R&S®PWC200
Plane Wave Converter
For 5G massive MIMO base station testing
The R&S®PWC200 plane wave converter is a bidirectional array of 156 wideband Vivaldi antennas placed in the radiating near field of the device under test (DUT). The phased antenna array can form planar waves inside a specified quiet zone within the radiating near field of the 5G massive MIMO base station DUT for real-time radiated power and transceiver measurements (EVM, ACLR, SEM, etc.).

The first 5G deployments will be in the sub 6 GHz band. Base stations will use massive antenna arrays to achieve both higher capacity and higher energy efficiencies, and each antenna will contain an RF transceiver with amplifiers, switches, downconverters, upconverters, etc. This new BS architecture with over 64 RF ports requires a new OTA measurement paradigm in order to measure traditional antenna parameters. Previously, cable connections were used for TX and RX measurements.

**Innovative design**

The R&S®PWC200 Vivaldi antennas are placed in the DUT’s radiating near field. Each antenna includes a phase shifter and attenuator path, allowing arbitrary synthesis of the electromagnetic field directly in front of the array at the spherical quiet zone enclosing the DUT. All signal paths are combined to a single port that can be connected to measurement equipment such as an oscilloscope, power meter, vector network analyzer, signal generator or signal analyzer. The R&S®PWC200 is a highly linear field transducer with very low intermodulation products, even for the very high radiating power densities expected to be generated by high-power 5G base stations.
An R&S®OSP120 open switch and control platform controls the settings of phase shifters and attenuators for each set of measured frequencies and can automate various self-test and monitoring functions.

With a height of 1.80 m, the R&S®PWC200 generates a 3D spherical quiet zone within a 1 m diameter sphere at a range of 1.50 m. This results in an extremely compact test system design for both R&D and production setups. Compact antenna test ranges (CATR) which are commonly applied for far-field measurements include a larger reflector and require at least four times more space for the anechoic chamber installation.

**Base station measurements**

The key application of the R&S®PWC200 is to measure large DUTs, including base stations, passive antennas and antenna arrays.

**Power measurement verification**

Verification of the theory and simulation results shows excellent correlation of radiated power measurements performed with the R&S®PWC200 to reference measurements performed by a certified laboratory.

First, a high-gain antenna array with dimensions of 60 cm x 60 cm was measured in a certified antenna chamber to provide far-field results. The DUT dimensions correspond to a far-field region of about 8 m at 2.4 GHz.

The verification of the antenna gain with the R&S®PWC200 was performed in the DUT’s radiated near field at a distance of 1.5 m. The realized gain, sidelobe level and location of nulls show excellent agreement.

Second, the R&S®PWC200 was replaced by a single measurement antenna in the same test setup, creating spherical waves. The test results shows the effect of insufficient far-field distance for the given reference DUT. Especially nulls of the radiation pattern cannot be determined correctly.

**R&S®PWC200 system software**

For accurate and effective control of the R&S®PWC200, various software tools are available that support field simulation/generation, calibration, self-test and dedicated measurements.

The R&S®AMS32 OTA performance measurement software provides basic features for test instrument control, test setup definition, test template generation and clearly structured result documentation.

The test templates can be easily configured for various test parameter settings such as frequency range, measurement bandwidth, pattern step size and more.

2D or 3D measurements can be acquired quickly with hardware triggered measurements provided by the base station positioner – both for network analyzers and vector signal analyzers.
**Test setup for R&D measurements with 3D positioner**

- R&S®SMW200A vector signal generator
- R&S®FSW8 signal and spectrum analyzer
- R&S®ZVA8 vector network analyzer, 2-port, with direct receiver access
- R&S®OSP120 open switch and control platform

**RF signal path**

**Anechoic test chamber**

Test distance adjustable

**Test setup for production measurements**

- R&S®SMW200A vector signal generator
- R&S®FSW8 signal and spectrum analyzer
- R&S®ZVA8 vector network analyzer, 2-port, with direct receiver access
- R&S®OSP120 open switch and control platform

**RF signal path**

**Anechoic test chamber**

Test distance = 1.50 m (nom.)

*Rohde & Schwarz* R&S®PWC200 Plane Wave Converter
**R&S®PWC200 system software architecture**

**R&S®PWC200 measurement software**
TX and RX measurements, management and display of configuration data

**R&S®AMS32-K60**

**R&S®PWC200 Field simulation, generation of complex antenna weighting**

**R&S®AMS32-K61**

**R&S®PWC200 Configuration data set (transparent file format)**

**R&S®AMS32-K67**

**R&S®PWC200 Power factor calibration, power density measurement**

**R&S®AMS32-K69**

**R&S®PWC200 Selftest and R&S®PWC200 hardware verification**

**R&S®AMS32-K67**

**R&S®PWC200 Field and path loss calibration**

**R&S®AMS32-K65**

**Parameter setting**

**Fiber optic control**

**R&S®OSP120 open switch and control platform**

**R&S®PWC200 control**

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**R&S®PWC200 measurements**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Measurement/evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transmitter characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Radiation pattern</td>
<td>3D pattern and 2D cuts, directivity, sidelobes and nulls, half power beamwidth</td>
</tr>
<tr>
<td>Gain, efficiency</td>
<td>passive antennas</td>
</tr>
<tr>
<td>EIRP, TRP</td>
<td>TX test, equivalent isotropic radiated power</td>
</tr>
<tr>
<td>EVM</td>
<td>modulation quality, error vector magnitude</td>
</tr>
<tr>
<td>ACLR</td>
<td>transmit linearity test</td>
</tr>
<tr>
<td><strong>Receiver characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Sensitivity, EIS, TRS</td>
<td>RX test, equivalent isotropic sensitivity, total radiated sensitivity</td>
</tr>
<tr>
<td>Throughput, BER</td>
<td>performance test</td>
</tr>
</tbody>
</table>

**Specifications in brief**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>2.3 GHz to 3.8 GHz</td>
</tr>
<tr>
<td>Quiet zone size</td>
<td>diameter = 1.00 m, spherical</td>
</tr>
<tr>
<td>Cross polarization</td>
<td>&gt; 27 dB</td>
</tr>
<tr>
<td>Polarization</td>
<td>single linear</td>
</tr>
<tr>
<td>Incident power density</td>
<td>average &lt; 50 mWcm⁻²</td>
</tr>
<tr>
<td>Third-order intermodulation distortion</td>
<td>two-tone, total power density &lt; 50 mWcm⁻² &lt; −60 dBc</td>
</tr>
<tr>
<td>RF connector</td>
<td>2 × N(f)</td>
</tr>
<tr>
<td>Control connector</td>
<td>fiber optic</td>
</tr>
<tr>
<td>Dimensions</td>
<td>W × H × D</td>
</tr>
<tr>
<td></td>
<td>172 cm × 172 cm × 28 cm (67.7 in × 67.7 in × 11.0 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>approx. 85 kg (187.4 lb)</td>
</tr>
</tbody>
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Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

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PD 5215.5971.32 | Version 02.00 | February 2019 (ch)
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