Mobile-radio networks are spreading at breakneck speed, meeting the growing demand worldwide for speech and data communication that is affordable and possible for everyone and everywhere using small, favourably priced terminals. Standards GSM and DCS1800 for digital modulation are becoming more and more popular. GSM networks are in operation in well over 50 countries, often several networks are installed in a country, and there is a strong upward trend. DCS1800 networks are already in use in Great Britain, Switzerland, Thailand, Malaysia and Germany, and introduction is imminent in another 15 countries.

Standards GSM and DCS1800 differ basically in their frequency band (GSM: 900 MHz, DCS1800: 1800 MHz) and the transmitting power of base stations and terminals. In DCS1800 networks, which are mainly intended for communication via handheld phones, transmitting power is lower and coverage area smaller than in GSM networks. Modern mobile-radio networks are organized in cells of varying size depending on the topography of the area in question and the traffic volume to be handled.

To reliably eliminate coverage gaps and thus prevent the interruption of radio links for an area, the directional patterns of antennas installed at BTS stations (base transceiver stations) must fulfill stringent requirements. Further criteria of interest to network operators are reliability and – last but not least – economy. Based on these requirements, Rohde & Schwarz has developed two families of antennas for the 900-MHz and 1800-MHz bands. These omnidirectional (HK...) and directional (HF...) antennas come in a variety of types of various gain levels, allowing for all conceivable applications of network operators (FIG 1).

BTS Antennas HF.../HK...

The right antenna for every mobile-radio base station

Besides offering the complete range of test equipment required for radio networks, Rohde & Schwarz supplies antennas for base stations providing radio coverage for assigned areas. Directional and omnidirectional antennas from Rohde & Schwarz can be used in all networks operating in the 900-MHz or 1800-MHz band: GSM, DCS1800 (PCN), TACS, Qualcomm, NMT900, NTT etc, thus opening up a virtually unlimited range of customers.

Design

Basically, BTS antennas are made up of vertically stacked dipoles [1]. If coverage is to be provided not for the whole surrounding area but only for a sector of it, the dipoles are mounted in front of a reflector. Antennas of this type are commonly classified by the horizontal half-power beamwidth of their directional patterns. For example, one speaks of 65° antennas (FIG 2). Another parameter determining the characteristics of a BTS antenna is its gain. The gain is proportional to the number of stacked dipoles and thus to the total length of the antenna. The gain and half-power beamwidth to be selected for a specific coverage area mainly depend on the topography and on the expected traffic volume (see table in blue box). Omnidirectional antennas are mainly used in areas with low traf-
fic volume and often replaced by directional antennas (sector antennas) as the number of subscribers increases.

**Radiation patterns**

The vertical pattern of a BTS antenna is shaped by the type of feed used for the vertically stacked dipoles. If all dipoles are fed with signals of the same amplitude and phase, maximum gain will be obtained. But this is not always the optimum solution. For example, it is often an advantage to lower the main lobe of the antenna electrically (down tilt) to achieve better illumination of the coverage area and reduce the risk of interference with an adjacent cell (FIG 3). The down tilt is usually between 1° and 6°. In practice, sector antennas often use a combination of electrical and mechanical down tilt. The latter is implemented by means of a swivel holder, which is of course included in the Rohde & Schwarz range of accessories.

Apart from down-tilting, further measures are recommended for optimizing the radiation characteristics of BTS antennas (beam forming, beam shaping). It is generally true that not only gain increases with the number of stacked dipoles but also the number of side lobes and minima (nulls). The side lobes above the main lobe provide no coverage but increase the risk of interference with adjacent cells; it is therefore advisable to suppress them as far as possible, which may afford higher gain at the same time. By contrast, the minima located between the side lobes below the radiation peak result in coverage gaps especially in the vicinity of the base station, which may cause breakdown of links even in digital networks. Therefore, BTS antennas are required not only to feature side-lobe suppression but also a certain amount of null fill-in (FIG 4). Carefully designed null fill-in contributes considerably towards reliable coverage, which has been verified not only in theory but also by numerous mobile tests [2] (FIG 5).

It goes without saying that Rohde & Schwarz antennas meet the standard requirements of network operators with regard to null fill-in and side-lobe suppression. In most cases much better specifications are achieved than those stipulated. Omnidirectional Antenna HK612, for example, fulfills particularly stringent requirements with respect...
to vertical radiation pattern shaping. Generally it can be said that all BTS antennas from Rohde & Schwarz are the result of elaborate optimization [3] and meet all of the described requirements.

Antenna feed

The antenna dipoles are fed with voltages of defined amplitude and phase via a power distribution network designed as a stripline. The stripline is an integral part including all junctions, phasing lines, transformers and matching pads required, doing away with error-prone adjustments and alignments and allowing high manufacturing precision to be maintained throughout a batch. Only a single solder joint is required between the antenna input and the stripline. This and the use of snap-in connections have drastically reduced the failure rate in production and increased MTBF by a factor of 80 compared with antennas featuring conventional coaxial-line connectors. Another essential advantage afforded by this concept is the extremely low intermodulation.

The stripline is fitted between two metal plates and fixed in position by dielectric supports. This design, which is known as a triplate line, makes for extremely low-loss feed of the dipoles and was therefore given preference over the commonly used method of depositing the stripline directly on a dielectric as in the case of PCBs. Another advantage of this feed concept is the small parameter spread of the antennas in production.

Characteristics

Through complete simulation of all parameters relevant to antenna characteristics, including dipoles, reflectors and distribution networks, the following features and benefits were achieved in all BTS antennas from Rohde & Schwarz:

• modularity, allowing application-specific gain figures to be implemented,
• effective suppression of radiation in unwanted directions,
• compact size,
• pattern shaping to avoid coverage gaps,
• extremely high reliability,
• favourable price/performance ratio.

Finally it should be emphasized that it is not only the electrical data of the BTS antennas but also their high resistance to environmental stresses that plays a decisive role for network operators. Accommodated in a weatherproof radome, all parts of the antenna are perfectly protected against environmental effects. Due to their very slim design, the antennas resist wind speeds up to 200 km/h without any appreciable impairment of their radiation patterns and thus of coverage (for example, a hurricane of wind force 12 has a speed of about 125 km/h). And, last but not least, the high quality standard maintained at Rohde & Schwarz – certified to ISO 9001 – guarantees not only the electrical and mechanical data but also a long service life for all BTS antennas.

Dr. Christof Rohner

REFERENCES


Condensed data of BTS Antennas HF.../HK...

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
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<tbody>
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