Photonic Universe

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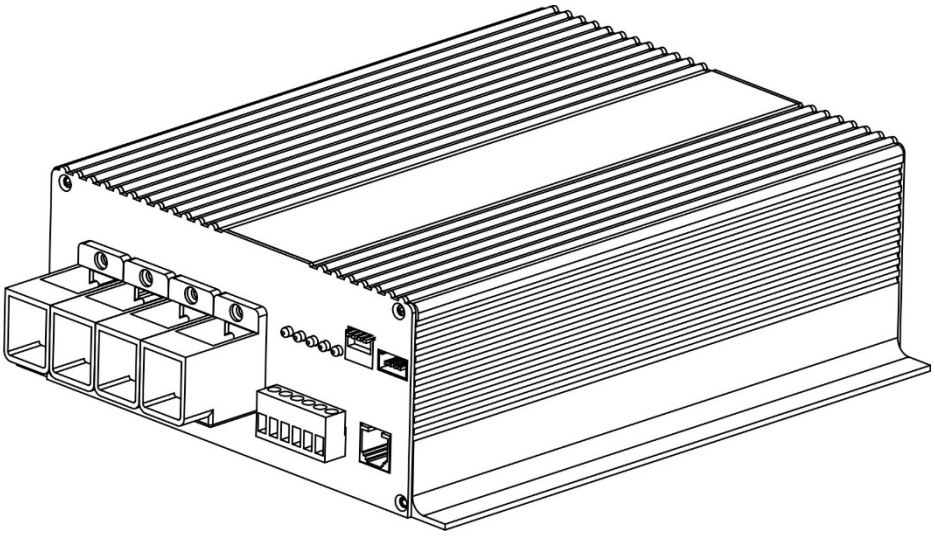
12V DC to DC and solar battery charger with the fridge output

DC1212-3020FR series

INSTRUCTION MANUAL



Overview

This Photonic Universe DC-DC battery charger with the fridge output is fully automatic and ideal for leisure vehicles, commercial and special purpose vehicles, boats, and any other systems with multiple batteries or power sources with an additional solar charging source and a fridge. The charger operates using an adjustable three-stage charging programme and is suitable for lead acid, AGM, GEL, LiFePO4 and Lithium-ion (NCM) batteries. The product features high frequency switching and buck-boost power conversion technology for reliable, consistent performance.

The charger comes with a powerful built-in MPPT solar charge controller, enhancing its capability with additional charging from solar panels. The unit will charge the target battery from solar panels whenever the DC-to-DC charging is not active. This is useful in applications where the DC-to-DC charging function is not used for significant periods of time, such as when a vehicle is parked or in storage, or when supplementary charging from solar panels is needed. MPPT technology of this charger extracts the energy from solar panels with the maximum efficiency which significantly exceeds efficiency of other non-MPPT chargers. The solar charging function will also provide a trickle charge to the source battery to prevent it from self-discharging.

This charger is equipped with 20A output terminals that allow a fridge to be connected directly to the battery charger. By adjusting the charger's DIP switches, it can be configured to draw power from either the source battery or the target battery, depending on the voltage level of the source battery and whether the vehicle's alternator output is available.

The charger features D+ terminal which can activate the DC-to-DC charging function automatically when the vehicle alternator starts, which prevents the target battery from being discharged when the vehicle is not running. A range of protection functions enables the charger to automatically disconnect the target (OUT) battery from the source (IN) battery under extreme conditions, such as in cases of overheating, overvoltage, short circuits, and over-currents. Backflow (from OUT to IN) is also prevented so the charge will not flow in the reverse direction.

The charger includes ports for a remote meter or a Bluetooth dongle (both sold separately), allowing data to be viewed on an LCD display or through a mobile phone app when connected.

An optional external temperature sensor (sold separately) can be connected to the charger for automatic adjustment of the charging voltages depending on the ambient temperature (lead-acid batteries only), keeping the charging programme to optimal voltages at very low or high temperatures.

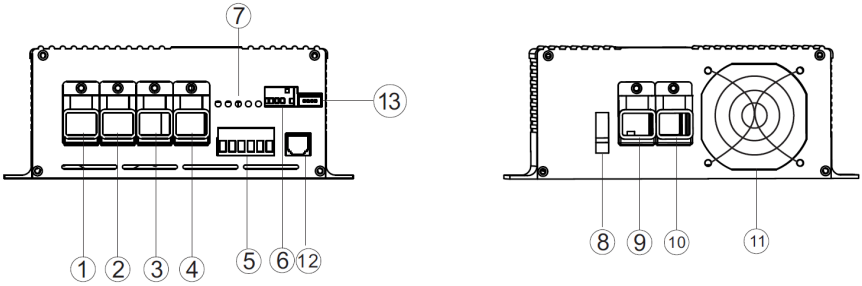
Installation

Install the charger as close to the target (OUT) battery as possible and keep the surrounding area clean, tidy, and well ventilated. This space should be moisture-proof, water-proof, and corrosion proof. Leave at least 10 cm of space around the charger to allow for proper airflow.

Note: before connecting and using the charger, please choose the type of target battery (lead-acid, GEL, AGM, LiFePO4, Lithium-ion (NCM)) by setting DIP switches 4-6. If you intend to charge a lithium battery in cold temperatures, ensure to verify if your battery can be charged at

temperatures below 0°C, and adjust DIP switch 3 as needed. For more information, refer to the DIP switches section in this manual.

Product features



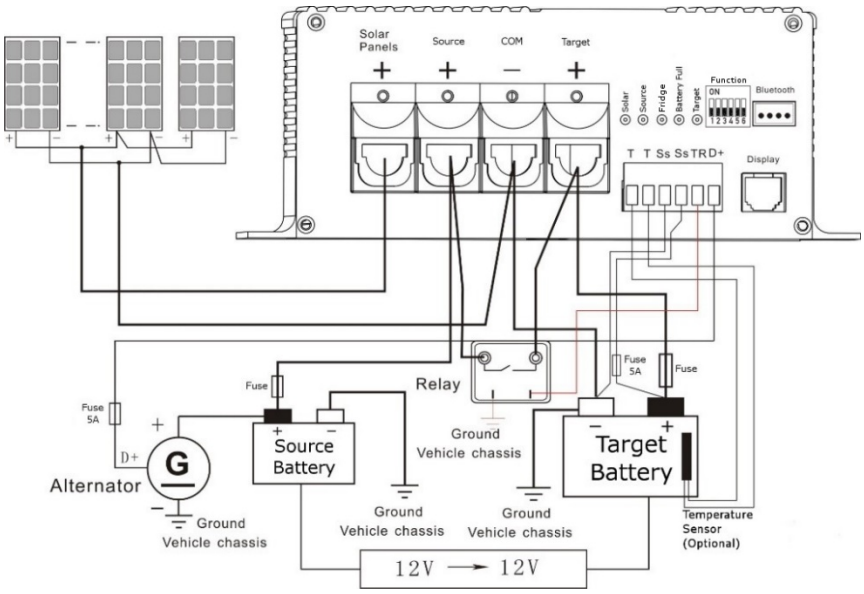
Reference	Description
1	Solar positive input (+)
2	Source battery positive input (+)
3	Common negative (-)
4	Target battery output (+)
5	Green terminals
6	DIP switches
7	LED display
8	Fridge output fuse
9	Fridge positive output (+)
10	Fridge negative output (-)
11	Cooling fan
12	Remote meter port
13	Bluetooth dongle port

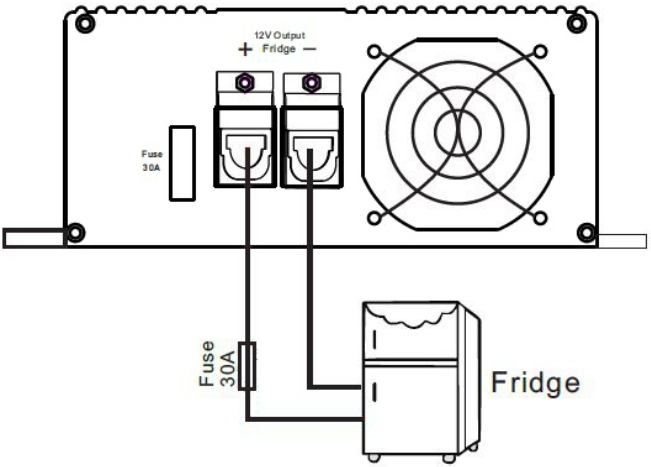
Connection diagrams

Use as short cables as possible, especially between the charger and the target battery. The recommended cable cross-section for “+” and “-” power cables is 1 mm2 cross-section for every 3A of maximum charging current. Always connect the cables to the charger terminals first before connecting them to the battery terminals, to ensure you are not working with live cables. When connecting the cables to the battery terminals, ensure the positive and negative poles are not reversed or short-circuited.

The fuses need to be located within 15 cm from the terminals of the batteries. Choose the rating of the fuses according to the maximum charging current.

Install an additional switch or a circuit breaker between the charger and the solar array rated up to the maximum power, voltage, and amperage of the solar panels.





Note: DIP switch 2 sets the trigger method for DC-DC charging:

- If the trigger is set to D+ signal, the charger will require a D+ signal to start DC-DC charging. If there is no signal applied to the D+ terminal, DC-DC charging will be off.
- If the trigger is set to voltage control, DC-DC charging will turn on and off depending on the voltage of the source battery. Please refer to the DIP switches section for more details.

Green terminals

The charger features a pluggable terminal block of 6 green terminals. In a place with limited installation space, the terminal block can be unplugged for connection or disconnection of the wires and then re-inserted. The size of the cable for this terminal block is 0.75mm² and the stripping length is about 6mm. Description of the terminal contacts is provided below.

"T T": these are the terminals for connecting an optional temperature sensor for measuring the temperature of the target battery.

If you install a temperature sensor in your system, please ensure that it is not affected by any heat source. Fix it on the case of the target battery or connect it to the negative terminal of the battery.

A temperature sensor is highly recommended for lead acid batteries in case if the ambient temperatures vary substantially from the baseline temperature of 25°C. The sensor performs two main functions:

- Charging voltage adjustment. The charging voltage for the target battery is compensated up or down depending on the ambient temperature to regulate the speed of chemical reaction inside the battery. The voltage will increase in the winter and decrease in the summer at the rate of 18mV for each degree Celsius away from the reference temperature 25°C.
- Battery protection. When the temperature is lower than -20°C or higher than 50°C, the charger limits the maximum charging current.

The charger can identify whether the temperature sensor is connected or not, or if it is damaged, short-circuited, or when an abnormal temperature is measured. In such case, the charger will automatically set the charging programme to the default temperature 25°C.

Note: there is no temperature compensation for lithium batteries.

"Ss-, Ss+": these are the terminals used for connecting optional battery cables directly to battery terminals for precise voltage measurement of the target battery. This will provide the charger with accurate readings of the voltage of the battery to ensure they are not affected by the voltage drop in heavy duty "+" and "-" charging cables. The voltage reading cables must be fused.

If these cables are not connected or the connection is interrupted, the charger will measure the voltage across the target battery terminals using the regular heavy duty charging cables connected to "+" and "-" terminals of the charger. If multiple batteries are being used in parallel, connect Ss- to the negative terminal of the first battery, and connect Ss+ to the positive terminal of the last battery.

"TR": relay signal terminal. If a high starting current is required by some electrical loads connected to the target battery (air conditioner, inverter, washing machine etc.), and the target battery cannot start them on its own and its voltage drops below 12.2V, the "TR" terminal can provide a 12V + signal which can close an optional relay (purchased separately) installed between the "+" of the source battery and the "+" of the target battery. This will effectively connect the two batteries directly to each other allowing the source battery to assist the target battery in starting the high current electrical load.

TR signal	Condition
On	DC-to-DC charging is active, target battery voltage < 12.2V and source battery voltage > 12.2V
Off	Target battery voltage > 12.6V or source battery voltage < 12.2V

"D+": this is the terminal for connecting a "D+" signal (12V +) from the alternator. This terminal controls the DC-DC function of the charger if:

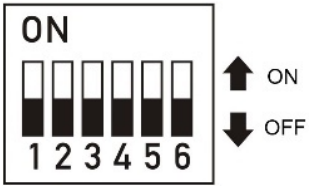
- The charger is used in a vehicle
- And the source battery (IN) is the vehicle's source battery
- And DIP switch 2 of the charger is set to "D+" signal (please refer to the DIP switches section for more information).

In such case, DC-DC charging function of the charger will only operate at times when the alternator sends a "D+" signal to this "D+" terminal (when the alternator is working). The voltage range for this signal is 8V – 16V.

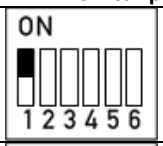
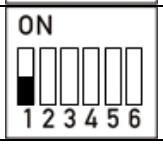
Alternatively, another connection option in a vehicle where the starter battery is used as a source battery, is to connect the "D+" terminal of the charger to the 12V + signal from the ignition of the vehicle. In such case, if the ignition is ON, the charger's DC to DC function will be ON. If the ignition is OFF, DC to DC charging from the source battery will be OFF and the solar panels (if connected) will charge the target battery.

DIP switch 2 can also be set to operate the charger in a voltage control mode. In such case DC-DC charging will turn ON and OFF based on the voltage of the source (IN) battery. In this mode, the D+ signal is not required to operate DC-DC charging.

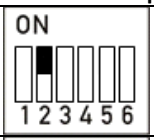
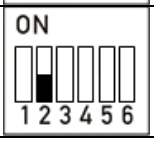
DIP switches



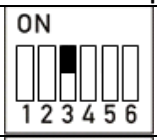
DIP switch 1: select the fridge type.

DIP switch position		Description
	1: ON	Absorption fridge
	1: OFF	Compressor fridge

DIP switch 2: select the trigger method to start DC-DC charging.

DIP switch position		Description
	2: ON	Voltage control mode: no need to connect “D+” for DC-DC charging. When the source battery voltage is > 13.2V, DC-DC charging will start automatically.
	2: OFF	“D+” control mode: the “D+” signal must be connected and active for DC-DC charging to start.

DIP switch 3: select the 0°C charging function for lithium batteries.

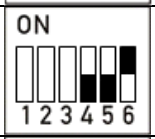
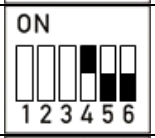
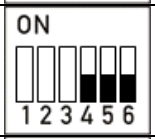
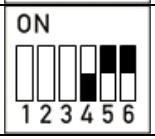
DIP switch position		Description
	3: ON	Target lithium battery will stop charging when the temperature drops below 0°C. Charging will resume when the temperature rises back above 3°C.
	3: OFF	Target lithium battery will be charged with reduced charging current between -20°C and 0°C (10A max). Normal charging will resume when the temperature rises back above 3°C.

DIP switches 4, 5, and 6: battery selection

The battery type for the target battery can be selected using DIP switches 4, 5 and 6. This setting will determine the charging parameters used for charging the target battery, such as charging voltage and temperature compensation.

Before you connect and use the charger, please set the correct battery type for the target battery from the range of 8 options below.

DIP switch position		Battery type	Boost voltage
	4: ON 5: ON 6: ON	GEL	14.3V
	4: ON 5: ON 6: OFF	Sealed lead-acid	14.4V

	4: ON 5: OFF 6: ON	AGM	14.7V
	4: OFF 5: ON 6: OFF	LiFePO4	13.9V
	4: OFF 5: OFF 6: ON	LiFePO4	14.2V
	4: ON 5: OFF 6: OFF	LiFePO4	14.4V
	4: OFF 5: OFF 6: OFF	LiFePO4	14.6V
	4: OFF 5: ON 6: ON	Li-ion	12.6V

Note: the battery type should not be changed whilst the charger is powered. If the battery type needs to be changed, first power off the charger, then change the DIP switch configuration, then turn the charger on again.

Note: any lithium battery used with this charger must have a Battery Management System (BMS). Charging of lithium batteries without BMS is not permitted.

Operation of the fridge output

Fridge type	D+ selection	Fridge output
Absorption	Works only with D+ (DIP switch 2: OFF)	1. When there is no D+ signal, there is no output to the fridge. 2. When there is a D+ signal, the fridge output is directly powered by the source battery.
	Without D+ signal (DIP switch 2: ON)	1. When the source battery voltage is >13.2V, the fridge output is directly powered by source battery. 2. When the source battery voltage is <11.9V, the output to the fridge is turned off.

Compressor	Works only with D+ (DIP switch 2: OFF)	1. When there is no D+ signal, the fridge output is powered by the target battery. 2. When there is a D+ signal, the fridge output is powered by the source battery as a priority. If the source battery is too low, the target battery is used to power the fridge output.
	Without D+ signal (DIP switch 2: ON)	1. When the source battery voltage is >13.2V, the fridge output is directly powered by source battery. 2. When the source battery voltage is <11.9V, the fridge output is powered from the target battery.

LED indicators

Name	Colour	LED status	Details
Solar	Green	OFF	The charger is working in the DC-DC mode
		Slow flashing (1 flash / 5 seconds)	Solar voltage is < target battery voltage.
		Fast flashing (1 flash / 2 seconds)	Solar voltage is > 50V
		ON	Solar voltage is normal
Source	Green	OFF	No D+ signal, no DC-DC charging
		Slow flashing (1 flash / 5 seconds)	Source battery voltage is < 11.0V. If the source battery voltage reduces further to < 10.8V, the DC-DC charging will stop. It resumes when the voltage returns to 12.5V.
		Fast flashing (1 flash / 1 second)	Source battery voltage > 16V
		ON	Source battery voltage is normal
Fridge	Yellow	OFF	Output off
		Slow flashing (1 flash / 3 seconds)	Output turned off (resumes after 5 min).
		Fast flashing (1 flash / 1 second)	Fridge output over-current
		ON	Output normal
Battery full	Green	OFF	No charging
		Slow flashing (1 flash / 5 seconds)	Boost (constant current) charging stage
		Fast flashing (1 flash / 1 second)	Absorption (constant voltage) charging stage
		ON	Battery full
Target	Red	Slow flashing (1 flash / 5 seconds)	Target battery voltage is normal
		Fast flashing (1 flash / 1 second)	Target battery over voltage, high voltage disconnect (HVD)

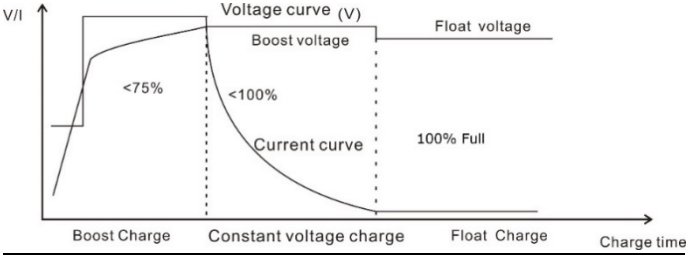
		Fast flashing (1 flash / 1 second) and buzzer sound	Internal over temperature
		ON	Target battery low voltage, low voltage disconnect (LVD)

Target battery charging

Boost (constant current) charging stage: during this stage, the charger will charge the target battery with the maximum rated current until the target battery voltage reaches the boost voltage.

Absorption (constant voltage) charging stage: when the target battery voltage reaches the boost voltage, the charger will enter the absorption (constant voltage) charging stage. During this stage the charger will maintain the boost voltage while the charging current will gradually reduce. This stage will last for 1 or 2 hours depending on the battery type.

Float charging stage: after the absorption stage, the charger will reduce the charging voltage to the float voltage and continue charging the target battery with a low current to maintain it at this level.



Equalisation: for selected battery types, the charger will perform equalisation charging by timer once a month with a higher charging voltage, in order to bring all battery cells to the same level. Equalisation charging will last for 2 hours. Please refer to the battery types table for more information.

Note: If the target battery voltage is > 12.6V at the start of the charging process, the charger will not perform the absorption (constant voltage) stage and will instead charge to the boost voltage level and then go straight to the float charging stage.

Source (starter) battery charging

In addition to charging the target battery, in certain conditions the charger can also trickle charge the source (starter) battery to maintain its level and ensure it's ready to start the vehicle:

- Solar: if the solar panels are charging the target battery in the Absorption or Float stage, and the source battery voltage is 5V – 12.58V, the charger will also charge the source battery from solar with the current up to 5A.
- DC to DC: if the source battery gets low, the charger can reverse charge the source battery from the target battery with the current up to 5A according to the table:

Reverse charging is ON	All of the following three conditions have to be met: 1) Source battery voltage: 7.0V – 12.0V 2) Target battery voltage: > 12.3V 3) The source battery is not supplying power to the fridge
Reverse charging is OFF	The reverse charging turns off in any one of the following scenarios: • If the source battery voltage is > 12.3V for more than 10s • If the source battery voltage is > 13.2V • D+ signal is available with the normal voltage • If the target battery voltage is < 12.0V for 10s or < 11.5V for 100ms • Charging current less than 0.1A in 10 seconds after charging started (the voltage difference between the batteries is small) • Solar panels are charging the target battery in the Absorption or Float stage • The source battery is supplying power to the fridge

Protection functions

Protection	Description
Target battery overvoltage	If the target battery voltage is > High Voltage Disconnect (HVD) voltage, the charging will stop. If the target battery voltage is > boost voltage value + 0.2V for 10 seconds, the charging will stop.
Target battery low voltage	If the target battery voltage is < Low Voltage Disconnect (LVD) voltage, the charging will stop. Buzzer alarm: beeps twice repeatedly for 7 seconds.
Source battery low voltage	If the source battery voltage is between 10.8V - 12.35V the charging current is reduced. If the source battery voltage is < 10.8V DC to DC charging stops.
Solar overpower	If the input solar power or current exceeds the maximum rated values of the charger, the actual solar charging power and current will be limited to the rated values.
Solar overvoltage	If the solar voltage is > 50V, the solar charging will stop. Buzzer alarm: beeps three times repeatedly for 1 minute.
DC to DC overpower	The maximum charging current and the maximum charging power is limited to the rating of the charger.
Battery reverse polarity	If the target or the source battery is connected with a reverse polarity, it will blow the fuse inside the charger and may also cause hardware damage to the charger. Please contact the supplier of the charger with all the details, including which battery was connected with a reversed polarity.
Overheating (internal temperature)	If the internal temperature is > 85°C, the charging will stop. Charging will resume once the temperature drops to 60°C. If the internal temperature is > 80°C but < 85°C, the charging current will be reduced to 25A. Charging at full current will resume once the temperature drops to 65°C. Buzzer alarm: two consecutive beeps followed by a single beep for 1 minute.

Fridge over-load protection	If fridge output current >25A for 1 second, the output will turn off. If fridge output current >24A for 3 second, the output will turn off. If fridge output current >23A for 10 second, the output will turn off. If an overcurrent event happens, the output will remain off for 10 minutes. If 3 overcurrent events happen in a row, the output will remain off.

Battery type parameters

Battery type	Boost	Float	Equalisation	High Voltage Disconnect (HVD)	Low Voltage Disconnect (LVD)	Constant voltage charging time
GEL	14.3V	13.8V	-	15.5V	11V	2h
Sealed	14.4V	13.5V	14.6V	15.5V	11V	2h
Flooded / AGM	14.7V	13.5V	14.8V	15.5V	11V	2h
LiFePO4 (13.9V)	13.9V	13.8V	-	15.5V	11V	1h
LiFePO4 (14.2V)	14.2V	13.8V	-	15.5V	11V	1h
LiFePO4 (14.4V)	14.4V	13.8V	-	15.5V	11V	1h
LiFePO4 (14.6V)	14.6V	13.8V	-	15.5V	11V	1h
Lithium-ion (NCM)	12.6V	12.5V	-	13.5V	9.3V	1h

Power derating

If the source battery voltage becomes low, the charging current will decrease to prevent over discharge of the source battery.

1. D+ working mode (DIP switch 2 is OFF)

Source battery voltage	Charge current	Recovery voltage	Charge current
> 12.6V	30A	-	-
< 12.35V	25A	> 12.55V	30A
< 12.20V	22A	> 12.50V	25A
< 12.05V	19A	> 12.45V	22A
< 11.90V	16A	> 12.40V	19A
< 11.75V	13A	> 12.35V	16A
< 11.60V	10A	> 12.30V	13A
< 11.40V	2A	> 12.25V	10A
< 10.8V	Stop charging	> 12.60V	30A

2. Voltage control mode (DIP switch 2 is ON)

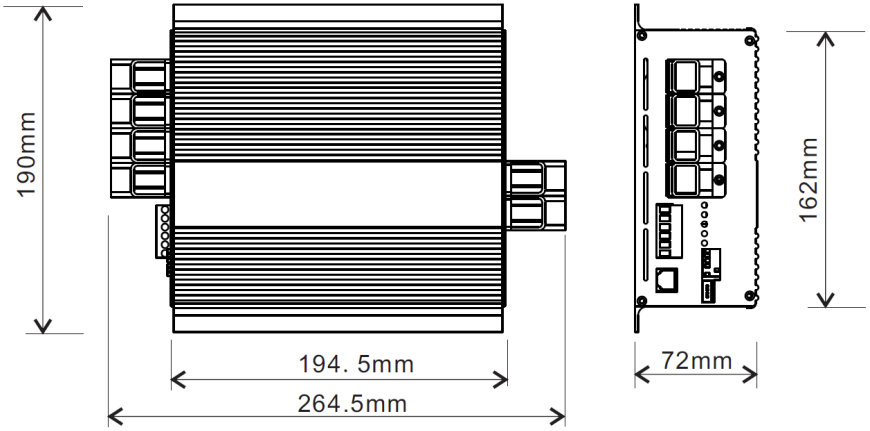
Source battery voltage	Charge current	Recovery voltage	Charge current
> 13.2V	30A	-	-
< 12.6V	25A	> 13V	30A
< 12.4V	22A	> 12.9V	25A
< 12.2V	19A	> 12.8V	22A
< 11.9V	Stop charging	> 13.2V	30A

Specifications

Parameter	Value
Target battery	
Gel, Sealed, AGM rated voltage	12V
LiFePO4 rated voltage	12.8V
Lithium-ion (NCM) rated voltage	11.1V
Recommended battery capacity	45-280Ah
Battery operating voltage range	8-16V
Source battery	
Rated voltage	12V
Recommended min. battery capacity	70-100Ah
Battery operating voltage range	10.5-16V
DC-DC charging	
Maximum charging power	390W
Maximum charging current	30A
Effective D+ signal voltage range	8-16V
Solar charging	
Maximum input solar power	250W
Maximum input solar current	14A
Maximum solar open circuit voltage	50V *
Maximum charging current to target battery	20A
Charging current to source battery	0-5A
Fridge output	
Maximum output current	20A
Output regulation	Automatic with or without D+ signal
Fuse rating	30A
General parameters	
Temperature compensation	-18mV/°C
“TR” signal	12V / 1A
Target battery temperature sensor input “T T”	Yes
Target battery voltage input “Ss-,Ss+”	Yes
Stand-by current	24mA
Weight	1.5kg
Operating temperature	From -20°C to 50°C
Dimensions	265x190x72 mm

** At minimum environmental temperature. For colder climates this typically means that the open circuit voltage of solar panels at 25°C should not exceed 45V.*

Dimensions



CB and CBR circuit breakers (optional)

Optional surface mounted (CB series) and recess mounted (CBR series) DC circuit breakers can be purchased from Photonic Universe and used instead of fuses when connecting this charger to the source and target batteries. The range of circuit breakers includes 30A, 40A, 50A, 60A and 80A circuit breakers rated for 12V / 24V systems with the product codes ***CB30*** – ***CB80***, ***CBR40***, ***CBR80***.

Temperature sensor DCDC-TS (optional)

This charger is compatible with an optional temperature sensor **DCDC-TS**. The sensor will measure the external temperature of the target battery and provide the real time temperature readings to the charger for voltage adjustment and protection (please see the section about “T T” terminals for reference). The voltage adjustment applied for lead acid batteries is 18 mV/°C. If the temperature sensor is not connected, the charger will charge the target battery based on the default temperature settings for 25°C.

Remote meter ACDC-RM (optional)

An optional remote LCD meter **ACDC-RM** can be connected to the charger to display charging parameters such as real time battery voltage, charging current, charging Ah, charging Wh and any fault information.

Bluetooth dongle ACDC-BT (optional)

With an optional Bluetooth dongle **ACDC-BT** this charger can be connected to a smartphone app to allow the user to monitor charging parameters such as the real time battery voltage, charging current, charging Ah, charging Wh and any fault information.

To setup the Bluetooth dongle and connection to the smartphone, please install the correct and up-to-date version of the app using the name, links or QR codes for the app provided in a separate user manual for the Bluetooth dongle.

If you would like to purchase any of these optional extras, please visit our online shop

www.PhotonicUniverse.com

or call 0203 150 1111 (international +44 203 150 1111) for a phone order.

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