RAMROD 200

Electronic Subsystem Overview

Kit No. CBMD-009

CB Model Designs

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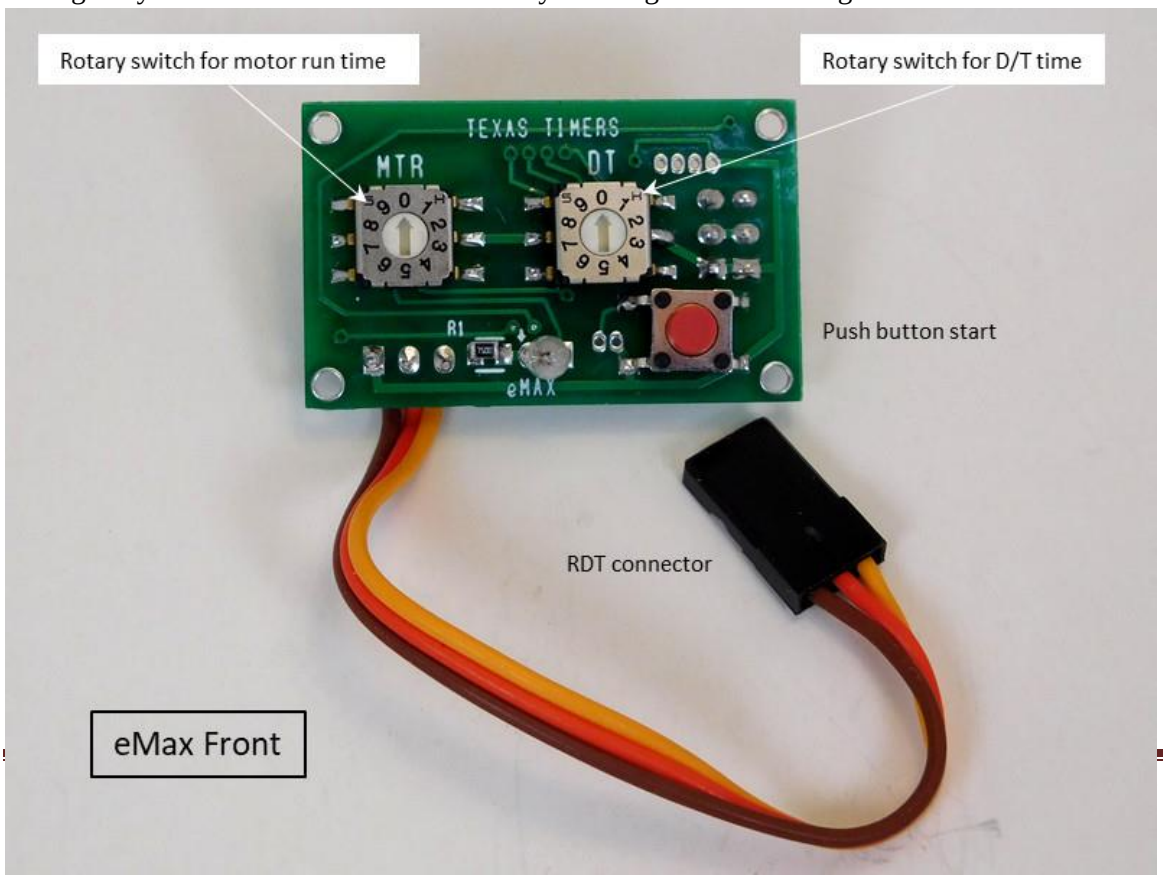
I have prepared this document to describe the details of the electronic subsystem components used in electric free flight models. The system described is the same as that used for E-36 or any other electric powered free flight model utilizing this range of battery power. The intent of the document is to introduce these components to those starting to fly electric free flight and building the Ramrod 280 eNos model.

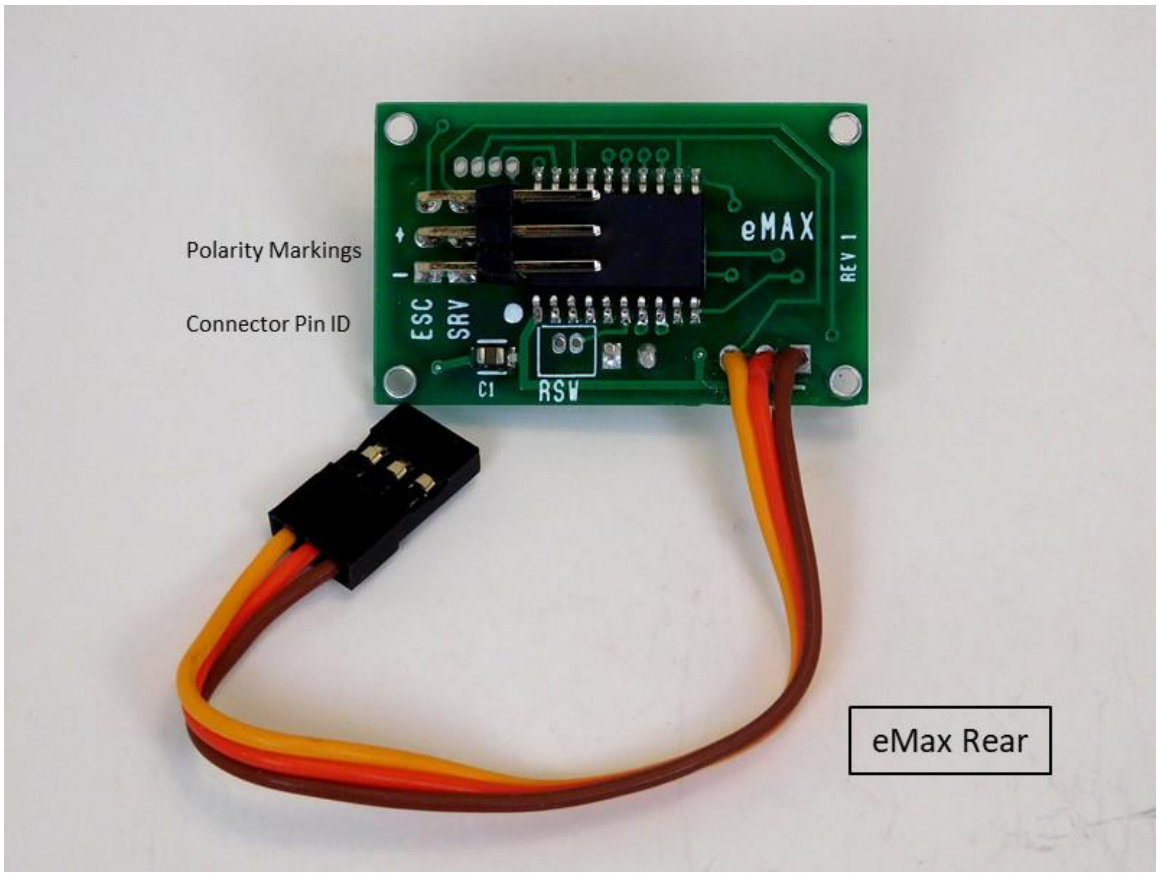
Introduction to the Subsystem Components

Electronic Timer

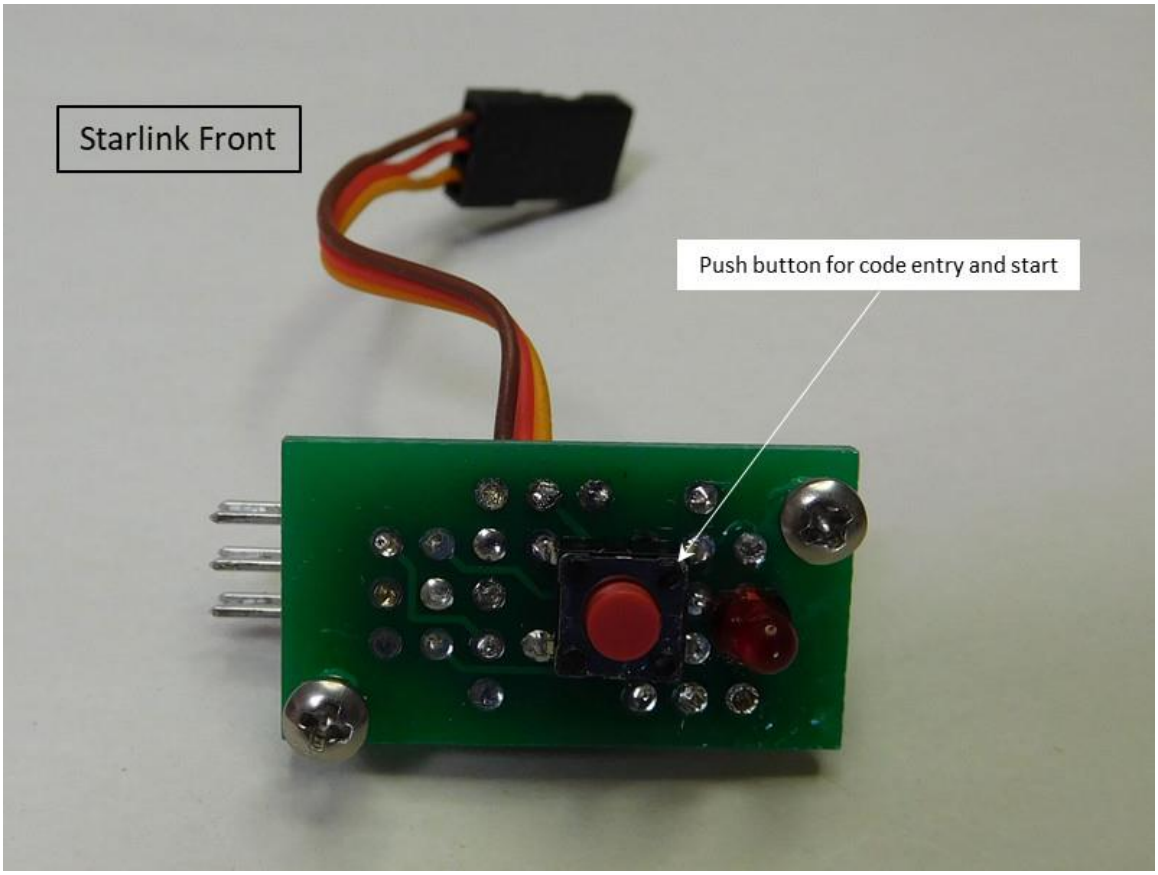
The heart of the system is the electronic timer which controls the motor run and D/T time for your flight. It emulates what a radio control receiver would do except in an automated fashion by virtue of the programming made on the computer chip the timer utilizes as the "brain". The timer processes the signals necessary to start and stop the motor, and cause the D/T servo to rotate and return to center. It's fairly simple functionality in operation. I have two recommended timers to use on your Ramrod 280, described below.

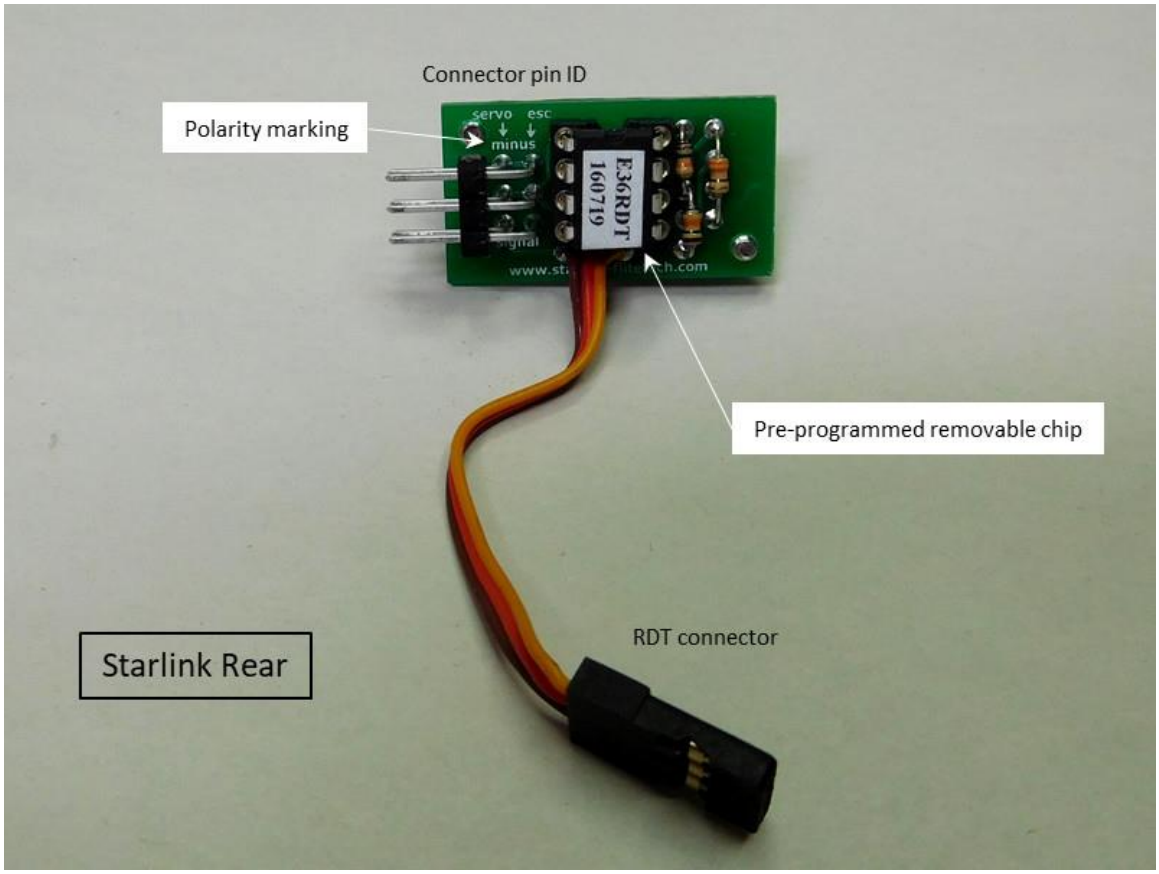
Texas Timers eMax electronic timer: this is a very popular and lightweight timer used for all classes of electric free flight. It normally has two functions; one to limit the motor run time and another to actuate a servo for dethermalizer release. There is a variant available that has an auto-rudder function should you wish to set up that sort of operation on your model. This requires a special servo wheel to handle the two-position output from the servo-also available from Texas Timers. The advantage of this timer is the combinations of motor run and D/T times which can be user set for the desired competition being flown. This timer works for E-36 as well as eNostalgia with simple adjustment of the rotary switches on the timer face. You get a timer that can be used on a variety of competition class models with no modifications required. Also, your settings stay the same for each launch unless you change the dial settings.




Polarity Markings
Connector Pin ID
eMAX
REV 1
ESC
SRV
C1
RSW
eMax Rear

Starlink-Flitetech electronic timer: Another very popular timer in E-36, it has only single push button entry to select pre-programmed profiles for motor run and D/T times. Easy to use, it's light and effective and relatively inexpensive. If you want to use if for eNostalgia you will need to specify the 'NOS' chip when you order it. The chips on the timer can be removed and exchanged if you want to run different flight profiles and different programmed chips are available from Starlink. On this timer, you need to push button set the code for each flight as the timer re-sets after each cycle is completed.





There are other electronic timers available, and I have not used any of them. I'm sure they all work well in their own way-I'm just recommending the ones I have the most experience with. Both timers noted have RDT capability but you have to specifically order it that way. In addition to the pigtail connector lead for the RDT receiver (host), the firmware programming of the timer needs to include the RDT functionality.

Your Ramrod has been designed to mount the eMax timer directly to the timer mounting frame surrounding the timer opening in the fuselage. A plywood adapter plate is included to allow you to mount the Starlink timer to it and then mount to the same timer mounting frame on the fuselage. If you use the Starlink timer-you need to mount it to the fuselage such that the connector pins for the ESC and servo are facing aft. Any version of the eMAx will fit into the fuselage without this consideration. My personal favorite eMax is the 'H' version as it occupies the least amount of volume of all eMax versions and is the best value in my opinion.

Some misunderstandings about these electronic timers:

1. They do not control the mode your motor starts or stops in. This is a function of ESC programming.
2. They do not determine shut-off voltage for the system. This is a function of ESC programming.
3. They do not shut down the system in any way other than programmed or if you push the button to stop it after starting the motor. Please take careful note of this fact: if you choose a launch grip with one hand holding the airplane and your thumb on the push button to start, it is very likely you will actuate the push button a millisecond after you

release to start the timer and launch the model. The motor will stop almost the instant you let go of the airplane; bad juju is possible. A slight brush of your thumb against the push button is enough to stop the timer. If you insist on this launch method, make a conscious effort to reposition your grip slightly for the launch to avoid any contact with the push button as you let go. A two- handed launch normally does this for you-one hand dedicated to starting and releasing the timer button, the other positioned comfortably to launch the airplane.
More about ESC functions below.

Outrunner (or brushless) Electric motor

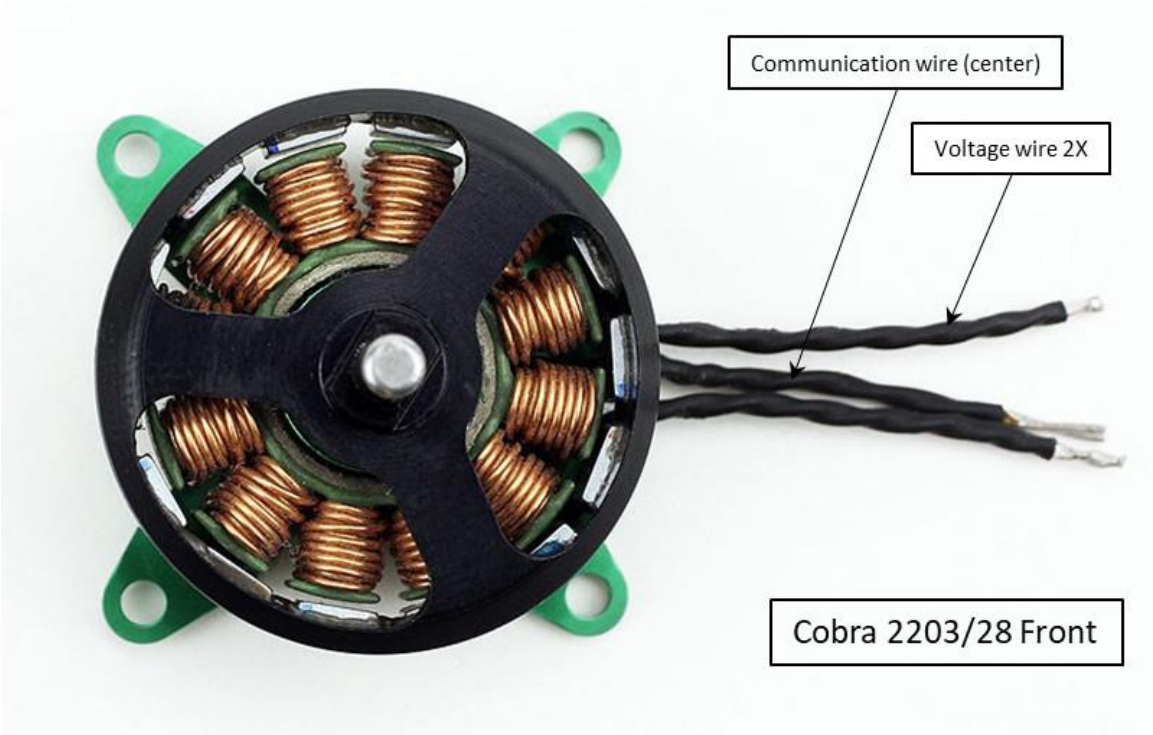
Outrunners are the most efficient of the electric motors available due to light weight and operating efficiency from their design. Instead of an armature turning inside a cylinder ("can"), the armature is stationary and the outside of the motor ("bell") turns about this, much as was the design of rotary aircraft engines in the WW1 era. Instead of electrical brushes touching an armature to transmit electricity, the bell contains a ring of tiny magnets glued in and gapped to the end of the fixed stators and the timing of the stators to receive electrical energy provides the motivation to rotate the bell. The timing is controlled by the ESC and timing can be adjusted by re-programming the ESC-usually two or three pre-sets are available to adjust, depending on the ESC brand.

There are many outrunners manufactured to support the R/C hobby and other product applications. It's hard to select motors by looking through all the advertising. For the Ramrod 280 you want a motor that operates in the voltage range offered by the two cell lipo power source which is typically 7.4 volts. Motors typically have a Kv value associated with them. This gives an idea of the potential RPM the motor is capable of turning (probably without a prop installed). 'K' is thousands, sub V is volts, so a 2400Kv motor is going to turn 2,400 RPM per volt. Potential RPM is 7.4 x 2400= 17,760, at least for the instant the motor sees exactly 7.4 volts. In reality, electric power is a lot like rubber power in that the system runs down in RPM as the battery is discharged. Since we are under power bursts for a short time, we are interested in the top end power potential more than anything. By the time you release the timer button and launch, the 7.4 voltage has dropped to 7.1V or something and continues to ramp down as the run proceeds. Another fact-it's hard to get a battery 100% charged to a full 7.4 volts-most of the time it's around 98% at best for a fast charge routine.
All that said, select a good high Kv motor and do the best you can with it.

The Ramrod was set up around the Cobra 2203/28 outrunner that is claimed to be for E-36/F-1S flying. I'm not sure what makes that so, but it is a very popular motor, has a high Kv, is well engineered and surprisingly inexpensive. There are probably five or six other Cobra's in similar size but different Kv ratings, intended for helicopters, airplanes, etc. that have different operating requirements; it can get confusing.

Another motor choice is the Texas Timers Red Max outrunner. This motor has been around for some time, and is capable of developing quite a bit of power. It's one of the heavier motors for its size, and in this case can offer you an advantage by putting some weight at the front end in a functional way. The Ramrod 280 size is perfect for this motor, and it too is not going to break the bank to obtain.

I'm sure I missed some good choices for other motors and word of mouth is more likely to be the best reference in the future.


Communication wire (center)
Voltage wire 2X
Cobra 2203/28 Front


Bell (rotating part-attached to the 3MM output shaft)
2203/28 Kv=2800
CB1512300051
E36/FS1
Non-rotating Stator assembly
Cobra 2203/28 Side

Electronic Speed Control (ESC); this can be 10-12A (amp) for the system shown for the Ramrod 280 kit using a 2 cell lipo. There are many brands out there-some have different names but may be the same ESC under the wrapping. If you really want to investigate, look for an ESC with the least amount of internal resistance. I can't offer any suggestions-they all seem to work well. Look for a light one with minimum size as well. The front of the ESC has three wires coming out of it. The rear of the ESC has a black and red wire coming off each corner, and a three-wire ribbon with connector plug coming out of the center. The front three wires connect to the motor. The center wire of the ESC connects to the center wire of the motor. This is the communication wire to the motor from the ESC. The other two wires simply create the electrical circuit with the motor to allow it to turn. You can reverse rotation on the motor by reversing the wire connections-this is something you will need to check when setting up your motor connections. The beeping sound you hear from a completed system when a battery is attached comes from the motor and is telling you the power link and connection to the ESC "brain" is completed. The red and black wire coming off the back of the ESC are the two leads to your battery-you will have to install a connector of some sort. The ribbon wire with plug is to connect to the timer connector pin block-the circuit board on the timer indicates which one this is-normally the top of the stack of two. Also, make sure the polarity is correct on the timer hookup-the black or brown wire on your ESC ribbon wire is negative and this side of the plug should match the negative pin in the connector-usually indicated on the timer board with a marking to indicate which side of the connector pins are negative polarity. Look closely as the markings are small and easy to miss.

As stated in the timer section, the ESC is normally programmable for pre-set parameters governing motor start up mode, motor braking, shut down (cutoff) mode, cutoff voltage threshold, timing and battery type plus some other parameters you probably don't want to play with. You can program from an R/C transmitter or purchase a programming card associated with the make and amperage range of the ESC you purchased.

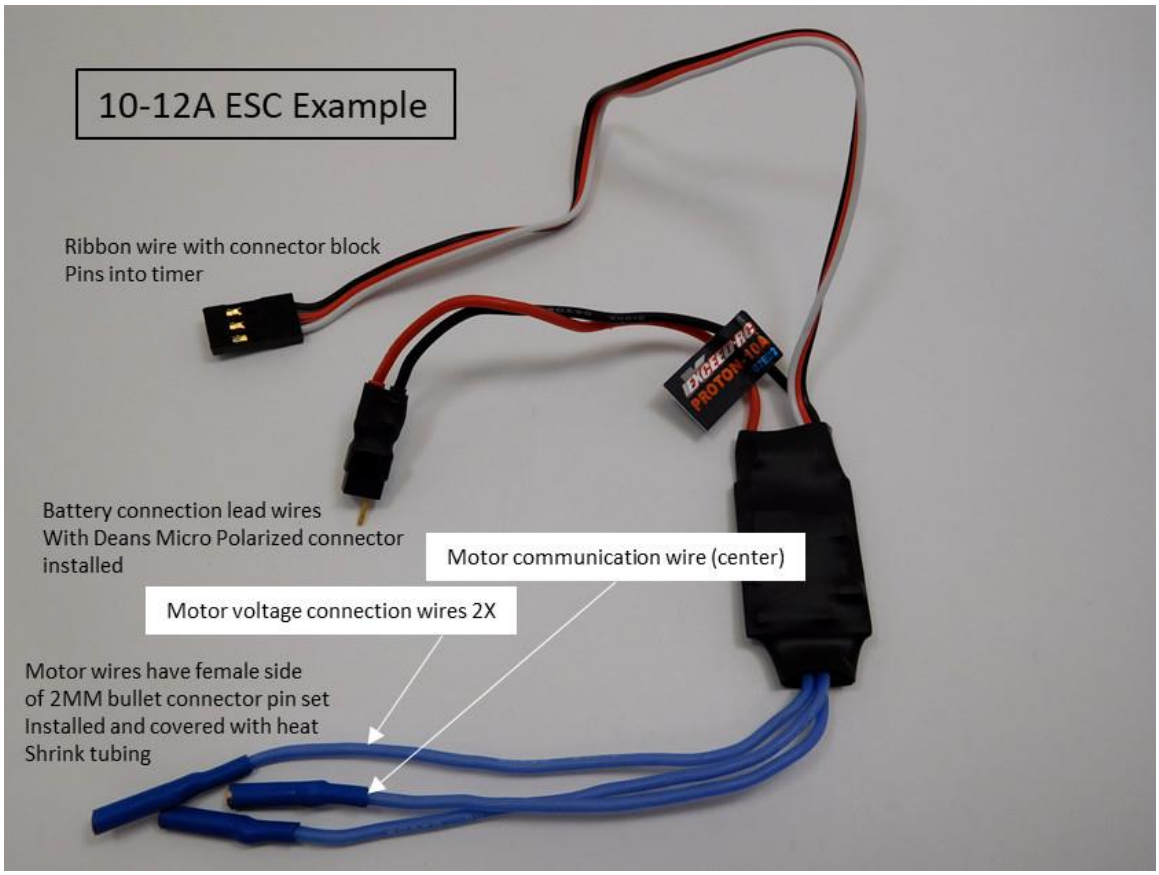
All ESC's come with motor braking 'OFF' as a factory pre-set, cutoff voltage 'HIGH' and some other standards as pre-sets. Below is a checklist for ESC parameters I change on ESC's for E-36 and also eNos models. Not all ESC's have the same exact parameters but mostly they are the same for what you can manipulate with the programming card. Yellow highlights are items that are changed from factory pre-set. Good news; programming cards are cheap.

Item			
Motor Brake	Off	On	
Battery Type	Li-ion / Lipo	NiMH / NiCd	
Cut-off mode	Soft-Cut	Cut-off	
Cutoff Threshold	Low	Medium	High
Start Mode	Normal	Soft	Super soft
Timing	Low	Medium	High

ESC connector plugs in here
Apply battery power thru ESC, not direct to the battery connector on the card!

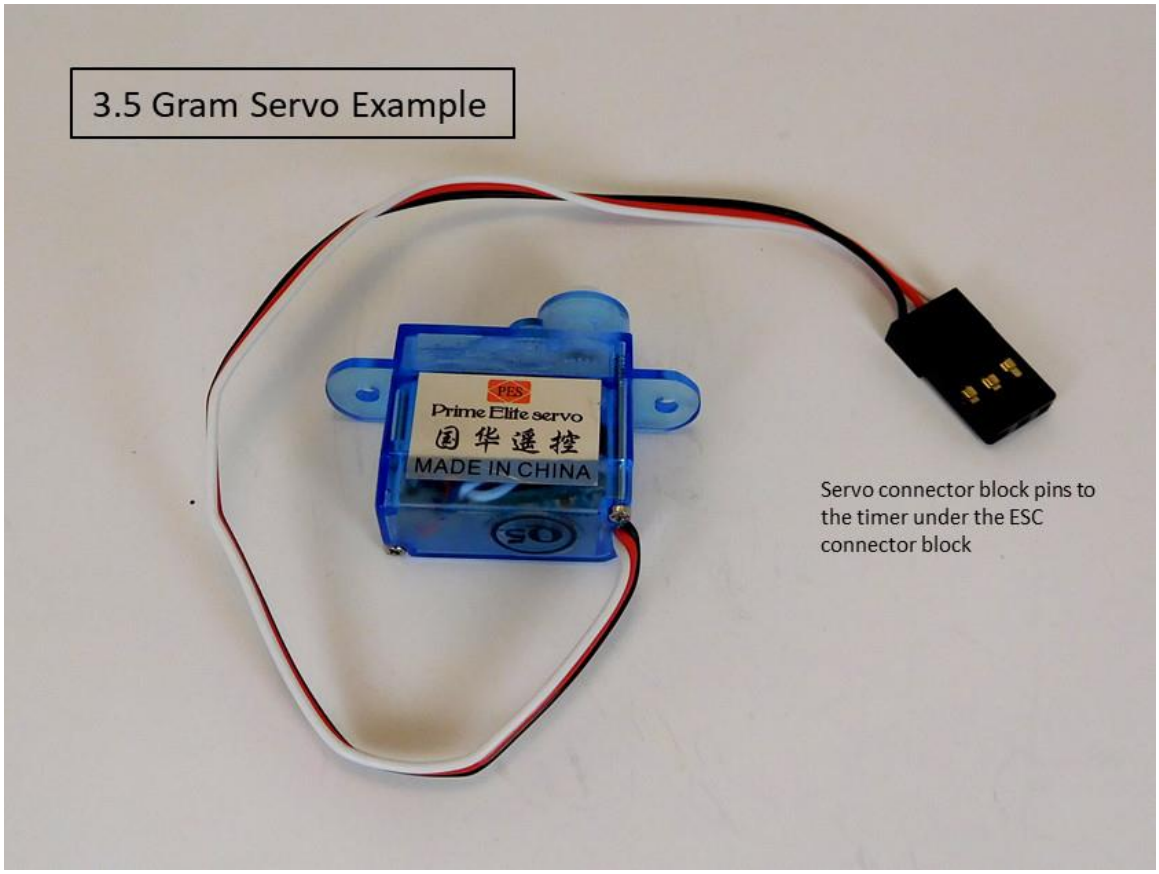
Always check model and make of ESC's the card is intended to work with. If you plug in an ESC and the LED's don't light- the card is not calibrated for that product

Hobbywing ESC Programming card
Also works on the "Proton" brand ESC


10-12A ESC Example
Ribbon wire with connector block
Pins into timer
Battery connection lead wires
With Deans Micro Polarized connector
installed
Motor communication wire (center)
Motor voltage connection wires 2X
Motor wires have female side
of 2MM bullet connector pin set
Installed and covered with heat
Shrink tubing

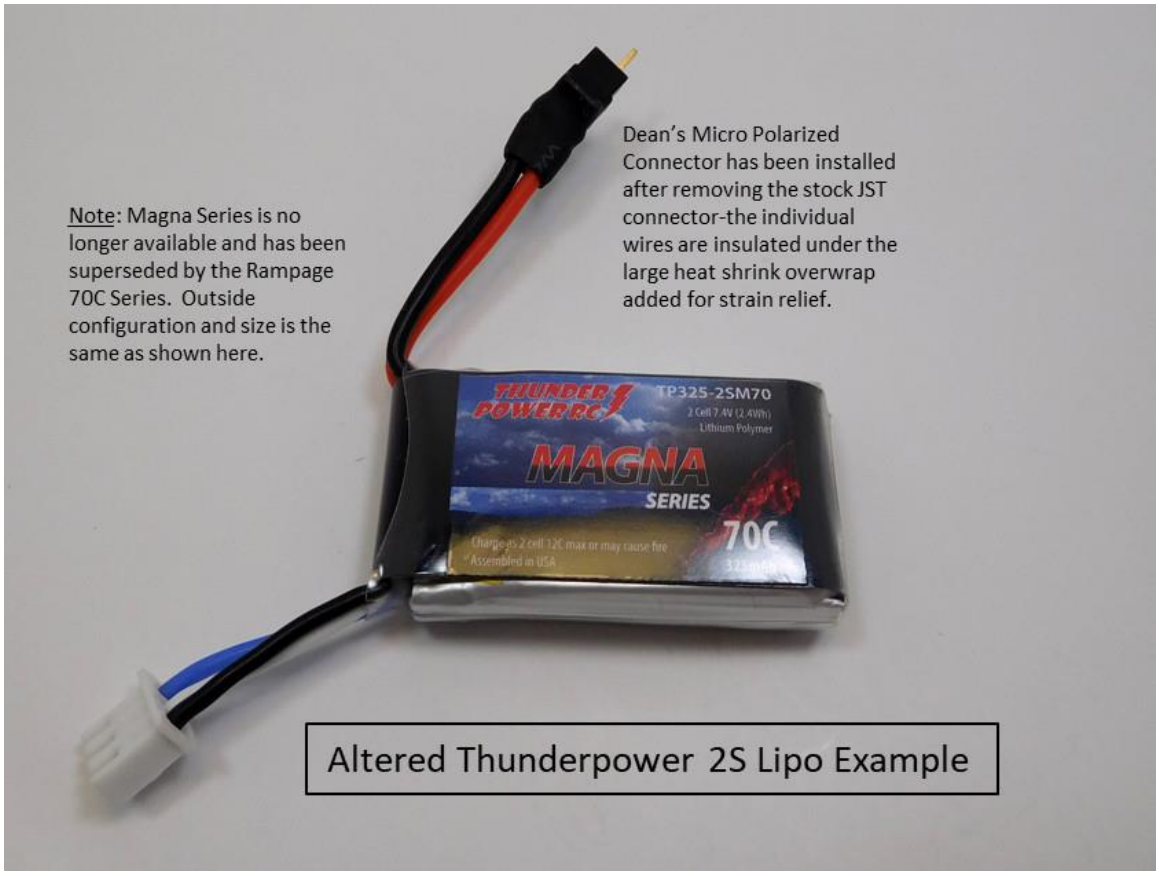

2MM Bullet Pin Connector Set
Male side-solder to end of wires
coming from the motor
Female side-solder to end of ESC
motor wires
These are also known as Banana Plugs

Servo: this is normally a sub-miniature size, 3.5 gram weight. There are really cheap servos out there and these are usually poor quality and won't take much tension load from the D/T lanyard. Anything that groans and chatters is junk-don't use it. Texas Timers sells a nice servo that has good durability. Blue Arrow brand is probably the best of the inexpensive servos I have used. There may be others but I generally stick to the two mentioned. The servo simply connects to the other connector pin set on the timer-usually the one closest to the circuit board. Again, respect the negative wire side of the connection-the dark wire on the servo is negative.

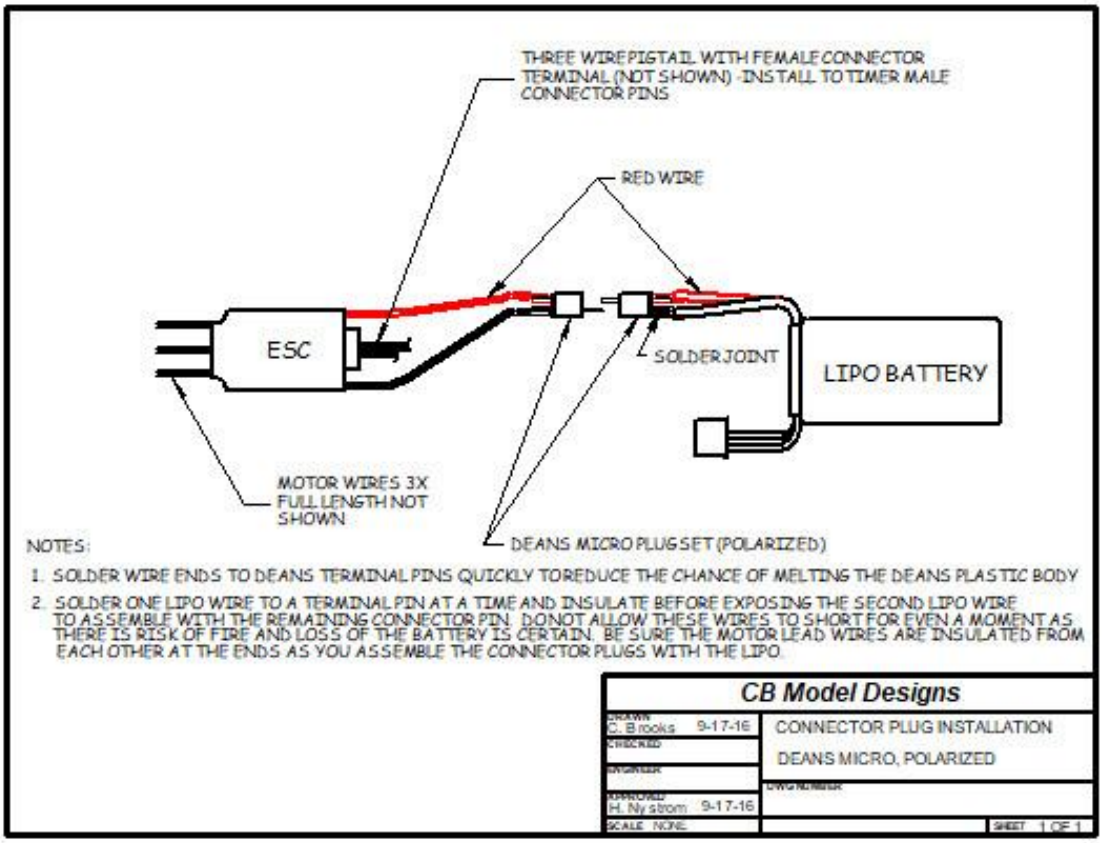


Lithium Polymer battery (lipo for short): The Ramrod is designed to install a two series (2S) lipo. Specifically, the Thunderpower R/C 325 Mah/70C Rampage series or whatever is current at the time of your build. The 'C' rating is code for the internal resistance the battery has. The higher the number, the more it can discharge in a given period (in theory). How true this is has been subject to debate, but for free flight you want high discharge rate batteries as you need to dump as many electrons as you can on the motor for 12 seconds or less. High discharge rate is like high nitro content in fuel if you want to think of it like that. It's doubtful you will find high discharge rate lipos at your local hobby dealer. What is sold there is in the 35-45C range and won't give the top performance you want. On-line sources are best for finding these batteries. Turnigy offers some high discharge rate lipo's through Hobby King. Thunderpower products are available directly from them on-line or from Texas Timers. Order at least three so you can charge one while flying one, etc. and keep a good pace on your flight sorties. Be sure to pick up a charger that allows balance charging and a storage charge setting. You can temporarily wire the charger to your auto battery terminals for field charging or bring a 12-volt battery along to use as a voltage source for your flying sessions. See the end of this document for an example of a field charger I use.

All lipo's are generally supplied with a red plastic male JST connector (Japan Solderless Terminal). Given the name, it's easy to see why-no soldering required to install! However, for a high discharge current rate these little connectors are not very good. They work, but they also heat up quite a bit which is a sign there is a significant amount of resistance at the connector. This is robbing energy from your motor and prop which may be a concern to you if you are after top performance.



A lot of us have been removing the battery JST connector and replacing it with a Deans Micro Polarized connector which seems to have more contact area and no noticeable heat buildup during use. The only downside is you have to solder them onto the battery after removing the JST connector. It's not as hard as it sounds, but you do have to be careful about polarity and shorting during the process. In practice, you cut one lipo wire, strip the end and solder to one pin on the Deans connector and insulate with heat shrink tubing before cutting the second lipo wire and doing the same for the remaining Deans pin. This way the battery wires remain insulated from each other as you work. You can order Thunderpower 2S lipo's from Texas Timers already altered to this standard if you don't want to undertake it yourself. If you don't like to solder then it's probably best to get it from an expert. You will still have to solder the mating half of the Deans connector to your ESC to complete the connection. Review the polarity standard below for the Deans installation. Texas Timers follows it for the altered lipo the Timer Guy sells. If you read his ESC section on their website you will see he also prepares the ends of an ESC you purchase from him to match the connector on the battery, and also install the 2MM bullet connectors on the motor wires. Talk about turn key service….!



The Propeller

Under the eNos rules you are allowed to use a folding propeller. This is fine, but folding props on this model can be a problem with so many parts of the model likely to be in the range of the blade fold. The main issue is at start-up. If you are holding the model up at a steep angle like you should for the launch, the blades are going to be folded aft. When the motor starts, you can catch a prop tip on the landing gear strut or forward edge of the pylon. You can mitigate this to some degree by clocking the lower prop blade to be adjacent to the landing gear strut leg on the upswing side for the prop, prior to start-up. In the instant the motor starts the blade will swing out and clear the next obstacle-the pylon. The blade coming down on the opposite side will be deployed far enough to clear the landing gear strut. This saves some valuable electron flow for the actual flight and not spent positioning the model if you hold the nose down to start. This is assuming a hard start up mode for the motor. You can program your ESC for a soft start, which allows the motor to start slowly and ramp-up to full speed in about 1.5 seconds. You can hold the model level or down to start the motor, take a few moments to get into launch position, wait for the full speed sound and then release the timer button and launch. This type of start-up can also help with the energy surge that can sometimes trick the ESC into thinking the threshold voltage has been reached and shutting off the motor, particularly if you are using a weak or cold battery.

A lot of us use the Graupner folding prop blades and the machined aluminum hub available from Texas Timers. The hub for the motors shown on the Ramrod 250 design is for a 3MM bore for the output shaft, and 6MM root (clevis width) that matches the Graupner 7.5 x 4 diameter blade set. This just slips onto the motor output shaft and clamped in place using two set screws in the

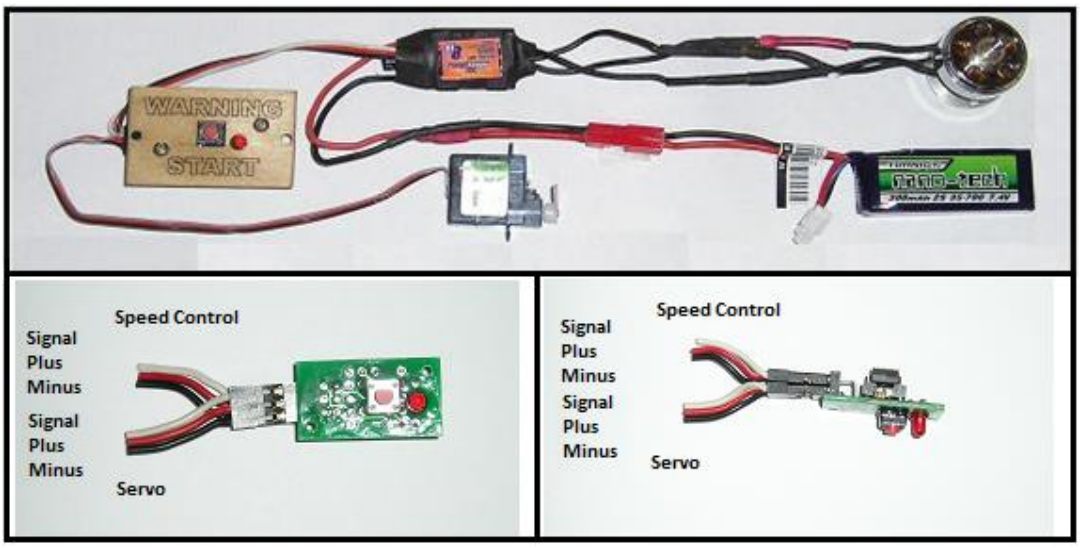
hub. The Cobra has a flat machined onto the shaft to allow clocking and firm bite on a set screw clamp which is a nice design feature of that motor.

You can use any fixed blade prop that you would use on a gas-powered model. You have to buy a prop hub adapter that clamps onto the motor shaft and allows you to fit a conventional prop. Or you can use the prop saver adapter included in the Cobra motor kit and retain the prop using O-rings as restraining bands. Use McMaster-Carr O-ring part number 9452K6 or equivalent (3/4 outside diameter x .062 cross section, buna-N oil resistant grade, medium durometer hardness).
.
I have used APC 6 x 6E and 7 x 6E props with great performance. If you want to de-tune the model for speed in the climb the 6 x 6E is probably good to start with. After you get things trimmed step up your game with the 7 x 6E prop for a higher speed ascent.

I personally prefer the fixed blade prop on the Ramrod as it makes the model the same as the gas-powered version. At contests we find eNos and Nos gas get combined in one event, and since the gas fliers don't have a folding prop option, I fly fixed blade props just to be fair about it.

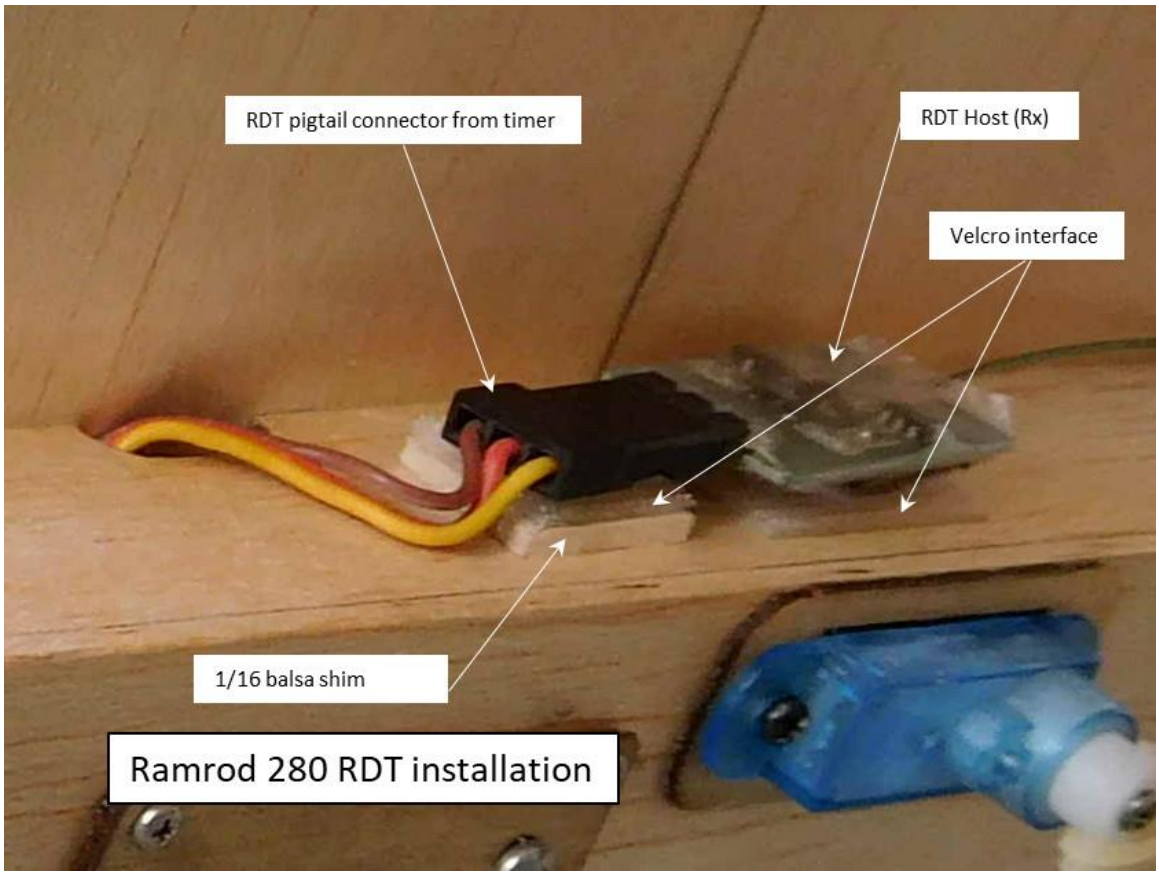
System hook-up and bench testing

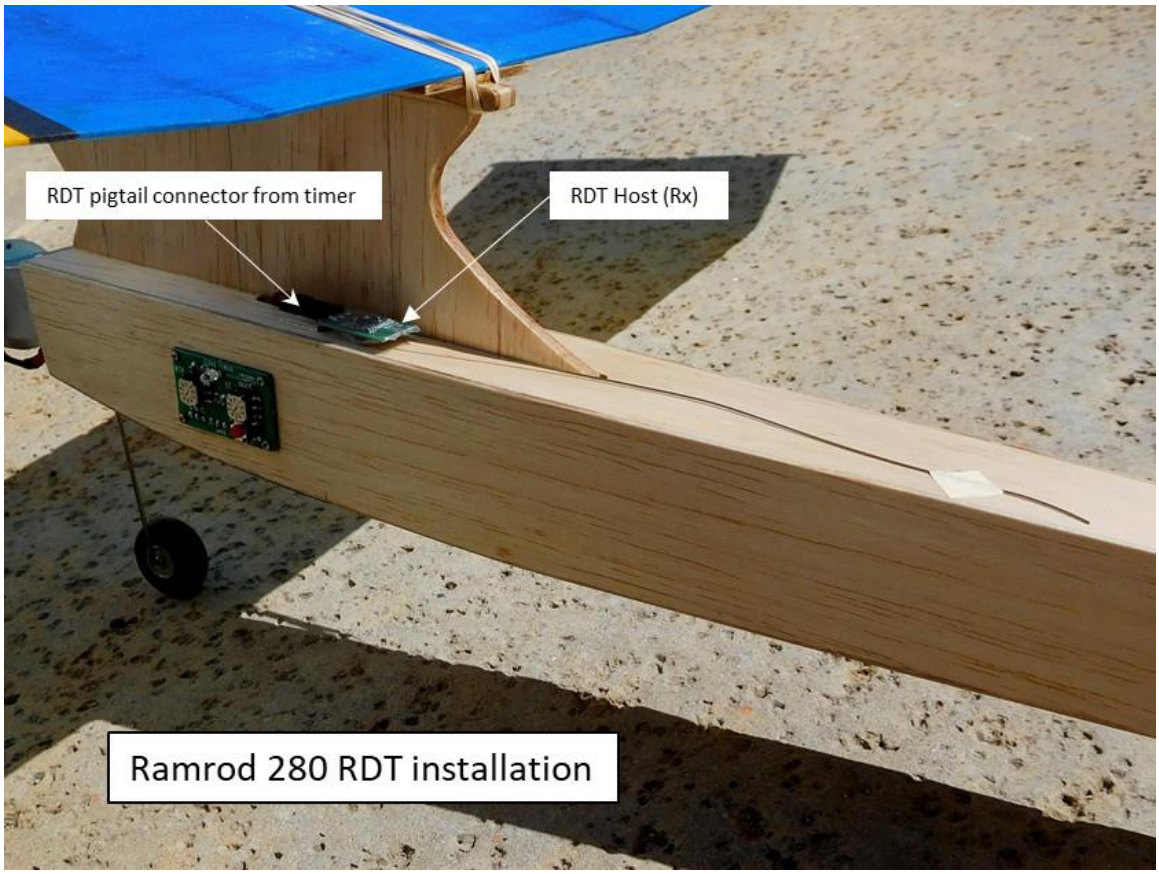
Here is an image from the Starlink-Flitetech instruction sheet for the Starlink timer. It shows a typical system hook-up, ready to run. Once you have all your components and have done the soldering and understand how it is all intended to work, connect everything together and run it on the bench prior to installation in your Ramrod.



At this time, I usually determine the motor rotation and install color coded pieces of heat shrink to the motor wire connectors to indicate the proper connection side for the counter-clockwise motor rotation. If all checks out, tear it down and install the components in the model-ESC first by fishing the motor wires through the firewall and torque box openings to allow connection to the motor. Then the servo, and then the timer so you can connect the ESC and Servo outside the fuselage, pass the RDT plug through the port in the upper fuselage skin and finally positioning the timer into place against the timer mounting frame.

On the RDT plug I usually add a small shim to the top of the fuselage at the location the plug will be positioned. I put a small piece of Velcro on top of the shim, and on the side of the RDT plug I want to attach to for hold down. On the RDT host that plugs into this, I also apply Velcro to the fuselage top and one side of the host to allow it to be retained while plugged into the RDT connector. I usually apply a small square of masking tape to keep the tail end of the host antenna captured against the fuselage top to complete this installation. Add your prop, plug in a lipo and test run again to confirm proper operation of the installed subsystem.





Now, go flying!

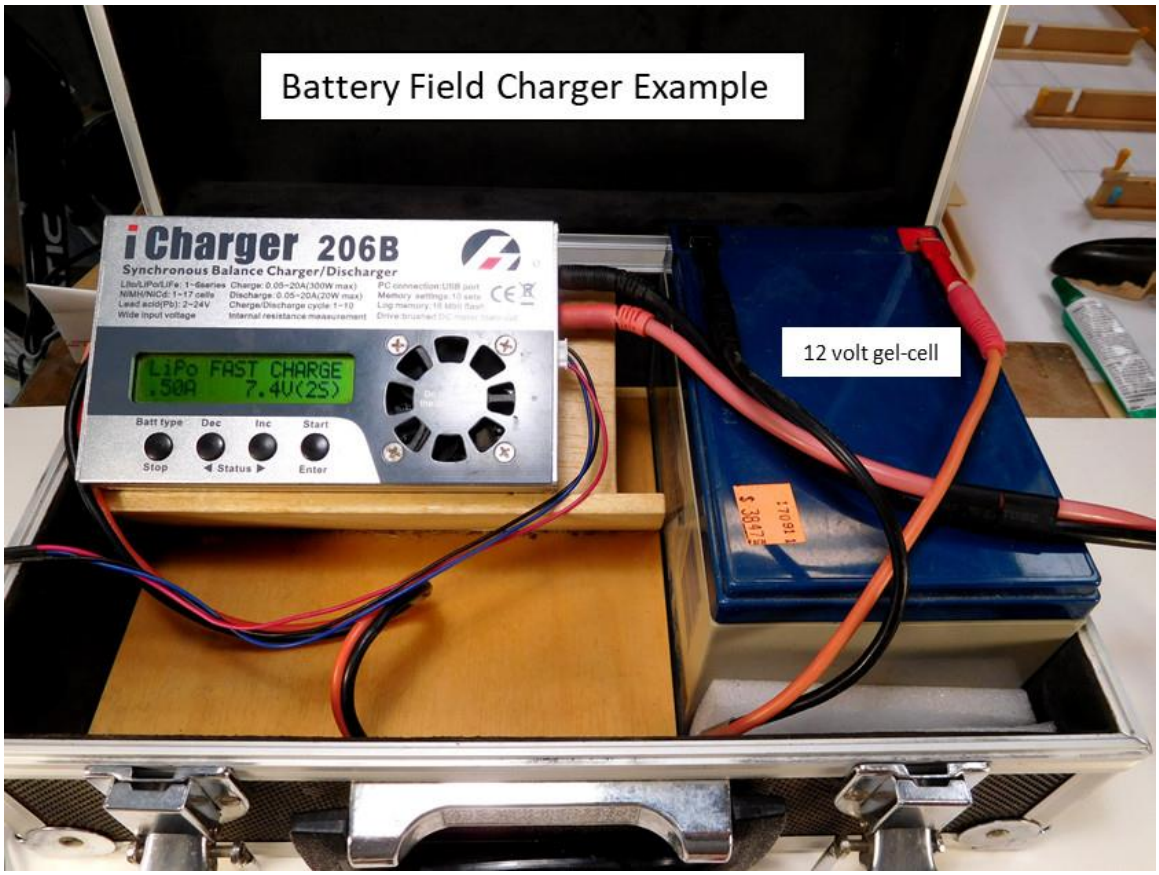
Clint Brooks
6 March 2019

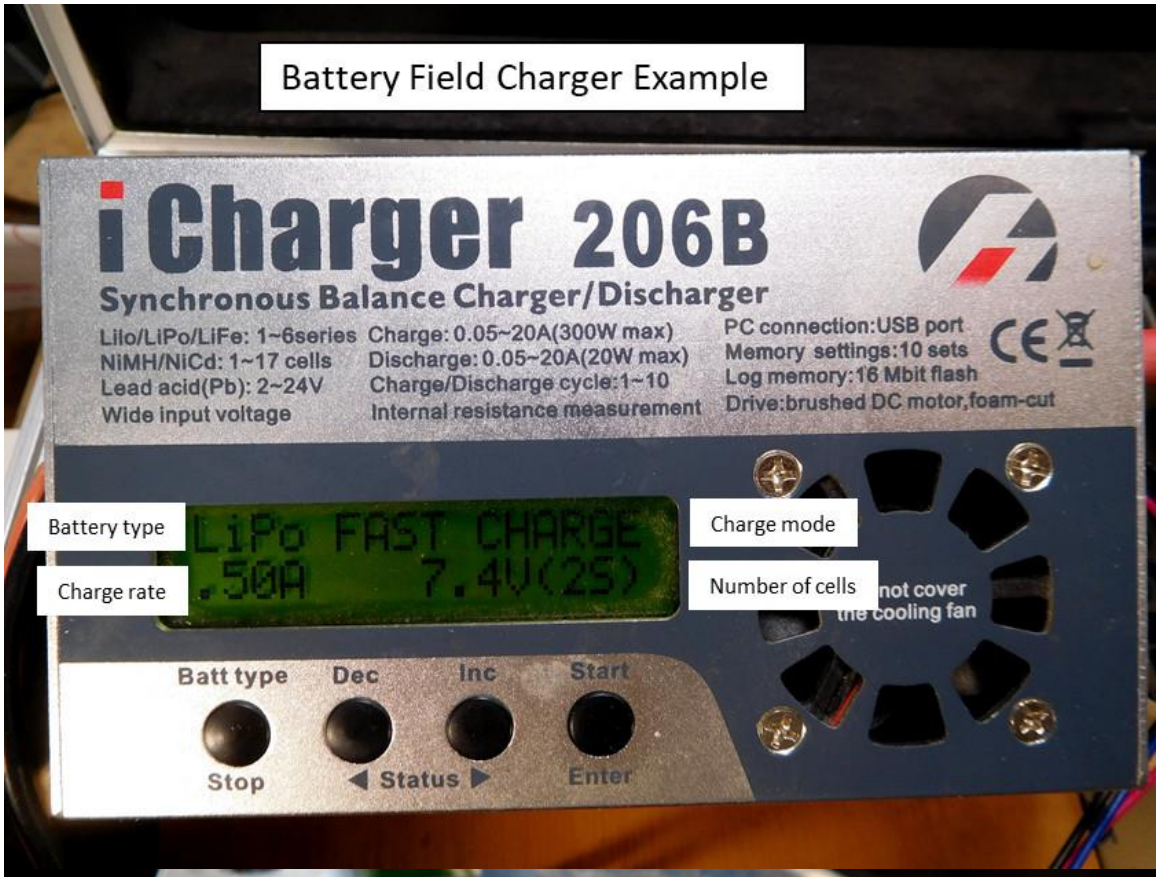
Field Charger Details

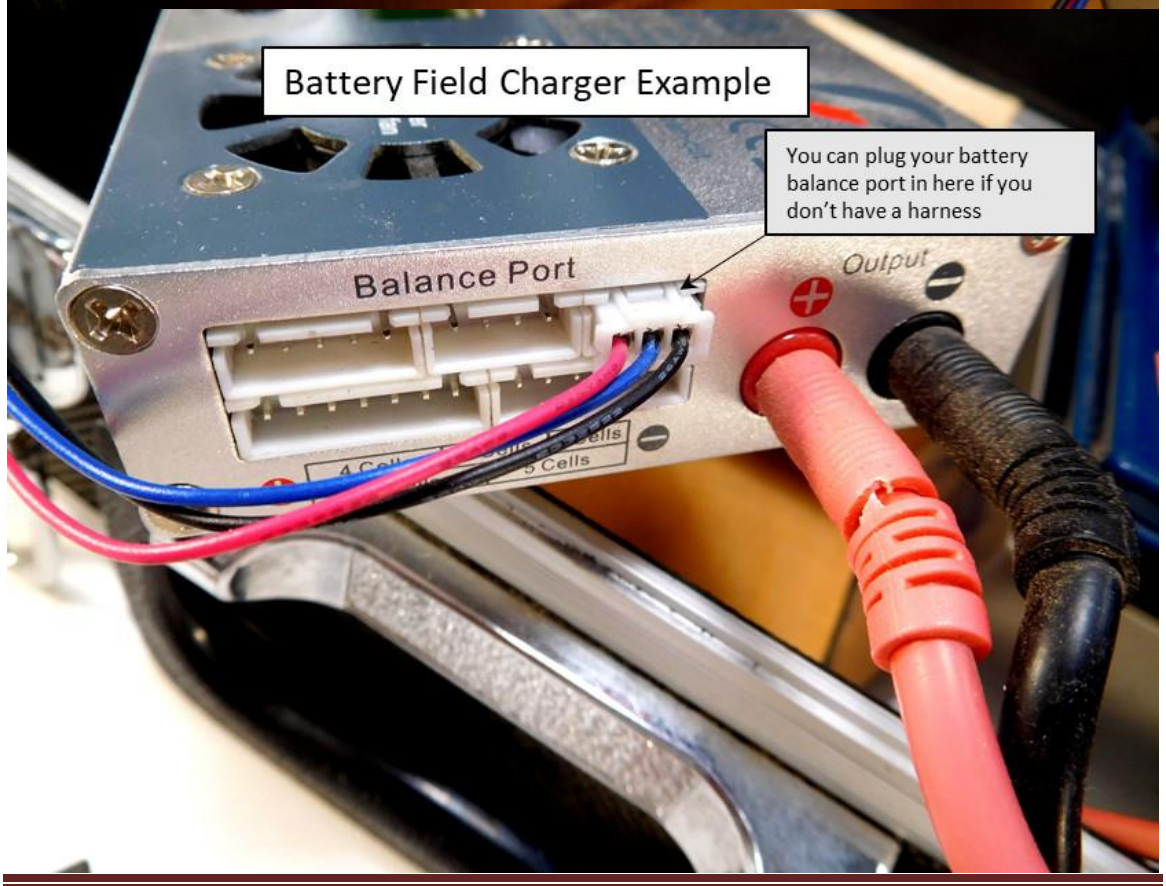
Here are some pictures of my field charger set-up. This package was built by Ralph Ray for me and some of the other Southern California electric flyers. He built the multi-plug harnesses to allow a lot of lipos to be charged at once, but I have only charged one at a time so far. This seems adequate provided you have one charging while you are flying so there is minimal down time waiting for a charge to complete.
The iCharger is for multiple battery chemistry and number of cells. It's all programmable for charge rate, etc. You can read the front panel for some of the functionality it supports. It also comes with a thick instruction manual if you want to get into the many options it supports.

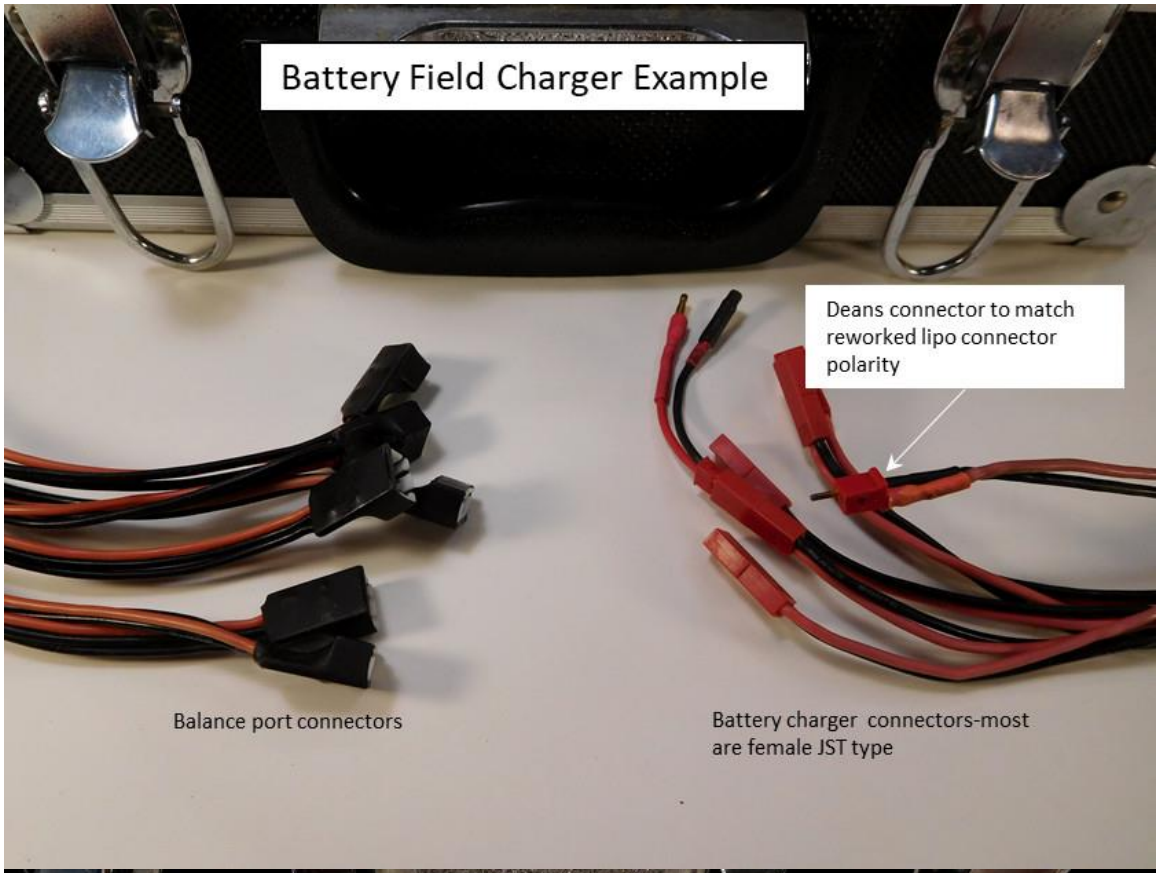
The main thing you want is a balance charge (slowest and most likely to fully charge a battery), normal charge (faster yet) and fast charge (usually what I use once flying starts) plus a storage charge setting. It's important to charge a lipo up or down before storing it, to about 50% of the battery voltage capacity. Some chargers don't have this feature, so make sure when you are researching a charger to include it.

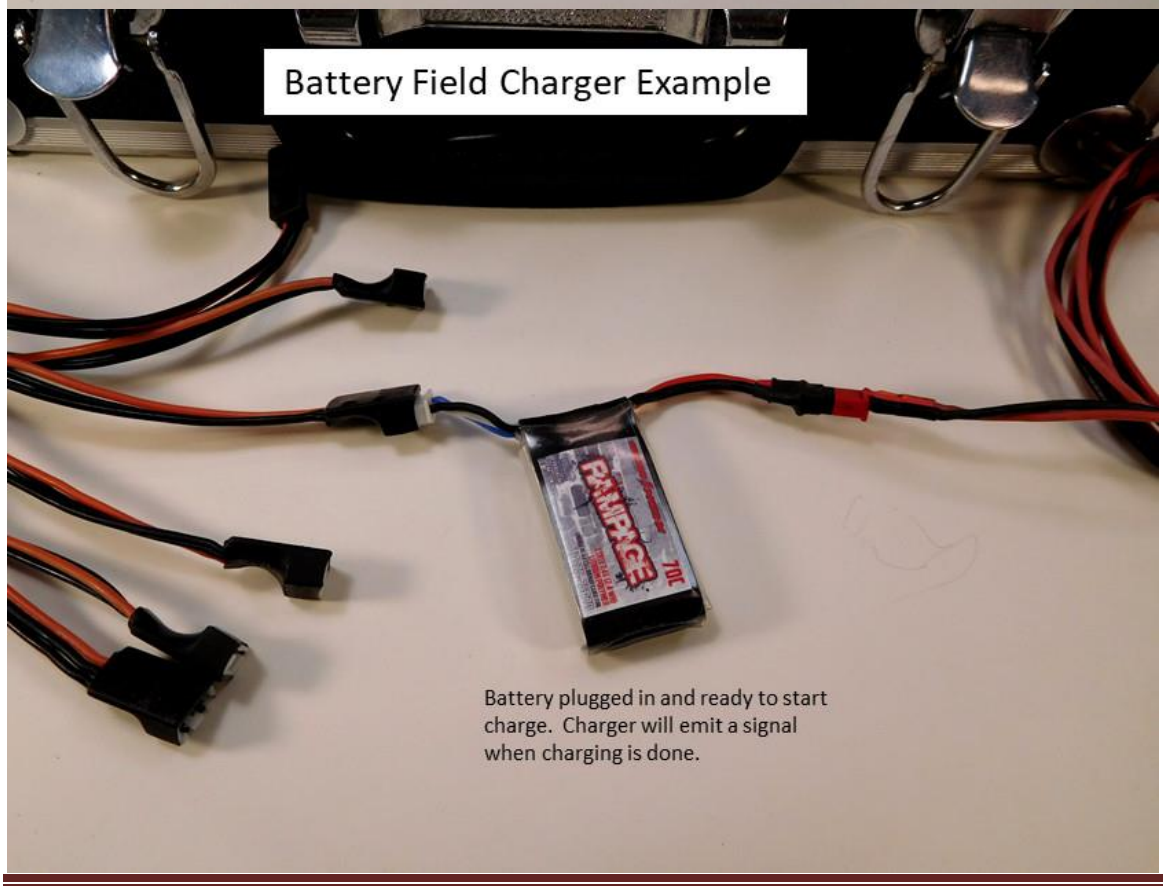
You don't need the case and portable battery to charge your batteries. The charger comes with a set of wires that have battery terminal clamps on the end so you can hook up to your car battery and fly. Beware-you can deplete your car battery in a busy day of flying so start the car once in awhile during use to make sure you aren't spending the night on the field!

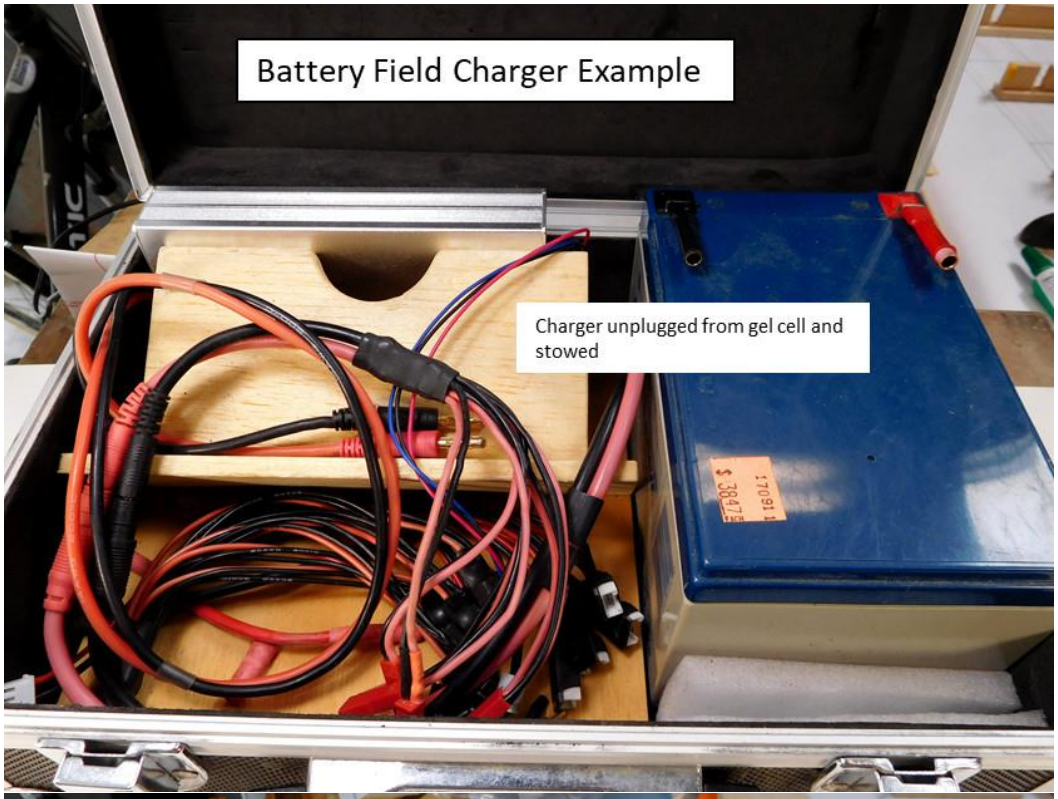


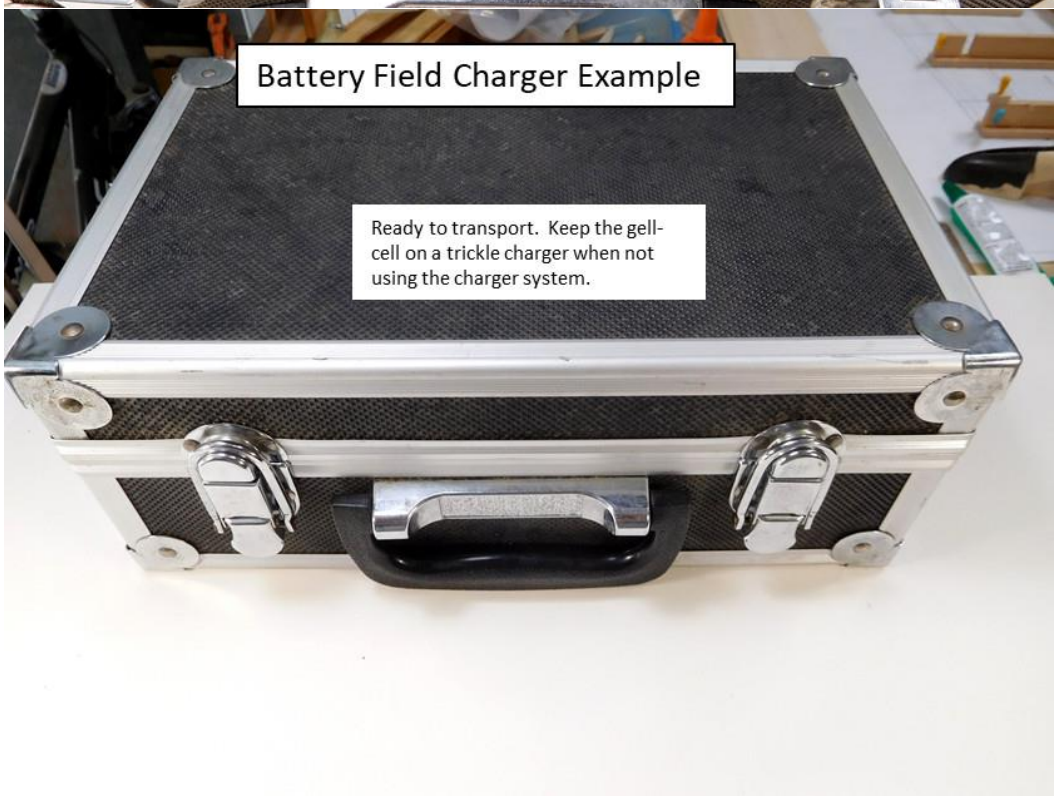

Battery Field Charger Example
iCharger 206B
Synchronous Balance Charger/Discharger
Lilo/LiPo/LiFe: 1~6series
NiMH/NiCd: 1~17 cells
Lead acid(Pb): 2~24V
Wide input voltage
Charge: 0.05~20A(300W max)
Discharge: 0.05~20A(20W max)
Charge/Discharge cycle:1~10
Internal resistance measurement
PC connection:USB port
Memory settings:10 sets
Log memory:16 Mbit flash
Drive:brushed DC motor,foam-cut
Battery type
Charge rate
LiPo FAST CHARGE
.50A 7.4V(2S)
Charge mode
Number of cells
not cover
the cooling fan
Batt type
Dec
Inc
Start
Stop
Status
Enter


Battery Field Charger Example
You can plug your battery balance port in here if you don't have a harness
Balance Port
Output
5 Cells


Battery Field Charger Example
Deans connector to match reworked lipo connector polarity
Balance port connectors
Battery charger connectors-most are female JST type


Battery Field Charger Example
Battery plugged in and ready to start charge. Charger will emit a signal when charging is done.


Battery Field Charger Example
Charger unplugged from gel cell and stowed


Battery Field Charger Example
Ready to transport. Keep the gell-cell on a trickle charger when not using the charger system.