

## Always a Wavelength Ahead

- One of WERA's unique features is the flexibility to be set-up in **Compact** or **Array Type configuration**. In the table below the parameter for these configurations are listed. This enables you to find the **best radar configuration** for **your specific application** !
- The **compact WERA** site configuration uses Direction Finding methods to provide ocean current data to monitor **mesoscale current** features. With an **array type antenna** system the high resolution software Beam Forming allows to monitor **sub-mesoscale current** features and in addition **wave data maps** are provided.
- The WERA system core can operate over a broad frequency range from **4.5 to 70 MHz** to provide **longest ranges** of more than **300 km** or **highest resolution** for **short ranges**. To change the operating frequency band just some filter modules and the antenna tuning need to be changed.
- A **multi-frequency band** operation with automatic switching is available as option.
- **Very low RF-power** typically <30 Watts to prevent interference with other radio services.
- The **FM-cw principle** provides **the best signal to noise ratio** and makes WERA the most effective ocean radar with the **best frequency to range** performance.
- The **robust and small antenna** system are easy to install and can be integrated smoothly to the natural environment or into existing structures.
- WERA always provides the best ocean radar configuration for your specific application.

Pos	Parameter	Description	Value		
01	<b>Working range @ 30 psu</b> <i>Can be reduced due to environmental effects, e.g. reduced range if ocean is covered with breaking waves or at reduced salinity</i>	Depends on frequency	<b>all values are valid for 16.5 MHz</b>		
		for currents:	80 km		
		Integration depth:	app. 1 m		
		wind direction & ship detection:	55 km		
		for wave height:	35 km		
		for wave spectra and wind speed:	25 km		
02	<b>Range resolution</b> <i>Integration in range</i>	Depends on allocated bandwidth	<b>50 kHz</b>	<b>100 kHz</b>	<b>150 kHz</b>
		The used grid size should be 20 % wider than this value:	3000 m	1500 m	1000 m
03	<b>Angular field of view</b>	100° with 8 antennas (60 m long array) 120° for 12 antennas in a linear array (90 m long array) > 140° for 12 antennas in a curved array > 180° for 4 antennas in a square (7 x 7 m square as Compact Array)			

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04	<b>Angular Accuracy</b>	with 8 antennas	$\pm 2^\circ$ stable under all conditions*		
		with 12 antennas	$\pm 1^\circ$ stable under all conditions*		
		with compact 4 antenna array	* due to automatic calibration $\pm 5^\circ$ (antenna calibration recommended)		
05	<b>Beam width</b> <i>Integration in azimuth</i>	depends on beam steering angle	<b>at centre</b>	<b>Typical</b>	<b>at edge</b>
		for 16 antennas	$\pm 3^\circ$	$\pm 4^\circ$	$\pm 6^\circ$
		for 12 antennas	$\pm 4^\circ$	$\pm 6^\circ$	$\pm 8^\circ$
		<b>for 8 antennas</b>	<b><math>\pm 7^\circ</math></b>	<b><math>\pm 10^\circ</math></b>	<b><math>\pm 16^\circ</math></b>
		for compact array	No beam, using Direction Finding methods		
		<b>Angular resolution</b>	<b>always finer than <math>1^\circ</math></b>		
06	<b>Temporal resolution</b> <i>Integration time</i>	recommended integration time to get independent data sets:	For current measurements:	3 ... 5 min	
			For wave parameters:	10 ... 20 min	
06			For disaster warning:	2 min	
			Minimal time step:	30 sec	
07	<b>Data up-date rate</b> <i>to optimise data transfer rate</i>	recommended up-date rate:	For current measurements:	15 ... 30 min	
			For wave parameters:	20 ... 60 min	
07			for disaster warning:	30 sec	
08	<b>Data output</b> <i>all data (current, wind and wave) are provided on a user defined grid</i>	<i>for each individual WERA station</i>	<b>Compact</b>	<b>8 Antennas</b>	<b>12 to 16 Ant.</b>
		radial current velocity	Yes	<b>Yes</b>	Yes
		significant wave height	No	<b>Yes</b>	Yes
		Tsunami Detection	Limited	<b>Yes</b>	Yes
		Tsunami Warning	No	<b>Yes</b>	Yes
		<i>Within the overlapping area of two or more WERA stations</i>			
		current velocity vectors	Yes	<b>Yes</b>	Yes
		wave height & direction (spectra)	No	<b>In Center <math>\pm 30^\circ</math></b>	Yes
		Wind direction	Yes	<b>Yes</b>	Yes
		Wind Speed	No	<b>In Center <math>\pm 30^\circ</math></b>	Yes

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09	<b>Accuracy</b> <i>These parameters are typical values, affected by site configuration, geometry and environmental conditions. A plot of the geometric dilution of precision should be used to estimate the specific accuracy.</i>	for 16 MHz, radial current velocity:	4 cm/s @ 5 min integration time
		significant wave height:	< 10 % @ 20 min integration time
		mean wave direction:	< 5° @ 20 min integration time
		mean wave period:	< ± 0.6 sec
		directional wave spectra:	0.01 Hz
		wind direction:	10° ... 40° depends on wind speed
10	<b>Limits for wave detection</b>	min. significant wave height	0.40 m
		min. for wave directions (spectra)	1.0 m
		max. significant wave height	6.0 m
11	<b>Limits for wind direction</b>	at very low wind speed the measurement of the direction becomes uncertain	
12	<b>Antenna construction</b> <i>Transmit and receive antennas are designed identical</i>	Simple vertical monopoles, individually match to site specific ground conditions  Very robust to withstand strongest wind of up to 250 km/h	Pole length: 2.0 m guy ropes may be used for stabilisation  Overall height: 3.0 m Equipped with spark arrestors (1000 V)
13	<b>Antenna array</b> <i>The array type antenna system can be arranged as linear, curved or arbitrary spaced array</i>	<b>Rectangular configuration for Tx</b>	<b>3 x 9 m</b>
		<b>Linear receive array, 8 antennas</b>	<b>60 m</b>
		Linear receive array, 12 antennas	90 m
		Linear receive array, 16 antennas	125 m
14	<b>Transmit power</b>	Low, non harmful rf power, typically 7.5 W per antenna pole, 30 Watts total.  The power amplifier can provide >50 W to compensate cable losses.  FMcw transmit signal providing best out-band signal suppression.	
15	<b>Synchronise WERA systems</b>	Multiple stations can use the same frequency band with WERA-Share method	
16	<b>Analog data acquisition system</b>	Non multiplexed quadrature detector with amplitude and phase conserving 2 x 16 bit analogue to digital conversion	
		Lowest noise system design providing a noise level of -166 dBm at the receiver input.	
17	<b>Digital data acquisition</b>	<ul style="list-style-type: none"> <li>- WERA software beam forming with automatic beam calibration</li> <li>- Unique WERA noise reduction in connection with beam forming</li> <li>- Optional direction finding software for compact antenna type systems</li> <li>- Open data interfaces at all pre-processing steps</li> <li>- Various output data formats including GRIB and NOAA defined formats</li> </ul>	

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18	<b>System control</b>	<ul style="list-style-type: none"> <li>- Access to all radar parameters via web based user interface</li> <li>- listen before talk mode with frequency adaptation</li> <li>- rf interference reduction</li> <li>- automatic antenna beam calibration</li> <li>- system self-check with the option to generate and transmit warnings</li> </ul>	
19	<b>System Hardware</b>	<p>Modular system concept to allow easy configuration and service</p> <p>Desktop case to be installed indoors width: 19" rack      depth: 650 mm      height: 850 mm</p> <p>Supply 115 – 230 V / 50 - 60 Hz / 400 to 600 Watts-peak with intelligent UPS</p> <p>To be operated in air conditioned environment: 0 ... 30°C, 5 ... 80% relative humidity (no condensation)</p> <p>Lightning protection at all system inputs by means of surge arrestors (230 V)</p>	
20	<b>WERA Container</b>	<p>The WERA system should be installed indoors in an air conditioned room. If such a room is not available a WERA container can be provided:</p> <p>Vandalism protected, thermal insulated cabin, electricity installation, 19" cabinet for WERA rack, desk, shelves, lightning protection, fire proof, water tight, integrated high efficient air-conditioning. dimensions: 3000 x 2200 x 2300 mm (L x W x H) (other dimensions available) weight app.: 900 kg</p>	
21	<p><b>Software packages</b></p> <p><i>All packages are included in the standard WERA tool box.</i></p>	<p><b>WERA-RT:</b> real-time processing</p> <p><b>WERA-CTL:</b> remote system control of system parameter via web interface</p> <p><b>WERA-RFI:</b> unique noise reduction for array type WERA systems</p> <p><b>WERA-FA:</b> frequency adaptation (listen-before-talk mode)</p> <p><b>WERA-Share:</b> Use of allocated radio band for multiple WERA stations</p> <p><b>WERA-DF:</b> direction finding</p> <p><b>WERA-BF:</b> beam forming with automatic self calibration feature</p> <p><b>WERA-crad:</b> radial current velocity</p> <p><b>WERA-wrad:</b> significant wave height for about 40 % of the current range</p> <p><b>WERA-Wind:</b> wind direction for about 70 % of the current range</p> <p><b>WERA-2D:</b> combines radial data of wind, waves and currents of multiple WERA stations</p> <p><b>WERA-GRID:</b> defines grid size for data maps</p> <p><b>WERA-QC:</b> Quality control</p> <p><b>WERA-HK:</b> House keeping tool to optimise the available disk space</p>	

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22	<b>Software packages</b> <i>Optional (extra charge)</i>	<p><b>WERA-Data-Manager</b></p> <ul style="list-style-type: none"> <li>- Combines data of multiple WERA stations with user defined management.</li> <li>- Provides vector maps for ocean currents, wind and waves.</li> <li>- Comfortable user interface for data viewer and data archive.</li> <li>- Display of time series of individual grid points.</li> <li>- Generation of animated data maps for ocean currents, wind and waves</li> </ul> <p><b>WERA-Clean-Map</b></p> <ul style="list-style-type: none"> <li>- Provides artefact removing tools as add on for Data Manager.</li> <li>- Optional gap-filling feature</li> </ul> <p><b>WERA-Synthetic-Wave-Buoy</b></p> <ul style="list-style-type: none"> <li>- Provides directional wave spectra for selected user-defined grid cells within the overlapping radar ranges</li> <li>- Time-series of derived parameters such as significant wave height, peak period, peak direction as well as wind direction.</li> </ul> <p><b>WERA-Wave-Grid</b></p> <ul style="list-style-type: none"> <li>- Provides directional wave spectra for all grid cells with sufficient signal quality within the overlapping radar ranges.</li> <li>- Various options for real-time or off-line processing are available.</li> </ul> <p><b>WERA-Parallel</b> (Variable integration time)                      Required for time sensitive applications like disaster warning.                      Recommended to get optimised wave data and sub-mesoscale current structures in parallel. Recommended integration times and update cycles are:                      15 to 20 min for wave measurements with 2 or 3 updates per hour                      5 to 10 min for current measurements with 4 or 5 updates per hour                      2 min for time sensitive applications, updated 2 times per minute.</p> <p><b>WERA-TEWS</b>                      Extracts current signature generated by an approaching tsunami at the shelf edge. Providing automatic alerts according to user settings.</p> <p><b>WERA-CurDrift</b>                      Surface current drift prediction for search and rescue or environmental protection applications.</p> <p><b>WERA-SDT</b>                      Ship detection and tracking software in non real-time mode for scientific applications.</p>

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23	Software services	<p>All output data can be formatted in user specific formats.</p> <p>Special services for data assimilation into oceanographic models are available.</p> <p>Bathymetry data can be used to correct the measured data.</p> <p>External sensors can be connected to the WERA data processing computer to use the same data transfer channel as WERA.</p> <p>External sensor data can be integrated into WERA data maps.</p> <p>The integration of WERA output data in GRIB format into meteorological data networks can be provided.</p> <p>Configuration to generate automatic warnings if user defined thresholds of oceanographic parameters (current velocity, wave height or wind speed) are reached.</p>
24	Additional Services	<p>Site Planning</p> <p>Site preparation</p> <p>Installation of WERA systems</p> <p>User training at Helzel factory and at customers site</p> <p>WERA system configuration</p> <p>WERA data management service</p> <p>Extended warranty</p> <p>Software hotline</p> <p>Maintenance contracts</p> <p>Financing support ( leasing)</p>