1. General Description

The Orion-Tr Smart DC-DC Charger Isolated can be used as a power supply or as a battery charger. In charger mode the three-state charge algorithm will increase battery life by properly charging the battery. Especially in the case of vehicles with a smart alternator, or voltage drop caused by long cable runs, controlled charging is indispensable. Controlled charging will also protect the alternator in lithium systems where direct charging can overload the alternator due to the low impedance of the lithium battery. In fixed output mode the output voltage will remain stable independent of the applied load or varying input voltage (within the specified range).

The Orion-Tr Smart DC-DC Charger Isolated can be set up to only provide power when the engine is running. This is possible thanks to the built-in engine shutdown detection. This also prevents the onboard voltage of the vehicle from becoming too low. It is not necessary to intervene in the system of the vehicle, to install a separate motor run sensor or to intervene in the CAN-bus system. Apart from this detection, the Orion-Tr Smart DC-DC Charger Isolated can also be activated by a forced allowed to charge feature, e.g. connected to the ignition switch.

The Orion-Tr Smart DC-DC Charger Isolated is fully programmable with the VictronConnect app.
Discover all setup possibilities here:
https://www.victronenergy.com/live/victronconnect:start

2. Features

Smart alternator compatibility
Vehicle manufacturers are now introducing smart ECU (Engine Control Unit) controlled alternators to increase fuel efficiency and reduce emissions. Smart alternators deliver a variable output voltage and are shut down when they're not needed. The converter has an engine running detection mechanism. This prevents the converter from discharging the starter battery when the alternator does not supply power. See section 5 of this manual for more details.

Separation of the starter battery and the service battery
The Orion-Tr Smart DC-DC Charger Isolated separates the starter battery from the service battery when the engine is not running.

Extensive electronic protection
Over-temperature protection and power derating when temperature is high.
Overload protected.
Short circuit protected.
Connector over-temperature protection.

Adaptive three step charging
The Orion-Tr Smart DC-DC Charger Isolated is configured for a three-step charging process:
Bulk – Absorption – Float.
Bulk
During this stage the controller delivers as much charge current as possible to rapidly recharge the batteries.
Absorption
When the battery voltage reaches the absorption voltage setting, the controller switches to constant voltage mode. For lead acid batteries it is important that during shallow discharges the absorption time is kept short in order to prevent overcharging of the battery. After a deep discharge the absorption time is

automatically increased to make sure that the battery is completely recharged. For lithium batteries absorption time is fixed, default 2 hours. The fixed or adaptive mode can be chosen on the battery settings.

Float

During this stage, float voltage is applied to the battery to maintain it in a fully charged state. When the battery voltage drops substantially below this level, due to a high load for example, during at least 1 minute, a new charge cycle will be triggered.

Flexible charge algorithm

Programmable charge algorithm, and eight preprogrammed battery settings.
Configurable with VictronConnect.

Adaptive absorption time

Automatically calculates the proper absorption time.
Configurable with Victron Connect.

Configuring and monitoring

Bluetooth Smart built-in: the wireless solution to set-up, monitor and update the controller using Apple and Android smartphones, tablets or other devices.
Several parameters can be customized with the VictronConnect app.
The VictronConnect app can be downloaded from:
http://www.victronenergy.nl/support-and-downloads/software/
Use the manual – VictronConnect - to get the most out of the VictronConnect App when it's connected to an Orion Smart:
https://www.victronenergy.com/live/victronconnect:start

Input voltage lock-out

Shutdown if the input voltage drops below the lock-out value and restart when the input voltage increases above the restart value.
Configurable with Victron Connect.

Remote on-off
Use the remote function to enable and disable the converter remotely with the remote on/off connector or using the VictronConnect app. Typical use cases include a user operated hard wired switch and automatic control by for example a Battery Management System. If the minus of the service battery is not at the same potential as the minus of the alternator or starter battery an isolated remote on/off cable between the BMS and the on/off port is required, see chapter 4.4 for details.

3. Safety instructions

SAVE THESE INSTRUCTIONS – This manual contains important instructions that shall be followed during installation and maintenance.

Danger of explosion from sparking

Danger of electric shock

- Please read this manual carefully before the product is installed and put into use.
- Install the product in a heatproof environment. Ensure therefore that there are no chemicals, plastic parts, curtains or other textiles, etc. in the immediate vicinity of the equipment.
- It is normal for the Orion-Tr Smart DC-DC Charger Isolated to get hot during operation, keep any objects that are heat-sensitive away.
- Ensure that the equipment is used under the correct operating conditions. Never operate it in a wet environment.
- Never use the product at sites where gas or dust explosions could occur.
- Always provide proper ventilation during charging.
- Avoid covering the charger.
- Refer to the specifications provided by the manufacturer of the battery to ensure that the battery is suitable for use with this product. The battery manufacturer's safety instructions should always be observed.
- In addition to this manual, the system operation or service manual must include a battery maintenance manual applicable to the type of batteries used.
- 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.

- This device is not to be used by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction.
- Use flexible multistranded copper cable for the connections. The maximum diameter of the individual strands is 0,4mm/0,125mm² (0.016 inch/AWG26).
- The installation must include a fuse in accordance with the recommendations in the table "CABLE AND FUSE RECOMMENDATIONS".

4. Installation

4.1 General

- Mount vertically on a non-flammable surface, with the power terminals facing downwards. Observe a minimum clearance of 10 cm under and above the product for optimal cooling.
- Mount close to the battery, but never directly above the battery (in order to prevent damage due to gassing of the battery).

4.2 Connection setup for power supply mode

1. Disconnect the remote on/off (remove wire bridge).
2. Connect the input supply cables.
3. Open the VictronConnect App to setup the product. ***(always adjust the output voltage before connecting in parallel or connecting a battery)***
4. Connect the load. The converter is now ready for use.
5. Reconnect the remote on/off to activate the product.

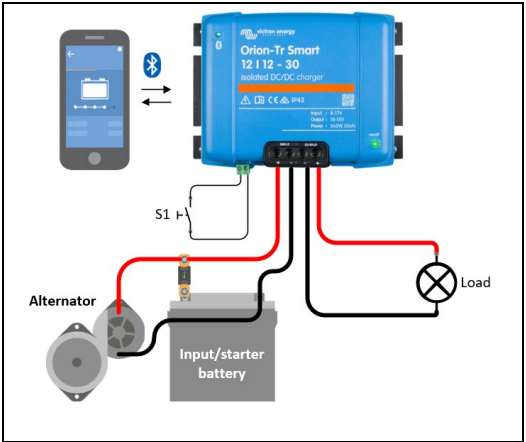


Figure 1: Typical connection setup as DC-DC converter

4.3 Connection setup for charger mode

1. Disconnect the remote on/off (remove wire bridge).
2. Connect the input supply cables.
3. Open the Victron Connect App to setup the product. ***(always setup the correct charger algorithm before connecting a battery)***
4. Connect the battery to be charged.
5. Reconnect the remote on/off to activate the product.

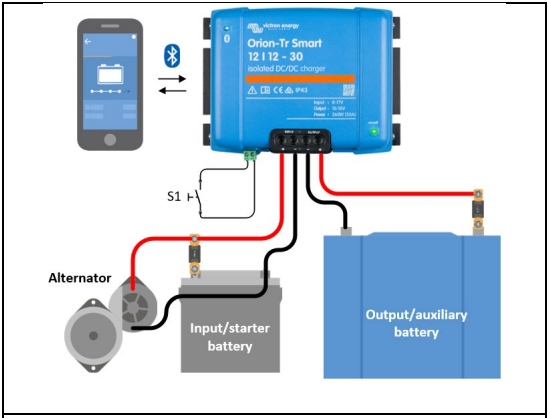


Figure 2: Typical connection setup as charger

4.4 Connection remote on-off

The recommended use of the remote on-off is:

a) A switch wired between the L-H pins (On-level impedance between L-H pins: <500kΩ)

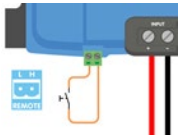
b) A switch wired between (input/starter) battery plus and H-pin (on level: >3V)

c) A switch between the L-pin and (input/starter) ground (on level: <5V)

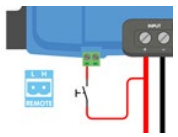
d) Isolated remote on-off cable e.g. controlled by a (mini)BMS

Note: Voltage tolerance L & H pin: +/- 70V_{DC}

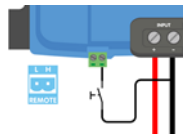
a) L-H pin wiring



b) H-pin wiring



c) L-pin wiring



d) Isolated remote on-off cable

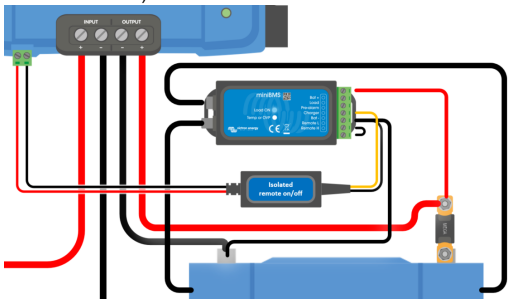


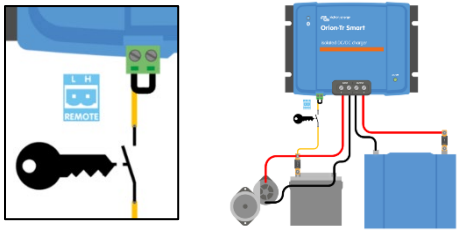
Figure 3: Remote on/off connections

4.5 Engine detection override

In charger mode the “engine on detection sequence” determines if conditions are met to enable charging, see chapter 5. The “engine detection override” forces the charger to allow charging independent of the engine on detection. Engine detection override is activated by applying >7V to the remote L-pin. This allows external control (e.g. ignition switch, CAN bus engine on detector) to enable charging.

This function does not override the remote function. Therefore, remote connection a), b) or d) must be configured in combination with engine dection override. See examples in figure 4.

Enable charging with an ignition switch and remote option a)



Enable charging with an ignition switch and remote option d)

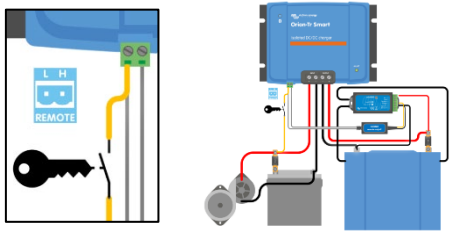


Figure 4: Engine Detection Override connection diagram

4.6 Cable and fuse recommendations

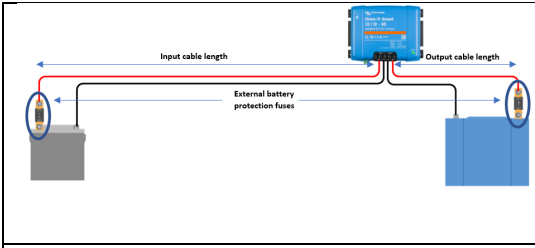


Figure 5: Cable and fuse recommendations

		Minimum cable gauge		
Voltage rating (input or output)	External battery Protection Fuse	1m	2m	5m
12V	60A	10mm^2	10mm^2	16mm^2
24V	30A	6mm^2	6mm^2	10mm^2

4.7 Recommended torque

Figure 6: Recommended torque

5. Smart alternator compatibility

The engine is running detection is based on the voltage of the starter battery. The charger is not always able to measure the exact starter battery voltage because of voltage drop over the input cable. The voltage drop is determined by variables like current, cable length and cable gauge. The “engine on detection sequence” (see figure 7) will perform periodic tests to determine the exact starter battery voltage during charging. The test result determines if the engine is running and charging can be enabled.

This feature is only active in charger mode and when “engine detection override” is not activated. In converter mode the “input voltage lock-out” determines when the output is active.

Configurable with VictronConnect

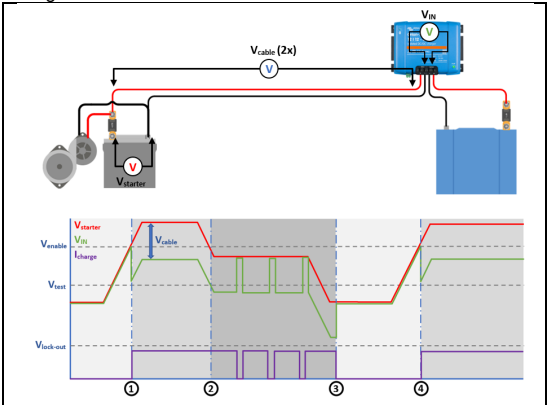


Figure 7: Engine on detection sequence

0 → 1:
When the engine runs the alternator voltage will ramp-up, when $V_{starter}$ increases above V_{enable}, charging starts.
1 → 2*:*
Due to the charge current a voltage drop will occur across the input cable (V_{cable}), this voltage reduces the voltage at the input of the charger (V_{IN}). While V_{IN} remains above V_{test}, charging is enabled.
2 → 3:
If V_{IN} drops below V_{test}, the “engine on detection sequence” is started. Every 2 minutes the charger is paused for 10 seconds to measure the voltage. Without current flow V_{IN} is equal to $V_{starter}$, if V_{IN} is above V_{test}, charging will resume. While remaining in this state, the test is performed every 2 minutes.
3 → 4:
During the detection sequence V_{IN} dropped below V_{test}, this means that the engine stopped running and charging must be stopped, the charge sequence is paused.
4 → 5:
V_{IN} increases above V_{enable}, the charge sequences continues.

6. LED stated

The blue LED is dedicated to Bluetooth functionality and the green LED to product state.

Status LED (Green LED)

- *LED off*:
  - No input voltage;
  - Remote shutdown;
  - Shutdown by the user;
  - Connector over-temperature protection
  - User defined under voltage lock-out
  - Engine off detected (when in Charger mode)
- *LED on*:
  - Output active on DC/DC Converter Mode;
  - Charger in Float State (Battery charged);
- *LED Blinking at 1.25Hz*:
  - Charger in Bulk or Absorption State (Battery is being charged);

BLE LED (Blue LED)

- LED *off*:
  - No input voltage;
- LED *Blinking at 0.33 Hz*:
  - Error – needs to be checked on VictronConnect;
- LED *Blinking at 1.25 Hz*:
  - Connected via Bluetooth;
- LED *Blinking at 2.5 Hz*:
  - Identify;
- LED *on*:
  - All other conditions;

7. Specifications

Orion-Tr Smart Charger Isolated 220-280 Watt	12/12-18 (220W)	12/24-10 (240W)
Input voltage range (1)	8-17V	8-17V
Under voltage shut down	7V	7V
Under voltage restart	7,5V	7,5V
Nominal output voltage	12,2V	24,2V
Output voltage adjust range	10-15V	20-30V
Output voltage tolerance	+/- 0,2V	
Output noise	2mV rms	
Cont. output current at nominal output voltage and 40°C	18A	10A
Maximum output current (10 s) at nominal output voltage	25A	15A
Short circuit output current	40A	25A
Cont. output power at 25°C	280W	280W
Cont. output power at 40°C	220W	240W
Efficiency	87%	88%
No load input current	< 80mA	< 100mA
Standby current	Less than 1mA	
Galvanic isolation	200V dc between input, output and case	
Operating temperature range	-20 to +55°C (derate 3% per °C above 40°C)	
Humidity	Max. 95% non-condensing	
DC connection	Screw terminals	
Maximum cable cross-section	16mm² AWG6	
Weight	1,3 kg (3 lb)	
Dimensions hxwxd	130 x 186 x 70 mm (5.1 x 7.3 x 2.8 inch)	
Standards: Safety Emission Immunity Automotive Directive	EN 60950 EN 61000-6-3, EN 55014-1 EN 61000-6-2, EN 61000-6-1, EN 55014-2 ECE R10-5	

Specifications - continuation

Orion-Tr Smart Charger Isolated 220 – 280 Watt	24/12-20 (240W)	24/24-12 (280W)
Input voltage range (1)	16-35V	16-35V
Under voltage shut down	14V	14V
Under voltage restart	15V	15V
Nominal output voltage	12,2V	24,2V
Output voltage adjust range	10-15V	20-30V
Output voltage tolerance	+/- 0,2V	
Output noise	2mV rms	
Cont. output current at nominal output voltage and 40°C	20A	12A
Maximum output current (10 s) at nominal output voltage	25A	15A
Short circuit output current	50A	30A
Cont. output power at 25°C	300W	320W
Cont. output power at 40°C	240W	280W
Efficiency	88%	89%
No load input current	< 100mA	< 80mA
Standby current	Less than 1mA	
Galvanic isolation	200V dc between input, output and case	
Operating temperature range	-20 to +55°C (derate 3% per °C above 40°C)	
Humidity	Max. 95% non-condensing	
DC connection	Screw terminals	
Maximum cable cross-section	16mm² AWG6	
Weight	1,3 kg (3 lb)	
Dimensions hxwxd	130 x 186 x 70 mm (5.1 x 7.3 x 2.8 inch)	
Standards: Safety Emission Immunity Automotive Directive	EN 60950 EN 61000-6-3, EN 55014-1 EN 61000-6-2, EN 61000-6-1, EN 55014-2 ECE R10-5	

Specifications - continuation

Orion-Tr Smart Charger Isolated 360 – 400 Watt	12/12-30 (360W)	12/24-15 (360W)
Input voltage range (1)	10-17V	10-17V
Under voltage shut down	7V	7V
Under voltage restart	7,5V	7,5V
Nominal output voltage	12,2V	24,2V
Output voltage adjust range	10-15V	20-30V
Output voltage tolerance	+/- 0,2V	
Output noise	2mV rms	
Cont. output current at nominal output voltage and 40°C	30A	15A
Maximum output current (10 s) at nominal output voltage	40A	25A
Short circuit output current	60A	40A
Cont. output power at 25°C	430W	430W
Cont. output power at 40°C	360W	360W
Efficiency	87%	88%
No load input current	< 80mA	< 100mA
Standby current	Less than 1mA	
Galvanic isolation	200V dc between input, output and case	
Operating temperature range	-20 to +55°C (derate 3% per °C above 40°C)	
Humidity	Max. 95% non-condensing	
DC connection	Screw terminals	
Maximum cable cross-section	16mm² AWG6	
Weight	12V input and/or 12V output models: 1,8 kg (3 lb) Other models: 1,6 kg (3.5 lb)	
Dimensions hxwxd	12V input and/or 12V output models: 130 x 186 x 80 mm (5.1 x 7.3 x 3.2 inch) Other models: 130 x 186 x 70 mm (5.1 x 7.3 x 2.8 inch)	
Standards: Safety	EN 60950	
Emission	EN 61000-6-3, EN 55014-1	
Immunity	EN 61000-6-2, EN 61000-6-1, EN 55014-2	
Automotive Directive	ECE R10-5	

1) If set to nominal or lower than nominal, the output voltage will remain stable within the specified input voltage range (buck-boost function).
If the output voltage is set higher than nominal by a certain percentage, the minimum input voltage at which the output voltage remains stable (does not decrease) increases by the same percentage.

Note 1) The VictronConnect App will not display current in or current out.

Note 2) The Orion-Tr Smart DC-DC Charger Isolated is not equipped with a VE.Direct port.

Specifications - continuation

Orion-Tr Smart Charger Isolated 360 – 400 Watt	24/12-30 (360W)	24/24-17 (400W)
Input voltage range (1)	20-35V	20-35V
Under voltage shut down	14V	14V
Under voltage restart	15V	15V
Nominal output voltage	12,2V	24,2V
Output voltage adjust range	10-15V	20-30V
Output voltage tolerance	+/- 0,2V	
Output noise	2mV rms	
Cont. output current at nominal output voltage and 40°C	30A	17A
Maximum output current (10 s) at nominal output voltage	45A	25A
Short circuit output current	60A	40A
Cont. output power at 25°C	430W	480W
Cont. output power at 40°C	360W	400W
Efficiency	88%	89%
No load input current	< 100mA	< 80mA
Standby current	Less than 1mA	
Galvanic isolation	200V dc between input, output and case	
Operating temperature range	-20 to +55°C (derate 3% per °C above 40°C)	
Humidity	Max. 95% non-condensing	
DC connection	Screw terminals	
Maximum cable cross-section	16mm² AWG6	
Weight	12V input and/or 12V output models: 1,8 kg (3 lb) Other models: 1,6 kg (3.5 lb)	
Dimensions hxwxd	12V input and/or 12V output models: 130 x 186 x 80 mm (5.1 x 7.3 x 3.2 inch) Other models: 130 x 186 x 70 mm (5.1 x 7.3 x 2.8 inch)	
Standards: Safety Emission Immunity Automotive Directive	EN 60950 EN 61000-6-3, EN 55014-1 EN 61000-6-2, EN 61000-6-1, EN 55014-2 ECE R10-5	

1) If set to nominal or lower than nominal, the output voltage will remain stable within the specified input voltage range (buck-boost function).
If the output voltage is set higher than nominal by a certain percentage, the minimum input voltage at which the output voltage remains stable (does not decrease) increases by the same percentage.

Note 1) The VictronConnect App will not display current in or current out.

Note 2) The Orion-Tr Smart DC-DC Charger Isolated is not equipped with a VE.Direct port.