

Mark Grasser - DC Power Solutions, LLC.

With everything in life becoming so complicated our goal is to keep our solutions simple.

Introduction

Thank you for purchasing a **SMART CHARGE ONE** Advanced Alternator Regulator from Mark Grasser – DC Power Solutions. As the name implies, the company is owned and operated by Mark Grasser. Mark has over thirty years of experience in the recreational marine industry with a focus on marine electrical repair, marine electronic device installation and, for the last twelve years, electronic design and manufacturing. Mark is almost always in the building to take calls, overseeing operations, and being hands-on in the manufacturing of our product.

The Smart Charge One regulators are manufactured in Taiwan. We re-program them to our own specification, add the Force-to-Float hardware, do a detailed board inspection and put every regulator through a four hour full load burn in test. Changes to the software were made after compiling comments from customers from the cruising community that experience the daily needs of keeping their batteries properly charged. These changes include: 1. A better selection of charge algorithms, 2. A shorter calculated absorption charge when the batteries exhibit a full charge at engine start-up, 3. A multi step alternator cutback during alternator over temperature conditions, 4. A low current quick start to have the alternator driven tachometer available at startup, and 5. A Force-to-Float input that gives an on board battery-management-system control of the regulator and/or allows the operator to keep the regulator in float mode.



Without Force-to-Float button	PN: 13105	\$164.95
With Force-to-Float button	PN: 13106	\$184.95
“LFP” with Force-to-Float	PN:13107	\$189.95

Four Lead Acid settings: PN 13105 and 13106

		Switch #1	Switch #2
Open FLA	Absorption = 14.7 volts _ Float = 13.5 volts	on	on
Sealed FLA	Absorption = 14.5 volts _ Float = 13.4 volts	on	off
AGM	Absorption = 14.3 volts _ Float = 13.3 volts	off	on
GEL	Absorption = 14.1 volts _ Float = 13.8 volts	off	off

Four Lithium Iron Phosphate (LiFePO4 or LFP) settings: PN 13107

		Switch #1	Switch #2
1.	Absorption = 14.8 volts _ Float = 13.4 volts	on	on
2.	Absorption = 14.6 volts _ Float = 13.3 volts	on	off
3.	Absorption = 14.4 volts _ Float = 13.2 volts	off	on
4.	Absorption = 14.2 volts _ Float = 13.1 volts	off	off

Consider Safety first!

Before starting the installation of your new **SMART-CHARGE-ONE** marine advanced regulator, please use the following guidelines for a safe installation. Failure to follow these guidelines could result in serious injury or damage to your vessel's electrical system.

1. Switch off and disconnect the AC shore power cable to eliminate the chance of contact to any high voltage AC wiring.
2. Switch off and disconnect all DC battery banks.
3. Remove any loose fitting clothing to prevent getting caught up in moving engine belts and accessories.
4. Remove all jewelry to prevent getting caught up in moving motor belts and accessories, WORSE YET, wedding rings get red hot when shorted to high current DC wiring.
5. Wear ANSI-approved safety glasses or eyewear.
6. Check that the engine is cool enough to touch prior to installation.
7. Ensure that the work area is sufficiently ventilated and that no fuels or solvents are present in or around your work area.
8. Do not perform any work while under the influence of alcohol or medications which could impair your judgment or reaction time.
9. Use the proper tool for the job. Use of improper tools could result in serious injury and/or damage to equipment.

Essential Electrical Requirements

1. All cables between the alternator output and all battery banks **MUST** be sized above the current capability of the alternator.
2. All cables need to have a fuse or circuit breaker at the battery end of all DC positive cables. This protection is to be rated at or below the rating of the cable. The only exception to over current protection of any wire is for the engine starter cable.
3. It is good practice to use colored cable, red for positive leads and black or yellow for negative. The new practice is for yellow to be used as it differentiates negative from AC 120 volt wiring.
4. If this is unfamiliar territory for you please consider getting the help of a qualified ABYC certified marine electrician.

Accessing the Inside of the Regulator

You will need to access the inside of the regulator for set-up and to connect the temperature sensors and Force to Float switch.

1. Remove the eight screws, four on each side of the front cover. If you purchased the **SMART CHARGE ONE** with the Force to Float button mounted to the cover, be gentle, the wires are not very long.

Selecting a Charge Algorithm

1. The algorithm is set using the small switch module located at the lower left corner of the printed circuit board. Use the switch position guide associated with the model you purchased to set the two switch locations.
2. The **SMART CHARGE ONE** PN.13105 and PN.13106 advanced alternator regulator has four different LEAD ACID Algorithms to choose from. It is highly recommended that the installer do research on the specific batteries being used to determine what the battery manufacturer recommends and then use the closes algorithm to that recommendation.
3. The **SMART CHARGE ONE** PN.13107 advanced alternator regulator has four different Lithium Iron Phosphate (LiFePO₄ or LFP) Algorithms to choose from. It is highly recommended that the installer do research on the specific batteries used to determine what the battery manufacturer recommends and use the closest algorithm to that recommendation. My experience with LFP would suggest the following:

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- a. If using LFP as a house bank that is always on charge (plugged in at the dock) I would select #2 (Absorption = 14.6 volts _ Float = 13.3 volts) and activate the Force-to-Float function. 13.3 volts is the resting voltage of most LFP 12 volt battery packs. Below 13.3 volts the pack will lose some capacity. Above 13.3 volts the LFP will be forced to take a constant current charge. The further above 13.3 the charger forces the LFP to rest, the more constant current the pack is forced to take. Over time this will be detrimental to the life of the battery and given enough time it could even lead to a catastrophic event.
- b. If using LFP as a power system or traction battery, (Full charge of the battery followed by up to a full discharge and repeating the cycle) I would again select #2 (Absorption = 14.6 volts _ Float = 13.3 volts) but in this instance do not activate the Force-to-Float function. This will put the pack through an absorption voltage and when the pack is fully charged the alternator will go to float, ending the charge cycle until the battery is removed from charge or the engine is switched off. NOTE: it would additionally be wise to use a Battery Management System in conjunction with the Force to Float input so as to make sure the alternator does not charge the LFP bank for too long of time. It should also be noted that if the LFP bank is fully charged and the engine is shut down and re-started it might be a good idea to engage Force to Float prior to starting the engine.
- c. What are the other three Algorithms for? There are many different LFP batteries on the market with their own electrolytes which makes for different charge voltages.

Installing the 24 volt shunt

To convert the **SMART CHARGE ONE** to a 24 volt regulator place the supplied shunt (jumper) over the two pin connector located next to the switch module.

Alternator and Battery Temperature Sensor Installations

Please NOTE! At the end of the red and black pair of wires is a ring terminal. Within the crimp point of this ring terminal is a temperature sensor. Please do not remove the ring terminal just because you do not like the size of the hole and crimp on a new ring terminal you like better. Doing so will create a fault code within the regulator and cause it to cease operating.

1. It would be a good idea to twist the Temperature sensor cable to keep it from being influenced by magnetic forces produced by the DC electrical system. Try to have a full 360 degree twist every two inches. I use a cordless drill. Go slowly! Do the cable twisting before cutting to length.
2. Alternator Temp Sensor. The temp sensor ring terminal should be flat against the rear frame of the alternator. What I like to do is find a flat or nearly flat area on the rear frame, check that there is nothing behind this area and then drill and tap for a #10-32 screw. Use a short screw and a large enough washer to hold the temp sensor in place.
3. Battery temp sensor. Being that there is only one, this temp sensor should be connected to the negative terminal of the battery that is mid pack of the most used bank, typically called the house bank.
4. You may shorten the red/black temperature sensor wires as needed. Please do so on the end of the pair of wires that is used to connect to the **SMART-CHARGE-ONE**
5. You may also extend the temperature sensor wires. 18ga wire would be a good choice. Please solder, not just crimp, this connection as it is very sensitive to any resistance change that could happen over time due to corrosion.
6. Prior to attaching the wires to the terminal strip remove only 1/4 inch of insulation and tin the wire (apply solder) before inserting into the board connector.
7. Polarity is not important, red-black, black-red, does not matter.

Optional Force to Float Input Connections

The two Force to Float screw terminals (indicated by the label on the cover) can be used for a remotely mounted switch. By using a simple single pole switch and two wires, one connected to each of the two screw terminals, the operator can force the advanced regulator into permanent float. The switch can be activated or deactivated while the engine is running without any ill effect on the charging system. Going from Force to Float to normal operation will give you a ten minute absorption. If a more serious absorption is required simply switch off the engine and ignition and then restart to get a full calculated absorption time period.

Installation

If you are installing this regulator in conjunction with our **STAGE ONE** marine grade alternator please also read the installation manual that is supplied with the alternator, specifically pages 7 and 8 of that manual for the electrical connections.

Alternator Field Polarity

Alternator field polarity needs to be figured out. The most difficult part of installing any external regulator on an existing alternator is connecting the output wire of the regulator to the field rotor brush. Some alternators, such as our **STAGE ONE** marine alternator, already have an external field connector. This makes life easy. If not you will need to do the following:

1. Remove the rear frame of the alternator to expose the internal regulator and its connection to the field rotor brush.
2. After finding the connection point between the regulator and the brush we need to figure out if it is positive feed or negative feed.
3. Using an ohm meter set to the lowest range connect one lead to the regulator/brush connection point. Connect the other to the frame. If you see a very low resistance, possibly as low as 1 to 10 ohms then your alternator has a POSITIVE feed field rotor. If this reading is in the tens of thousands range then connect the second lead to the large output stud of the alternator while the first lead stays connected to the regulator/brush location. If you see a resistance of 3 to 10 ohms then you have a NEGATIVE feed field rotor.
4. Using this information you will need to position the fuse. The regulator comes with the fuse in the POSITIVE position as indicated by the label located on the top of the black colored relay. If you have a NEGATIVE feed field rotor you will need to remove the fuse by pulling straight up, a pliers is good to use, and reinstall it into the NEGATIVE location.

Regulators in parallel or single regulator operation

At this point a choice needs to be made. Do you want to run the **SMART-CHARGE-ONE** advanced regulator by itself or do you want the existing regulator to run along with it. The benefit to running the existing regulator along with the new **SMART-CHARGE-ONE** advanced regulator is redundancy. If one regulator fails the other keeps working. There is a downside though. During the Bulk and absorption phase of the **SMART-CHARGE-ONE** advanced regulator the alternator charge voltage will be at the **SMART-CHARGE-ONE** selected absorption voltage (14.7 for open FLA). When the **SMART-CHARGE-ONE** advanced regulator switches to float (13.5 for open FLA) the internal regulator will hold the alternator output voltage at whatever the set point the internal regulator is, anywhere from 14.1 to 14.7 volts. Personally I prefer the proper charge voltages of the new advanced regulator, meaning I would use only the new **SMART-CHARGE-ONE** regulator. **SUGGESTION!** If your internal regulator is the source for the onboard tachometer and charge indicator light, leave it totally intact except for the output connection to the field brush. This will enable you to keep all of the existing functions and have charging totally controlled by the **SMART-CHARGE-ONE** only.

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Installation for using just the external **SMART-CHARGE-ONE** advanced regulator:

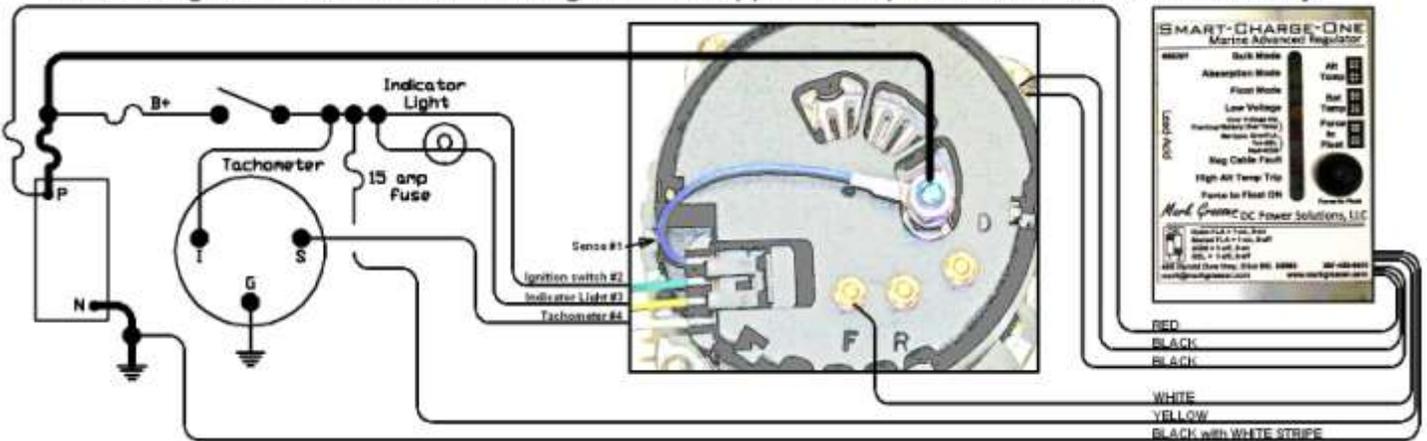
1. Remove the connection between the internal regulator and the field brush.
2. Connect the white wire from the **SMART-CHARGE-ONE** to the field brush terminal. Typically this will need to be soldered into place.
3. Bring the white wire through the rear cover where it will not interfere with the rotating rotor or be in contact with any high temperature components.

Installation for using both the internal and the external **SMART-CHARGE-ONE** advanced regulator:

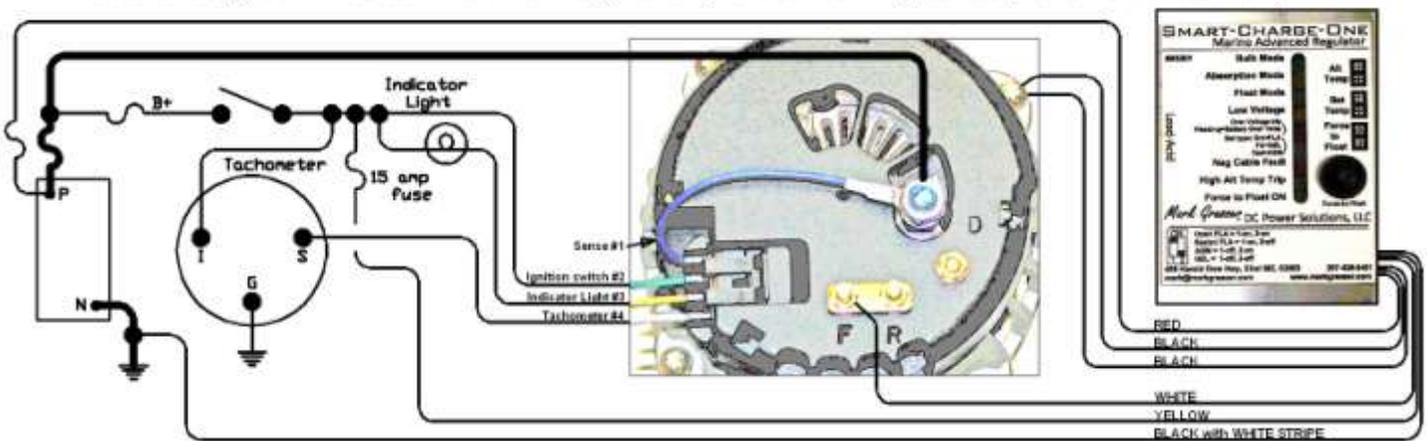
1. Connect the white wire from the **SMART-CHARGE-ONE** to the field brush terminal, leaving the internal regulator output connection to the field brush in place. Typically this will need to be soldered into place.
2. Bring the white wire through the rear cover where it will not interfere with the rotating rotor or be in contact with any high temperature components.

As shown below if you purchased our **STAGE ONE** alternator all of the hassle of making the brush connection is taken care of for you. On the rear cover of the alternator there is a stud for field connection and a stud for the internal regulator output. By not placing the jumper the internal regulator does not output to the field. By placing the jumper as in the second drawing, the internal regulator is then operating in parallel with the **SMART-CHARGE-ONE**.

Basic Diagram - Uses External regulator (copper strap removed) and one battery



Basic Diagram - Uses internal regulator, external regulator, and one battery



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Electrical:

The rest of the wires coming from the regulator:

1. The red wire is the positive sense lead and connects to the output terminal of the alternator. For more accurate charging it is recommended it be extended with a 14 ga. Wire and connected to the positive of the battery or its nearest connection bus.
2. The yellow wire is the regulator power feed, commonly connected to the ignition or engine on switch.
3. The white wire was discussed above. It is the output of the regulator connected to the alternator field brush.
4. Black w/white stripe is the negative sense lead and connects to the frame of the alternator. For more accurate charging it is recommended it be extended with a 14 ga. Wire and connected to the negative of the battery or its nearest connection bus.
5. Black wire x 2, both wires need to connect to alternator negative or engine frame. Do not combine these two wires into one.
6. The large output cable needs to be checked to see if it is adequately sized to the capability of your new alternator. Please refer to the wire chart on the last page of this manual to be sure it is of adequate size.
7. **MOST IMPORTANT:**
 - a. **The fuse at the battery in the output cable must be rated higher than the current output rating of the alternator.**
 - b. **The cable used for the output cable must be rated higher than the fuse rating. Use the graph on the last page of this manual to size this cable.**
 - c. **The red wire and black w/white stripe wire should have a fuse at the connected end with a rating of 5 amps.**
 - d. **The yellow wire should have a fuse at the connected end with a rating of 15 amps.**

The simple approach, for the experienced installer

Red wire	Positive sense lead – to positive battery post or nearest connection
Yellow wire	Ignition switch – somewhere that the engine-on wire is connected. Needs to carry field current. About 8 amps is typical
White wire	Field brush connection
Black w/white stripe	Negative sense lead – to negative battery post or nearest connection
Black wire x 2	both wires need to connect to alternator negative or engine frame. Do not combine these two wires into one.
Alt temp sense	The connector is the temp sensor. Do not cut it off! Drill and tap 10/32 on the rear frame. Mount with an oversized washer. This is the best way in my opinion. Trim the bare wire end as needed. Expose only 1/4 inch of wire. Tin the wire first, then insert and tighten.
Bat temp sensor	The connector is the temp sensor. Do not cut it off. Mount it to the battery that will get the warmest, typically in the center of the house bank pack. Trim the bare wire end as needed. Expose only 1/4 inch of wire. Tin the wire first, then insert and tighten.
Force to Float	Two wires connected to the force to float connector with a SPST switch at the other end will allow control of the absorption phase.

Additional Installation Information

Sizing Battery Cables

The addition of a high-output alternator to your charging system may make it necessary to increase the size of your battery cables to increase the current carrying capacity. To determine the proper cable size, consider BOTH cable length and alternator output current capability. Both positive and negative wire runs must be included in your calculations.

In other words, when determining battery cable size, we need to consider the “round trip” distance. Wire size may be calculated with the formula $CM = K \times I \times LE$ (whereas CM represents the circular mil area of the conductor, K represents the mil-foot resistance of copper, I represents current, and L represents the length, in feet, of the round-trip cable run and E represents voltage drop in volts). When using this equation, a K constant of 10.75 indicates copper’s mil-foot resistance and voltage drop should be calculated at 3% (the standard for critical functions affecting the safety of vessel passengers). In most cases, it is much easier to use the following chart as your guide.

FEET	5	10	15	20	25	30	40	50	75
AMPS									
75	8	6	4	2	2	1	0	2/0	3/0
100	8	4	2	2	1	0	1/0	3/0	
125	6	4	2	1	0	1/0	2/0		
150	6	2	1	0	1/0	2/0	3/0		
175	6	2	1	1/0	2/0	3/0	4/0		
200	4	2	0	1/0	3/0	4/0			
225	4	1	1/0	2/0	3/0	4/0			
250	4	1	1/0	3/0	4/0				
275	4	1	2/0	3/0	4/0				
300	2	1/0	2/0	4/0	4/0				
350	2	1/0	3/0	4/0					

Large Bank Cable layout

With battery banks getting larger consideration needs to be made for proper cable routing and additional fusing.

1. Note the ANL fuse on every battery. This protects the wiring from each battery to the bus.
2. Note the CLASS “T” fuse protecting the main feed which then goes to the power panel or in some cases simply to a power inverter. Because of the incredible amount of short circuit current available from a large bank of batteries an ANL fuse will not suffice. This fuse needs to be capable of greater arc suppression. A CLASS “T” fuse is recommended for this application and is available from us at Mark Grasser – DC Power Solutions.

