victron energy
BLUE POWER

Manual

Blue Smart IP65 Charger 120V
Cargador Blue Smart IP67 120V

12/5
12/7
12/10
12/15
24/5
24/8

IMPORTANT SAFETY INSTRUCTIONS

1. SAVE THESE INSTRUCTIONS – This manual contains important safety and operating instructions for Blue Smart Charger models.
2. Use of an attachment not recommended or sold by Victron Energy may result in a risk of fire, electric shock, or injury to persons.
3. To reduce risk of damage to electric plug and cord, pull by plug rather than cord when disconnecting charger.
4. An extension cord should not be used unless absolutely necessary. Use of an improper extension cord could result in a risk of fire and electric shock. If extension cord must be used, make sure:
   a) That pins on plug of extension cord are the same number, size, and shape as those of plug on charger;
   b) that extension cord is properly wired and in good electrical condition; and
   c) that wire size is large enough for ac ampère rating of charger as specified in “Technical Specifications”
5. Do not operate the charger with damaged cord or plug; contact your service agent or the manufacturer.
6. Do not operate the charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; contact your service agent or the manufacturer.
7. Do not disassemble the charger; contact your service agent or the manufacturer when service or repair is required. Incorrect reassembly may result in a risk of electric shock or fire.
8. To reduce risk of electric shock, unplug charger from outlet before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.
9. WARNING – RISK OF EXPLOSIVE GASES.
   a) BATTERIES GENERATE EXPLOSIVE GASES DURING NORMAL BATTERY OPERATION. FOR THIS REASON, IT IS OF UTMOST IMPORTANCE THAT EACH TIME BEFORE USING YOUR CHARGER, YOU READ THIS MANUAL AND FOLLOW THE INSTRUCTIONS EXACTLY.

b) Follow these instructions and those published by the battery manufacturer and manufacturer of any equipment you intend to use in vicinity of the battery.

10. PERSONAL PRECAUTIONS
    a) Consider having someone close enough by to your aid when you work near a lead-acid battery.
    b) Have plenty of fresh water and soap nearby in case battery acid contacts skin, clothing, or eyes.
    c) Wear complete eye protection and clothing protection. Avoid touching eyes while working near a battery.
    d) If battery acid contacts skin or clothing, wash immediately with soap and water. If acid enters eye, immediately flood eye with running cold water for at least 10 minutes and get medical attention immediately.
    e) NEVER smoke or allow a spark or flame in vicinity of a battery or engine.
    f) Be extra cautious to reduce risk of dropping a metal tool onto battery. It might spark or short-circuit the battery or an other electrical part that may cause explosion.
    g) Remove personal metal items such as rings, bracelets, necklaces, and watches when working with a lead-acid battery. A lead-acid battery can produce a short-circuit current high enough to weld a ring or the like to metal, causing a severe burn.
    h) Do not use the battery charger for charging dry-cell batteries that are commonly used with home appliances. These batteries may burst and cause injury to persons and damage to property.
    i) NEVER charge a frozen battery.

11. PREPARING TO CHARGE
    a) If it is necessary to remove the battery from a vehicle prior to charging, always remove the grounded terminal from the battery first. Make sure all accessories in the vehicle are off, so as not to cause an arc.
    b) Be sure that the area around the battery is well ventilated while the battery is being charged.

c) Clean battery terminals. Be careful to keep corrosion from coming in contact with eyes.
d) Add distilled water in each cell until battery acid reaches level specified by battery manufacturer. Do not overfill. For a battery without cell caps, such as valve regulated lead acid batteries, carefully follow the charging instructions of the manufacturer.
e) Study all battery manufacturer's specific precautions while charging and recommended rates of charge.
f) Determine the nominal voltage of the battery by referring to the owner's manual of the vehicle and make sure it matches the output rating of the battery charger.

12. CHARGER LOCATION
a) Locate the charger as far away from the battery as DC cables permit.
b) Never place charger directly above battery being charged; gases from battery will corrode and damage the charger.
c) Never allow battery acid to drip on the charger when reading gravity or filling the battery.
d) Do not operate the charger in a closed-in area or restrict ventilation in any way.
e) Do not set a battery on top of the charger.

13. DC CONNECTION PRECAUTIONS
a) Connect and disconnect the DC output clips only after removing the AC cord from the electric outlet. Never allow clips to touch each other.
b) Attach clips to battery and chassis as indicated in 14(e), 14(f), 15(b), and 15(d).

14. FOLLOW THE FOLLOWING STEPS WHEN THE BATTERY IS INSTALLED IN A VEHICLE. A SPARK NEAR THE BATTERY MAY CAUSE A BATTERY EXPLOSION. TO REDUCE RISK OF A SPARK NEAR BATTERY:

a) Position AC and DC cords to reduce risk of damage by hood, door, or moving engine part.
b) Stay clear of fan blades, belts, pulleys, and other parts that can cause injury to persons.
c) Check polarity of battery posts. POSITIVE (POS, P, +) battery post usually has larger diameter than NEGATIVE (NEG, N,–) post.
d) Determine which post of battery is grounded (connected) to the chassis. If the negative post is grounded to the chassis (as in most vehicles), see (e). If the positive post is grounded to the chassis, see (f).
e) In case of a negative-grounded vehicle, connect the POSITIVE (RED) clip from the battery charger to the POSITIVE (POS, P, +) ungrounded post of the battery. Connect the NEGATIVE (BLACK) clip to the chassis or engine block of the vehicle, away from battery. Do not connect the clip to the carburetor, fuel lines, or sheet-metal body parts. Connect to a heavy gage metal part of the frame or the engine block. Connect the AC cord to the socket.
f) In case of a positive-grounded vehicle, connect the NEGATIVE (BLACK) clip from the battery charger to the NEGATIVE (NEG, N, –) ungrounded post of the battery. Connect the POSITIVE (RED) clip to the chassis or engine block of the vehicle, away from the battery. Do not connect the clip to the carburetor, fuel lines, or sheet-metal body parts. Connect to a heavy gage metal part of the frame or the engine block. Connect the AC cord to the socket.
g) When disconnecting the charger, disconnect the AC cord, remove the clip from the chassis of the vehicle, and finally remove the clip from the battery terminal.
h) See “charge alogorithms” for length of charge information.

15. FOLLOW THESE STEPS WHEN THE BATTERY IS OUTSIDE OF THE VEHICLE. A SPARK NEAR THE BATTERY MAY CAUSE BATTERY EXPLOSION. TO REDUCE RISK OF A SPARK NEAR THE BATTERY:

a) Check the polarity of the battery posts. The POSITIVE (POS, P, +) battery post usually has a larger diameter than the NEGATIVE (NEG, N, –) post.
b) Connect the POSITIVE (RED) charger clip to the POSITIVE (POS, P, +) post of the battery.
c) Do not face the battery when making the final connection.
d) When disconnecting the charger, always do so in reverse sequence of the connecting procedure and break the first connection while as far away from battery as practical.
e) A marine (boat) battery must be removed and charged on shore. To charge it on board requires equipment specially designed for marine use.

1. Quick user guide

A. Connect the charger to the battery.

B. Connect the charger to the wall socket. The TEST LED will indicate that the mains cable is connected to the wall socket.
All charge status LEDs will flash in case of reverse polarity connection, short-circuit or if a 12V charger is connected to a 24V battery.
The TEST LED will flash as long as a charge pulse does not increase battery voltage to more than 12.5V resp. 25V.
When the TEST LED is on continuously, proceed to C.

C. If required, press the MODE-button or use a Bluetooth Smart device to select another charge program.
When RECONDITION is selected in combination with NORMAL or HIGH; the RECONDITION LED will be on, and the RECONDITION LED will flash during reconditioning.
The charger can be switched to low current mode (see technical specifications) by pressing the MODE button during 3 seconds. The MODE LED will blink when in low current mode.
The low current mode remains activated until the MODE button is pressed again during 3 seconds.

D. The battery is about 80% charged and ready for use when the absorption LED switches on.

E. The battery is fully charged when the FLOAT or STORAGE LED is on.

F. Stop charging at any time by disconnecting the mains cable from the wall socket.

Explanation icons

2. ‘Must know’ features and facts

2.1 Blue Smart version
Set-up, monitor and update the charger (add new features when they become available) using Apple and Android smartphones, tablets or other devices.

2.2 Ultra high efficiency “green” battery charger
With up to 95% efficiency, these chargers generate up to four times less heat when compared to the industry standard.
And once the battery is fully charged, power consumption reduces to 0.5 Watt, some five to ten times better than the industry standard.

2.3 Durable, safe and silent
- Low thermal stress on the electronic components.
- Protection against ingress of dust, water and chemicals.
- Protection against overheating: the output current will reduce as temperature increases up to 60°C (140°F), but the charger will not fail.
- The chargers are totally silent: no cooling fan or any other moving parts.

2.4 Reverse polarity protected
Once the battery is connected, the charger immediately detects voltage and polarity. If the battery is connected incorrectly, all status-LEDs will start blinking. No sparks will occur.

2.5 Recovery function for fully discharged batteries
Most reverse polarity protected chargers will not recognize, and therefore not recharge a battery which has been discharged to zero or nearly zero Volts. The *Blue Smart Charger* however will attempt to recharge a fully discharged battery with low current and resume normal charging once sufficient voltage has developed across the battery terminals.

2.6 Temperature compensated charging
The optimal charge voltage of a lead-acid battery varies inversely with temperature. The *Blue Smart Charger* measures ambient

temperature during the test phase and compensates for temperature during the charge process. The temperature is measured again when the charger is in low current mode during float or storage. Special settings for a cold or hot environment are therefore not needed.

2.7 Adaptive Battery Management
Lead-acid batteries should be charged in three stages, which are [1] *bulk or constant-current charge,* [2] *absorption or topping charge* and [3] *float charge.*
Several hours of absorption charge are needed to fully charge the battery and prevent early failure to sulfation[1].
The relatively high voltage during absorption does however accelerate aging due to grid corrosion on the positive plates.
Adaptive Battery Management limits corrosion by reducing absorption time when possible, that is: when charging a battery that is already (nearly) fully charged.

2.8 Storage mode: less corrosion of the positive plates
Even the lower float charge voltage that follows the absorption period will cause grid corrosion. It is therefore essential to reduce the charge voltage even further when the battery remains connected to the charger during more than 48 hours.

2.9 Reconditioning
A lead-acid battery that has been insufficiently charged or has been left discharged during days or weeks will deteriorate due to sulfation[1]. If caught in time, sulfation can sometimes be partially reversed by charging the battery with low current up to a higher voltage.
Remarks:

a) Reconditioning should be applied only occasionally to flat plate VRLA (gel and AGM) batteries because the resulting gassing will dry out the electrolyte.
b) Cylindrical cell VRLA batteries build more internal pressure before gassing and will therefore lose less water when subjected to reconditioning. Some manufacturers of cylindrical cell batteries therefore recommend the reconditioning setting in case of cyclic application.
c) Reconditioning can be applied to flooded batteries to “equalise” the cells and to prevent acid stratification.

d) Some battery charger manufactures recommend pulse charging to reverse sulfation. However, most battery experts agree that there is no conclusive proof that pulse charging works any better than constant voltage charging. This is confirmed by our own tests.

2.10 Lithium-ion ($LiFePO_4$) batteries

Li-ion batteries do not suffer from sulfation.
But Li-ion batteries are very sensitive to under voltage or over voltage[2].
Li-ion batteries therefore often have integrated cell balancing and under voltage protection (UVP) circuitry.
Some reverse polarity protected chargers will not recognize a battery when the UVP has tripped.
The *Blue Smart Charger* will however automatically reset the UVP and start charging.

Important note:
NEVER attempt to charge a Li-ion battery when its temperature is below 0°C (32°F).

2.11 Low current mode

Some lead acid batteries can overheat if charged with a current exceeding 0.3C (C Is the capacity in Ah. A 12Ah battery for example should not be charged with a current exceeding 0.3 x 12 = 4A). The low current mode (charge current limited to 4A or less, see technical specifications) should therefore be used to charge low capacity lead-acid batteries.

3. Charge algorithms

3.1 Smart charge algorithm with optional reconditioning for lead-acid batteries

Charge voltages at room temperature:

MODE	ABS V	FLOAT V	STORAGE V	RECONDITION Max V@% of Inom
NORMAL	14.4	13.8	13.2	16.2@8%, max 1h
HIGH	14.7	13.8	13.2	16.5@8%, max 1h
LI-ION	14.2	13.5	13.5	n. a.

For 24V chargers: multiply all voltage values by 2.

NORMAL (14.4V): recommended for flooded flat plate lead antimony batteries (starter batteries), flat plate gel and AGM batteries.
HIGH (14.7V): recommended for flooded lead calcium batteries, Optima spiral cell batteries and Odyssey batteries.

Eight step charge sequence for lead-acid batteries:

1. **CHARGE/TEST**
   Tests if the battery can accept charge, even if the battery is fully discharged (zero or nearly zero Volt across the terminals).
   All charge status LEDs will flash in case of reverse polarity connection, short-circuit or if a 12V charger is connected to a 24V battery.
   The TEST LED will flash as long as a charge pulse does not increase battery voltage to more than 12.5V resp. 25V.. If the flashing persists during several minutes the battery is probably damaged (internal short-circuit): disconnect the charger.
   A false rejection may occur if a load is simultaneously draining a very weak or fully discharged battery during the test phase: disconnect the load and repeat the test.

The charger can be switched to low current mode (see technical specifications) by pressing the MODE button during 3 seconds. The MODE LED will blink when in low current mode.
The low current mode remains activated until the MODE button is pressed again during 3 seconds.

2. **BULK**
   Charges the battery with maximum current until absorption voltage is reached. The battery will then be about 80% charged and is ready for use.
3. **ABS - Absorption**
   Charges the battery at constant voltage and with decreasing current until it is fully charged.
   See table above for absorption voltage at room temperature.
   Adaptive battery management:
   The absorption time is short (minimum 30 minutes) if the battery was (nearly) fully charged and increases to 8 hours in case of a deeply discharged battery.
4. **RECONDITION**
   Optional reconditioning for deeply discharged lead-acid batteries.
   Reconditioning is applicable to the charge algorithms NORMAL and HIGH and can be selected by pressing the MODE button one more time after selection of the required algorithm.
   When in RECONDITION mode the battery will be charged with low current up to a higher voltage at the end of the absorption phase.
   The RECONDITION LED will be on during charging, and will blink during the reconditioning period.
   During reconditioning the maximum current is equal to 8% of the nominal current until the maximum voltage is reached. Reconditioning is terminated after one hour or when the maximum voltage is reached, whichever comes first. *See table.*
   Example:
   For a 12/7 charger: the recondition current is
   7 x 0.08 = 0.56A
5. **FLOAT**
   Keeps the battery at constant voltage and fully charged.

6. **STORAGE**
   Keeps the battery at reduced constant voltage to limit gassing and corrosion of the positive plates.
   Slow self-discharge is prevented by an automatic weekly refresh of the battery with a short absorption charge.
7. **READY**
   The battery is fully charged when the FLOAT or STORAGE LED is on.
8. **REFRESH**
   Slow self-discharge is prevented by an automatic weekly refresh of the battery with a short absorption charge.

3.2 Lithium-ion ($LiFePO_4$) batteries

When charging a Lithium-ion battery, the *Blue Smart Charger* uses a specific charging algorithm for Lithium-ion batteries, to ensure optimum performance. *Select LI-ION with the mode button.*

3.3 When a load is connected to the battery

A load can be applied to the battery while charging, as long as the current draw is much lower than the rated output of the battery charger.
Reconditioning is not possible when a load is connected to the battery.

Remarks:

a) Disconnect all loads before attempting to recharge a very weak or fully discharged lead-acid battery. Loads may be reconnected once the bulk phase has started.
b) Disconnect all loads before attempting to recharge a Li-ion battery when the under voltage protection (UVP) of the Li-ion battery has tripped. Loads may be reconnected once the bulk phase has started.

3.4 Triggering a new charge cycle

A new charge cycle will start when:

a) The charger has reached float or storage, and, due to a load, current increases up to maximum current during more than four seconds.
b) The MODE button is pressed during charging.
c) The AC supply has been disconnected and reconnected.

3.5 Estimating charge time

A lead-acid battery is about 80% charged at the beginning of the absorption period.
The time **T** to 80% charged can be calculated as follows:
T = Ah / I
Where:
I is the charge current (= charger output minus load current).
Ah is the amount of Ah to be charged.

A full absorption period of up to 8 hours is needed to charge the battery to 100%.

Example:
Charge time to 80% of a fully discharged 100Ah battery when charged with a 10A *Blue Smart Charger: T = 100 / 10 = 10 hours*

Charge time to 100%: *10 + 8 = 18 hours.*

A Li-ion battery is more than 95% charged at the beginning of the absorption period, and reaches 100% charge after approximately 30 minutes absorption charge.

3.6 High internal resistance

When a battery reaches the end of its cycle- or float life, or when it dies prematurely due to sulfation or corrosion, capacity will dramatically drop and internal resistance will increase. The charger will not recognise such a battery during the test phase (it could as well be a nearly fully charged battery).
A very short bulk phase when charging a supposedly discharged battery does however indicate that the battery has reached the end of its useful life.

Remark: sulfation can sometimes be partially reversed by repeated application of the RECONDITION MODE.

3.7 Can be used as a power supply
The charger will supply DC loads when no battery is connected.

4. Technical specifications

Blue Smart IP65 Charger 120V	12V 5/7/10/15A	24V 5/8A
Input voltage range	110-130 VAC (2-3A)	
Efficiency	94%	95%
Standby power consumption	0.5W	
Minimum battery voltage	Starts charging from down to 0V	
Charge voltage 'absorption'	Normal: 14.4V High: 14.7V Li-ion: 14.2V	Normal: 28,8V High: 29,4V Li-ion: 28,4V
Charge voltage 'float'	Normal: 13.8V High: 13.8V Li-ion: 13.5V	Normal: 27,6V High: 27,6V Li-ion: 27,0V
Charge voltage 'storage'	Normal: 13.2V High: 13.2V Li-ion: 13.5V	Normal: 26,4V High: 26,4V Li-ion: 27,0V
Charge current	5 / 7 / 10 / 15A	5/8A
Charge current in low current mode	2 / 2 / 3 / 4A	2/3A
Temperature compensation (lead-acid batteries only)	16 mV/°C (9mV/°F)	32 mV/°C (18mV/°F)
Can be used as power supply	Yes	
Back current drain	0.7Ah/month (1mA)	
Protection	Reverse polarity Output short circuit Over temperature	
Operating temp. range	-20 to +60°C (full rated output up to 30°C) 0 to + 140°F (full rated output up to 90°F)	
Humidity (non condensing)	Max 95%	
ENCLOSURE		
Battery-connection	Black and red cable of 1.9 meter (6 feet)	
120 V AC-connection	Cable of 1.8 meter (6 feet) with US NEMA 1-15 plug	
Weight	0.9kg (2lbs)	0,9kg (2lbs)
Dimensions (h x w x d)	12/5, 12/7: 47x95x190mm 1.8x3.7x7.5 inches 0ther: 60x105x190mm	24/5: 47x95x190mm 1.8x3.7x7.5 inches other: 60x105x190mm
STANDARDS		
Safety	EN 60335-1, EN 60335-2-29 (UL1236 / CSA C22.2)	
Emission	EN 55014-1, EN 61000-6-3, EN 61000-3-2	
Immunity	EN 55014-2, EN 61000-6-1, EN 61000-6-2, EN 61000-3-3	

victron energy
BLUE POWER

Manual

Blue Smart IP65 Charger

12/4
12/5
12/7
12/10
12/15
12/25

24/5
24/8
24/13

Safety instructions

- Always provide proper ventilation during charging.
- Avoid covering the charger.
- Never try to charge non-rechargeable - or frozen batteries.
- Never place the charger on top of the battery when charging.
- Prevent sparks close to the battery. A battery being charged could emit explosive gasses.
- Battery acid is corrosive. Rinse immediately with water if acid comes into contact with skin.
- This appliance is not designed for use by young children or people who cannot read or understand the manual unless they are under the supervision of a responsible person to ensure that they can use the battery charger safely. Children should be supervised to ensure that they do not play with the appliance
- Connection to the mains supply must be in accordance with the national regulations for electrical installations. In case of a damaged supply cord please contact the manufacturer or your service agent.
- The battery terminal not connected to the chassis has to be connected first. The other connection is to be made to the chassis, remote from the battery and fuel line. The battery charger is then to be connected to the supply mains.
- After charging, disconnect the battery charger from the supply mains. Then remove the chassis connection and then the battery connection.

1. Quick user guide

A. Connect the charger to the battery.

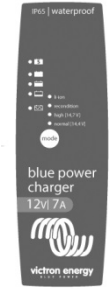
B. Connect the charger to the wall socket. The TEST LED will indicate that the mains cable is connected to the wall socket.
All charge status LEDs will flash in case of reverse polarity connection, short-circuit or if a 12V charger is connected to a 24V battery.
The TEST LED will flash as long as a charge pulse does not increase battery voltage to more than 12,5V resp. 25V.
When the TEST LED is on continuously, proceed to C.

C. If required, press the MODE-button or, in case of a Smart charger, use a Bluetooth Smart device to select another charge program.
When RECONDITION is selected in combination with NORMAL or HIGH; the RECONDITION LED will be on, and the RECONDITION LED will flash during reconditioning.
The charger can be switched to low current mode (see technical specifications) by pressing the MODE button during 3 seconds. The MODE LED will blink when in low current mode.
The low current mode remains activated until the MODE button is pressed again during 3 seconds.

D. The battery is about 80% charged and ready for use when the absorption LED switches on.

E. The battery is fully charged when the FLOAT or STORAGE LED is on.

F. Stop charging at any time by disconnecting the mains cable from the wall socket.



Explanation icons

2. “Must know” features and facts

2.1 Blue Smart version only
Set-up, monitor and update the charger (add new features when they become available) using Apple and Android smartphones, tablets or other devices.

2.2 Ultra high efficiency “green” battery charger
With up to 95% efficiency, these chargers generate up to four times less heat when compared to the industry standard. And once the battery is fully charged, power consumption reduces to 0,5 Watt, some five to ten times better than the industry standard.

2.3 Durable, safe and silent
- Low thermal stress on the electronic components.
- Protection against ingress of dust, water and chemicals.
- Protection against overheating: the output current will reduce as temperature increases up to 60°C, but the charger will not fail.
- The chargers are totally silent: no cooling fan or any other moving parts.

2.4 Reverse polarity protected
Once the battery is connected, the charger immediately detects voltage and polarity. If the battery is connected incorrectly, all status-LEDs will start blinking. No sparks will occur.

2.5 Recovery function for fully discharged batteries
Most reverse polarity protected chargers will not recognize, and therefore not recharge a battery which has been discharged to zero or nearly zero Volts. The *Blue Smart Charger* however will attempt to recharge a fully discharged battery with low current and resume normal charging once sufficient voltage has developed across the battery terminals.

2.6 Temperature compensated charging
The optimal charge voltage of a lead-acid battery varies inversely with temperature. The *Blue Smart IP65 Charger* measures ambient temperature during the test phase and compensates for temperature during the charge process. The temperature is measured again when the charger is in low current mode during

float or storage. Special settings for a cold or hot environment are therefore not needed.

2.7 Adaptive Battery Management

Lead-acid batteries should be charged in three stages, which are [1] *bulk or constant-current charge,* [2] *absorption or topping charge* and [3] *float charge.*

Several hours of absorption charge are needed to fully charge the battery and prevent early failure to sulfation[1].

The relatively high voltage during absorption does however accelerate aging due to grid corrosion on the positive plates. *Adaptive Battery Management* limits corrosion by reducing absorption time when possible, that is: when charging a battery that is already (nearly) fully charged.

2.8 Storage mode: less corrosion of the positive plates

Even the lower float charge voltage that follows the absorption period will cause grid corrosion. It is therefore essential to reduce the charge voltage even further when the battery remains connected to the charger during more than 48 hours.

2.9 Reconditioning

A lead-acid battery that has been insufficiently charged or has been left discharged during days or weeks will deteriorate due to sulfation[1]. If caught in time, sulfation can sometimes be partially reversed by charging the battery with low current up to a higher voltage.

Remarks:

a) Reconditioning should be applied only occasionally to flat plate VRLA (gel and AGM) batteries because the resulting gassing will dry out the electrolyte.

b) Cylindrical cell VRLA batteries build more internal pressure before gassing and will therefore lose less water when subjected to reconditioning. Some manufacturers of cylindrical cell batteries therefore recommend the reconditioning setting in case of cyclic application.

c) Reconditioning can be applied to flooded batteries to “equalise” the cells and to prevent acid stratification.

d) Some battery charger manufactures recommend pulse charging to reverse sulfation. However, most battery experts agree that there is no conclusive proof that pulse charging works any better than constant voltage charging. This is confirmed by our own tests.

2.10 Lithium-ion ($LiFePO_4$) batteries

Li-ion batteries do not suffer from sulfation.
But Li-ion batteries are very sensitive to under voltage or over voltage[2].
Li-ion batteries therefore often have integrated cell balancing and under voltage protection (UVP) circuitry.
Some reverse polarity protected chargers will not recognize a battery when the UVP has tripped.
The *Blue Smart Charger* will however automatically reset the UVP and start charging.

Important note:
NEVER attempt to charge a Li-ion battery when its temperature is below 0°C.

2.11 Low current mode

Some lead acid batteries can overheat if charged with a current exceeding 0,3C (C is the capacity in Ah. A 12Ah battery for example should not be charged with a current exceeding 0,3 x 12 = 4A). The low current mode (charge current limited to 4A or less, see technical specifications) should therefore be used to charge low capacity lead-acid batteries.

3. Charge algorithms

3.1 Smart charge algorithm with optional reconditioning for lead-acid batteries

Charge voltages at room temperature:

MODE	ABS V	FLOAT V	STORAGE V	RECONDITION Max V@% of Inom
NORMAL	14,4	13,8	13,2	16,2@8%, max 1h
HIGH	14,7	13,8	13,2	16,5@8%, max 1h
LI-ION	14,2	13,5	13,5	n. a.

For 24V chargers: multiply all voltage values by 2.

NORMAL (14,4V): recommended for flooded flat plate lead antimony batteries (starter batteries), flat plate gel and AGM batteries.
HIGH (14,7V): recommended for flooded lead calcium batteries, Optima spiral cell batteries and Odyssey batteries.

Eight step charge sequence for lead-acid batteries:

1. **CHARGE/TEST**
   Tests if the battery can accept charge, even if the battery is fully discharged (zero or nearly zero Volt across the terminals).
   All charge status LEDs will flash in case of reverse polarity connection, short-circuit or if a 12V charger is connected to a 24V battery.
   The TEST LED will flash as long as a charge pulse does not increase battery voltage to more than 12,5V resp. 25V. If the flashing persists during several minutes the battery is probably damaged (internal short-circuit): disconnect the charger.
   A false rejection may occur if a load is simultaneously draining a very weak or fully discharged battery during the test phase: disconnect the load and repeat the test.

   The charger can be switched to low current mode (see technical specifications) by pressing the MODE button during 3 seconds. The MODE LED will blink when in low current mode.

The low current mode remains activated until the MODE button is pressed again during 3 seconds.

2. **BULK**
   Charges the battery with maximum current until absorption voltage is reached. The battery will then be about 80% charged and is ready for use.
3. **ABS - Absorption**
   Charges the battery at constant voltage and with decreasing current until it is fully charged.
   See table above for absorption voltage at room temperature.
   Adaptive battery management:
   The absorption time is short (minimum 30 minutes) if the battery was (nearly) fully charged and increases to 8 hours in case of a deeply discharged battery.
4. **RECONDITION**
   Optional reconditioning for deeply discharged lead-acid batteries.
   Reconditioning is applicable to the charge algorithms NORMAL and HIGH and can be selected by pressing the MODE button one more time after selection of the required algorithm.
   When in RECONDITION mode the battery will be charged with low current up to a higher voltage at the end of the absorption phase.
   The RECONDITION LED will be on during charging, and will blink during the reconditioning period.
   During reconditioning the maximum current is equal to 8% of the nominal current until the maximum voltage is reached. Reconditioning is terminated after one hour or when the maximum voltage is reached, whichever comes first. *See table.*
   Example:
   For a 12/15 charger: the recondition current is 15 x 0,08 = 1,2A.
5. **FLOAT**
   Keeps the battery at constant voltage and fully charged.
6. **STORAGE**
   Keeps the battery at reduced constant voltage to limit gassing and corrosion of the positive plates.
   Slow self-discharge is prevented by an automatic weekly refresh of the battery with a short absorption charge.

7. **READY**
   The battery is fully charged when the FLOAT or STORAGE LED is on.
8. **REFRESH**
   Slow self-discharge is prevented by an automatic weekly refresh of the battery with a short absorption charge.

3.2 Lithium-ion ($LiFePO_4$) batteries

When charging a Lithium-ion battery, the *Blue Smart Charger* uses a specific charging algorithm for Lithium-ion batteries, to ensure optimum performance. *Select LI-ION with the mode button.*

3.3 When a load is connected to the battery

A load can be applied to the battery while charging, as long as the current draw is much lower than the rated output of the battery charger.
Reconditioning is not possible when a load is connected to the battery.

Remarks:

a) Disconnect all loads before attempting to recharge a very weak or fully discharged lead-acid battery. Loads may be reconnected once the bulk phase has started.
b) Disconnect all loads before attempting to recharge a Li-ion battery when the under voltage protection (UVP) of the Li-ion battery has tripped. Loads may be reconnected once the bulk phase has started.

3.4 Triggering a new charge cycle

A new charge cycle will start when:

a) The charger has reached float or storage, and, due to a load, current increases up to maximum current during more than four seconds.
b) The MODE button is pressed during charging.
c) The AC supply has been disconnected and reconnected.

3.5 Estimating charge time

A lead-acid battery is about 80% charged at the beginning of the absorption period.
The time **T** to 80% charged can be calculated as follows:
T = Ah / I
Where:
I is the charge current (= charger output minus load current).
Ah is the amount of Ah to be charged.

A full absorption period of up to 8 hours is needed to charge the battery to 100%.

Example:
Charge time to 80% of a fully discharged 100Ah battery when charged with a 10A *Blue Smart Charger: T = 100 / 10 = 10 hours*

Charge time to 100%: *10 + 8 = 18 hours.*

A Li-ion battery is more than 95% charged at the beginning of the absorption period, and reaches 100% charge after approximately 30 minutes absorption charge.

3.6 High internal resistance

When a battery reaches the end of its cycle- or float life, or when it dies prematurely due to sulfation or corrosion, capacity will dramatically drop and internal resistance will increase. The charger will not recognise such a battery during the test phase (it could as well be a nearly fully charged battery).
A very short bulk phase when charging a supposedly discharged battery does however indicate that the battery has reached the end of its useful life.
Remark: sulfation can sometimes be partially reversed by repeated application of the RECONDITION MODE.

3.7 Can be used as a power supply

The charger will supply DC loads when no battery is connected.

4. Technical specifications

Blue Smart IP65 Charger	12V 4/5/7/10/15/25A	24V 5/8/13A
Input voltage	230 VAC	
Efficiency	94%	95%
Standby power consumption	0,5W	
Minimum battery voltage	Starts charging from down to 0V	
Charge voltage 'absorption'	Normal: 14,4V High: 14,7V Li-ion: 14,2V	Normal: 28,8V High: 29,4V Li-ion: 28,4V
Charge voltage 'float'	Normal: 13,8V High: 13,8V Li-ion: 13,5V	Normal: 27,6V High: 27,6V Li-ion: 27,0V
Charge voltage 'storage'	Normal: 13,2V High: 13,2V Li-ion: 13,5V	Normal: 26,4V High: 26,4V Li-ion: 27,0V
Charge current	4 / 5 / 7 / 10 / 15 / 25A	5 / 8 / 13A
Charge current in low current mode	2 / 2 / 2 / 3 / 4 / 10A	2 / 3 / 4A
Temperature compensation (lead-acid batteries only)	16 mV/°C	32 mV/°C
Can be used as power supply	Yes	
Back current drain	0,7Ah/month (1mA)	
Protection	Reverse polarity Output short circuit Over temperature	
Operating temp. range	-30 to +50°C (full rated output up to 30°C)	
Humidity (non condensing)	Max 95%	
ENCLOSURE		
Battery-connection	Black and red cable of 1,5 meter	
230 V AC-connection	Cable of 1,5 meter with CEE 7/7, BS 1363 plug (UK) or AS/NZS 3112 plug	
Protection category	IP65 (splash and dust proof)	
Weight	IP65 12V 25A 24V 13A: 1,9kg Other: 0,9kg	
Dimensions (h x w x d)	IP65s 12V 4/5A: 45x81x182mm IP65 12V 7A 24V 5A: 47x95x190mm IP65 12V 10/15A 24V 8A: 60x105x190mm IP65 12V 25A 24V 13A: 75x140x240mm	
STANDARDS		
Safety	EN 60335-1, EN 60335-2-29	
Emission	EN 55014-1, EN 61000-6-3, EN 61000-3-2	
Immunity	EN 55014-2, EN 61000-6-1, EN 61000-6-2, EN 61000-3-3	

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