

Compact and Ultra-light Wind Turbine for Efficient Wind Power

AIRDOLPHIN Series

- Z-1000-250 AIRDOLPHIN GTO
- Z-1000-48 AIRDOLPHIN Pro
- Z-1000-24 AIRDOLPHIN Mark-Zero



Growing with the Wind — For Future Generations™

State-of-the-art technologies for achieving sustainable development

Zephyr's dream is to transform ever-changing winds into clean electric energy, and to make this power available at any location in the world. So we launched Project Z — the most ambitious small wind turbine technology project in Japanese history — combining research and know-how of leading experts in government, academia, and industry.

Project Z spent six years in developing the Airdolphin — a next-generation, lightweight wind turbine that can instantly adapt to changing wind conditions.

Through extensive testing in windy sites around the world, Airdolphin has proven tough, efficient, and reliable. It instantly responds to the vagaries of wind, while delivering over 170 kWh per month at average wind speeds of 6 m/s (13.4 mph).



AIRDOLPHIN Zephyr

Airdolphin GTO



Zephyr

Airdolphin Mark-Zero / Pro

Ten State-of-the-Art Technologies Inside Every Airdolphin

1 Ultra Lightweight

Airdolphin Pro/Airdolphin Mark-Zero weighs only 18 kg (39.7 lbs), while Airdolphin GTO weighs 20 kg (44.1 lbs), allowing installations on existing structures, rooftops, and other sites previously not possible with heavier machines. It also dramatically improves responsiveness to volatile wind conditions for efficient power production. We call this feature Airdolphin's "Dynamic Wind Capturability".

2 Swing Rudder System

Our patented Swing Rudder System is an attitude control system inspired by the tail fins of fish, which allows the turbine to instantly respond to subtle wind shifts for improved power generation.



3 Intelligent Power Management System

With our original patented technologies, the intelligent power management system (patent pending) allows for consistent blade rotation speed when encountering turbulent gusts. Even during hurricanes, Airdolphin can still deliver stable output power after reaching peak wind speed. This is a crucial attribute for small wind turbines which often face turbulence caused by tall city buildings. When the wind speed exceeds 20 m/s (44.7 mph), Airdolphin continues delivering output power at a reduced rotation speed with no need for cut-out. This outstanding performance is achieved by software driven microprocessors. Airdolphin also has various safety features enabling it to detect adverse conditions for automatic shut down.



Generator and Control Boards

4 Seamless Response Rotor

The rotor system seamlessly responds to various wind conditions, offering a high wind-to-power conversion factor by utilizing ultra low mass stiff blades, a multi-stagger blended airfoil blade, and a dynamically balanced blade and hub system. These elements work together to constantly control the rotor speed for maximum power output.



Rotor

5 Innovation for Low Noise

The Silent Disrupter (SD) Blade features numerous thin grooves on its surface, which significantly reduce air flow noise. The design was inspired by the wings of an owl that enable it to fly silently while approaching its prey.



SD blade



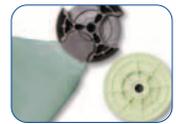
Owl Wing

6 Robust Body Structure

The structure of the body is inspired by Japanese traditional block puzzle structure. This ensures precise fitting and superb resistance to adverse weather conditions, requiring minimum maintenance.



Body Joints



Blade and Hub Cover

7 Power Assist Function

When there is no wind, the Airdolphin uses previously generated power to rotate for 10 seconds every minute. This lets the rotor start up from a subtle wind and efficiently reach the cut-in point. This function also prevents freezing in cold weather.

8 Generator

The light-weight generator achieves remarkably high power density with tightly wound coils and powerful neodymium iron boron magnets. These two features combine to encourage an optimal duty cycle by electronically damping the rotor.

9 Data Communication System

Every Airdolphin comes equipped with an RS-485 protocol wiring harness, allowing both on-site and remote monitoring via our RM-1000* unit and an optional IP address.



RM-1000

10 Life Cycle Assessment

An extensive survey based on Japan's LCA (Life Cycle Assessment) standards showed that an Airdolphin offsets its manufacturing carbon footprint (180 kg CO₂) with less than three months of operation in Japan at an average wind speed of 4.5 m/s (10.1 mph).

Data source: The University of Tokyo's Hirao Laboratory.

*Remote Monitor RM-1000: Displays accumulated generated output (daily, monthly, total) as well as real-time generation output, wind direction/speed, and battery voltage. Features PC connection by wired LAN, flash memory slot, AC adapter, and analog output.

AIRDOLPHIN GTO

The high DC voltage output Airdolphin GTO (Grid-Tie Optimized) is our latest small wind turbine model, rated 1.1 kW at 12.5 m/s (28 mph) with peak instantaneous output reaching 4 kW at 20 m/s (45 mph). Supported by its unique Intelligent Power Management System, the unit maintains seamless operation from cut-in wind speed of just 2.5 m/s (5.6 mph) to extremely windy conditions. Weighing only 20 kg (44 lbs.) with a rotor diameter of only 1.8 m (6"), the Airdolphin GTO is the most efficient and easily installed small wind turbine in its class. Zephyr's Airdolphin Series is engineered and tested for reliability under every condition, providing years of maintenance-free operation.



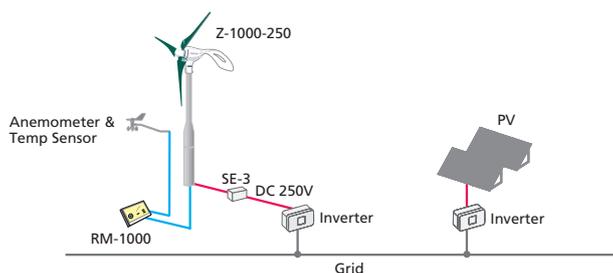
- Specifically designed for utility grid connections
- Peak instantaneous power output of 4 kW at 20 m/s wind speed
- Rated power of 1.1 kW at 12.5 m/s wind speed
- New rotor/turbine control mechanisms (with instantaneous braking) to meet utility needs
- New turbine control system software



On-Grid Systems

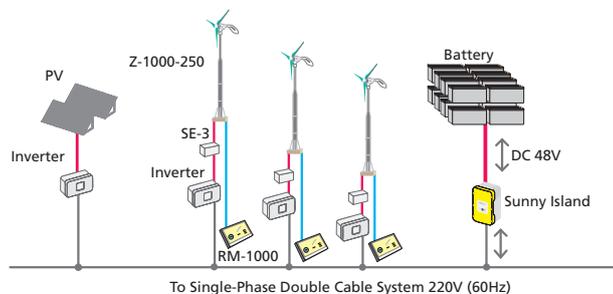
On-Grid System

Airdolphin GTO offers a simple solution for on-grid use.

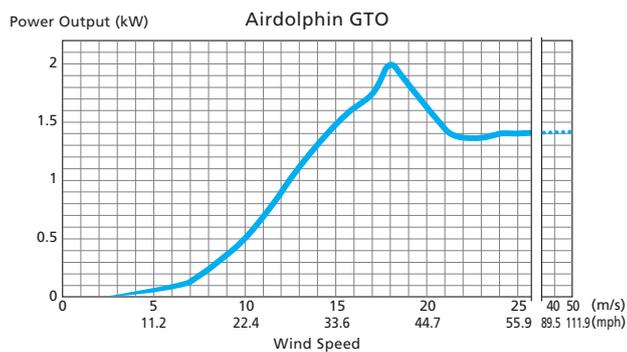


Micro-Grid System

Collaboration with performance evaluated and authorized SMA products has made this micro-grid system a powerful and reliable power source for remote areas, such as off-shore sites and mountainous camps. The main power is provided by single-phase double cable AC 220V (60Hz) or AC 230V (50Hz).



Power Output Characteristics



- Power loss due to inverter efficiency is not taken into account.
- Grid conditions are not taken into account and may affect power output.
- Power output may differ depending on installation site, wind regime, temperature, barometric pressure, and inverter size.
- Above power curve is for reference only.

Energy Production

Airdolphin GTO (Z-1000-250) Energy Production

Avg. Wind Speed m/s (mph)	Per Day (Wh)	Per Month (kWh)	Per Year (kWh)
2 (4.5)	150	5	50
3 (6.7)	720	20	260
4 (8.9)	1,800	50	660
5 (11.2)	3,440	100	1,260
6 (13.4)	5,620	170	2,060
7 (15.6)	8,290	250	3,020
8 (17.9)	11,110	330	4,060
9 (20.1)	13,910	420	5,080
10 (22.4)	16,520	500	6,030

- Theoretical data based on wind analysis, and are not guaranteed figures.
- Energy loss due to inverter efficiency is not taken into account.
- Grid conditions are not taken into account and may affect energy production.
- Energy production may differ depending on installation site, wind regime, temperature, barometric pressure, and inverter size.

Specifications

Model Name	Airdolphin GTO
Model Number	Z-1000-250
Wind Turbine Type	Horizontal axis, up-wind
Rotor Diameter	1,800 mm (5'10-7/8")
Mass	20 kg (44.1 lbs.)
Tower Diameter	48.6 mm (1-15/16")
Number of Blades	3
Blade Construction	Carbon fiber laminate over solid foam core
Blade Mass (per piece)	380 g (13 oz)
Blade Method	Interlock hub mounting
Body Material	Aluminum diecast
Body Construction	Block puzzle structure
Product Finish	Powder coating
Generator	Synchronous-type, three-phase power generator with permanent neodymium iron boron magnet
Control Systems	Built-in original Intelligent Power Management with: 1. Power Assist Function 2. Inverter Standby Function 3. Safety Control 4. Seamless Operation with Continuous Output 5. Data Communication
Protection Circuit	Built-in
Data Logger	Built-in (Total energy production)
Yaw Control	Free yaw (360 degrees)
Direction Control	Original Swing-Rudder System
Start-up Wind Speed	0 m/s (Power Assist Function)
Cut-in Wind Speed	2.5 m/s, 5.6 mph
Rated Power	1.1 kW
Peak Instantaneous Power	4.0 kW (20 m/s, 44.7 mph)
Maximum Rotor Speed	1,280 rpm (20 m/s, 44.7 mph)
Mass per Watt	18 g (0.6 oz)/W (at rated power)
Operating Voltage	274V DC
Operation Temperature	-20 – +60 °C
Braking System	Regenerative electromagnetic braking system
Communication System (Signal Output)	RS-485

AIRDOLPHIN Pro 48V

AIRDOLPHIN Mark-Zero 24V

Airdolphin Pro 48V Off-Grid (Battery System)

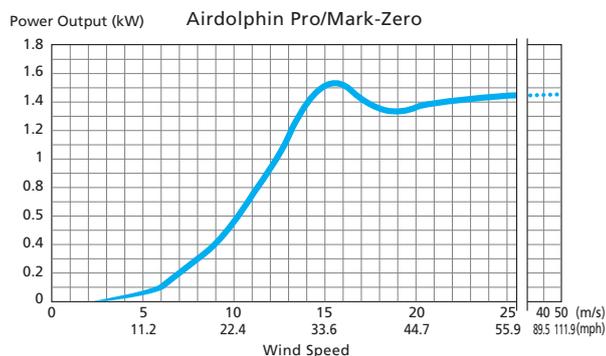
- Mountainous areas
- Ocean areas and islands
- Repeater stations
- Remote monitoring sites (web cameras, GPS receivers, wireless applications)
- Street lights (no utility electricity required)
- Public facilities (dams, weather observatories, etc.)

Telecom System

- Communication base stations



Power Output Characteristics



- Power loss due to battery charge/discharge is not taken into account.
- Load conditions are not taken into account.
- Power loss due to inverter efficiency is not taken into account.
- Power output may differ depending on installation site, wind regime, temperature, barometric pressure, and inverter size.
- Above power curve is for reference only.

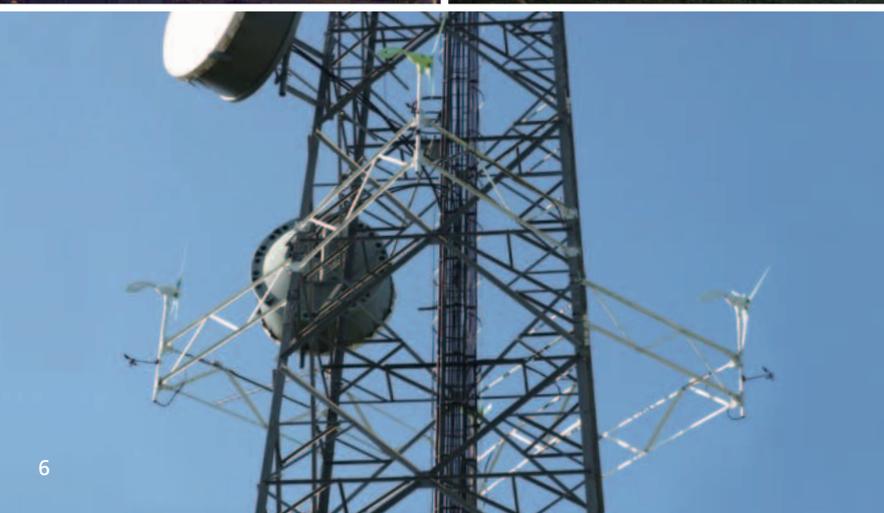
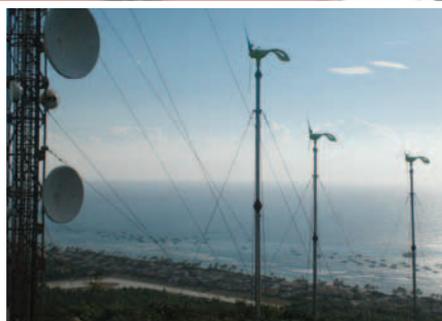
Airdolphin Pro/Mark-Zero (Z-1000-48/Z-1000-24) Energy Production

Avg. Wind Speed m/s (mph)	Per Day (Wh)	Per Month (kWh)	Per Year (kWh)
2 (4.5)	150	5	50
3 (6.7)	720	20	260
4 (8.9)	1,800	50	660
5 (11.2)	3,440	100	1,260
6 (13.4)	5,620	170	2,050
7 (15.6)	8,150	240	2,970
8 (17.9)	10,770	320	3,930
9 (20.1)	13,280	400	4,850
10 (22.4)	15,590	470	5,690

- Theoretical data based on wind analysis, and are not guaranteed figures.
- Energy loss due to battery charge/discharge is not taken into account.
- Load conditions are not taken into account.
- Energy loss due to inverter efficiency is not taken into account.
- Energy production may differ depending on installation site, wind regime, temperature, barometric pressure, and inverter size.

Specifications

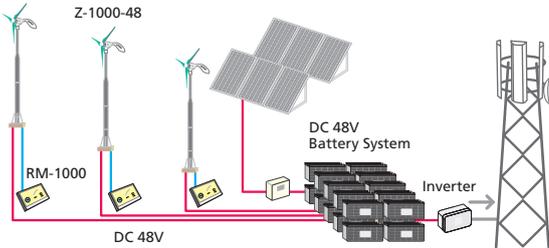
Model Name	Airdolphin Pro / Airdolphin Mark-Zero
Model Number	Z-1000-48 / Z-1000-24
Wind Turbine Type	Horizontal axis, up-wind
Rotor Diameter	1,800 mm (5'10-7/8")
Mass	18 kg (39.7 lbs)
Tower Diameter	48.6 mm (1-15/16")
Number of Blades	3
Blade Construction	Carbon fiber laminate over solid foam core
Blade Mass (per piece)	380 g (13 oz)
Blade Method	Interlock hub mounting
Body Material	Aluminum diecast
Body Construction	Block puzzle structure
Product Finish	Powder coating
Generator	Synchronous-type, three-phase power generator with permanent neodymium iron boron magnet
Control Systems	Built-in original Intelligent Power Management with: 1. Power Assist Function 2. Seamless Power Control Functions 3. Safety Control 4. Battery Charge Management 5. Data Communication
Protection Circuit	Built-in
Data Logger	Built-in (Total energy production)
Yaw Control	Free yaw (360 degrees)
Direction Control	Original Swing-Rudder System
Start-up Wind Speed	0 m/s (Power Assist Function)
Cut-in Wind Speed	2.5 m/s, 5.6 mph
Rated Power	1 kW
Peak Instantaneous Power	2.3 kW (20 m/s, 44.7 mph)
Maximum Rotor Speed	1,000 rpm (20 m/s, 44.7 mph)
Mass per Watt	18 g (0.6 oz)/W (at rated power)
Output Voltage	50V DC (Z-1000-48) / 25V DC (Z-1000-24)
Operation Temperature	-20 – +60 °C
Braking System	Regenerative electromagnetic braking system
Communication System (Signal Output)	RS-485
Recommended Battery Capacity	Deep cycle lead acid battery 500 Ah or more



Typical Off-Grid / Stand-Alone System

Telecom System (48V)

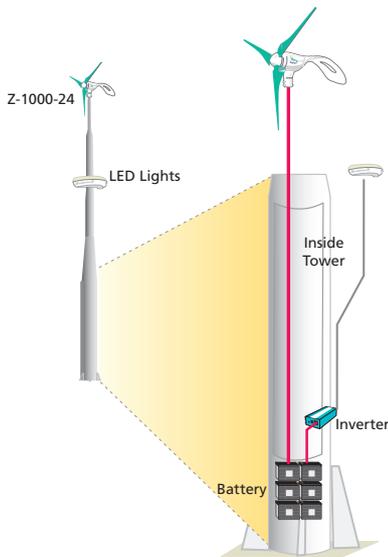
Airdolphin Pro is ideal for adding on to existing cell site towers to provide power and lower diesel costs.



- Airdolphin Mark-Zero 24V Off-Grid (Battery System)**
- Residences in remote areas
 - Remote monitoring sites (web cameras, GPS receivers, wireless applications)
 - Street lights (no utility electricity required)
 - Public facilities (dams, weather observatories, etc.)

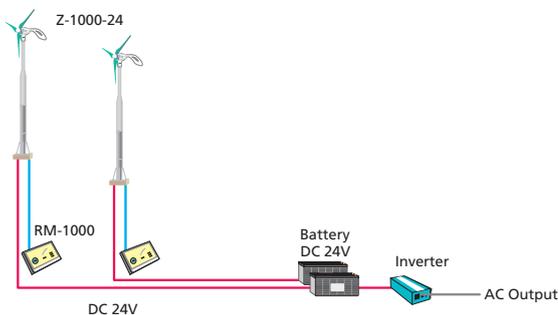
Street Light System (48V/24V)

Airdolphin stand-alone system is an effective way of providing lighting to remote areas.

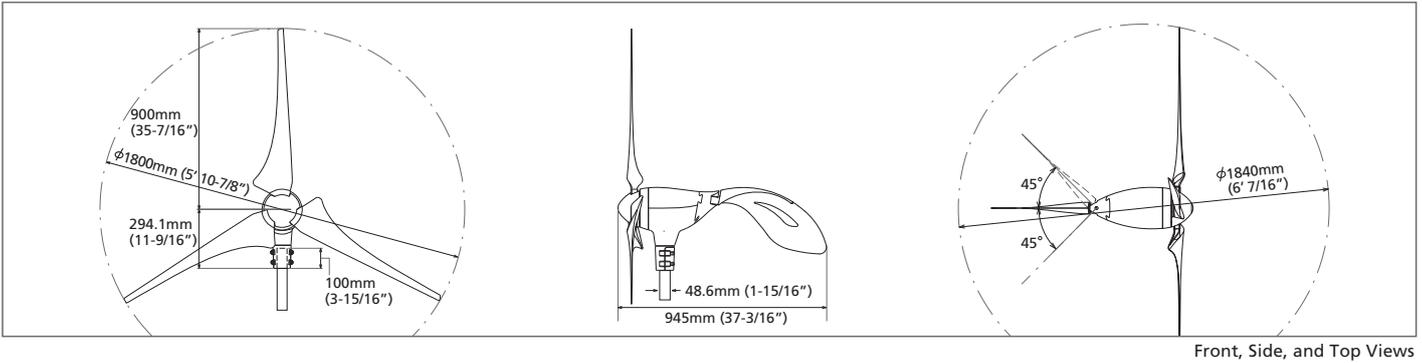


Small Off-Grid System (24V)

This system is ideal for ensuring electrical supply in times of disaster and for camping vehicles, fishing boats and other leisure vehicles.



Outer Dimensions



Front, Side, and Top Views

Airdolphins in Action Around the World



U.K.

Spain

Lithuania

Mongolia

Austria

Brazil

Japan

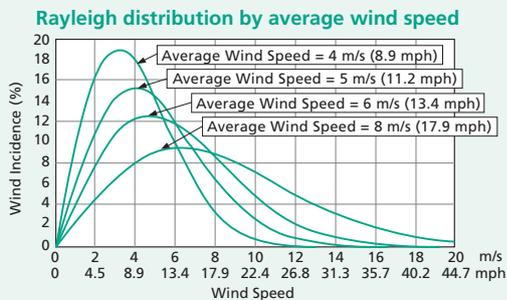
Airdolphin FAQ

Q1 How much energy does it produce?

A1 Please refer to charts on page 5 for Airdolphin GTO and page 6 for Airdolphin Pro and Mark Zero. The figures are calculated based on Rayleigh wind distribution index. Actual wind distribution may differ by location. The figures represent DC power output from the Airdolphin. Therefore, the efficiency of the grid-tie inverter for on-grid systems, the battery charge/discharge loss for off-grid systems, and inverter efficiency for stand-alone systems also need to be considered.

Q2 What is Rayleigh Wind Distribution?

A2 It is a distribution form generally used to illustrate wind distribution. For example, see below diagram for distribution form for wind speeds 4, 5, 6, and 8 m/s.



Q3 What happens in strong wind conditions like typhoons?

A3 Airdolphin automatically lowers rotational speed during strong winds, and continues to generate power under controlled conditions. Unlike furling (passive control) on other companies' wind turbines, Airdolphin uses active control. With automatic slowdown, the wind load is rapidly reduced to a safe condition, so there is no need for the user to stop turbine operation. Airdolphin's survival wind speed is over 65 m/s (145 mph).

Q4 Would the blades freeze and/or break in snowy areas?

A4 In snowy areas, the Power Assist Function has proved effective for preventing ice buildup. Even if the blades freeze, they will operate normally after snow and ice is removed.

Q5 How is it evaluated?

A5 Airdolphin's reliability evaluation is based on hundreds of vehicle-mounted tests at a circuit course which can simulate strong winds of 35 m/s (78 mph). Also, field tests have been carried out in severe climates around the world, for continuous improvement of the product's reliability.

- Government-sponsored performance test in southern France
- Performance test in areas below -35 °C (-31 °F) in Canada
- Performance test in Japan's remote areas with over 50 m/s (112 mph) wind speed, salt damage, or heavy snow.

Q6 How do you stop the wind turbine?

A6 With the optional RM-1000 remote monitor, you can safely stop turbine operation anytime for maintenance, etc. You can also monitor the operation or control stop/run of the unit from a remote location via the internet.

Q7 Why do you need the Power Assist Function?

A7 Airdolphin generates high power with ultra-efficient blade design and a generator with the world's strongest magnet. The only disadvantage is that large amount of torque is needed for rotor start-up, so the Power Assist Function was developed to bring out the best from the blades and the generator. Airdolphin starts up with the help of the Power Assist Function. When the wind is sufficient, the Power Assist Function automatically turns off.

Q8 How do I choose a grid-tie inverter? Are there any recommended manufacturers? Where can I buy them?

A8 Performance is warranted only when installed with Zephyr evaluated and authorized inverters. For information on authorized inverters, contact your local dealer.

* Inverters need to be set with specific parameters for Airdolphin GTO.



Zephyr Corporation

5th Floor, Pacific Marks Shinjuku Parkside
4-15-7 Nishi-Shinjuku, Shinjuku-ku
Tokyo 160-0023, JAPAN
TEL: +81-3-3299-1910 FAX: +81-3-3299-1977
<http://www.zephyreco.co.jp/en>

EMEA Central Office

Isafjordsgatan 39B, S-164 40 Kista, SWEDEN
TEL: +46-8-525-084-23 FAX: +46-8-752-99-00
www.zephyrcorporation.com

American Zephyr Corporation

280 South Taylor Avenue Suite 100
Louisville, CO 80027 U.S.A.
Main Office Phone: +1-303-749-5770
Toll Free Sales: +1-877-457-0155
Toll Free Tech Support: +1-877-457-0154
Fax: +1-303-749-5771
www.americanzephyr.com
z1000info@americanzephyr.com