

Installation & User Manual



Alternator (Adjustable) Voltage Regulator – ZM5

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Why Do I Need A New Regulator?

Here's the dilemma. To charge your battery efficiently, you need a relatively high charging voltage (± 14.5 V).

But if you stay at that voltage permanently, you will overcharge and damage the battery.

Conversely, if you use a lower charging voltage (< 14 V) you will prolong the battery life but will take a long time to reach full charge – in some cases you might never actually reach full charge!

The solution is an adjustable, multi-stage voltage regulator for your alternator.

The ZM4 allows you to configure the optimal charging voltage for **your** specific battery, and after a set time will automatically switch to a lower 'healthier' voltage. The best of both worlds!

Typically, with automotive regulators the battery acid does not get enough charge and this leads to acid stratification, which is where the water separates to the top and the acid settles on the bottom and in a 'pure' acid form will attack the battery plates leading to premature battery failure.



Charge voltage is probably the single most important factor in charging, as all other factors are related to it.

Signs that you could do with a new alternator voltage regulator include:

- Your battery is not charging to full capacity.
- Your battery is charging too slowly, and you're wasting fuel running an engine.
- Your battery suffers from sulfation.
- Your battery suffers acid stratification/damaged plates.
- You're technically minded and want better control over the charging behaviour.

Features

- An easily adjustable voltage setting to accommodate different battery types.
- Suitable for 12 and 24-volt system voltages (order desired voltage)
- Will regulate any N-type or P-type alternator (ensure you purchase the correct model based on your needs).
- Any type of alternator can be run by this regulator, reduces run time, saves fuel, reduces noise and emissions.
- ABSORPTION and FLOAT stages, indicated by LEDs to show state.
- Can run two alternators with one ZM5, up to 25-amp **field** current.
- Overvoltage protection as well as reverse polarity.
- Size: 155mm long x 58mm high x 66mm wide.
- 24-month warranty, we will repair or replace free of charge. This warranty does not include damage resulting from incorrect installation, accident, misuse or neglect. The warranty is void if the cover is removed or if the unit is tampered with.
- Designed, built and supported in New Zealand.
- Circuit boards treated with Conformal coating material to provide protection against moisture, dust, chemicals.

Specifications

Voltage	12- volt or 24-volt versions available
Polarity types	"N" or "P" switching versions available
Charging stages	Bulk – Absorption - Float
Adjustable ratio Absorption to Float	Yes, adjustable by user (0 to 2 volts)
Factory setting for ratio	(12v) 0.6 volt - (24v) 1.2 volts
Approximate time at Absorption rate	90 -100 minutes
Absorption Indicator	Yellow LED
Float Indicator	Green LED
Alternator range	0-350-amp alternator
Maximum Field current	25 amps (most alternators are 3-5 amps)
12-volt version voltage adjustment range	12 to 16.5 volts
Factory setting for voltage regulation	(12v) 14.7 volts - (24v) 29.4 volts
24-volt version voltage adjustment range	24 to 33 volts
Reverse polarity protection	Yes
Overvoltage protection	Yes, adjustable by user
Factory setting for overvoltage protection	(12v) 15.5 volts - (24v) 31 volts
Overvoltage/overtemperature protection	Shuts off FIELD control
Overvoltage/overtemperature Indicator	Red Flashing LED and buzzer (supplied)
Unit size	155mm long x 58mm high x 66mm wide.
Weight	150 grams
Cooling	40mm fan
Fuses	Ignition and Field recommend min 5 amp
Fuses	Battery sense recommended min 1 amp

How the ZM5 works

Broadly, the ZM5 regulator consists of a timer block, voltage comparison logic and a MOSFET output stage.

The timer block is responsible for overseeing the transition between the absorption and float stages, and is factory set from 80 to 100 minutes according to your battery capacity.

The voltage comparison logic continuously monitors the battery voltage and compares it to the voltage level you have selected with the adjustment control. Improved JFET-input operational integrated circuit (IC) has a lower Input Bias Current and high slew rates providing better overall performance.

If it detects that the battery voltage has fallen below your set point, the output MOSFET stage will be turned on to increase the field current to the alternator.

Once the voltage level has been raised back to your setting, the field current is disengaged. Hysteresis is built into the comparison logic to ensure the feedback loop remains stable.

A slight amount of current is held to ensure that the ignition light does not come on.

The unit design has an overvoltage function which disables the FIELD circuit in the event of an overvoltage.

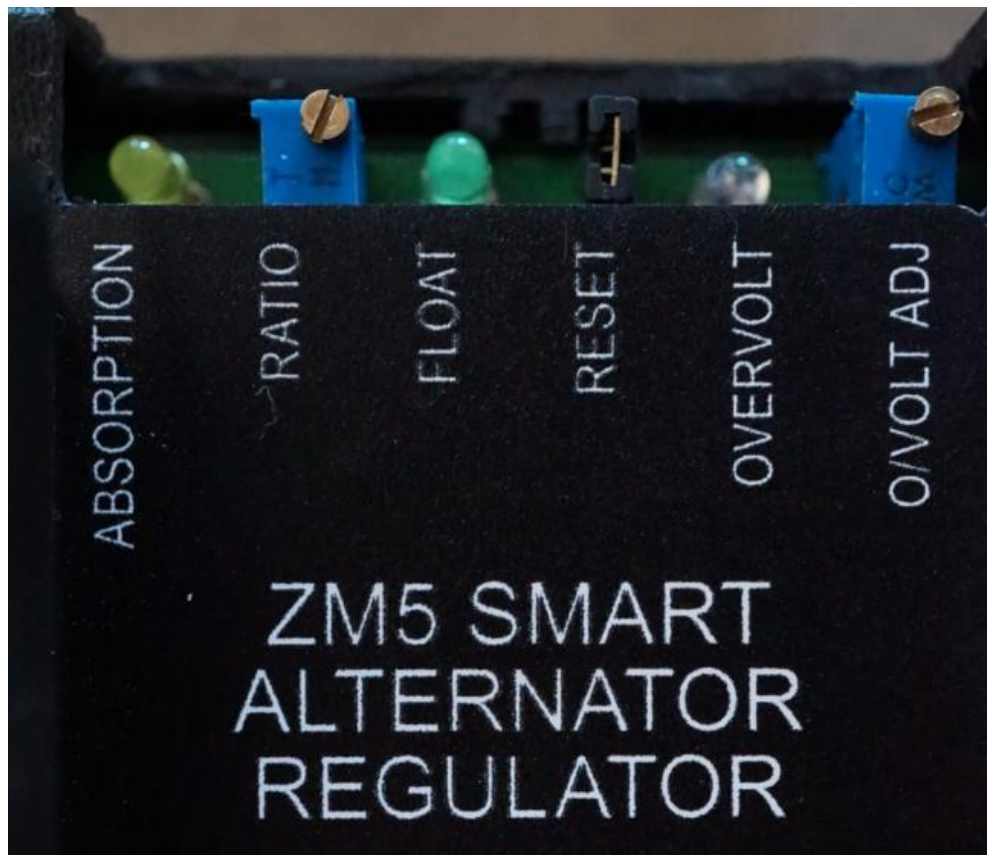
Also, an internal overtemperature sense capability will disable the FIELD circuit as well, typically 60-70 degrees is the set point

Control of reverse polarity is also built in to the new design. Better adjusting potentiometers are sealed and provide a more accurate setting

Any type of alternator can be run by this regulator, providing **field** current draw does not exceed 25 amps continuous or 30 amps intermittently.

Most alternators only draw 1-3 amps max.

ZM5 Overview of controls



ABSORPTION – YELLOW Absorption LED

RATIO – Adjusting voltage between Absorption and float, see adjustment instructions

FLOAT – GREEN Float LED

RESET – Voltage overvoltage/overtemperature reset jumper, with jumper removed, the system will detect but not disable the field circuit.

OVERVOLTAGE – RED Flashing LED for overvoltage/overtemperature situation, plus buzzer will sound (if fitted)

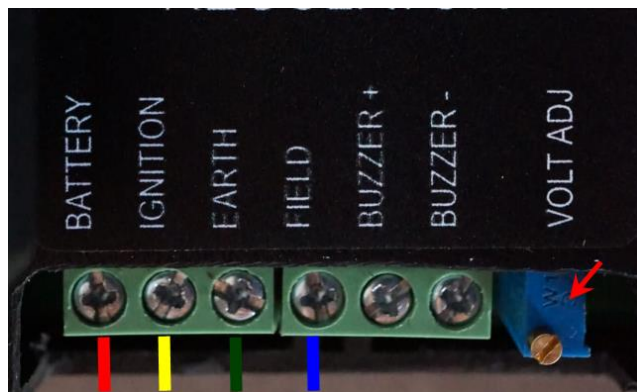
O/VOLT ADJ – Overvoltage adjustment, see instructions in following pages

FAN – The cooling fan is for the output stage MOSFET, where the heat dissipation ability of the heatsink requires the fan to be operational.

In the event of fan failure or internal component overheating the "Overvoltage" LED and buzzer will be activate and the field circuit shut down making the unit inoperative.

Installation

Mount the unit preferably remotely from the engine bay to ensure a clean dry, cool environment. Connect at least 18 gauge (0.75mm) (7.5amp) tinned wires to the following terminals.



VOLT ADJ – main adjustment for desired set voltage, 1 turn equals 0.12 volts.

BATTERY: Connect this terminal directly to the positive side of the battery. If you have two batteries i.e.: a start and house, suggest you connect it to the house battery, this will prevent any spikes from high drain current items like starters, etc. Suggest you use a red wire for this terminal, or mark the wire clearly. You should connect this wire with an inline fuse (1 amp) **Do not connect via any switch.**

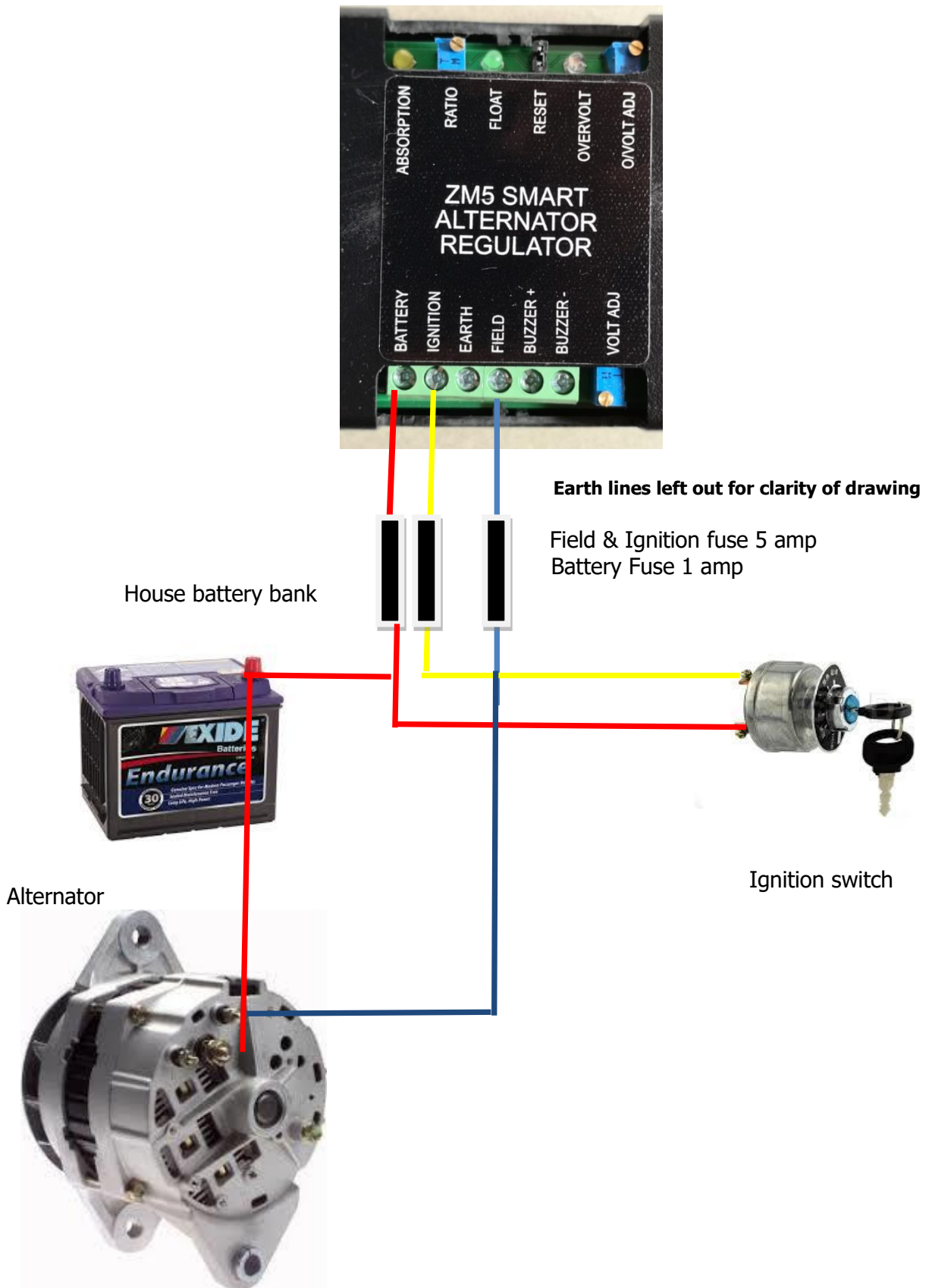
IGNITION: Connect this terminal to the ignition switch. To avoid confusion a suggested colour is Yellow or mark the wire clearly. You should connect this wire with an inline fuse (5 amp) located close to the ignition switch. Do not connect the IGN to the D+ terminal of the alternator. Make sure that the ignition feed is off the same battery as the charging circuit, the reason is the battery overvoltage detection is a combination of BATT and IGN. voltages in the logic circuit. This should only be a problem with a separate starter battery alternator.

EARTH: Connect this terminal directly to a good negative supply bus bar. If you are unsure place it directly on the negative post of the battery, suggest you use a black wire for this terminal, or mark the wire clearly.

FIELD: This unit controls the field side of the brush block. Connect this wire directly to the alternator field terminal. You should connect this wire with an inline fuse (5amp).

BUZZER + and - : If using the supplied buzzer/ light unit then the polarity is not critical. Maximum current draw 3 amps for any device connected. It is not critical to fit the buzzer as there is an onboard flashing LED, and if the overvoltage system activates the charge current will drop to zero.

Installation – Diagram



Alternator Modification

There is no performance difference or advantage it is more an alternator manufacturers choice.

Some alternators are best suited to P type but the majority are N type.

The objective is to have the ZM5 N control the negative side of the brush block

The ZM5 N is a negative brush control system, this means that the positive brush requires power at all times and the theory is we control the negative brush which controls the output of the alternator as per the setting on the ZM5. The switching mode is indicated on a decal on the bottom of the unit. ***The unit cannot be used for P switching.***

To be compatible with the ZM5 and only for N switching ZM5 units the supplied electrolytic capacitor must be fitted at the alternator end of the connection of the FIELD wire.

The objective is to have the ZM5 P control the positive side of the brush block

The ZM5 P is a positive brush control system, this means that the positive brush is the field control and the negative brush is earthed

The switching mode is indicated on a decal on the bottom of the unit. ***The unit cannot be used for N switching.***

Modification of your existing alternator to accept an external regulator is a requirement and can be done by yourself or a reputable auto electrical shop. Depending on your alternator type, an external brush block is available from most auto electrical shops.

We also offer a service to modify your alternator.

We have available on the download section of our web site instructions for different alternator conversions to accept an external regulator.

You can leave the existing internal regulator working and the ZM5 will override the internal regulator, providing a field wire is attached to the correct brush.

Installation tips

Make sure your pulley ratios are correct for your cruising rpm, i.e. the alternator needs to be turning at least 3000 rpm, and preferably 5000 rpm and up to 8000 rpm for a decent charge to be outputting from your alternator.

Ensure your earth leads from the engine block to the alternator and starter are not used via the block. If there is any high resistance the earth trace will find itself tracking through your engine bearings and could cause arcing. Get peace of mind and run separate earth leads.

Try to use the same type of batteries i.e. Lead acid /Gel / AGM. Don't mix them up.

Your installation should have two battery banks, one for starting and one for house loads.

Charge batteries in parallel, using a voltage sensitive relay.

Make sure your engine has enough "belt" to drive the alternator you select.

Do not leave batteries discharged for extended periods of time.

Plan your battery capacity to ensure your house batteries are run no less than 50% of capacity.

Provide a means to cross-connect battery banks for emergency starting.

Protect circuits with fuses or circuit breakers.

Voltage drop is the enemy, look to find the offending connections and fix them.

Connecting batteries in series, the amp hour capacity remains the same as a single battery however the voltage is doubled.

Connecting batteries in parallel, the amp hour capacity is doubled and the voltage remains the same as a single battery. If you have a solar panel connected make sure it has a blocking diode to prevent a reverse charge or to upset the sense side of the ZM4.

An alternator has a huge fan that draws air from the back to the front of the alternator for cooling; imagine if this air has salt laden air in it, this will cause corrosion in non marinised alternators. Consider getting the internals painted in good quality paint to get a longer life out of your alternator.

Automotive 'in line' ammeters are a huge voltage drop in your charging system. If your system charges at a low current charge and quickly drops down to 10 amps it is most probably the 'in line' ammeter at fault. The best option is a 'shunt' type ammeter.

NEVER turn OFF the battery switch with the engine running, it can blow up the alternator and or the smart regulator.

Set up

It is suggested that you start this process with fully charged batteries. This will provide a stable platform for setting the ZM5 'set voltage'.

The charge voltage is factory set to 14.7 volt and the overvoltage is set to 15.5 volts.



If you are unsure if your alternator is configured correctly do the following test: Remove the field wire from ZM5 N and with engine idling, briefly (2-4 seconds) hold the alternator field wire to earth. Field to positive for ZM5 P. Note: you will get a spark. You will hear the engine load up and the output voltage should quickly rise, this indicates the alternator is configured correctly. Connect a suitable digital voltmeter to the battery that you have the BATT connection on. Start the engine, monitor the battery voltage and if required adjust. When the Green Float LED is on the unit will be approximately 0.6 volts lower than your set voltage (1.2 volts 24v units).

The Green LED should illuminate to indicate the float voltage setting; this should be approximately in the range of 90-100 minutes of operation.

If you wish to adjust the ratio between Absorption and Float refer to section unit CHANGING RATIO.

Final settings to voltage should be made once engine is at normal cruise RPM.

Note: voltage setting should be done by turning the adjusting screw clockwise one turn = 0.12volt

This should be done **ONLY** when the Yellow Absorption LED is on.

Suggested set voltages

12 VOLT UNITS

Suggested Set Voltages	From	To
Lead Acid and AGM (Absorption Setting)	14.6 V	14.8 V
Lead Acid and AGM (Float Voltage)	13.8 V	14.0 V
Gel Cell (Absorption Setting)	13.9 V	14.4 V
Gel Cell (Float Voltage)	13.1V	13.8 V
Nickel Cadmium (Absorption Setting)	15.0 V	15.5 V
Nickel Cadmium (Float Voltage)	14.4 V	14.9 V

24 VOLT UNITS

Suggested Set Voltages	From	To
Lead Acid and AGM (Absorption Setting)	28.4 V	29.6 V
Lead Acid and AGM (Float Voltage)	27.2 V	28.4 V
Gel Cell (Absorption Setting)	27.6 V	28.4 V
Gel Cell (Float Voltage)	26.4 V	27.2 V
Nickel Cadmium (Absorption Setting)	30.0 V	31.0 V
Nickel Cadmium (Float Voltage)	28.8 V	29.8 V

Remember to set voltage at your normal cruise rpm if possible and only adjust after battery level has stabilised.

If you have a lead acid battery with vented caps then you can set the voltage to the upper limit. If the battery is 'maintenance free' sealed type then you will need to set the voltage to the lower end of the scale.

Over the following weeks of operation monitor the water levels in your battery, you may find that due to gassing you will use slightly more water, this is quite normal. This is a far better situation than not using any water at all.

Once you have this set, there should not be any further adjustments required.

The above is only a guide, check with your battery manufacturer.

Changing ratio

The unit has been factory set to provide a ratio of 0.6v between the Absorption and Float rates. Some AGM batteries require a 1.0v ratio. To change this ratio, proceed as follows;

Note: Please read carefully before proceeding, if you get this wrong, you will have to send the unit back for factory adjustment.



1/ all adjustments follow logic, i.e. OUT is to lower the voltage, IN is to increase the voltage.

2/ with engine running at normal cruise rpm and normal load applied and **ONLY** when the **Green** Float LED is **On**. Adjust the VOLT ADJ potentiometer to the desired **lower** voltage, let's say 13.7v, stabilise and ensure voltage steady on desired figure, do not re adjust this pot until finished items 3 and 4.

3/ Trip the EARTH feed to the unit, wait for 1 minute, reconnect, make sure your rpm remains constant to ensure the voltage remains steady. With the tripped ignition, the **Yellow** Absorption LED will be On.

4/ You then adjust the RATIO potentiometer to the desired **upper** voltage, say 14.7v, stabilise for 5 minutes and ensure voltage steady on desired figure.

Changing Overvoltage sense.

The factory default setting is =15.5 volts, 24-volt versions = (31 volts)

Each turn on the adjustment potentiometer is:

¼ of a turn = 0.4 volts

½ turn = 0.7 volts

1 turn IN = 1.25 volts.



Method 1

- 1/ Adjust the adjusting screw in (clockwise) 2 turns to take it well out of range
- 2/ Set main voltage at 15.5 volts (31 volts)
- 3/ Adjust over voltage screw out (counter clockwise) until warning buzzer activates.
- 4/ Lower main voltage setting down at least 0.5 volts less than 15.5 volts, reset overvoltage reset.
- 5/ Raise voltage and check threshold of alarm activation.

Method 2

If you do not want to run your charging system at 15.5 volts (31 volts)

- 1/ Adjust the adjusting screw in (clockwise) 2 turns to take it well out of range.
- 2/ Set main voltage at 14.5 volts (29 volts)
- 3/ Adjust over voltage screw out (counter clockwise) until warning buzzer activates.
- 4/ Turn off charging
- 5/ Adjust over voltage screw in $\frac{3}{4}$ of a turn

Note:

Depending on the size of your alternator and/or battery bank, you might find situations where on start up or sudden/rapid changes in power the overvoltage threshold is entered, in this case just wind IN the overvoltage screw $\frac{1}{4}$ of a turn until the alarm does not sound.

FAQ – Frequently Asked Questions

Q What wiring changes are required on my existing installation?

A As well as running a wire to your alternator field terminal, you will need an ignition source to the ZM5 and a battery positive and earth.

Q Will this unit work through a VSR (Voltage Sensitive relay)?

A Yes. A good way to allow dual battery charging.

Q Will this unit work through a diode splitter?

A Yes. The ZM5 can compensate for the typical voltage drop over a diode bank, providing that the battery sense wire is on the battery side of the diode bank.

Q Can I fit a ZM5 to an outboard motor?

A No. For the ZM5 to work it must have a field control, an outboard motor does not have this function.

Q Can I fit a ZM5 to a solar panel or wind turbine?

A No. For the ZM5 to work it must have a field control.

Q Can the ZM5 run two alternators?

A Yes, check our web site for wiring configuration.

Q What changes are required to my alternator?

A This does depend on your alternator type; some are easy to convert others are a bit more difficult. Check our web site for wiring configuration.

Q Can I modify my own alternator?

Yes. It is a matter of running a field wire to the appropriate side of the brush block.

A The ZM5 N controls the earth side of the brushes.

The ZM5 P controls the positive side of the brushes.

Q What is the difference between N and P switching

A Certain manufacturers elect to switch the positive brush whilst the majority of others switch the negative brush, as a user you do not know the difference in an operational sense.

Q Can you provide the modification required for my alternator?

A Yes, call with the details first.

Q Can you refurbish my alternator and convert it for an external regulator?

A Yes, we do this on a regular basis for clients.

FAQ – continued

Q I have been told that a smart regulator is hard on my alternator?

A The old adage, the harder you work something the faster it is going to wear out. Good regular maintenance must be adjusted accordingly. There are some less suitable alternators out there. Call and discuss your brand.

Q Why does my voltage vary with lower engine rpm?

A It is a indication of the alternator output being too low for that given rpm, so your battery capacity and or status is too low for the unit to be able to achieve the desired set voltage.

Q Can I connect the V+ brush directly to the B+ terminal?

A Only on a ZM5 N model. This will work fine and will not drain your battery as the ZM5 field circuit is disconnected during ignition off situations.

Q What is the system for switching over from Absorption to Float?

A It is a combination of time and a sensing circuit detecting the state of charge of your batteries. The Green LED should illuminate to indicate the float voltage setting; this should be approximately in the range of 90 - 100 minutes of operation.

Q Sometimes my Overvoltage buzzer sounds although my voltage setting is correct.

A At times there are voltage spikes within your electrical system typically these are inductive loads (motors of high current draw). The ZM5 is detecting these spikes and isolating the system, reset the jumper and monitor what is creating the spike. If it cannot be prevented you may need to adjust the setting threshold up slightly to reduce the annoying warning.

Q Why does my overvoltage buzzer and LED sound at times when I definitely do not have an overvoltage situation?

A Could well be an over temperature situation which trips the same overvoltage buzzer. The system will activate with component internal failure or fan failure.

Q What internal temperature leads to a shutdown of the system?

A Typically, 70 degrees C of the output MOSFET

Q Can I connect the ZM5 Ignition terminal to the alternator D+ Ignition light connection?

A No as the alternator will drop out the feed once the alternator is excited and the ZM5 ignition feed will be lost.

Fault Finding

Write down the circumstances leading to the discovery that a problem exists. Make it as clear as possible. If you're not charging, and you have just installed a new alternator, suspecting the regulator is faulty may not be the best decision. Wiring errors or compatibility issues between the alternator and regulator are prime suspects. We are happy to work through any charging issues you have, but please do the basic fault finding first. The majority of faults reported are wiring installation issues.

No Alternator Output

Check to see if there is a voltage supply to IGN terminal on ZM5, Absorption LED should be ON.

Is ignition light connected and working correctly, i.e.: is alternator 'excited'? Check fuses.

Remove the field wire from ZM5 N and with engine idling, briefly (2-4 seconds) hold the alternator field wire to earth. Note: you will get a spark. You will hear the engine load up and the output voltage should quickly go towards 16v+.

Remove the field wire from ZM5 P and with engine idling, briefly (2-4 seconds) hold the alternator field wire to positive. Note: you will get a spark. You will hear the engine load up and the output voltage should quickly go towards 16v+.

This would indicate that the alternator is fine and the ZM5 is at fault.

Another way of checking the field output is to put a small wattage bulb (incandescent) between FIELD and BATT on a ZM5 or between FIELD and EARTH for a ZM5 P and again adjust the pot. You should see light come on. However, battery voltage must be above 13.6 volts for this test to work.

Overvoltage Flashing

There are several scenarios that this LED could activate:

1/ If this LED flashes at "ignition on" it indicates an internal microprocessor fault, unit will not function, return to supplier.

2/ If the LED and alarm sounds during operation, either a transient spike occurred or the unit is over voltage, try resetting jumper bridge and if fault persists try turning down the voltage adjuster at least 6 turns and try again.

3/ Another possibility is overheating either a fan failure or internal component failure. Check to see if the fan is rotating. If after shutting down the unit and allowing 15 minutes to cool down and upon starting again if the unit functions for a short while and the overvoltage LED activates again there is an internal overtemperature situation.

Note: the battery sense wire is critical to the sensing operation, if for any reason this wire is disconnected the voltage will run away to maximum output.

Product Liability

In no event shall we be held liable for any direct, indirect, punitive, incidental, special consequential damages, to property or life whatsoever, arising out of installation or misuse of our products.

Please ensure installation is as per our installation instructions.

Warranty Details

This unit is covered by a 24-month warranty on a return to base basis.

We will repair or replace free of charge.

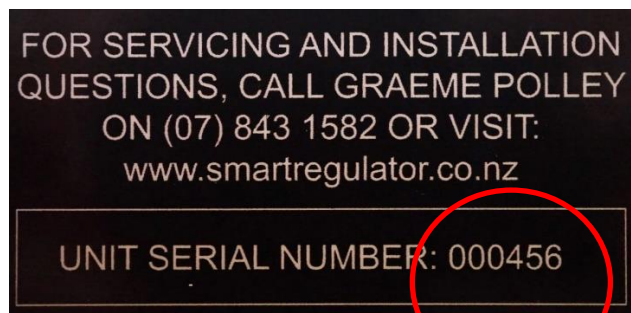
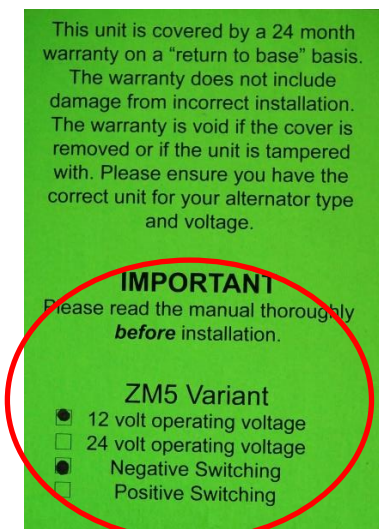
Freight charges to return units is not covered by warranty.

The warranty does not include damage from incorrect installation.

The warranty is void if the cover is removed or if the unit is tampered with.

If you do have a problem please refer to the fault-finding section first to ensure the problem is not an external to the ZM5 fault.

When you do make contact please provide as much information about your installation in order that we can best assist with fault finding. The data plate on the underside spells out version of ZM4, we do need this information please.



Contact Details

For any questions or warranty matters contact:

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Latest copies of this manual can be obtained from our website

www.smartregulator.co.nz