



INSTALLATION MANUAL

Belt Power belt driven generator

W-BD 3.5 / W-BD 5: 230V 50Hz



Art.nr. 40200591

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1 INTRODUCTION

1.1 GENERAL

This installation manual applies to the installation of the Belt-Power belt driven generators, first launched in June 2010. This manual is valid for the following models:

Part number	Description
41301000	W-BD 3.5, 230V 50 Hz
41302000	W-BD 5, 230V 50 Hz

For other models and products see our website:
www.whisperpower.eu.

FIRST READ THE SAFETY CHAPTER IN THE USERS MANUAL!



WARNING

A warning symbol draws attention to special warnings, instructions or procedures which, if not strictly observed, may result in damage or destruction of equipment, severe personal injury or loss of life.



DANGER

This danger symbol refers to electric danger and draws attention to special warnings, instructions or procedures which, if not strictly observed, may result in electrical shock which will result in severe personal injury or loss of life.



WARNING!

Before working (installation) on the system read the section safety instructions in the user's manual



WARNING!

Never connect the inverter output to a 230V connection of the public grid.

When a connection to the public grid is required, a "shore" or "land" power source selector switch must be installed between the inverter and the boat's/vehicle's electrical system.

1.2 THE APPLICATION OF BELT DRIVEN GENERATOR

1.2.1 Belt driven generators

A belt driven generator is a very good solution for vehicles and small boats that require AC power and does not have enough space for a diesel generator. As the inverter works independently from a battery the installation is not as

heavy as a battery based inverter system and also more efficient, because a fully battery based inverter system has a battery efficiency loss of at least 20% + a transformer loss of 10%. Especially when high power is needed from 2 kW up to 5kW the belt driven generator system is superior.

For some applications where power is needed while the vehicle cannot run or when the engine runs at a too low speed (RPM) a combination with a battery based inverter/charger (COMBI) system is recommended.

While the engine is not running (or running at too low speed) the battery based inverter can take care of power supply and when the engine is running again the belt driven generator can charge the batteries via the charger. As both inverters can work in parallel, they can work together to provide extra power for short periods or handle inrush currents for motor starting (starting up air conditioners or compressors).

1.2.2 How does it work

A special designed generator (generator) has to be mounted on an available engine such as the main automotive engine or propulsion engine in a boat.

This generator generates a high voltage between 200 Volt and 340 Volt (on a very high frequency) that is converted to a 230 Volt 50 Hz sine wave output by a special designed inverter, independently of the rpm of the engine with a very high efficiency of about 94%.

There are two benefits that makes this system superior to systems that work on low DC voltage (12V or 24V). First high voltage means low currents and little resistant losses and thinner cables.. Secondly the inverter does not need to transfer a low battery voltage up to 230 Volt which saves a transformer or step up module. All together the efficiency is much higher and the installation much easier.

There are two hurdles to overcome to apply a belt driven generator successfully. This manual will help to deal with these issues:

- One has to mount the generator in a proper way on the engine.
- One has to determine the RPM of the generator and calculate the drive pulleys in a way that the rpm will match the application.

2 INSTALLATION

2.1 GENERAL

To ensure reliability and durability of the equipment, it is very important that the installation is carried out with the utmost care and attention. To avoid problems, such as temperature problems, noise levels, vibration, extreme wear out, etc. the instructions set out in this manual must be followed and all installation work must be carried out professionally.

2.2 LOCATION

When looking for a proper place for the generator in a vehicle all relevant aspects have to be taken into account:

Generator

- Accessibility: When selecting the location area in which to mount the generator, make sure there is sufficient room to carry out any maintenance work. The unit must be easily accessible on the distribution side to have access to the V-belt.
- Create a solid mounting position
- Find space to mount the generator
- In a boat: mount the generator high enough to avoid water damage from the bilge. In a vehicle: mount the generator high enough to avoid damage from splashing water and dirt from the road.

Inverter

- Accessibility: Take care one has access to the control on the inverter box. When using a remote control this will be less important.
- Find a dry and clean place protected from strong vibrations. Do not expose the Inverter Box to rain, snow, spray, bilge water or dust.
- Mount the inverter box not too far from the generator to keep the cables short
- Provide fresh air for cooling. Do not cover or obstruct the ventilation openings. Overheating may cause malfunction. Do not install the Inverter Box in a zero-clearance compartment. This may result in overheating.
- The inverter contains components which can produce arcs or sparks. To prevent fire or explosion do not install in compartments containing batteries or flammable materials or in locations which require ignition protected equipment. This includes any space containing gasoline-powered machinery, fuel tanks or joints, fittings and other connections between components of the fuel system.

Remote control

An optional remote control is available and can be mounted on the dashboard of the vehicle/boat, or in an other place from where one wants to operate the BeltPower.

2.3 VENTILATION

The inverter normally draws air from the compartment and circulates the air, that will be warm when coming out. The same is true for the generator.

With natural ventilation the compartment must have ventilation openings of adequate size and location to enable the inverter and generator to operate without overheating.

On cars the generator will be cooled by air in the relative open engine compartment. In boats the engine compartment could be almost closed. When this is the case the instructions below must be followed.

A "sealed" compartment must have a good extraction ventilator to maintain reasonable temperatures. High temperature ambient air reduces inverter/generator performance. To minimise these effects the room temperature must not be more than 15°C above the outside ambient air temperature.

Apply a combination of ventilators, blowers and air intake ducting to meet the temperature limit. The air inlet ducts should run to the bottom of the compartment to circulate fresh air. Air outlets should be at the top of the compartment to remove the hottest air. A compartment blower should be used as an extraction ventilator to remove air from the compartment.

In cases where it is impossible to meet the above mentioned temperature limit by using compartment ventilation, connections are to be made for an air inlet directly to the inverter/generator. With these connections the inverter/generator can be directly connected to an air duct. Air inlets should be louvered, where appropriate, to protect the room and to protect the generator from rain and water spray.

2.4 CONNECTIONS

Shielded cable

The belt driven generator comes with the special shielded cable between generator and inverter. The connections are marked 1 to 5 as shown in figure 2. The inner copper shield is used for grounding (yellow/green) Refer to 2.8 for details.

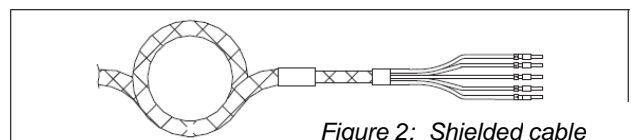


Figure 2: Shielded cable

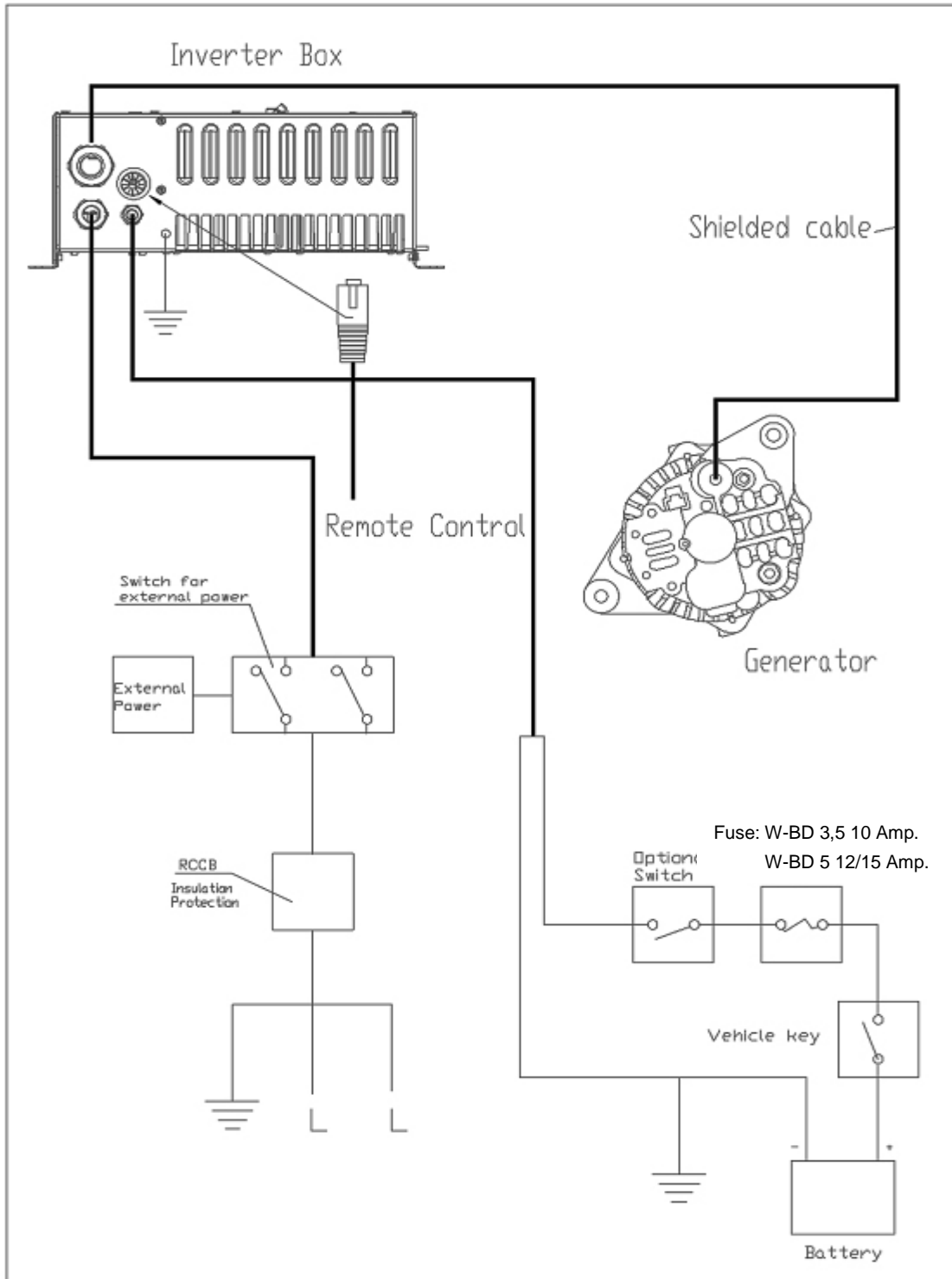


Figure 1: general lay out of the system

Remote control cable

When an optional remote control panel is in the delivery a 5 m connection cable will be included. A 10 m and a 15 m cable is available on request.

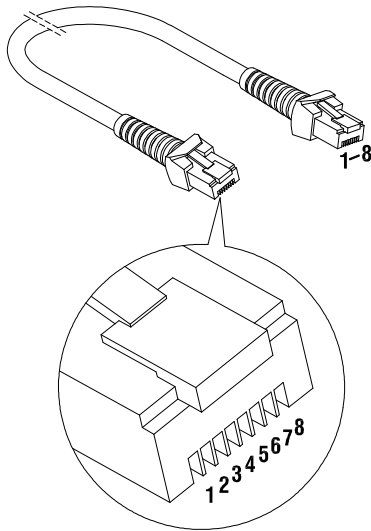


Figure 3: Remote control cable

Output cable

The output cable is not included, but it can be any cable of appropriate rating and length to accommodate the application. Refer to 2.7

2.5 LOW VOLTAGE DC CONTROL SYSTEM

The electrical control system for the W-BD 3.5 is standard 12 to 24 Volt DC and self ranging. The electrical control system for the W-BD 5 is standard only 12V. When needed a small 12V to 24V converter can be supplied. This power is taken from the cars/boats starting battery. When operating there is no significant power consumption. When the unit is off there will be no consumption at all.

A DC 2 wire supply cable 2 x 2.5mm² has to be connected to the vehicle (boat) starter key and should be fused W-BD 3,5 with a **10 Amps fuse** and the W-BD 5 **12/15 Amps fuse**. This current is only drawn when the engine is starting up.

An additional switch could be applied. Refer to figure 1 and to 2.4-3 figure 8.

2.6 CONTROL

A local control panel is on the inverter box. A remote control is optional. A 5 m intermediate 8 pole communication cable comes with the remote control. (refer to figure 3).

The control (both on the case and the remote) has an on/off switch, a scroll button, 4 LEDs that will signals an alarm if something is wrong (only on the inverter box) and

a display showing specific information on the status of the system, warnings and alarms. Refer to the users manual for a full overview of all signals and displays for operation and for fault finding.

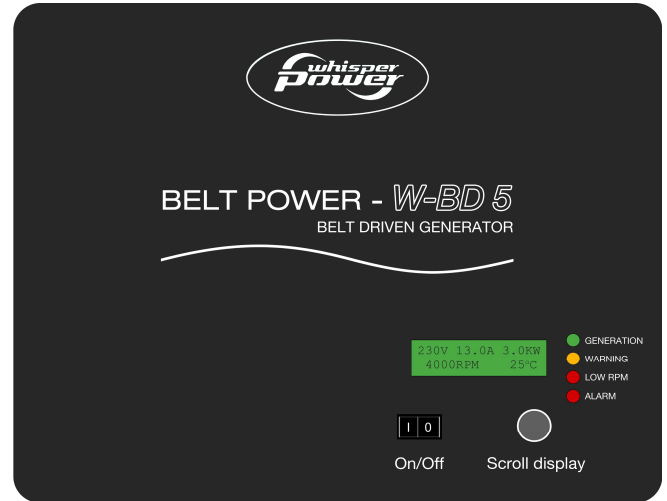


Figure 4: control panel on inverter box

One can mount the remote control on any flat surface and guide the cable in all directions by opening the pre-shaped ports in the sides of the plastic case or drill a hole in the dashboard. For the dimensions see page 15.



Figure 5: remote control panel

2.7 AC POWER SYSTEM (230 VOLT)

The output of the inverter box is 230V AC 50 Hz.



ATTENTION!

Before working (installation) on the system read the section safety instructions



The electric power supplied by the generator is of a high voltage and dangerous to people. Before working (installation) on the system read the sections on safety in the users manual.



Be aware hat people are not used to have 230V available on a vehicle. Put warning signs on wall sockets and on junction boxes.

Instruct non-regular users of the vehicle. Warn maintenance personal of garages that do service on the vehicle.



Generators used on vehicles that are operated in a hazardous environment have often to fulfill special regulations and additional measures have to be taken accordingly.

2.8 CONNECTING THE CABLES

1 GENERATOR OUTPUT CONNECTIONS

The generator has an output voltage between 200V and 340V. The output terminals on the generator and the input terminals in the inverter has to be connected to the shielded cable that comes with the supply. Includes is a kit with installation materials, cable, numbers and glands to

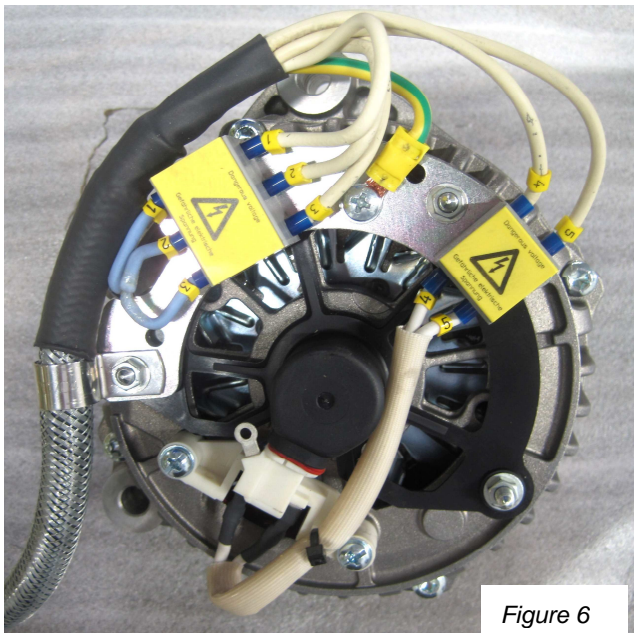


Figure 6



guide the cable through the casing of the inverter.



Do not alter the shielded cable. Do not connect an extension to the shielded cable. Different cable lengths are available from your Whisper Power dealer.

Each cable conductor of the shielded cable is marked with a number 1 up to 5. Connect each cable wire to the terminal with a corresponding number.

1, 2 and 3 are AC1, AC2 and AC 3.

4 and 5 are the auxiliary field wires that control the output.

On the generator the wires has to be fastened with screws M3x1.5. Do not fasten too tight; apply a torque wrench and apply a maximum torque: 0.3 -0.5 Nm.

The cable has to be connected to the inverter with the connector in the delivery accordingly to picture 8 below.



Figure 8

3 POWER SUPPLY

The inverter needs 12V from the battery to control the electronic system. A two wire 2.5mm² cable (not included in the delivery) is used to connect the inverters to the "contact key" of the drive engine. A fuse of 3 amp should be applied to protect the circuit and an additional on/off switch could be applied. The 2 p delivery must be used according to f



Figure 9

4 INVERTER OUTPUT CONNECTIONS

Figure 10 shows where to connect the AC output connection cable. All electrical connections, cable types and sizes must comply with the appropriate national regulations.

Yellow/green – earth/grounding.

Next is -0- (neutral) and on the right L1 (line).

For the power cable we recommend the use of 3 wire single phase oil resistant cable with a sufficient cross sectional area. One wire for earth is included. For long

cables it is recommended to apply cables with a larger cross section (refer to ISO 13297 annex A).

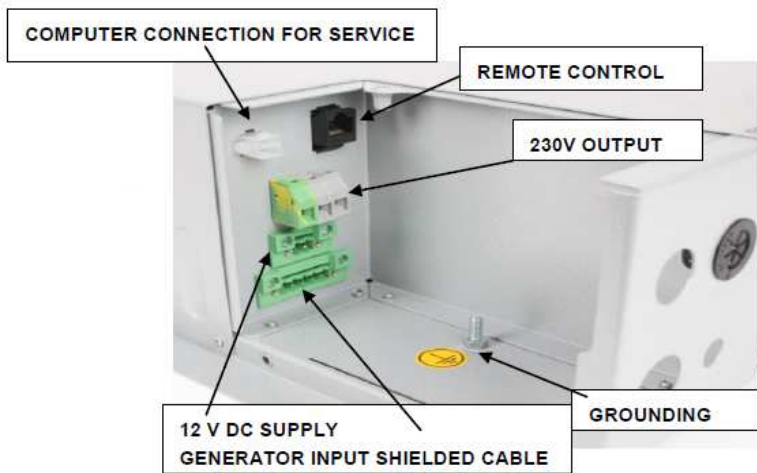


Figure 10: inverter connections



Figure 11

INSTALLATION MATERIALS INCLUDED

The following table give a recommendation for cables that are rated accordingly:

Model	Maximum single phase output current
W-BD 3.5	16 Amps 3x 2.5mm ² max 100 m
W-BD 5	25 Amps 3x4 mm ² max 100 m

Be sure that all electrical installations (including all safety systems) comply with all required regulations of the local authorities. All electrical safety/shutdown and circuit breaking systems have to be installed onboard as the inverter itself cannot be equipped with such equipment for every possible variation.

The vehicle's/boat's power supply system should be suitable and safe for the AC voltage which is applied and the power that will be generated. Special attention has to

be paid on dividing the system in branches which are fused individually. It is absolutely essential that each and every circuit in the electrical system is properly installed by a qualified electrician.

5 FUSE

An output fuse (between the inverter set and the electrical installation) should be installed to protect the installed electrical system. The following maximum single phase output current applies:

Model	Maximum single phase output current
W-BD 3.5	16 Amps
W-BD 5	25 Amps

The fuses must be of the slow reacting type. For electrical motors connected to the system, a motor protection switch could be installed

6 GROUNDING

The AC output generator windings are **NOT** grounded. The housing of the generator, inverter and all other metal parts are grounded.

There is a connection between the housing of the generator and the housing of the inverter to be made by the yellow green wires that is connected to in inner copper sheet of the shielded cable inverter. Also the 230 v output cable should have a yellow/green wire for grounding. The L1 and -0- of the 230V AC output wiring are **NOT** grounded.

To make a connection between “neutral” and “ground” of the AC 230V output could be necessary as part of a specific insulation failure protection system. This should only be done by experts when installing such an insulation failure system, earth leakage system or RCCB.

It is possible that the electric installation in the vehicle must be protected against insulation failures. Methods of protection are subjected to rules that can be different depending on the use of the vehicle and local standards. Experts in this field should be consulted

The same is true for boats. Pleasure craft smaller than 24 m in Europe is subjected to the CE recreational craft directive that refers to ISO 10133 (DC) and ISO 13297 (AC).

7 TRANSFER SWITCH

When a connection to the public grid is required, a “shore” or “land” power source selector switch much be installed between the inverter and the boat's/vehicle's electrical system. This switch must ensure that all AC consumers can be switched off at once. This switch should also be installed to keep the inverter set and shore (grid) power systems separate.

Transfer switches - to switch over from a land line to vehicle or from generating set to the inverter - should be well designed to switch over all wires including neutral (and not only phases or line) and there should be provisions with the aid of timers to prevent relays from clattering.

A manual double pole transfer switch with a -0- position in the middle is the most simple, reliable and low cost solution.

When an automatic switch is preferred WhisperPower recommends the installation of a WhisperPower Systemswitch as the power source selector. This switch works automatically when the generator is off, the input remains in the land line position and as soon as the generator is operating the Systemswitch switches automatically after 10 seconds delay time over to the generating set position.



In all situations the transfer switches between land line, inverter and generator should switch both neutral and L1. Of course this is the case when using a WhisperPower transfer switch.

2.9 INSTALLATION OF THE GENERATOR

1 Determine the pulley diameter design

Relation between pulley diameter and output power:

The graphs on the next page show the available power corresponding to the generator speed.

First one need to know the engine speed = crankshaft speed when idling and at full speed. When the drive pulley is not on the crankshaft the rpm of the pulley drive shaft must be determined.

The pulleys should be selected in such a way that at low speed the generator can bring the power required. The speed of 2 pulleys relate to each other proportional to the diameter of the pulleys.

Example 1): Assume that applying a W-BD3.5 one need 1 kW at idle (stationary speed); according to the graph the generator must run 2400 RPM.

When the engine speed is only 800 RPM the pulley ratio must be 1 to 3. However the max. speed must not exceed 15000 RPM. When the max speed of the engine is 4500 RPM; the generator speed at full speed will be 13.500 RPM (3x4500 rpm). This is below 15000 rpm and is OK!

Example 2): When one need 3 kW at idle speed the generator must have 3500 RPM. The Pulley ratio must be 4.4. At full speed the generator rpm will be 19.800 RPM (4.4x4500); this is too much; and is NOT OK.

Max power at idle will be $15000/4500=3.33 \times 800 \text{ RPM}=2.8 \text{ kW}$. Further more the engine must be capable to bring 2.8

kW at 800 RPM. In most cases the engine of a Van or 4WD will be strong enough. Further one could increase the engine idle speed to 900 RPM.

In the calculations above we started at idle speed. One has to check if the max power is also available on the speed that will be available when one needs it. For 3.5 kW one need 4500 RPM.



ATTENTION!

The W-BD5 model needs 6500 RPM to generate 5 kW. Compared with the W-BD3.5 the 5 kW model will also need more RPM (3200) to generate 1 kW. Refer to the graph.



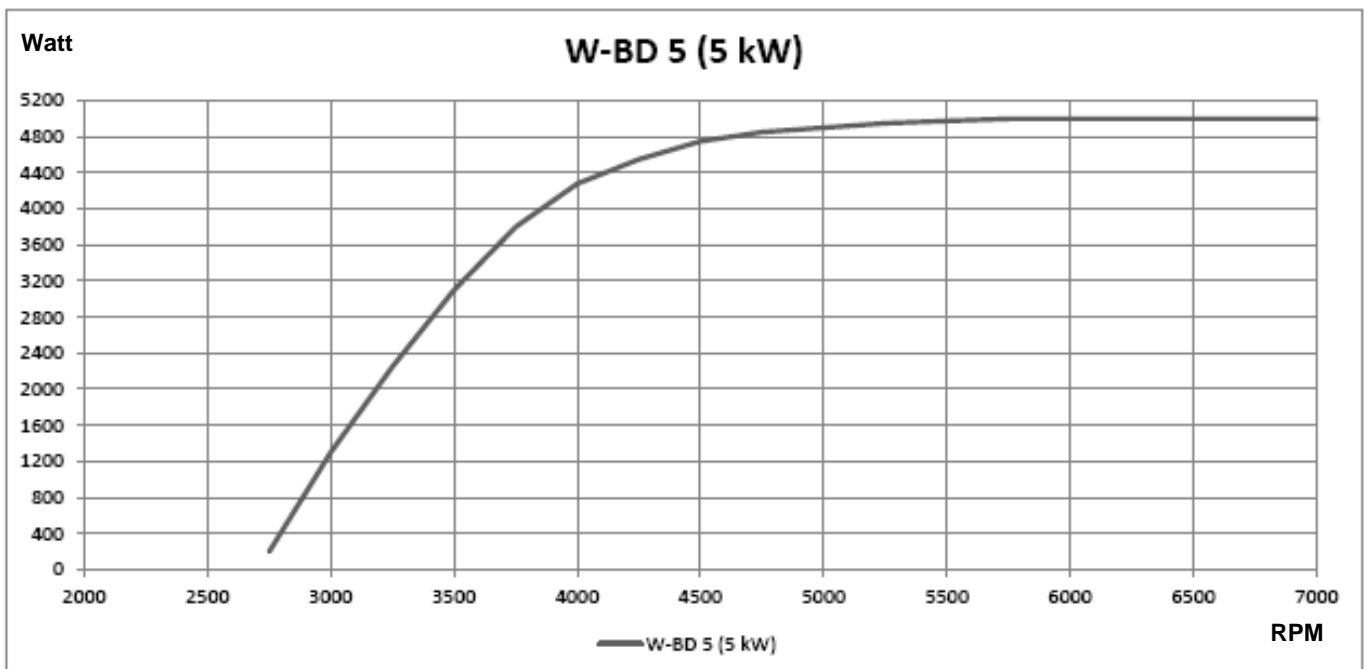
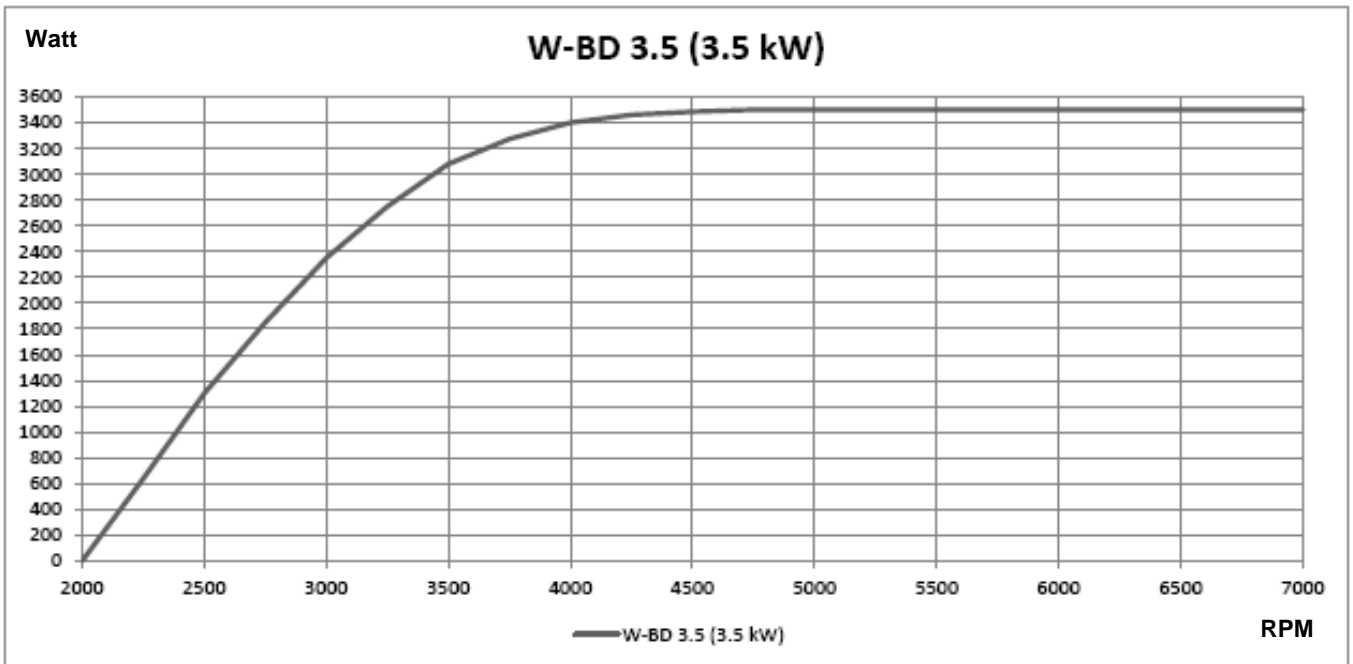
ATTENTION!

For some "3.5 kW installations" WhisperPower advices a 5 kW generator in combination with a 3.5 kW inverter. In this case the RPM must be selected according to the W-BD 5 diagram.

2 Temporarily increase of idle speed

When one need more power at idle than according to the calculation is allowed one could increase the idle speed of the engine temporarily by means of a speed control. This could be a manual (pull cable type) control or an electric actuator control activated with a push button. It is also possible to operate an electric speed control automatically by the inverter. The inverter has a facility to control an actuator when it needs more power. In general WhisperPower advices to keep the installation as simple as possible, but when necessary automatic speed control can be done. Contact the WhisperPower dealer for additional information on this feature.

SPEED/POWER DIAGRAMS



3 Mounting the generator on the engine

Find a place on the engine where the generator can be mounted. The pulley of the generator should be aligned with the pulley on the crankshaft.

For some car models there are standard brackets available to mount the generator. However as there are many different vehicle brands and models on the market of which the engine configuration can change from year to year, one has to design his own mountings. For fleet owners WhisperPower can offer engineering help and adapt the design to make it a standard.

Otherwise one has to design brackets that are solidly supported by the engine. For applications that require large power at minimal RPM a belt tensioner will be necessary to increase the contact between belt and pulleys.

4 Alignment of the pulleys

The generator pulley must be mounted parallel and aligned to the crankshaft pulley as shown in fig. 9



ATTENTION!

It is of the highest importance that the generator mounting is done properly. Misalignment or too light mounting brackets, or vibrations will shorten the lifetime of the belt and influence the available power.

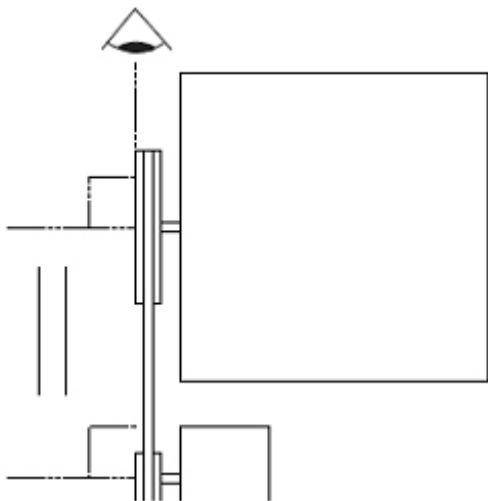


Figure 13: checking the alignment

To obtain a good alignment as possible it may be necessary to put washers (shims) on the generator shaft behind the pulley. As shown in figure 12.

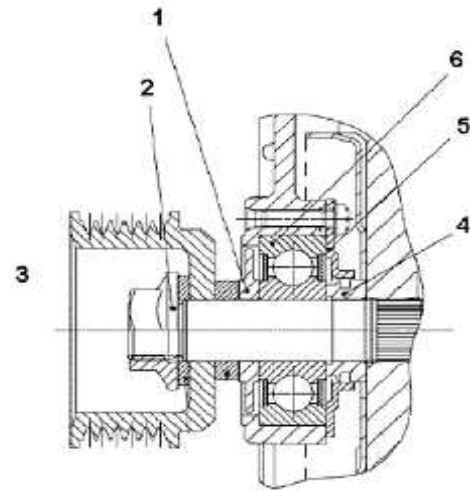


Figure 14

- 1) Large support washer (part of the generator)
- 2) Throat nut (torque 80+ 5 Nm)
- 3) Pulley
- 4) Position ring
- 5) Fixing plate
- 6) Bearing

The washers for alignment should be placed on the large support washer (1) to transfer the force to the shaft. The pulley must press on the position ring and indirectly on the bearing. Without this transmission of the force to the shaft the lifetime of the generator will be decreased extremely.

5 Brackets

There are many vehicles on the market and every model has several different engine arrangements. Moreover this arrangement will change from year to year for each model. For this reason it is very difficult to supply mounting brackets for each vehicle model. In case of a new application WhisperPower can check if brackets are already available. If not WhisperPower dealers can arrange a cooperation with a local workshop that can do the design and make the brackets for a specific vehicle. In case of applications for fleet owners with many cars of the same model WhisperPower engineering department can offer assistance to design and manufacture brackets.

In any case the brackets must assure a solid and stable mounting of the generator. The alignment must be guaranteed; also when the v-belt is on tension and the power demand will pull heavily on the belt. Vibrations must not occur.

Use Loctite to secure bolts and nuts.

One can arrange V-belt tension by designing the brackets with a provision for adjustment.

In general one can make the brackets more simple and the V-belt tension adjustment more effective by applying an idler tensioner pulley. The idler tensioner pulley also extends the contact area between V-belt and pulley.

When the generator is not connected to the engine block, but mounted next to the engine block a V-belt tensioner must be applied. To prevent damage induced by vibrations the mounting bracket parts must be installed without build-in tension.

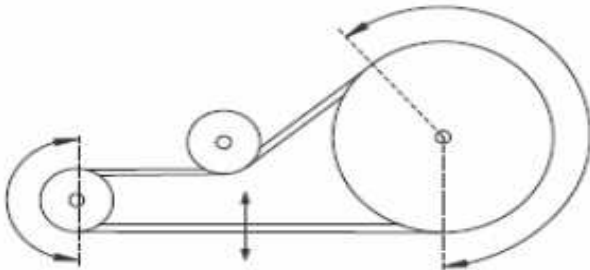


Figure 15: Idler tensioner



Be aware that while changing the load on the generator the belt can strike violently on the non-pulling side.

Tighten the belt according to the instruction of the manufacturers recommendations. A belt too tight or too loose will reduce the life of the belt and generator and will impair the performance of the generator.

6 Pulleys

A poly V belt pulley with 6 grooves and a diameter of 60 mm and an overhang of 5 mm. (refer to the figure 14) is recommended. A 6 groove pulley 50 mm is the minimum diameter that can be applied.

Other pulleys are available on request.

When applying a double groove classic V-belt, a diameter of 75 mm is recommended. In this case 70 mm is the minimum diameter. Refer to the table for available pulleys:

Type	diameter	overhang	Art No
Poly V 6 groove	60 mm	5 mm	41301050
Poly V 6 groove	50 mm	5 mm	41301051
Poly V6 groove OAP*	60 mm		
Double V 12.7 mm	70 mm		41301052

Overrunning Generator Pulley OAP*

Available on request is an Overrunning Generator Pulley or OAP which absorbs vibrations in the belt drive system.



Figure 16: Overrunning Alternator Pulley

2.10 DIMENSIONAL DRAWINGS

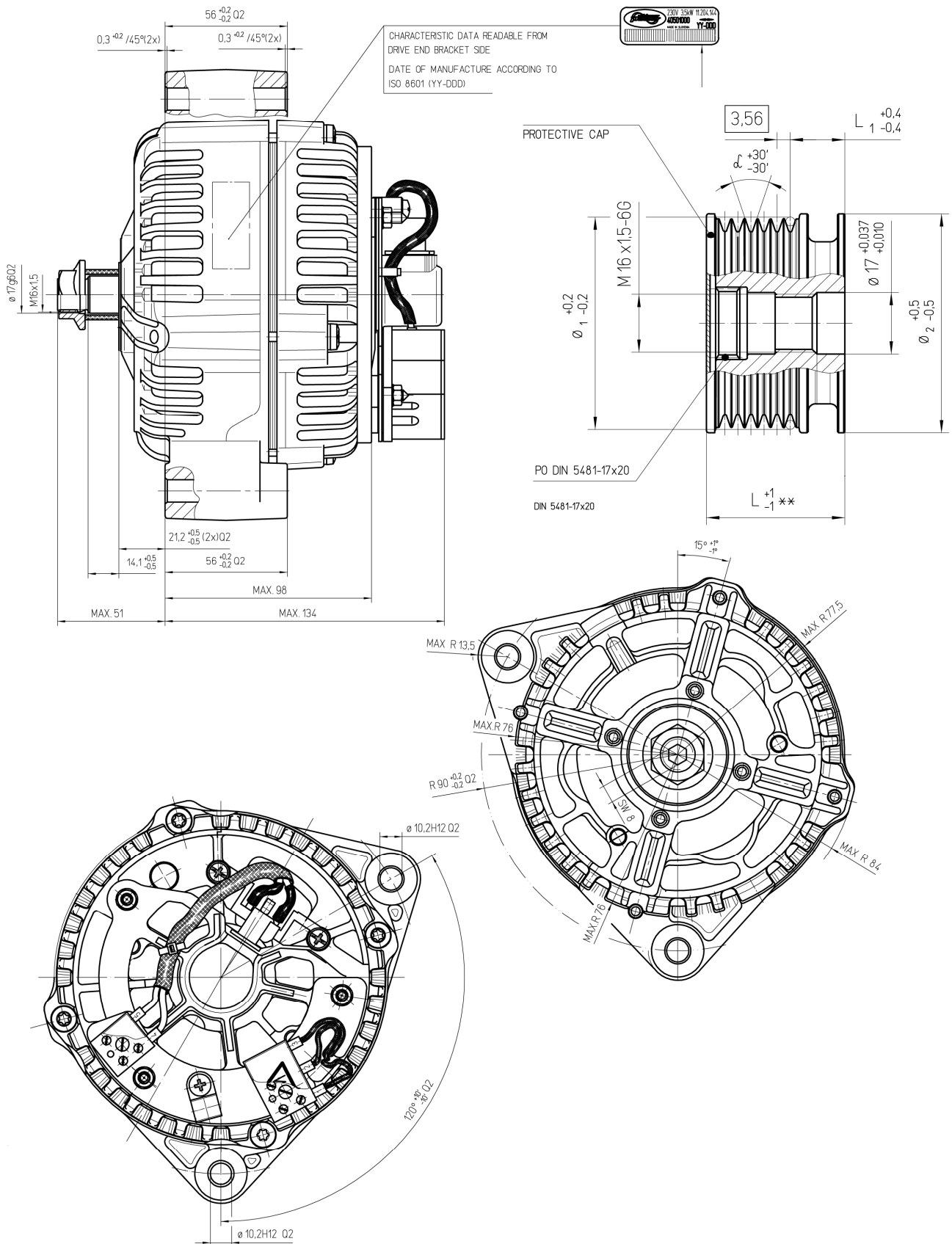


Figure 17

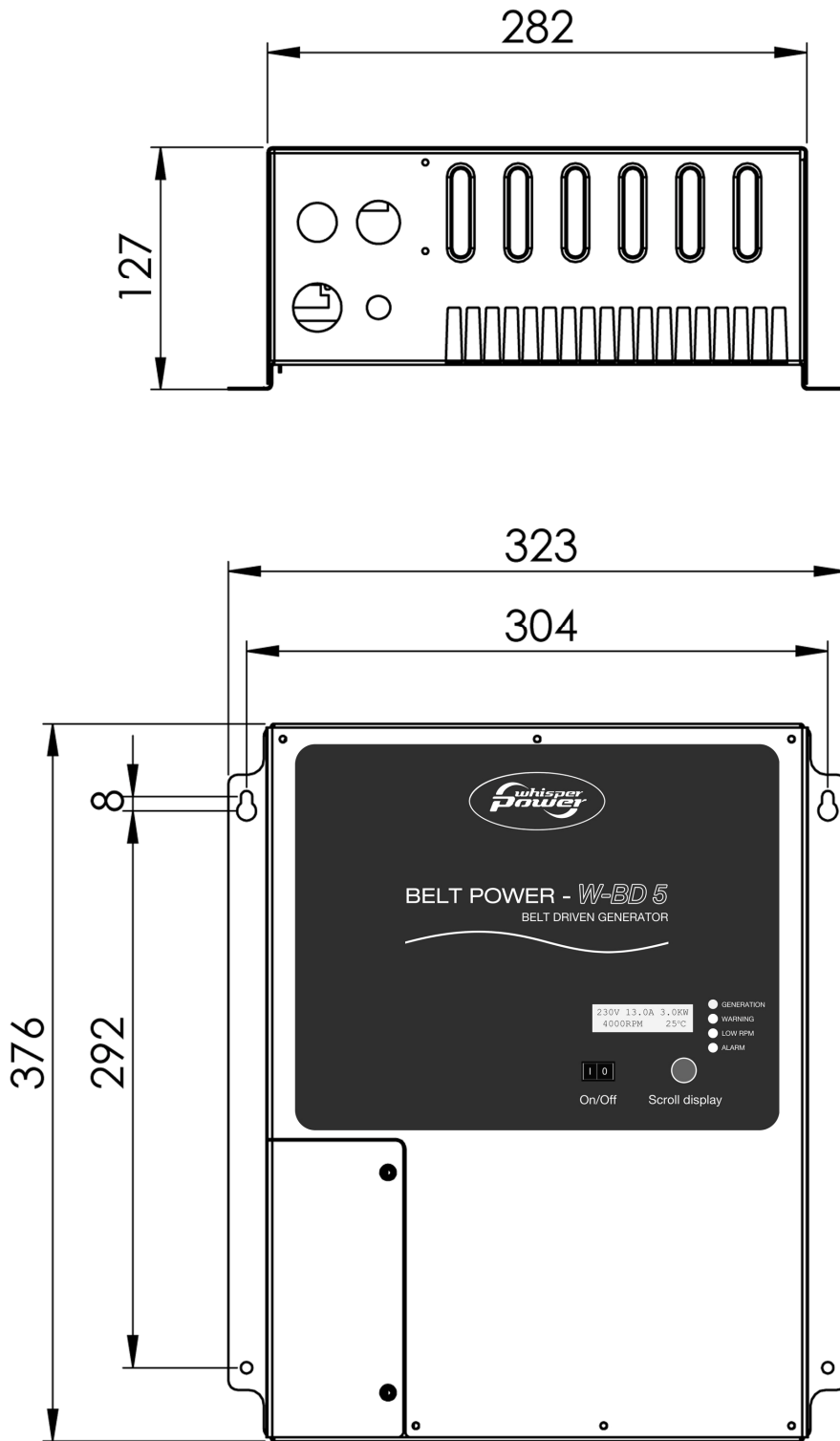


Figure 18: dimensions inverter box W-BD3.5 and W-BD 5

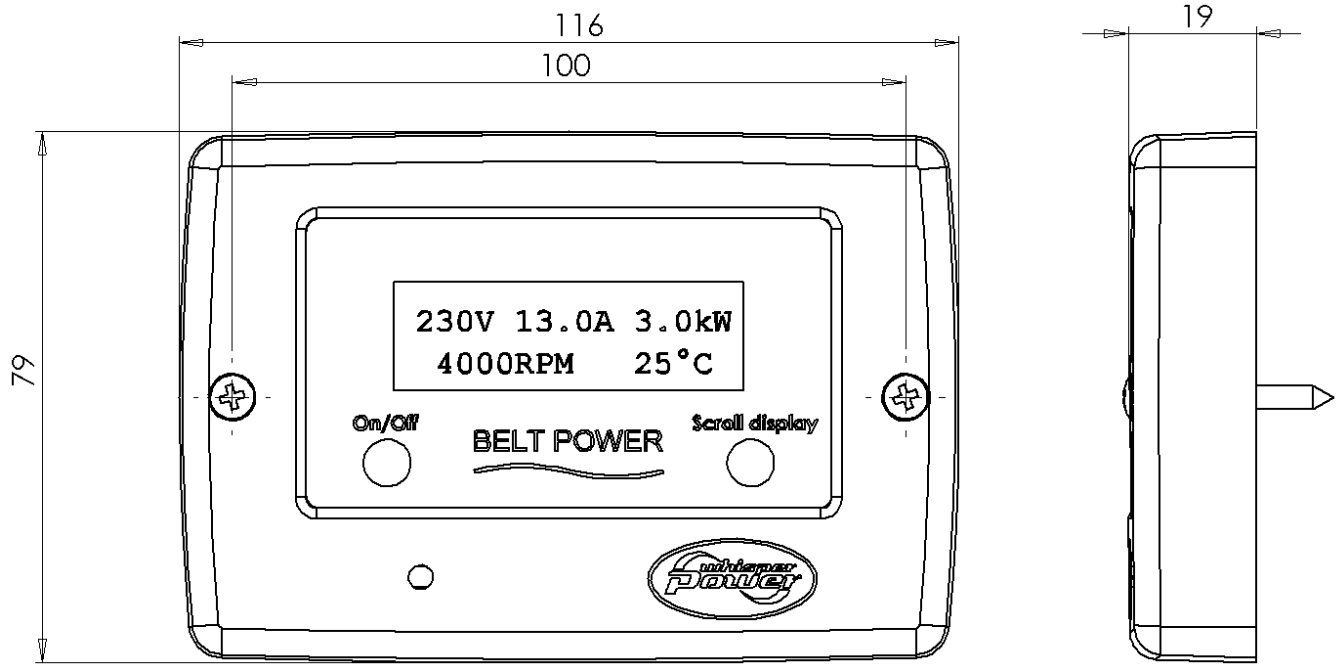


Figure 19: dimensions remote control



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