



Wind Energy

Resource Assessment and Power Performance Measurement Systems



For over 40 years, **Campbell Scientific** has been a worldwide leader in designing and manufacturing rugged measurement and control data-loggers and monitoring systems in environmental, research, and industrial applications, and since 1984 in wind-energy resource assessment.



Campbell Scientific designs, manufactures, and sells rugged dataloggers, data acquisition systems, and measurement and control products used worldwide in environmental, research, and industrial markets. The company was established in 1974 with its corporate headquarters in Logan, Utah, United States. The majority of Campbell Scientific products are manufactured at its U.S. facility, which employs over 300 people in engineering, production, marketing, and administration departments.

Campbell Scientific products are known for their flexibility, precision measurements, and dependability—even in harsh, remote environments. In addition to a family of powerful dataloggers, Campbell Scientific offers a variety of related product lines for the measurement field, including sensors and devices for the collection, storage, communication, and retrieval of data. Using these components, Campbell Scientific employees work with customers to configure unique data acquisition and measurement and control systems that meet specific instrument and application needs.



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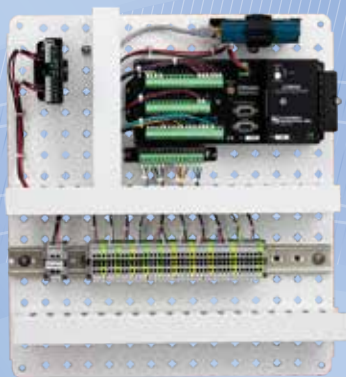
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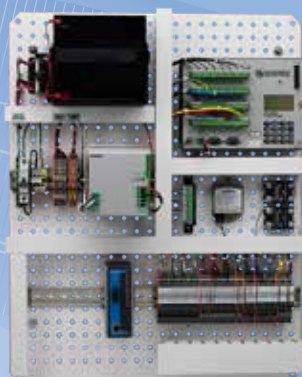


Systems Integrated

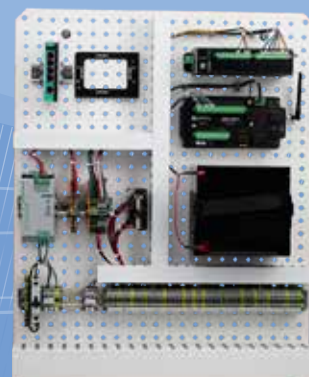
WRA100



WMS100



WMS100A



RELIABLE
SINCE 1974
MONITORING

Campbell Scientific integrated measurement systems deliver the highest quality, highest data availability data sets, reliably in any weather condition in easy to install, easy to maintain packages. Systems are built using best-practice design and implementation

methodology from industry and the knowledge gained from over 40 years of developing the world's most reliable, rugged, and trusted measurement and control dataloggers available.

Benefits and Features

<p><i>Best-practice, experienced designs making met towers the easiest part of the project</i></p> <ul style="list-style-type: none"> › No programming › No assembly › No wiring › No time wasted 	<p><i>Laboratory quality measurements in the field</i></p> <ul style="list-style-type: none"> › 24-bit (50 nV) resolution › -55° to 85°C › 50/60Hz noise rejection › Input/excitation reversal › Time synchronization › Self-calibration › Low power 	<p><i>Reliability</i></p> <ul style="list-style-type: none"> › Industry's longest datalogger warranty period available › Any weather condition
<p><i>Systems Integrated</i></p> <ul style="list-style-type: none"> › We build it › We program it › We document it › We test it › We support it for the life of the product 	<p><i>Data Security</i></p> <ul style="list-style-type: none"> › Multifactor authentication › Data encryption › Secured access 	<p><i>Extreme Flexibility</i></p> <ul style="list-style-type: none"> › Any measurement › Any sensor configuration › Any input power › Any backup power size › Any data collection method



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August 9, 2016

More info: 435.227.9120
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Wind Energy

Wind Resource Assessment and Power Performance Measurement Systems



Campbell Scientific's turn-key systems are designed for permanent operational meteorological, wind resource assessment, and power performance monitoring and testing. These systems have a wide range of options for measuring wind speed, wind direction, air den-

sity, and electric power. Real-time or interval data are stored locally on the datalogger, and can be transmitted via all standard communication methods.




MAJOR SYSTEMS

		Measurements		Datalogger	Power Requirement	Communications Supported	Description
		Typical	Optional				
WMS100A Advanced Wind Measurement System 100 Meteorological station for wind energy applications		Wind speed <ul style="list-style-type: none"> • Anemometer • Class 1 MEASNET • Ultrasonic • Heated • Vertical Wind direction Air temperature Differential air temperature Relative humidity Barometric pressure Precipitation Tower light diagnostics	3D wind speed/ direction Ice detection/ surface moisture Electric field, light- ning warning Solar radiation Remote sensing Lidar Turbine electric power	CR6	AC, DC, or solar	Modbus cellular email DNP3 FTP TCP/IP fiber optic radio serial field display satellite Wi-Fi	Datalogger enclosure supports user-specified sensor and communication specification in a turn-key package. Installation, maintenance, and field servicing are quicker and easier because of CR6 features.
WMS100 Wind Measurement System 100 Meteorological station for wind energy applications		Wind speed <ul style="list-style-type: none"> • Anemometer • Class 1 MEASNET • Ultrasonic • Heated • Vertical Wind direction Air temperature Differential air temperature Relative humidity Barometric pressure Precipitation Tower light diagnostics	3D wind speed/ direction Ice detection/ surface moisture Electric field, light- ning warning Solar radiation Remote sensing Lidar Turbine electric power	CR3000 CR1000	AC, DC, or solar	Modbus cellular email DNP3 FTP TCP/IP fiber optic radio serial field display satellite Wi-Fi	Datalogger enclosure supports any user-specified sensor and communication specification in a turn-key package

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	Measurements		Datalogger	Power Requirement	Communications Supported	Description
	Typical	Optional				
WRA100 Wind Resource Assessment Station 100 Meteorological station for wind resource assessment 	Wind speed Wind direction Air temperature Relative humidity Barometric pressure	DC current/voltage Visibility/present weather Electric field, lightning warning Delta temperature Vertical wind speed	CR800	AC, DC, or solar	Modbus cellular email DNP3 FTP TCP/IP fiber optic radio serial field display satellite Wi-Fi	Configured to support legacy-sensor designs and packages commonly deployed for performing wind resource assessment in North America
ZephIR300 Remote Sensing Lidar 	Horizontal wind speed, Vertical wind speed, Wind veer Wind shear Turbulence intensity Temperature Relative humidity Barometric pressure GPS location and time	Any co-located Campbell Scientific MET mast	CR1000 CR3000	AC, DC, or solar	Modbus cellular email DNP3 FTP TCP/IP fiber optic radio serial field display satellite Wi-Fi	Continuous wave lidar measurement system, used to make wind measurements at user-configurable heights from 10 m to 300 m
SWP100 System for wind turbine performance monitoring 	AC power DC power	Generator frequency Shaft speed Vibration Movement Stress Strain Meteorological	CR3000 CR1000 CR800	AC, DC, or solar	Modbus cellular email DNP3 FTP TCP/IP fiber optic radio serial field display satellite Wi-Fi	User-configurable station for power measurements. Ideal for IEC 61400-12-1 power performance tests

Wind Energy Case Studies

Our wind energy systems have helped a variety of organizations reach their goals. The following are just a few of these:

A Campbell datalogging system monitors an offshore wind farm in Wales. Even though the wind farm experiences harsh conditions, the system has provided better than 99 percent data recovery.

www.campbellsci.com/wales-wind

Campbell gear is used to monitor meteorological and power-generating parameters at a wind farm in Tehachapi, California. CalWind Resources owns and operates the wind farm.

www.campbellsci.com/california-wind-energy

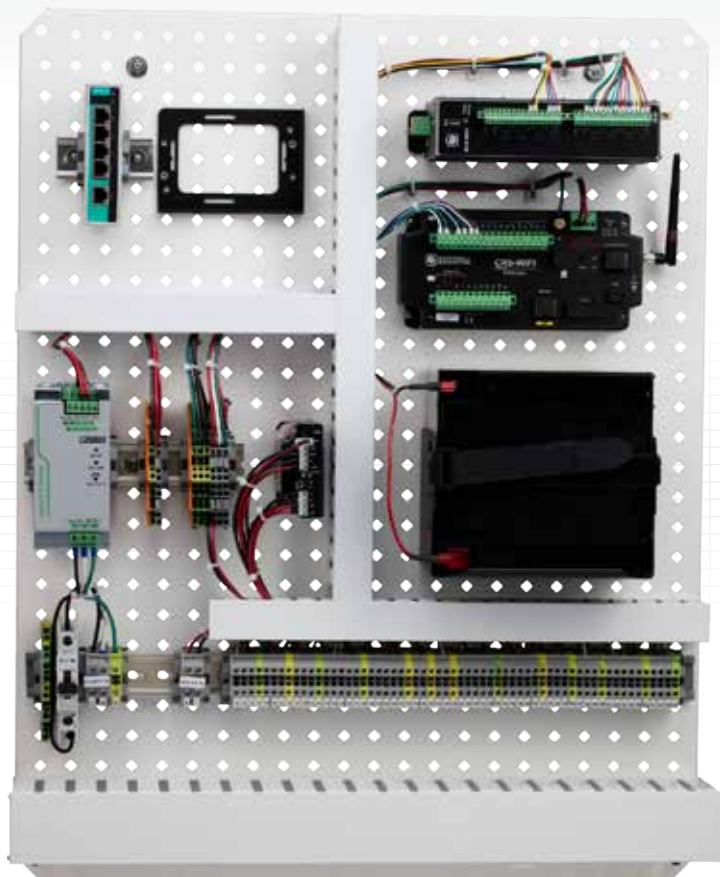


Campbell Scientific equipment allows the wind farm in Tehachapi, California to report data to the California ISO.



WMS100A

Advanced Wind Measurement System



Seriously Advanced MET Station

Operational Performance Assessment

Applications

- Performance Assessment of Operational Site
- SCADA Permanently Integrated MET Station
- Site Calibration
- MET + Turbine Power Synchronization

Overview

The WMS100 is designed to provide operational wind data stakeholders maximum measurement flexibility while delivering wind energy's most accurate meteorological data sets. Based on the new CR6 measurement and control platform, the WMS100A includes features that make installation, maintenance, and field servicing quicker and easier.

Campbell Scientific measurement systems are built with a focus on high quality hardware using best-practice system design and manufacture. By consistently providing highly accurate and extremely reliable wind measurement data, the WMS100 has become the MET station industry standard when measurements matter.

Benefits and Features

- › Industry's most rugged, reliable, and flexible measurement platform
- › Campbell Scientific CR6 Measurement and Control Datalogger and CDM-A108 Input Module included
- › Delivered field-ready with plug-and-play features—no programming necessary
- › Offered in Campbell Scientific standard or customized client specified designs
- › Real-time data collection via Modbus, DNP3, JSON, XML, and/or other standard M2M protocols supported
- › Historical data collection via FTP(s), email, PakBus, and/or software solutions supported
- › Advanced security functions provided that protect proprietary data stored on-site and during transfer

More info: 435.227.9030

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WMS100A Advanced Wind Measurement System for Operational Assessment

The WRA100A provides 24-bit (50 nV effective resolution) precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control datalogger, terminal block for sensor connection, communications hardware, and power supply. Standard operating range is -40° to +70°C; an optional extended range of -55° to +85°C is available. Although offered as a turn-key package, nearly every aspect of the system is customizable to meet your exact needs and specifications.

Versatile Communications

Fiber, Ethernet, Cellular, RF, Satellite, DNP3, Modbus, XLS, JSON, email

Uninterruptible Power Supply

With monitoring and alarm

Flexibility

Ability to measure up to 12 anemometers, 16 single ended analog measurements, and any RS-485 or digital device

CDM-A108 Input Module

24-bit resolution and time-synchronized measurements

Wi-Fi

Builtin Wi-Fi provides access to datalogger and a new configuration interface

CR6 Datalogger

Programmable 24-bit measurement, communications, and control. Integrated early warning, background system calibration, surge ESD and overvoltage protection on all terminals

Turn-key, field-ready

Campbell Scientific build or user-specified systems using industry best-practice design and manufacture. Complete system factory test for immediate data availability in the field.

Customizations

Although standard Campbell Scientific builds are available, the WMS100A is completely customizable, allowing you to configure the station to your project's exact specifications, while retaining turn-key functionality. Building on a Campbell Scientific datalogger platform yields the industry's most versatile, robust, and accurate MET systems available.

The WMS wind monitoring system supports nearly all sensors used in the wind energy industry, including sensors that are user-supplied or purchased through Campbell Scientific. The WMS100A supports sensors at any height, junction boxes, down-tower cabling, and many other customer-specific measurement configurations.

Common Measurements

- Wind Speed
 - Anemometer
 - Class 1 MEASNET
 - Ultrasonic
 - Heated
 - Vertical
- Wind Direction
- Air Temperature
- Differential Air Temperature
- Relative Humidity
- Barometric Pressure
- Precipitation
- Tower Light Diagnostics

Optional Measurements

- Three-Dimensional Wind Speed/Direction
- Ice Detection/Surface Moisture
- Electric Field/Lightning Warning
- Solar Radiation
- Remote Sensing Lidar
- Turbine Electric Power



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May 20, 2016

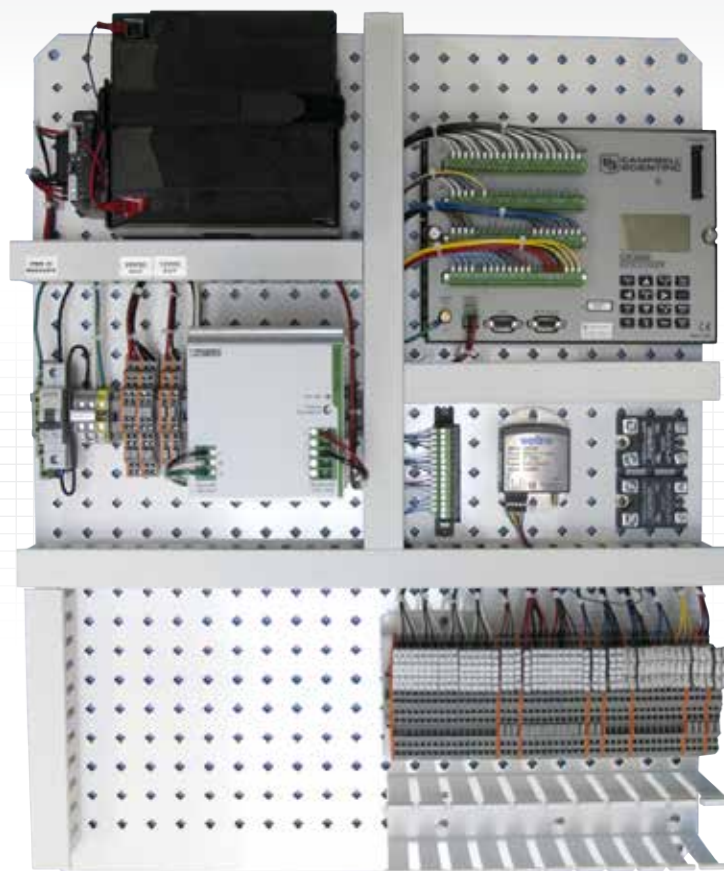


WMS100

Wind Measurement System

Best in Class MET Station

Permanent MET for Operational
Performance Assessment



Applications

- Performance Assessment of Operational Site
- SCADA Permanently Integrated MET Station
- Site Calibration
- MET + Turbine Power Synchronization

Overview

The WMS100 is a purpose built wind measurement system specifically designed for operational wind power plants. The WMS station delivers data shareholders, site operators and power off-takers with accurate real-time and historical meteorological data for operational performance assessment.

Campbell Scientific measurement systems are built with a focus on high quality hardware using best-practice system design and manufacture. By consistently providing highly accurate and extremely reliable wind measurement data, the WMS100 has become the MET station industry standard when measurements matter.

Benefits and Features

- › Industry's most rugged, reliable, and flexible measurement platform
- › Campbell Scientific CR1000 or CR3000 Measurement and Control Datalogger included
- › Delivered field-ready with plug-and-play features—no programming necessary
- › Offered in Campbell Scientific standard or customized client specified designs
- › Real-time data collection via Modbus, DNP3, JSON, XML, and/or other standard M2M protocols supported
- › Historical data collection via FTP(s), email, PakBus, and/or software solutions supported
- › Advanced security functions provided that protect proprietary data stored on-site and during transfer

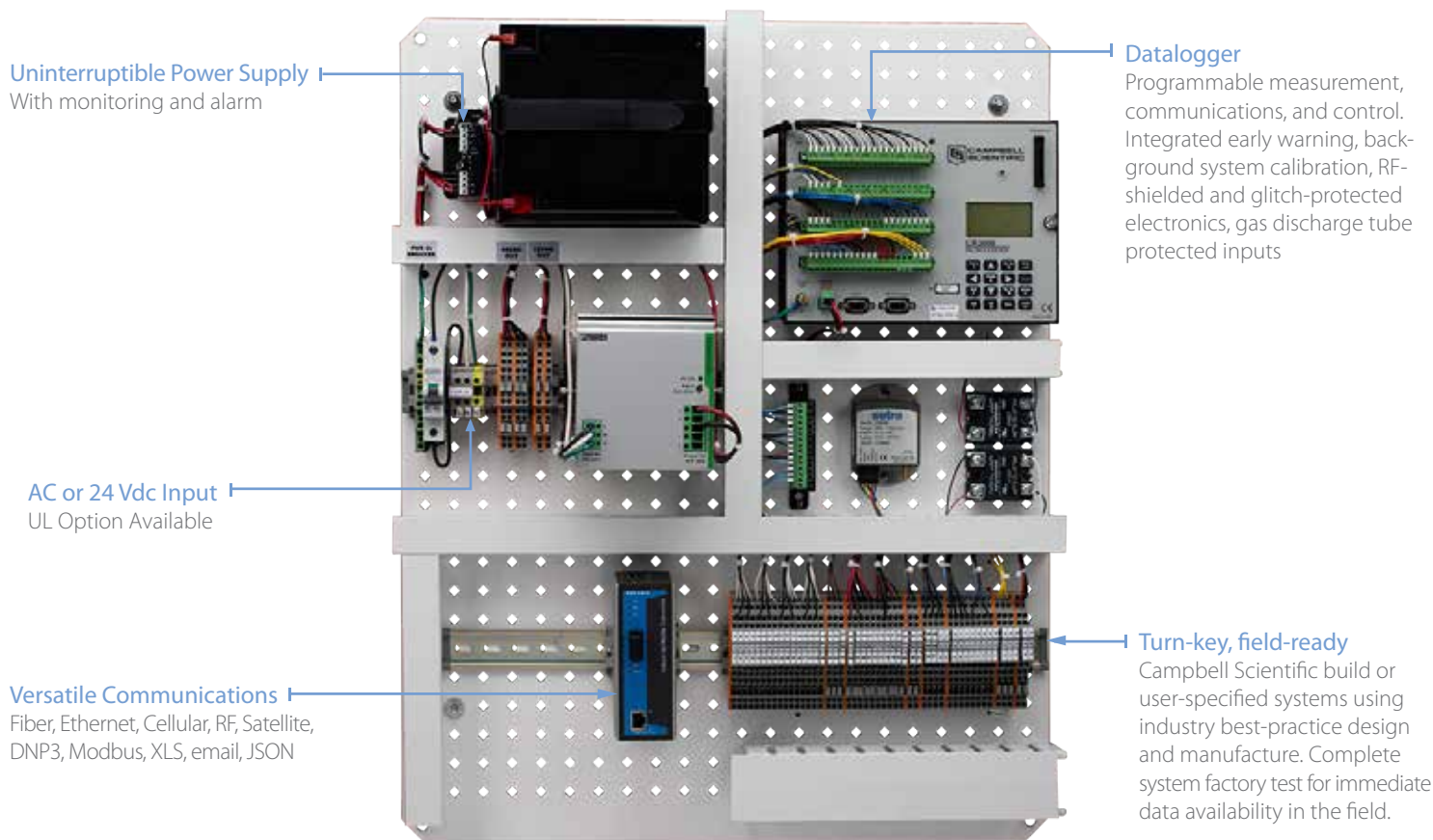
More info: 435.227.9120

www.campbellsci.com/wms100



WMS100 Wind Measurement System for Operational Assessment

The WMS100 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control datalogger, terminal block for sensor connection, communications hardware, and power supply. Standard operating range is -25° to +50°C; an optional extended range of -55° to +85°C is available. Although offered as a turn-key package, nearly every aspect of the system is customizable to meet your exact needs and specifications.



Customizations

Although standard Campbell Scientific builds are available, the WMS100 is completely customizable, allowing you to configure the station to your project's exact specifications, while retaining turn-key functionality. Building on a Campbell Scientific datalogger platform yields the industry's most versatile, robust, and accurate MET systems available.

The WMS wind monitoring system supports nearly all sensors used in the wind energy industry, including sensors that are user-supplied or purchased through Campbell Scientific. The WMS100 supports sensors at any height, junction boxes, down-tower cabling, and many other customer-specific measurement configurations.

Common Measurements

- Wind Speed
 - Anemometer
 - Class 1 MEASNET
 - Ultrasonic
 - Heated
 - Vertical
- Wind Direction
- Air Temperature
- Differential Air Temperature
- Relative Humidity
- Barometric Pressure
- Precipitation
- Tower Light Diagnostics

Optional Measurements

- Three-Dimensional Wind Speed/Direction
- Ice Detection/Surface Moisture
- Electric Field/Lightning Warning
- Solar Radiation
- Remote Sensing Lidar
- Turbine Electric Power



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WRA100

Wind Resource Assessment Station

Lowest Uncertainty WRA Data Sets

Legacy Design,
Advanced Performance

Applications

- Up to 10 anemometers
- Data encryption
- Drop in replacement
- FTPS, XML, JSON, email data transfer options

Overview

The WRA100 is a wind measurement system configured to support legacy MET tower designs and packages commonly deployed for performing wind resource assessment. The WRA100, an ideal drop-in replacement when you need more than your old and unreliable datalogging systems can support, integrates seamlessly with your existing tower and sensors.

Campbell Scientific measurement systems are built with a focus on high quality hardware using best-practice system design and manufacture. Since 1984, Campbell Scientific has consistently delivered highly accurate and extremely reliable wind resource measurement data in simple and complex applications when measurements matter.

Benefits and Features

- › Industry's most rugged, reliable, and flexible measurement platform
- › Campbell Scientific CR6, CR1000 or CR800 Measurement and Control Datalogger included
- › Delivered field-ready with plug-and-play features—no programming necessary
- › Offered in Campbell Scientific standard or customized client specified designs
- › Real-time data collection via Modbus, DNP3, JSON, XML, and/or other standard M2M protocols supported
- › Historical data collection via FTP(s), email, PakBus, and/or software solutions supported
- › Advanced security functions provided that protect proprietary data stored on-site and during transfer

specs, questions, & quotes: 435.227.9120

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WRA100 Wind Resource Assessment Measurement System

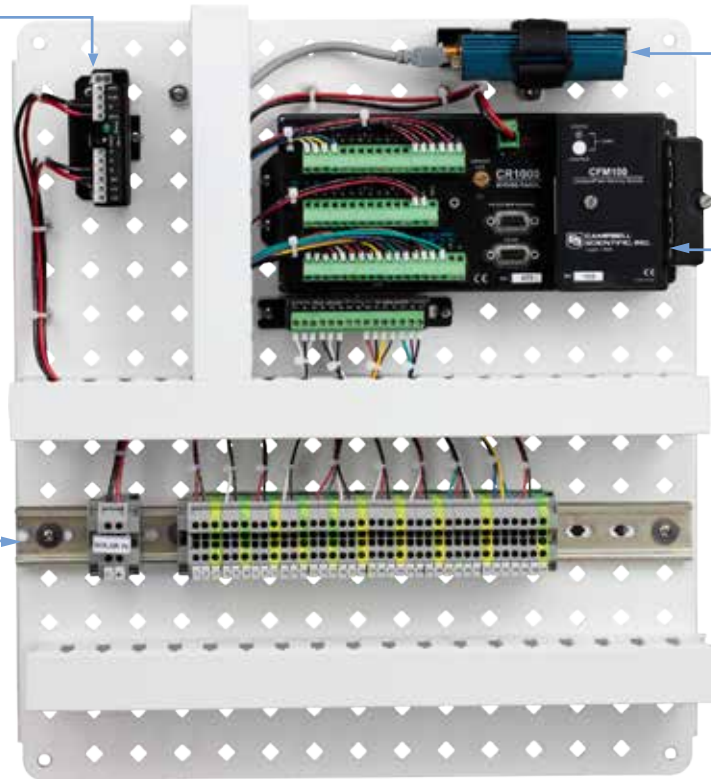
The WRA100 provides precision measurement capabilities in a rugged, battery-operated package. It consists of a measurement and control datalogger, terminal block for sensor connection, communications hardware, and power supply. Standard operating range is -25° to +50°C; an optional extended range of -55° to +85°C is available. Although offered as a turn-key package, nearly every aspect of the system is customizable to meet your exact needs and specifications.

Uninterruptible Power Supply
With monitoring and alarm

Versatile Communications
Fiber, Ethernet, Cellular, RF, Satellite, DNP3, Modbus, XLS, JSON, email

Turn-key, field-ready
Campbell Scientific build or user-specified systems using industry best-practice design and manufacture. Complete system factory test for immediate data availability in the field.

Datalogger
Programmable measurement, communications, and control. Integrated early warning, background system calibration, RF-shielded and glitch-protected electronics, gas discharge tube protected inputs



Customizations

Although standard Campbell Scientific builds are available, the WRA100 is completely customizable, allowing you to configure the station to your project's exact specifications, while retaining turn-key functionality. Building on a Campbell Scientific datalogger platform yields the industry's most versatile, robust, and accurate MET systems available.

The WRA100 resource assessment system supports nearly all sensors used in the wind energy industry, including sensors that are user-supplied or purchased through Campbell Scientific. The WRA100 supports sensors at any height, junction boxes, down-tower cabling, and many other customer-specific measurement configurations.

Common Measurements

- Wind Speed
 - Anemometer
 - Class 1 MEASNET
 - Ultrasonic
 - Heated
 - Vertical
- Wind Direction
- Air Temperature
- Differential Air Temperature
- Relative Humidity
- Barometric Pressure
- Precipitation
- Tower Light Diagnostics

Optional Measurements

- Three-Dimensional Wind Speed/Direction
- Ice Detection/Surface Moisture
- Electric Field/Lightning Warning
- Solar Radiation
- Remote Sensing Lidar
- Turbine Electric Power



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July 27, 2016



ZEPHIR300

Remote Sensing Wind Measurement Lidar for Meteorological Applications



ZephIR 300

Finance Grade Performance

Industry's most validated lidar

Overview

The ZephIR300, industry's most validated wind lidar, is a ground based, continuous-wave lidar system that provides wind measurements across ten user-defined heights from 10 m to 200 m. The ZephIR300 has become widely accepted for wind resource assessment, site classification and micro-siting, power performance testing, and operational assessment.

The ZephIR300 can be synchronized with a hub height meteorological mast or short mast (annex L) during wind turbine power performance testing. A communications package is available for connecting to a datalogger for met and power measurement synchronization as well as to facilitate regional cellular support.

Benefits and Features

- › DNV GL Stage 3 approved finance-grade data in non-complex terrain
- › Natural-power-approved, finance-grade data in complex terrain
- › Performance verification at IEC compliant site
- › Proven extreme operation from -40° to +50°C across 650+ lidar deployments globally
- › True 1 second and averaged 10 minute wind direction, horizontal, and wind speed
- › No annual servicing or annual calibration, 2 year warranty

questions & quotes: 435.227.9120

campbellsci.com/zephir-lidar



Description

The ZephIR300 delivers measurements at heights across the entire rotor-swept area, confirming hub-height resource as well as wind shear, veer and turbulence across the rotor-reducing shear extrapolation bias and uncertainty.

The ZephIR300 is re-deployable, portable and does not require lengthy planning applications before installation. Data can be col-

lected at multiple points on a site to provide representative measured data for all turbine locations and tuning points for flow models.

SCADA integration is made simple by combining the ZephIR300 with a Campbell Scientific communications package or by direct Ethernet connection via Modbus.

Measurement Technique

The ZephIR300 is a coherent lidar system that uses continuous wave technology. Constant sensitivity and 50 measurements at

each height ensures high data availability at each height and in all conditions, even at sites with very clear air or complex terrain.



Communications

The ZephIR300 has multiple communications options, giving users the flexibility necessary to integrate the ZephIR300 into their specific applications. Standard in every ZephIR300 is a built-in WiFi. Users can connect over this Wi-Fi network with their laptops for initial setup, configuration, or data collection.

The ZephIR300 supports TCP/IP communications and comes standard with an Ethernet port for applications where the ZephIR 300 can be connected to a local network for data collection, or for connection to an external modem.

A Campbell Scientific communications package is available for connecting to a datalogger for met and power measurement synchronization, as well as to facilitate local area cellular support.

The ZephiR300 also supports the Modbus protocol, making it compatible with existing SCADA systems on operational wind farms.

Data Retrieval Methods/Protocols:

- Waltz Software Modbus

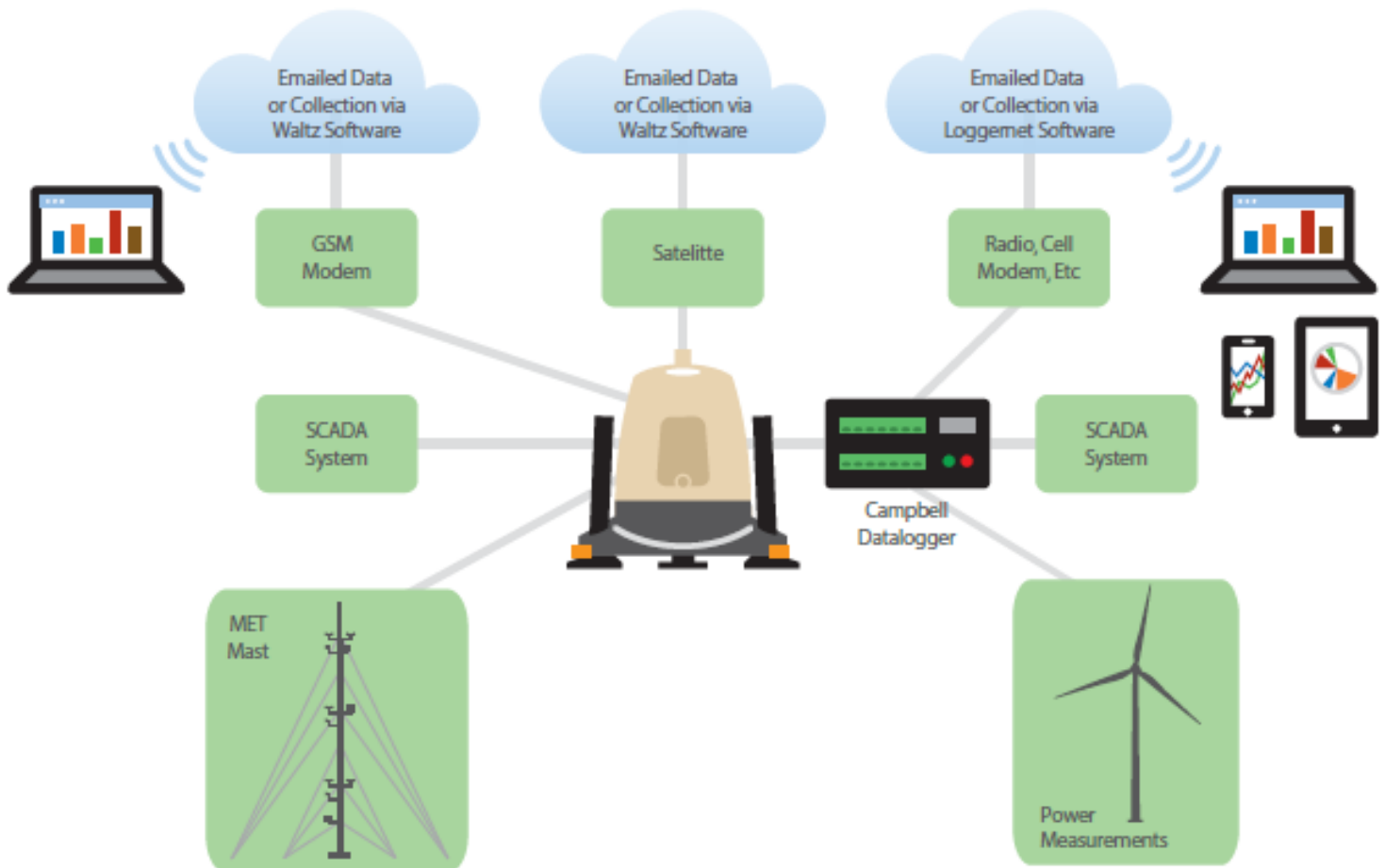
Data Retrieval Methods when Routed through Campbell Datalogger:

- › Loggernet
- › Modbus
- › FTP(S)
- › Pakbus
- › DNP3
- › XML/JSON

ZephIR 300 and Campbell Scientific Dataloggers

Campbell Scientific dataloggers, including the CR6, CR800, CR1000, or CR3000, can be used to integrate and synchronize ZephIR300 lidar data with data from other instruments, such as instrumentation on a meteorological tower. Using a Campbell Scientific datalogger to gather data from the ZephIR300 also enables integrated tower and lidar data collection through a

single gateway via an external cell phone modem, radio, or direct connection. Campbell Scientific dataloggers support multiple protocols such as Modbus, Pakbus, DNP3, XML, JSON, FTP(S), HTTP, and many other M2M protocols, giving users maximum flexibility and customization of data retrieval methods.



ZephIR 300M

The ZephIR300M is fully-marinated version of the ZephIR300, designed specifically for offshore fixed platform measurement campaigns. Rugged housing, marine grade connectors, stainless steel framing, silicone wiper blade, and IP68 rated.

Campbell Scientific offers a modified ZephIR300M for operation in Class 1, Division 2 environments.



ZephIR DM

The ZephIRDM is a turbine-mounted lidar, used on operational wind farms to assess turbine performance and highlight the potential production increases or O&M strategy refinements to extend turbine life or reduce wind farm operating costs. Yaw misalignment and other sensor calibration issues can be detected.

Combined with a Campbell Scientific Communications Package allows for MET tower synchronization over RF or Ethernet.



ZephIR300 Specifications

Operations

- Temperature Range: -40° to +50°C
- Power Consumption: 69 W
- Input Power Range: 9.5 to 13.5 Vdc or 90 to 264 Vac
- Weight: 55 kg (121.3 lb)

Performance

- Measurement Height Range: 10 m to 200 m (33 ft to 656 ft)
- Number of Measurement Heights: 10, user configurable
- Sampling Rate: 50 Hz
- Averaging Period: 1 second upwards (user configurable)
- Scanning Cone Angle: 30°
- Wind Speed Accuracy: <0.5% (as measured against a calibrated moving target)
- Wind Speed Range: < 1 m/s to 70 m/s
- Wind Direction Accuracy: < 0.5°

Probe Length

- At 10 m (33 ft) measurement height: 0.07 m (0.23 ft)
- At 100 m (328 ft) measurement height: 7.70 m (25.26 ft)

Data

- 10-min. Averaged Data: 80 kB/day
- 3-s Data: 3 MB/day

Safety

- Laser Classification: Class 1
- Eye Safety Standard: IEC 60825-1
- IP Rating: IP67 (excludes external fans)

EMC Compliance

- EEN55022 Class A, EN61326 Industrial
- FCC Radiated and Conducted Emissions



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August 9, 2016



Wind Energy Sensors

Sensors for Wind Energy Applications

*Rugged, Reliable, and Ready
for any Application*



Most meteorological sensors can be measured by our dataloggers, allowing stations to be customized for each site. Typical sensors used on our

stations include, but are not limited to: wind speed, wind direction, barometric pressure, temperature, relative humidity, and delta temperature.

CUP ANEMOMETERS

P2546A-L | IEC Class 1
Performance



Signal Type/Output

contact closure
(pulse)

Measurement
Description

wind speed

Output Range

0 to 70 m s⁻¹

Operating
Temperature

-30° to 70°C

Calibration

IEC 61400-12-1
MEASNET

A100LK-L | IEC Class 1
Performance
Great for turbulent terrain



electronic pulse

wind speed

0 to 77 m s⁻¹

-30° to 70°C

IEC 61400-12-1
MEASNET

Thies 4.3351.10.000^a | IEC
Class 1 Performance



opto-electronic
converted to
square wave
(pulse)

wind speed

0.3 to 75 m s⁻¹

-50° to 80°C

IEC 61400-12-1
MEASNET

Thies 4.3351.00.000^a | Heated
Anemometer with IEC Class 1
Performance



opto-electronic
converted to
square wave
(pulse)

wind speed

0.3 to 75 m s⁻¹

-50° to 80°C

IEC 61400-12-1
MEASNET

MetOne 011E^a | IEC Class 1
Performance



optical chopper
(pulse)

wind speed

0 to 60 m s⁻¹

-50° to 85°C

IEC 61400-12-1
MEASNET

#40C | Wind Speed Sensor



low level ac sine
wave (pulse)

wind speed

1 to 96 m s⁻¹

-55° to 60°C

--

More info: 435.227.9120

campbellsci.com/wind-energy



WIND VANES

020C-L | Reliable and accurate



Measurement	Measurement Description	Output Range	Operating Temperature
potentiometer (half bridge)	wind direction	0° to 360°	-50° to 85°C

200P | Wind Direction Sensor



analog potentiometer (half bridge)	wind direction	0° to 360°	-55° to 60°C
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Thies 4.3150.10.212^a | First Class, Accurate and Rugged



analog potentiometer (half bridge)	wind direction	0° to 360°	-50° to 80°C
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Thies 4.3150.00.212^a | Heated First Class Transmitter
Accurate and Rugged



analog potentiometer (half bridge)	wind direction	0° to 360°	-50° to 80°C
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HELICOID & ULTRASONIC ANEMOMETERS

05108-45-L | Alpine Version
Wind Monitor-HD,
High Performance
Designed to prevent ice buildup



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog potentiometer, ac sine wave	wind speed and direction	<u>Wind Speed</u> 0 to 100 m s ⁻¹ <u>Direction</u> 0° to 360°	-50° to 70°C

Thies 4.382x.xx.xxx^a | Robust and well suited for cold climates
Heated transducers and arms.



RS-485, RS-232, analog (configurable for other types)	wind speed and direction	<u>Wind Speed</u> 0 to 75 m s ⁻¹ <u>Direction</u> 0° to 360°	-50° to 70°C
-------------------------------------------------------	--------------------------	--------------------------------------------------------------------------------------	--------------

Vaisala WMT700^a | Heated and Suited for Cold Climates



RS-485, RS-422, RS-232, SDI-12 (user programmable)	wind speed and direction	<u>Wind Speed</u> 0 to 75 m s ⁻¹ <u>Direction</u> 0° to 360°	-55° to 70°C
----------------------------------------------------	--------------------------	--------------------------------------------------------------------------------------	--------------

WINDSONICX-L | High Quality and Lightweight



RS-485, RS-232, SDI-12	wind speed and direction	<u>Wind Speed</u> 0 to 60 m s ⁻¹ <u>Direction</u> 0° to 359°	-35° to 70°C
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RM Young 85004^a | Heated Ultrasonic for Extended Cold Weather Use



RS-485	wind speed and direction	<u>Wind Speed</u> 0 to 70 m s ⁻¹ <u>Direction</u> 0° to 360°	-50° to 50°C
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ULTRASONIC 3D WIND SENSORS

CSAT3 | 3D Sonic Anemometer

Best instrument for flux and other high-level turbulence research projects



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
RS-232, analog, SDM	u_x, u_y, u_z, C	Full Scale Wind: $\pm 65.535 \text{ m s}^{-1}$	-50° to 70°C

TEMPERATURE & RELATIVE HUMIDITY

CS215-L | Reliable and easy to maintain



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
SDI-12	temperature relative humidity	<u>Temperature</u> -40° to 70°C <u>Relative Humidity</u> 0 to 100%	-40° to 70°C

083E-L | Accurate and reliable sensor



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog voltage	temperature relative humidity	<u>Temperature</u> -50° to 50°C <u>Relative Humidity</u> 0 to 100%	-50° to 50°C

HC2S3-L | Accurate and rugged



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog voltage	temperature relative humidity	<u>Temperature</u> -40° to 60°C <u>Relative Humidity</u> 0 to 100%	-40° to 100°C

BAROMETRIC PRESSURE SENSORS

CS100 (Setra 278) | Standard Barometer Reliable and accurate



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog voltage	barometric pressure	600 to 1100 mb ^b	-40° to 60°C

092-L | Includes Weather-proof Enclosure Reliable and accurate



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog voltage	barometric pressure	600 to 1100 mb	-40° to 55°C

VERTICAL WIND SENSORS

27106T-L | Low threshold precision vertical wind sensor



Signal Type/Output	Measurement Description	Output Range	Operating Temperature
analog voltage	vertical wind speed	0 to 40 m s ⁻¹	-50° to 50°C

DELTA TEMPERATURE

43347-L | Highly accurate RTD for atmospheric stability monitoring $\pm 0.1^\circ\text{C}$ accuracy with NIST calibration



	Signal Type/Output	Measurement Description	Output Range	Operating Temperature
	analog voltage	temperature	$\pm 50^\circ\text{C}$	$\pm 50^\circ\text{C}$

43502-L | Aspirated Shield, provides more accurate measurement



OTHER

0871LH1 | Freezing Rain Detector



LWS-L | Surface Wetness Sensor
Dielectric sensor to determine presence of water and ice



CS120 | Visibility Sensor
High Performance Visibility Measurements



CS135 | LIDAR Ceilometer
Sensitive, Long Range Cloud Measurement



CS47X-L | Radar Water Level Sensor
FCC Approved



ZephIR300 | Remote Sensing Lidar
Accurate and reliable



	Signal Type/Output	Measurement Description	Output Range	Operating Temperature
	RS-485	ice detected/ no ice detected	state dependent, ICE = 1 NO ICE = 0	-51° to 71°C
	analog voltage	dry, frosted, wet	250 mV to 1500 mV, millivolt reading relates to moisture state	-20° to 60°C
	RS-232, RS-485	Meteorological Observable Range (MOR)	12 m to 32 km	-25° to 60°C
	RS-232, RS-485	cloud height and vertical visibility	5 m to 10 km: Up to four cloud layers reported	-40° to 60°C
	SDI-12	distance	50 mm to 70 m	-40° to 80°C
	cellular, Modbus	wind speed, wind direction, turbulence intensity, wind shear, wind veer	Up to 10 program- mable measure- ment heights from 10 m to 300 m	-40° to 50°C

NOTES:

^aItem is special ordered and cabled by Campbell Scientific.

^bThe CS100 is available in special ranges of 500 to 1100 and 800 to 1110; contact Campbell Scientific for more information.



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July 29, 2016



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