If you cannot keep a stock TM gun alive for a year or so, an upgraded gun will break in your hands within weeks. Do NOT upgrade your gun unless you know how to properly use it.

What will happen with improper shimming?

And what should I do to remedy the problem?

With incorrect shimming (being too loose), at least one of your gears (the sector gear in particular) will break within one or two rounds of hi-cap. If shimming has been overly done (too tight), the gears will not break but your motor and your battery will get hot quickly. You will also experience frequent lock up and will run out of battery power very fast.

If several teeth of the sector gear go broken after 600 shots, you will need to re-shim again in such a way that the sector gear and the spur gear can come closer to each other. If the motor is eating up battery power like there is no tomorrow, check the shimming on the bevel gear and the spur gear. **When you re-shim any one gear, also double check shimming on the rest.**

How do I prolong the life of the mechbox?

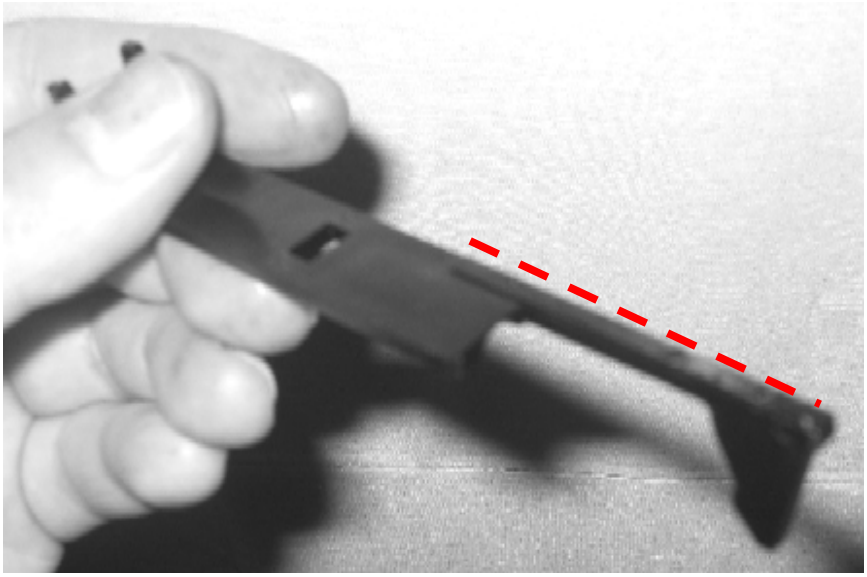
Both proper usage and proper upgrade are essential. One ugly situation is when the bushing holders can no longer hold the bushings tight, that the bushings themselves are rotating together with the gears. Use of epoxy to firmly affix the metal bushings is one viable measure for early prevention. Proper shimming is another (less accurate shimming is a major cause of this problem. Make sure nothing is too tight or too loose!).

When the mechbox is running, the nozzle does not move at all. What is wrong?

My mechbox got stalled after replacing the tappet plate. What's wrong?

It is highly likely that the tappet plate has been broken. If your mechbox is a heavily upgraded one, consider getting yourself a reinforced tappet plate.

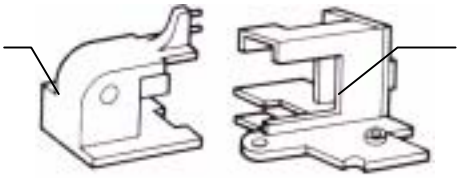
Even though most tappet plates look identical, different makes do have small difference that can introduce big problems. Take for example the tappet plate made by ICS. We tried to use it to replace a broken one found in a Cybergun DPMS AR15. The mechbox got stalled after making the replacement. Upon checking, we found that on the ICS plate there was an alignment stripe which prevented the plate from sliding inside the Cybergun mechbox. Therefore, when replacing the tappet plate, double check and ensure that the replacement plate can really fit into your mechbox. Minor cutting may be necessary to permit smooth sliding.



My gun stopped working in semi-auto mode. What's wrong?

In fact, experienced airsofter will tell you that firing semi-auto frequently is no good for the gun. Inside your mechbox there is a switch comprising a movable block and a stationary block.

Movable block, with one metal block on it.



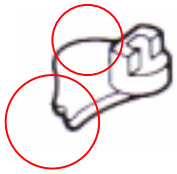
Stationary block, with two metal plates on it.

When you pull the trigger, the movable block is pushed towards the stationary block. When the metal plates on the stationary block get in touch with the metal block on the movable block, an electrical connection is made, thus activating the motor.

Semi-auto shooting is achieved mechanically (which automatically releases the movable block back to the original position). Frequent single shot can make the blocks and the mechanical parts worn away faster than usual. Poorer trigger response time is one possible consequence when the two metal plates on the stationary block went further apart due to excessive movement.

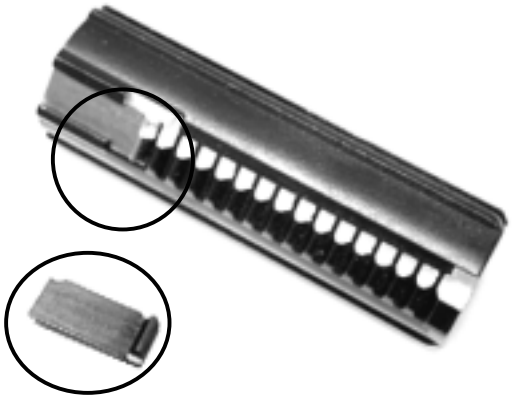
Single shot should NOT be exercised frequently especially on the V2 implementation.

On MP5 and some M16 variants the selector plate can easily get worn out with frequent usage. That can also affect the capability to fire single shots.



What cause the piston gear to break prematurely?

Let's recall what we have talked about regarding the installation of long spring. The sector gear keeps rotating anti-clockwise, and the piston is being driven to (almost) the leftmost position. If the spring is too long (meaning the "length before set" of the spring exceeds what can be accommodated by the piston at the leftmost position) and if the motor insists on running, the sector gear that keeps rotating will either break itself or the piston gear. Since the piston gear is usually of a weaker construct than the sector gear, it is the one that is ultimately broken. Check and see if your spring is too long or if there are too many spacers in use (sometimes a spring with too many coils together with a ball bearing spring guide can be the cause of such problem).



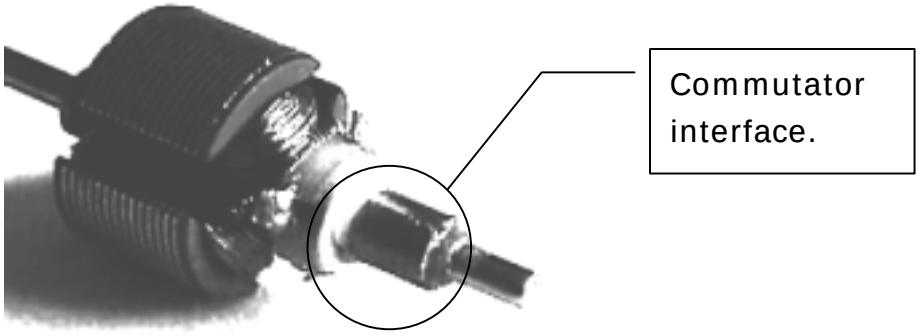
My EG1000 was overheated. What should I do?

Keep in mind that excessive heat will weaken the magnets of the motor. It is not uncommon for EG1000s to get overheated and stop working. First you should find out why your EG1000 is overheated. Most of the time improper shimming is the problem. Remember, with proper shimming, you do not need a super powerful battery pack to kick start the motor. If the outdoor weather is very hot (to an extent where yourself cannot afford staying inside the car without A/C), give the gun a break after every 800~1000 shots. Remove the motor plate and give the motor enough time to cool down. Also refer to the motor maintenance section below.

What should I do for proper motor maintenance?

With proper maintenance, your stock motor should be able to run with maximum power and speed. Below are what you should proactively do:

- Every time after a one-day game, use a high quality motor spray to clean out the dirt and the carbon deposits.
- Replace the motor brushes regularly (refer to the last section of this book on regular parts replacement). For guns running at 400FPS+, always check the brushes. If the tips that touch the commutator have turned purple, replace them immediately.
- When you change the brushes, consider to also change the brush springs as they might have lost their tension already.



What cause the strange noise from the motor and/or the motor gear?

Most AEGs have their motors being held inside the hand grip. Instead of affixing the motor with screws, the typical approach is to use a motor plate to get the motor in the appropriate position. Since the hand grip has very limited space, sometimes it can be very tough to accommodate the motor and also the two wires (one red wire and one black wire).

When installing the motor plate, make sure that none of the wires gets in the way, otherwise the motor will not be correctly positioned and will generate very strange noise when firing.

The two screws that attach the mechbox to the lower receiver are completely stripped. What should I do?

This kind of problem always happens with MP5s and G3s. To tell you the truth, you do NOT need these screws. Even without them your mechbox won't go loose UNLESS you also break the receivers. If they are stripped, just do whatever you can to get rid of them.

What causes gear stripping?

The gears can strip easily if:

- you go full auto all the way until an entire hi-cap mag is emptied
- your mechbox is running way too fast
- misaligned gears and improper shimming
- broken bushings

Gear stripping is a fact of live. Every mechbox will come across this problem – it is just a matter of time. Proper usage together with proactive maintenance measures can delay stripping. Open up your mechbox regularly (like every 10000 shots) and do a check up. Remove the dirt and other unknown particles that are accumulated inside the mechbox. Apply grease if necessary.

* If yours is a Cybergun AR15, do not open up the mechbox too frequently. Every time you want to take out the mechbox you have to disassemble the gun body. The AR15 plastic body is no good for frequent screwing and unscrewing.

What can cause the hopup rubber to break?

I have to wind my hop almost all the way up just to get flat flight. What is wrong?

Extreme cold weather can cause the hopup rubber to get hardened and break. Release the hopup rubber after every game and apply sufficient silicon oil spray to the rubber surface. If it is snowing outside, the weather is cold enough to justify staying home rather than airsofting.

If your hopup does not produce the desired effectiveness, chance is that the hopup spacer is too soft.

You can buy replacement made by Systema or Guarder, but a lot of the time you can save time and $ by using simple quick fixes. For example, to “harden” the spacer a little bit, you may insert a small piece of electric wire into it so the space inside is effectively filled up. Or, you can use the ink tube inside a pen as a cheap replacement. You just have to look for one with identical dimension.

Another possible cause is that your gun is equipped with a poor quality hopup rubber. We found that it takes time for certain China / Korea made hopup rubber units to “warm up” (even under regular temperature) just to generate enough friction for producing the needed back spinning effect on the bullets. Generally speaking, by emptying a hi-cap under full auto mode you can properly warm up these hopup rubbers.

Regardless of what you do with the hop spacer, always perform a visual check by looking through the inside of the barrel. If the hop bucking sticks too far into the barrel, your gun will shoot the sky. You don't want this to happen. Also note the following:

Slippery when wet?

Humidity is the amount of moisture in the air. It is either expressed as absolute humidity, which is the mass of water in a specified volume or mass of air, or as relative humidity, which is the absolute humidity divided by that absolute humidity that would make dew form at the same temperature.

To be precise, relative humidity is the ratio of the current vapor pressure of water in the air, to the vapor pressure at which the air would become saturated at its current temperature, usually expressed as a percentage. Saturation refers in this context to the inability to absorb further water vapor.

Rubber is a hydrocarbon polymer, occurring as latex in the sap of a number of plants. The major commercial source of the latex used to create rubber is the para rubber tree.

Every manufacturer of plastic and rubber parts defines humidity levels by a different scale but in general it can be defined as such:

Low Humidity: 0 to 40%
Mid Humidity: 41 to 70%
High Humidity: 71 to 100%

When an object rides in extremely high humidity, wet friction or suction can occur, which will require energy to break (and therefore slows it down).

As we all know, hopup requires friction in order to generate the desired back spinning action. Therefore, slippery surface on the hopup rubber is definitely no

good. Quality of the rubber surface is one factor. Humidity is another. The quality of the BBs you use also has a role in this equation. And this is why fixed hopup is not desirable - we need to adjust the hopup according to different humidity levels.

How to prolong the life of my battery?

Heat is the largest enemy of your battery as it causes the separator and seals to weaken and accelerates changes in the plate material, which in turn causes the dreaded memory effect.

Overcharging abuse is one easy way to overheat your battery. In theory, most battery cells have incorporated a protection mechanism against overcharging through increasing their ability to resist venting. However, heat is still generated along the process and is causing irreversible damage.

To avoid overcharging, use computerized charger (those capable of pulse charging) if you have a deep pocket, or use slow charging if you are not in a rush. If you really need to get the battery charged in less than an hour, set an alarm to remind yourself when to stop the charger, or use a failsafe timer if one is handy. In any case, consider having a fan blowing at the battery to keep it cool.

Is slow charging always good for my battery?

How to safely charge a battery?

One major reason why slow charging is good is because it is less likely to overheat the battery. However, very slow charging (those over a day) may also not be as good.

Under moderate charging currents, the cadmium that is deposited inside the battery pack are very small crystals. Given time, these crystals tend to coalesce and form larger crystals. This is no good for the battery since it makes the cadmium harder to dissolve during high current discharge (the battery is in high current discharge stage when in use by the AEG), and can lead to high internal resistance as well as voltage depression. Very slow charging is no good because slow growth aids the formation of larger crystals.

Based on our experience, getting a battery pack fully charged in about 5~6 hours is the most ideal.

One common way to judge whether a battery is fully charged is through calculating the output of the charger to match the capacity of the battery pack. Another cheap way is to measure the battery temperature by hand. If you feel that the battery temperature is rising steeply, full charge is almost reached. To be accurate, stop charging when the temperature rises to 10 degrees C or so above ambient.

Is NiMH battery free from the memory effect problem?

Should I fully discharge the battery every time after use?

How do I fix the battery memory effect problem?

With memory effect taking place, the battery retains the characteristics of the previous charge cycle. This can happen when the battery is recharged without being fully discharged, and can result in the temporary loss of capacity.

The memory effect was once thought to be absent from NiMH battery. However, it is now being recognized that memory effect can occur on NiMH battery. Refer to the next section for information on how to avoid memory effect.

To prevent the problem: You do NOT need to cycle your battery each time it is used. In fact, DON'T deliberately discharge the battery to avoid memory effect as this will shorten its life span. A good way to avoid memory effect is to use the battery until it is about 90%~95% discharged. Do this only once in a while. And, fully discharge the battery once every 30 or so cycles.

To correct the problem: Simply perform a few cycles of slow discharging and slow charging (but don't go too slow – charging and discharging over a day is no good as well).

My gun keeps mis-firing. How do I tell if this is a magazine problem or a mechbox problem?

I suspect that the hi-cap magazine is not working. What should I do to fix it?

Generally speaking, mis-firing has nothing to do with the gears of the mechbox. To find out whether or not this is a magazine problem, simply test fire with another magazine. If problem persists, try to test fire with a low-cap mag. If a low-cap mag still cannot make things work, chance is that something is wrong with the hopup unit, OR that the nozzle in use is not the correct one for this AEG.

A systematic approach for determining the true cause of full-auto misfiring problem:

First you need to know the symptom. Does misfire occur solely in full-auto mode? If so, move to Solution 1. Otherwise, move to Solution 2.

Solution 1: try to fire full-auto using good quality 0.12g BBs. If the gun doesn't mis-fire with 0.12g BBs, you may solve the problem by removing (by way of filing down) 1 to 2mm of tapered plastic from the Nozzle. Based on our experience, a nozzle that is too long can hinder bullet feeding when heavier BBs (like the 0.20s) are in use.

Solution 2: try to fire semi-auto using good quality 0.20g BBs with a standard cap magazine. If this works, try going full-auto. If full-auto works as well, it is (very likely) a magazine problem - you may need to repair or replace your hi-cap

mag. If full-auto doesn't work, try out Solution 1 with the standard cap mag. The worst case scenario is that you need to modify the nozzle AND replace the high cap mag.

** If mis-fire happens in semi as well, it is likely that the Hop Up chamber is seriously deformed or that there is a magazine wobble problem.*

In any case, after each outdoor game you should clean the magazine inside and out. Take out the internal, release the spring and remove all the dirt and dust. For MP5 mags in particular, frequent cleaning is a MUST.

As a side note, the springs in use by the hi-cap mags are known as constant-force springs. They are a special variety of extension spring that consists of a spiral of strip material with built-in curvature so that each turn of the strip wraps tightly on its inner neighbor. When the strip is extended, the inherent stress resists the loading force at a nearly constant rate. Are these springs replaceable? Yes, but they are not cheap at all (it may just be better off for you to replace the entire magazine).

To prolong the usable life of a constant-force spring, always have it released after each game. A hi-cap mag under proper maintenance should last for 30000 ~40000 rounds at the least.

What causes double feeding?

My gun makes an unwinding noise after full auto firing. What's wrong?

Double feeding refers to the feeding of two (or more) BBs at once. Double feeding may result in both BBs breaking or serious jamming in the barrel. Even if the BBs do not break, their range and accuracy may be greatly reduced.

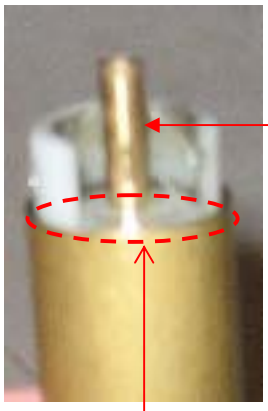
Double feeding may occur when the feeding mechanism is over lubricated or when the nozzle is seriously deformed. Based on our experience, a spring that is too soft can also lead to double feeding. Try installing an ACX stock spring into a TM and you will know what we mean.

Some people complained that by not following the "one o'clock rule" the resulting gear timing problem can introduce double feeding as well. Please refer to our section on the one o'clock gear timing issue – as long as you follow our recommendations this problem should never occur.

An "unwinding" noise after you fire is a symptom of either a malfunctioning anti-reversal latch OR a weak anti-reversal latch spring. When the latch is deformed or when the spring is too weak to support the latch, it fails to grab onto the bevel gear. **Your gun can shoot without a working anti-reversal mechanism, but at the risk of breaking the teeth of the gears.** Based on our experience, you should replace the spring per every 30000 shots. You don't need to replace the latch until after around 50000 shots (if you have an insane ROF, there may be a need to replace the latch sooner).

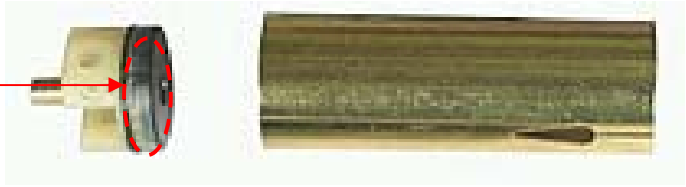
What causes air leakage?

Most of the time air leakage occurs due to problems with the cylinder. With air leakage you will see a sudden drop in FPS and range (NOT ROF).



On heavily upgraded gun this tubing can eventually turn loose and shaky (which will then require replacement).

It is recommended that you apply grease around here to help stop air leakage.



What needs to be regularly replaced to keep my gun in good shape?

Our recommendation for UPGRADED AEGs (at a minimum) is that for every 15000~20000 rounds, replace the following items even if they aren't broken:

- the hopup rubber and the hopup spacer (bucking)
- the motor brushes
- the spring
- the piston head (the O ring in particular)
- the bushings

Our recommendation for stock AEGs (at a minimum) is that for every 30000 rounds, replace the following items even if they aren't broken:

- the spring
- the piston head (the O ring in particular)
- the bushings

* also replace the motor brushes and the hopup rubber after about 40000~50000 rounds.

Also check the safety cover, which is mostly made of weak plastic (refer to the picture below). Sometimes they just break without ever getting noticed.

One way to avoid breakage here is to loosen the screw a little bit. Over tightened safety cover breaks ten times faster.

Special Topic: BE Tech plastic mechbox series

Are the stock plastic gears durable enough?

Should I replace the plastic gears with metal gears?

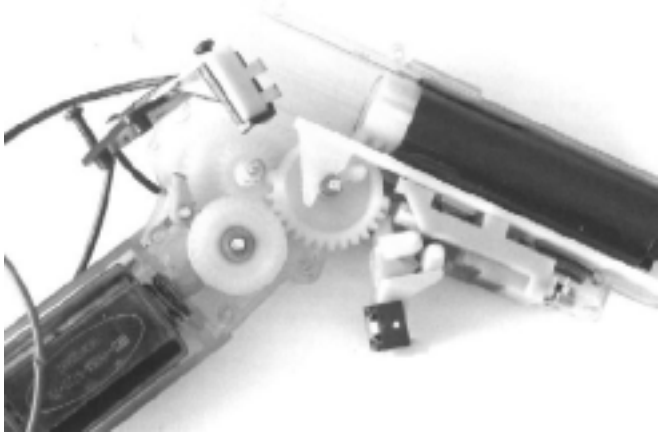
Should I replace the stock cylinder set?

Can I mix and match TM piston with the stock cylinder?

How do I fix the fore grip wobble problem?

Can I use the TM high cap on it?

The BE Tech AUG somehow reassembles the architecture of the TM AUG. The new XM8, on the other, is a G36C replica with a futuristic skin. Their plastic mechbox is an excellent V3 replica – surprisingly durable and easy to assemble even though everything inside is plastic.



I do not have anything against plastic gears. Remember, gears used in the RC cars are almost entirely plastic, and they run just fine most of the time. The BE Tech mechbox is special though – it is of a bushing-less setting.

Based on our experience, stay at the 300 FPS +- 10% power level using a softer spring (such as the PDI spring or a Guarder SP series spring) and the gears will do just fine. I do not recommend replacing the plastic gears with metal gears. If

you want to use metal gears, you will need to drill holes on the mechbox to accommodate bushings. This process is likely to be imprecise. Mixing and matching plastic gears with metal gears is a real bad idea – it can accelerate the killing of the plastic gears dramatically. Staying with the stock plastic gears is your best bet.

The stock cylinder is a plastic made one-piece cylinder. It is good at air sealing. However, because of its small volume, improper air volume balancing is resulted on the AUG (remember, the AUG has a damn long barrel). To effectively increase FPS, replace the stock cylinder set AND the piston with a bore up set. Keep in mind that:

1. You can't use the stock piston in a TM cylinder. The stock one is about 5% smaller. If you are to replace the cylinder, you MUST also replace the piston.
2. You can't use the stock air nozzle with a TM cylinder set. The stock one has an inner diameter too large to give room for air leakage.
3. If you use a TM compatible air nozzle, minor cutting work is necessary for it to fit into the stock tappet plate.

A PDI 120 / Guarder SP90 is a decent spring upgrade option for the plastic mechbox. Don't use Systema M series spring on it, they are too stiff for the plastic mechbox to sustain.

To fix the foregrip wobble issue, simply add a thin washer to either side of the fore grip assembly. Note that the TM high cap does not fit with the BE Tech guns without modifications. However, you can install the internals of the TM high cap into the stock mag shell – they will work together well, we have been doing that since day one ☺

For more coverage on the BE Tech guns, please refer to our Practical LPEG Upgrade ebook.

Special Topic: Springer-to-AEG conversion

Is springer-to-AEG conversion possible?

What are the steps involved?

At present there is no ready-made conversion kit in the market. However, the trend is for the manufacturer to produce parts that are compatible with the popular AEGs. Two examples are Monica (Korean) and Cybergun (Academy as the OEM manufacturer).

This is a smart move. By producing compatible parts the overall costs can be lowered, and that flexibility in product development can be enhanced. The Monica M4s are using TM compatible hi-cap mags. The Cybergun M4s have structures highly similar to its line of AEG, thus making “after-market” conversion possible (all that you need to do is to plug in a mechbox and figure out battery storage - cost is a different matter though).

If you attempt to convert your springer in the future, the correct first step is to choose the right springer. The Cybergun M4s (including the Kitty Kat) are our favorites.

Converting a springer to an AEG has been possible but impractical due to the extensive efforts involved. However, with the introduction of the Cybergun M4 series springers, the story is destined to change. Look at the pictures below, we have successfully fitted a Version 2 mechbox into a Cybergun Kitty Kat. The whole process took less than an hour to complete (assuming you have the AEG mechbox ready to go).

The Kitty Kat was designed from the ground up with AEG compatibility in mind. Except for the pistol grip, the motor plate and the fire selector switch, almost all parts can be used to support the conversion effort.

Note the following:

- The Cybergun springer receiver can take all V2 AEG mechboxes currently available in the market.
- The Cybergun V2 mechbox does not fit with the TM pistol grip due to difference in the layout of the wiring/screw holes.

- The Cybergun springer stock pistol grip can ONLY be used with the Cybergun V2 mechbox. It is not compatible with any of the TM V2 mechboxes. It can use TM motor plate but cutting works are necessary.
- You cannot use the stock springer plastic cover plate to do the conversion.
- To summarize – you need to choose from ONE of the following combinations:

a TM compatible V2 mechbox shell + TM compatible pistol grip + TM compatible grip end motor cover plate

OR

a Cybergun V2 AEG mechbox shell + stock Cybergun M4 springer pistol grip + TM compatible grip end motor cover plate

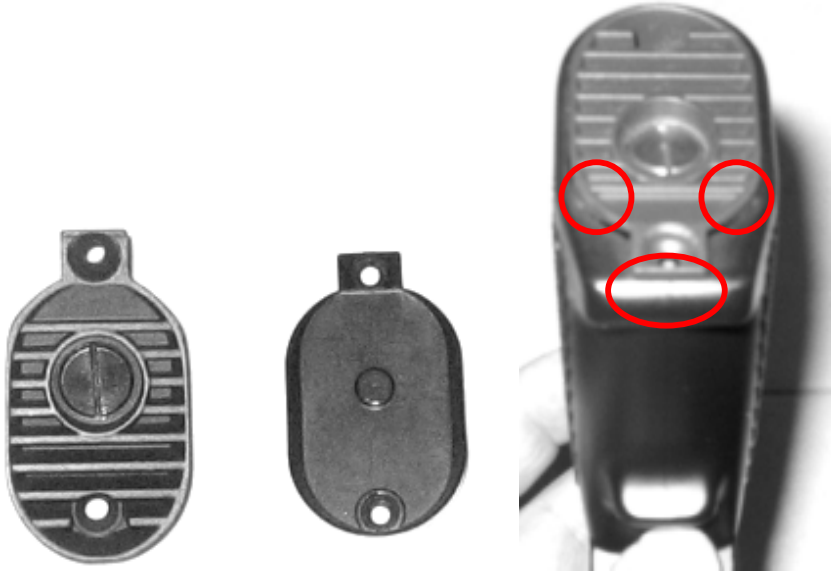
OR

a Cybergun V2 AEG mechbox shell + Cybergun M4 AEG pistol grip + Cybergun M4 AEG grip end motor cover plate

An even cheaper solution is to use the WELLs R6 V2 mechbox and its pistol grip/motor/motor plate set. The quality is not as good though.

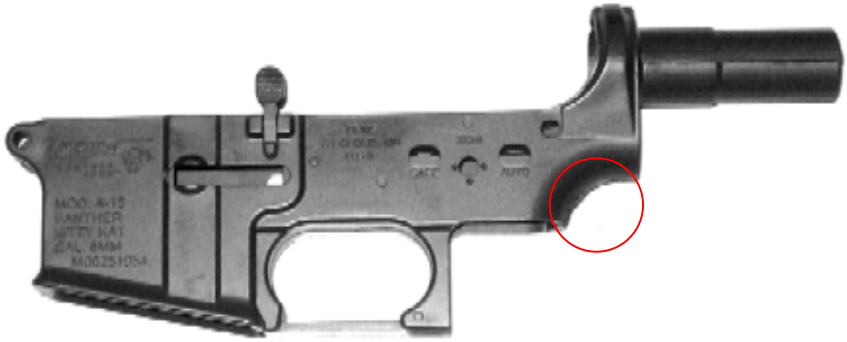
Left: TM compatible pistol grip Right: stock Cybergun Springer pistol grip

Left: a TM compatible motor plate (they call it Low Noise Grip End). Right: the stock Cybergun springer cover plate. It is smaller than the TM compatible one (the left one), meaning cutting work on the stock pistol grip is necessary for the TM cover plate to fit into it.



The stock Cybergun Springer lower receiver:

Note: If you are using Cybergun V2 mechbox, since there is a spring release lever at the back, we need to accordingly make room in the lower receiver for accommodating it:

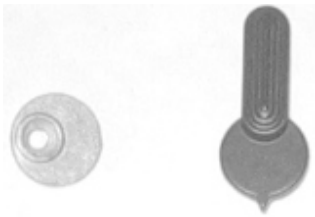


The original piston assembly on the upper half of the receiver has to be removed (keep only the hopup unit and the barrel and almost nothing else). Plug in a Select Fire safety switch unit, a M4 pistol grip, a long type AEG motor and a motor cover plate and you can go semi/full auto almost immediately.

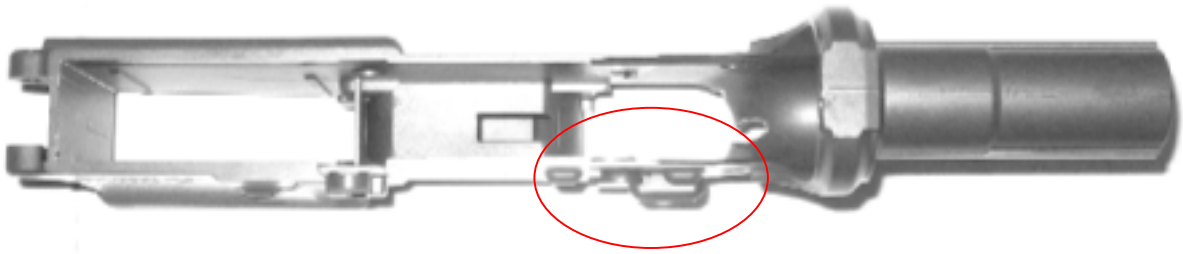
For this demo project the following third party components were used:

The CA motor cover plate, the CA M15 safety switch, and the ICS 2000 motor

The CA safety switch unit (you can also use the Cybergun A15 AEG safety switch if you have one handy)



Safety switch installed:



As you put everything together, you will notice that some minor cuttings on the receiver are necessary for things to fit well.

Battery has to be hosted externally due to the lack of space in the foregrip.

Putting everything back together, and a full blown Kitty Kat AEG is born.

Note: The stock springer hopup unit (a V-Hop) works great. However, if frequent mis-fires in full auto mode are encountered, you may need to shorten the air nozzle by 1 to 2mm minimum. This will for sure fix the problem.

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