“KATHREIN-Werke KG was founded in 1919. Since then, we have been developing, producing and marketing a wide range of antenna systems and electronical components.

For more than 50 years we have specialised in the field of professional transmitting and reception antennas; we have been producing broadcast transmitting antennas since the 1950s.

Today, five decades on, we can boast a very high market share of DVB-T broadcast antennas in Germany.

The “ÜberallFernsehen” (TV Everywhere) has arrived and in Germany you can see Kathrein antennas everywhere.”
Introducing KATHREIN’s current broadcast antenna team

Top row, left to right: Roland Manner, Janusz Wojnarowski, Manfred Schlientner, Robert Oberneder, Helmut Obereder, Andreas Lukas, Christian Sautter

Middle row, left to right: Otto Stutzig, Johann Niedermayr, Klaus Kreuder, Wolfram Hoßfeld, Rainer Vogt, Jochen Bonath, Anton Vogl

Bottom row, left to right: Sonja Heinrich, Wolfgang Niedhammer, Irene Winter, Georg Klauser (Head of Department), Claudia Schwarzler, Johann Seebacher (Team Leader Mechanical Development), Sabine Huber, Hermann Zehetner (Team Leader Electrical Development)

Not present:

Adrian Petrut, Christian Finger, Manfred Hellstern, Bernhard Doll, Wolfgang Keil, Frank Giesendorf
2005 was the year that digital television came to Bavaria. Exactly 50 years after the first order from the Bavarian Broadcast Authority to install a transposer in Würzburg, KATHREIN was contracted by the same customer, though this time to supply the new DVB-T broadcast antenna at the Wendelstein transmitter station (see picture).

This reflects the philosophy inherent in KATHREIN products, i.e. over 50 years of customer loyalty thanks to extremely well thought-out technical solutions and excellent quality. This is why our company motto for the future remains:

“Quality leads the way”.
One of the first “tailor-made” systems for the Bavarian Broadcast Authority, which was adapted to suit their special electrical and mechanical conditions, consisted solely of two single antennas, so-called 4-element panels. Their purpose was to “re-steer” the sole Band III TV program available at the time, supplied by the broadcast station at Mount Wendelstein, from the top of the 1600m “Kreuzeck” in order to cover Garmisch-Partenkirchen. The corresponding reception antenna and necessary amplifier – by the way, these were also a first for Kathrein – were installed in an existing FM transmitter located in a nearby gondola station.

The modest 2-watt transmitting power available did not overload the antennas in any way – they would have been able to handle 500 times that amount of power even back then.

Of course, in those days however, the electrical specification of the complete antenna system also had to be measured. This technology even had a slight romantic touch back in the pioneer days of television.

Due to a lack of alternatives, KATHREIN technicians had to spend the night in the transmitter room at the gondola station while the customer acceptance tests were being conducted. The evening meal consisted of Wiener sausages, which were cooked in melted snow due to the frozen water pipes and heated up by the FM transmitter as no oven was available, and pretzels. Afterwards they were lulled to sleep by the loud noise of the turbine from the transmitter’s cooling fan.
1952–1959

A good start

Television is introduced to Germany in December 1952. Service is available for 2 hours a day.

It is not exactly clear when the first development work for professional broadcast antennas at KATHREIN actually began. However, there is evidence that KATHREIN was producing antennas for installation in broadcast transmitting stations as early as 1953/1954. The first clear documentation can be found in the Kathrein year book of 1955, where the editor commented:

“It was a great success for Kathrein to receive the Bavarian Broadcast Authority’s order to install a TV transmitting antenna and a relay reception antenna in the Würzburg transposer.”

This goes to prove that Kathrein can, today, look back proudly on over 50 years’ experience in the field of broadcast transmitting antennas.

The early success led to further orders and by the end of the 1950s numerous similar transposer antennas were supplied to the Bavarian and other Broadcast Authorities.

These transposers were necessary in order to bring television signals to remote and isolated valleys. At the time large TV stations such as Mount Wendelstein were few and far between.
Modern Test and Measurement Laboratory at Kathrein in the 1950s

Exhibition display from the 1950s
As early as the 1950s Kathrein was known for radio and TV reception antenna technology.

Stuttgart, TV Exhibition, 1956
Frankfurt, German Radio and TV Exhibition, 1957
1960–1969

One step leads to another: Growth

In the early 1960s more and more transposers were being built. These were not only required by the German Broadcast Authorities but also by the German Post and Telegraph Authority, which became responsible for broadcasting the 2nd German national television station (ZDF) from 1963 onwards.

The product portfolio for broadcast antennas was extended further. Initially, TV Bands I and III were of prime importance. However, these were then joined by antennas and splitter systems for the UHF frequency spectrum as well as for the transmission of FM radio programs.

Kathrein broadcast antennas gradually became more and more popular abroad, and it was only a matter of time before the first orders were received from the neighbouring countries of Austria and Switzerland.

It was certainly a great advantage that the Kathrein products were produced and designed to withstand harsh environments. They were already in operation and had proven to be a success on the higher lying transmitting stations of the Bavarian Broadcast Authority.

The technical advancements of broadcast antennas and components enabled Kathrein to design and build broadcast antenna systems for large transmitting stations from the mid-1960s onwards. Due to the increasing technical possibilities and competence more and more business opportunities abroad were realised, e.g. projects in Lebanon, Libya, and Thailand.

However, the Kathrein antenna systems were of particular interest in the Nordic countries due to their weather-resistive characteristics (snow/ice) and as a result, numerous large contracts were secured from Sweden, Finland and Iceland.
Examples of Further Projects from the 1960s

Emmaboda, Sweden

Chouf, Lebanon

Pajala, Sweden

Fischbachau, Germany
1970–1989

World-wide success

During the 1970s Kathrein broadcast antenna systems conquered all 5 continents. Kathrein antenna systems were delivered to Jakarta (Indonesia, 1974) (see picture to the right), Mussoorie (India, 1972), Casablanca (Morocco, 1976), Bern (Switzerland), Montreal (Canada) etc. and this laid the foundation stone for the export presence of Kathrein-Werke KG for the next decades.

The products were not only delivered directly to the broadcast authority of the country in question, but many large companies such as Siemens, Philips, Marconi, SEL and Asea also integrated Kathrein components into their systems. In the meantime, the coverage for the second and third TV program is expanding in Germany.

Numerous “BFT” concrete-construction telecommunications towers were erected by the German Post and Telegraph Authority. For this project Kathrein supplied self-supporting fibreglass cylinders which housed the antennas. This solution allows access regardless of weather conditions (see picture to the left) and further reduces the danger of heavy icing on the antenna. The installation of this type of fibreglass cylinder often requires large cranes and this was a major attraction back then – as it still is today.

In the early 1980s private radio broadcasting was introduced in Germany. The terrestrial broadcast for these services was taken over by the German Authority for Post and Telegraphs and Kathrein had access to a further market, i.e. the construction of the necessary FM broadcast antenna systems on the FMT towers (see picture bottom left). At the same time that these activities were taking place, numerous orders were also received from abroad. These included large projects, such as supplying the Canadian TV Network. During this period Kathrein engineers were also sent to Canada - Georg Klauser who now is Head of the Department, was just one of these engineers and he remembers it only too well.
Further examples of projects from the 1970s and 1980s

The picture below shows the difficult transport of the 20-metre long fibreglass cylinder on a narrow forest path up to the “Hoher Bogen” transmitting station (Bavarian Broadcast Authority and German Post and Telegraph Authority). The path was so steep in some places that special vehicles were required to overcome the gradient (1976).
1990–1999

**Truly Nationwide Coverage**

After the reunification of Germany it became necessary to replace the aging antenna systems of east European origin that were located on the telecom towers. In addition, many new stations were added in order to close the gaps in coverage.

This meant that the order books of Kathrein’s Broadcast Antenna division (internally known as PTR at the time) were suddenly well filled. Practically every single person was stretched to fulfil these important projects.

The production facilities of the Professional Antenna division were transferred to the newly built Plant IV in 1994, after the production facilities in Plant II became too small to accommodate the accelerated growth of both the Broadcast and Mobile Communications products. New antenna systems were delivered to various well-known locations such as the “Brocken” in the Harz district (see photo to the right), Berlin’s Alexanderplatz, Inselsberg, etc.

By 1996 the terrestrial broadcast coverage of the former East German states was more or less completed.

In order to secure and maintain the level of business, it was necessary for Kathrein to increase exporting activities. New customers and markets had to be acquired. Assistance came with the opening of the former eastern bloc countries, which formed a completely new market for Kathrein broadcast antennas. Orders for broadcast antenna systems were soon received from the Slovakian Republic, Bulgaria, Hungary, Czech Republic and Romania.

Apart from the direct sales activities, the well developed sales network of Kathrein representatives and distributors also contributed to the success story. Kathrein SEA (Malaysia), Kathrein France, Kathrein Scala Division (USA), Omega (today Kathrein India) and Romkatel (Romania) are just a few which deserve mentioning.

Employees from Kathrein’s subsidiaries became a common sight in Rosenheim during training sessions (see picture bottom left).
However, from an international perspective it became clear that a highly competitive market had evolved. Customers were becoming increasingly price conscious, which opened the door to low-cost operators. Kathrein continued to rely on quality, service and ever more sophisticated system technology. The production of broadcast antennas was still located in Rosenheim and supported by a highly experienced team, many of whom had more than 20 years’ experience in the management of large broadcast antenna systems, from conception and production to customer acceptance testing.

Particularly prestigious projects during this time were, for example, the new construction of the antenna system at Berlin’s “Alexanderplatz”, as well as the Swisscom “Säntis” project (see picture to the right). On the top of the Säntis mountain in the Swiss Alps, at an altitude of 2,500 metres, an antenna was integrated into a heatable radome construction. This enabled the operator to reduce the danger of falling ice to such an extent that the platform under the transmitting antenna could even be used as a panoramic view point for tourists.
The Digital Era Begins

At the beginning of the new millennium many countries were continuing to expand their conventional analogue broadcast networks, while in other regions digital systems were being introduced. During this period the volume of orders for analogue systems still exceeded those for digital systems.

Large projects for conventional transmitting technology were implemented in Algeria, Nigeria, India, Indonesia and Turkey (see picture below). The “Zero Base Project” in Holland was initiated; the requirement here was to expand the coverage capacity within the FM frequency band so that new private radio stations could offer their services via terrestrial broadcast systems. Consequently, the planning of the transmitting antenna systems had to be refined considerably and it was therefore necessary to design completely new concepts of antenna combining components.

How important system engineering had become for modern broadcast transmitting antenna systems was evident with the introduction of DVB-T in Germany. When the new technical requirements were announced in autumn 2003 the Broadcast Electrical Development Dept. (AEB) worked intensively on a solution. The result was the implementation of well known radiating elements. However, these were set in a completely new configuration. All special conditions in terms of the omni-directional radiation characteristic, the VSWR and access for general service throughout the complete antenna system had to be fulfilled, irrespective of whether horizontal and vertical polarized systems are involved, or whether these are mounted on a steel mast or integrated inside a fibreglass cylinder.

In 2004, Germany was ready for DVB-T. Five urban areas were selected for coverage via digital terrestrial television. At this point in time only Kathrein was in a position to deliver the technology defined in the T-Systems specifications and required by broadcast authorities. The network operators put their trust in Kathrein to such an extent that during 2004 Kathrein delivered a total of 27 new broadcast antenna systems for DVB-T in Germany.

Endem Tower in Cekmece, Istanbul, Turkey.

RCTI and SCTV Surabaya, Indonesia, 2000 (120 kW total)
2005 started in much the same way. The Nuremberg and Munich/Upper Bavarian regions turned on their digital terrestrial television on 30th May.

Kathrein secured the orders for all deliveries of transmitting antenna systems for Nuremberg, Dillberg, the Munich Olympic Tower and Mount Wendelstein. All the projects were delivered and completed on time.

Other countries have also introduced DVB-T. Orders from Switzerland, France and Taiwan are being processed.

Conception work for numerous regions around the world is underway: England, Indonesia and Brazil.
The Start and Roll-out of DVB-T in Germany

Start 2002/2003

Before the introduction of digital terrestrial television the importance of TV reception via a rooftop antenna was steadily decreasing. The majority of people now began to receive their TV via satellite or cable.

The primary reason for the steadily decreasing demand for classical terrestrial reception was the restricted choice of programs. As a result, the classical form of analogue terrestrial transmission became increasingly uneconomical for broadcast companies.

Taking this into account, the German Government decided to back the 1998 proposal put forward by the “Initiative for Digital Broadcasting” to completely replace the standard terrestrial analogue television service with the new digital terrestrial TV technology (DVB-T) by 2010. In February 2002 the public and private broadcast companies together with the Media Institution Berlin-Brandenburg signed an agreement which defined the DVB-T standard as the sole method of TV terrestrial transmission in the greater metropolitan region of Berlin.

After conducting a feasibility study, Kathrein received the order to re-design the antenna system on the Berlin transmitting station towers at “Alexanderplatz” and “Schäferberg” as well as the new “Scholzplatz” DVB-T transmitting site.

Redesigning the first two existing sites posed several significant challenges for Kathrein engineers:

- the new 8-channel UHF antennas had to be designed for an extreme broadband transmission system
- construction work had to be carried out with as little interruption to the transmission service as possible

The radiation polarization of the “Alexanderplatz” and “Schäferberg” systems were to remain horizontal; the Superturnstile radiation elements were replaced with special modified versions and the self-supporting fibreglass outer structure also had to be modified.

DVB-T antenna, “Alexanderplatz”, Berlin
Although the Kathrein team of development engineers had to implement new ideas and technology, and the installation crew had to perform the difficult modifications during night shifts, the first two DVB-T channels could go on air by 1st November 2002.

By 1st March a further 6 channels had followed. The target was fulfilled. Now the DVB-T standard offers the possibility of transmitting up to four times the number of programs with the same frequency resources as contemporary analogue broadcasting systems using the PAL-G standard. The modulation technology COFDM used in DVB-T also allows the mobile and portable use of TV without the irritating mirrored or doubled images caused by multi-path reception (e.g. by reflections) which was the case with analogue applications.

Motto: Television Made Possible Everywhere

While taking this effect into account, the idea was conceived to use the reflections to fill in areas where coverage was poor. For example, this concept could be used in the shadow of large buildings where no direct reception was possible. In order to use this effect for mobile and portable reception, vertical polarization was considered more appropriate and effective due to the greater majority of vertically orientated “natural” reflectors (e.g. street lighting masts). On the other hand, it also seemed logical to maintain a horizontally polarized system because many customers had their rooftop antenna horizontally orientated from former analogue reception times.

As early as the summer of 2003 Kathrein received a query about whether vertically polarized broadband UHF antenna systems with an excellent omni-directional characteristic could be realised. After checking the requirements it was found that the usual configuration of four antenna elements per bay was not feasible due to physical restrictions. A broadband omni-directional characteristic could not be achieved in this manner.

The Broadcast Development Dept. at KATHREIN-Werke KG were able to provide a solution with the help of a computer simulation program which foresaw the implementation of eight vertically polarized antenna elements per bay mounted in a special geometric nature (octagonal structure). As a result, a practical solution could be presented for the following basic requirements:

- an omni-directional radiating characteristic with less than 3 dB indentations across the complete UHF frequency band
- tuning of the VSWR to less than 1.2 for individual channels in the complete UHF frequency band
- general access throughout the complete antenna system in line with the safety requirements of Deutsche Telekom (80 x 80 cm)

The construction described above could be realised using an octagonal supporting structure and a self-contained fibreglass cylinder.

Further Roll-out during 2004

Shortly afterwards Kathrein were able to further show their competence in the field of broadcast transmitting antennas when the DVB-T roll-out reached other metropolitan areas.

Here follows a brief list of the DVB-T broadcast antenna systems delivered by Kathrein in 2004:

Greater metropolitan area of Cologne/Bonn:
- Re-design and modification of the UHF antenna system at Bonn-Venusberg to
a vertically polarized octagonal structure in a fibreglass cylinder.

- New construction of the top of the “Colonius” Telecom Tower in Cologne with UHF antennas of a vertically polarized octagonal structure in a fibreglass cylinder.

On air by 24th May 2004

**Greater metropolitan area of Hannover/Braunschweig:**

- Re-design and modification of the UHF antenna system at Hannover 9 (“Telemax”) with a new broad-band horizontally polarized Superturnstile in a fibreglass cylinder. In addition, a new VHF antenna was supplied.

- New construction of the Hannover-Hemmingen broadcast antenna system, horizontally polarized dipole panel antenna array mounted on a lattice mast.

- New construction of the Braunschweig 3 (“Broitzem”) antenna system with a vertically polarized octagonal structure in a fibreglass cylinder. In addition, a new VHF antenna was supplied.

- New construction of the “Braunschweig-Kraftwerk” (power station) antenna system with VHF and UHF antennas behind a fibreglass radome.

On Air by 24th May 2004

Braunschweig DVB-T antenna, power station, Braunschweig, antenna mounted behind a fibreglass radome (bottom photos).
Rhein-Main District:
- New construction of the top of the Frankfurt Telecom Tower (“Europaturm”) with vertically polarized UHF antennas in an octagonal structure inside a fibreglass cylinder. An additional VHF antenna was also supplied.
- New construction of the Feldberg-Taunus antenna system with vertically polarized UHF antennas in an octagonal design mounted on a steel supporting system.

On air by 4th October 2004

Bremen/ Unterweser District:
- Re-design and modification of the Bremen 38 UHF antenna system (“Utremer Str.” Telecom Tower) with a new broadband horizontally polarized Superturnstile inside a fibreglass cylinder.
- New construction of the Bremerhaven/ Schiffdorf UHF antenna system, horizontally polarized dipole panel antenna array mounted on a pipe mast.

On air by 24th May 2004

An additional VHF antenna was also supplied.
- New construction of the Wiesbaden VHF and UHF antenna system (“Hohe Wurzel”), consisting of vertically polarized dipole panel antenna array mounted on a pipe mast.

On air by 4th October 2004

DVB-T antenna, Bremen

DVB-T antenna on the Europaturm in Frankfurt
Hamburg/Lübeck/Kiel District:
- New construction of the Hamburg 22 UHF antenna system ("Telemichel") with horizontally polarized new broadband Superturnstile inside a fibreglass cylinder. An additional VHF antenna was also supplied.
- Re-design and modification of the Hamburg-Rosengarten UHF antenna system with horizontally polarized new broadband Superturnstile inside a fibreglass cylinder.
- New construction of the Hamburg 140 UHF antenna system ("Höltigbaum"), horizontally polarized dipole panel antenna array mounted on a lattice mast.
- Re-design and modification of the Lübeck-Berkentin UHF antenna system with a horizontally polarized new broadband Superturnstile inside a fibreglass cylinder.
- New construction of the Lübeck 23 UHF antenna system ("Stockelsdorf") with vertically polarized dipole panel antenna array mounted on a pipe mast.
- New construction of the Schleswig UHF antenna system with 10 panels per bay vertically polarized special dipole panel antenna array on a pipe mast.
- New construction of the Kiel UHF antenna system with horizontally polarized new broadband Superturnstile inside a fibreglass cylinder. An additional interim skew antenna was also installed during the transition period.
- New construction of the Flensburg UHF antenna system, vertically polarized dipole panel antenna array mounted on a lattice mast.
- New construction of the Bungsberg/Eutin UHF antenna system, vertically polarized dipole panel antenna array on a lattice mast.
- New construction of the Sibesse antenna system ("Landkreis Hildesheim"), dipole panel antenna array mounted on a lattice mast.

On air by 8th November, 2004

Rhein-Ruhr District:
- New construction of the Dortmund, Wesel and Essen UHF antenna systems, each of which are fitted with vertically polarized UHF antennas in octagonal design inside a fibreglass cylinder.
- New construction of the top of the "Rheinturm" Telecom Tower in Düsseldorf with vertically polarized UHF antennas in octagonal design inside a fibreglass cylinder.
- New construction of the Langenberg UHF antenna system consisting of vertically polarized dipole panel antenna array mounted on a lattice mast.

On air by 8th November, 2004
The sheer number and variety of the broadcast antenna systems already described is an indication of the work load that the respective staff at KATHREIN-Werke KG and the installation companies were faced with during an extremely short period of time. It is obvious that only a harmonised team of specialists in the field of radio frequency engineering, mechanical engineering and installation could master this challenge. It must also be noted that all systems were delivered on time and also fulfilled the usual high level of quality associated with Kathrein.

A total of 9 antenna systems were mounted on the top of antenna towers using helicopters. Previously such installation procedures were considered extremely risky. However, every one of these DVB-T antenna systems was installed by helicopter without any difficulty or delay.

**The Introduction of DVB-T in Bavaria during 2005**

Kathrein acquired their first order for a TV broadcast antenna from the Bavarian Broadcast Authority in 1955. Exactly 50 years later Kathrein received the order for the construction of the antenna system for digital terrestrial TV in the Munich/Upper Bavaria region and Nuremberg.

For the first time, exposed transmitter sites were chosen so that not only metropolitan areas but also large rural districts could be supplied with DVB-T coverage. It was possible to take advantage of the experience gathered during the roll-out of DVB-T broadcast antenna systems in various German regions during 2004. However, not all technical solutions could be implemented without them being adapted. The location and topography of the “Wendelstein” transmitter site, at 1838m above sea level on the German/Austrian border, required special development work in order to achieve the corresponding radiation pattern and required reductions. The installation work also created special challenges to all concerned due to the general prevailing climatic conditions. However, the experience of the Kathrein engineers in broadcast antenna project management also paid off in this case. Each antenna system was mounted and commissioned on schedule.

The details were as follows:

- New construction of the top of the Munich Telecom Tower (“Olympiaturm”) with vertically polarized UHF antennas in an octagonal design inside a fiberglass cylinder. An additional VHF antenna was also supplied.
- New construction of the Wendelstein antenna system with vertically polarized...
UHF antennas in an octagonal design thereby ensuring a directional radiating characteristic and mounted inside a fibreglass cylinder. An additional VHF antenna was also supplied.

- New construction of the top of the Nuremberg Telecom Tower with vertically polarized UHF antennas in octagonal design and mounted inside a fibreglass cylinder. An additional VHF antenna was also supplied.

- New construction of the Dillberg Antenna System with vertically polarized UHF antennas in octagonal design and mounted on a steel supporting structure.

On air by 30th May, 2005
DVB-T coverage in Germany

- DVB-T in operation
- DVB-T in operation (national broadcast stations)
- DVB-T start on 5th December, 2005 (national broadcast stations)
- DVB-T start in planning phase (national broadcast stations)
- DVB-T start in planning phase

Source for all DVB-T footprints: DVB-T project in Germany, www.ueberallfernsehen.de
For more than 50 years broadcast transmitting antennas in the frequency range between 30 MHz and 3 GHz have always been a feature of the KATHREIN-Werke KG product portfolio. The planning and production of the large broadcast antenna systems is therefore just as important as the development and optimisation of the respective components in line with electrical and mechanical requirements. During these 50 years enormous technological developments have been achieved. Computer technology opened the door for completely new design opportunities. Here is a short summary about the technology implemented from FM and TV broadcast antennas to the latest developments required for the broadcast of DVB-T.

With the introduction of broadcasting in the VHF and UHF bands after the Second World War new antenna radiating elements were developed. The main criterion was the considerably shorter wavelength in comparison to the previously used medium wave systems. In the past, the mast itself was in fact the radiating element. With this new technology one or multiple radiating elements were mounted as high as possible on the supporting structure. The following aspects now had to be considered:

- configuring the radiating elements in a certain way in order to achieve the required radiating diagram
- nominal power rating of the complete system
- installation and wind-loading restrictions of the antenna supporting structure
- mechanical strength and life span of the radiating elements

Apart from radiating structures with an omni-directional radiating characteristic which were mounted on the top of the antenna supporting structure, e.g. turnstile antennas, slot antennas or Superturnstiles, one particular kind of antenna radiating structure has emerged as the most frequently implemented type of radiating element over the last 50 years: the framed dipole structure (also known as “dipole panel antenna”). This type of radiating element consisted of one or multiple dipoles mounted on a reflector screen.

This construction had the following advantages:
- practically complete decoupling from the antenna support structure
- can be used as an individual element for sectorising groups of antennas
- mechanically very robust
- the VSWR for each element can be optimised
- power distribution and feeding systems for the antenna array can be achieved using splitters, whereby coaxial star-point distributors with impedance transformers are integrated.

The antenna system components were originally dimensioned with the help of published formulas, tables and experience and then optimised using measurements. The advent of computers in the 1970s opened the door to a whole new range of possibilities.

A modern test and measurement laboratory in the 1950s

K 52 33 5, antenna for the 174 - 230 MHz frequency band
Computer simulations, for example, were used in order to calculate the radiation characteristic and level of reflection of wired systems in advance. However, it often took several days before the results of such complex calculations were available.

Today software programs such as FEKO (see below) or Microwave Studio (bottom photo) are implemented, whereby the basis for the calculation is the Method of Moments or Finite Integration. Using high speed microprocessors the complex calculations are completed within seconds.

As a result, radiating elements and splitters can be finely optimised within a very short period of time. If the radiation characteristic of each radiating element is known, then the characteristic of an array can be calculated with the help of vector addition. The mechanical configuration as well as the amplitude and phase of the distribution system offers numerous possibilities for forming the array radiation characteristic. In the pioneer days this would have required lengthy vector addition by hand. However, by the 1970s, project engineers could make use of such computer-supported software and thereby accelerate technological development considerably.

If one compares the broadcast antenna systems of 40 years ago with those of today then one will immediately see that the shape of the individual radiating elements has not changed significantly. There are good reasons for this: namely the high power and the mechanical loading requirements do not allow for further simplification and miniaturization. However, it would be wrong to believe that no improvements have been made in the field of broadcast antennas.

System engineering development has taken a leading role. Computers have made it possible to analyse a significantly higher number of possible solutions via simulations. In particular, this means that a larger number of combinations and permutations of individual radiating elements and forms can be analysed in various configurations and the optimal solution can be found.

However, the experienced antenna engineer is the one responsible for entering the necessary data into the computer and subsequently checking the results for practical feasibility.

New systems had to be developed in order to fulfil the special requirements that DVB-T broadcast systems placed on TV broadcast antennas. The antennas for analogue TV were optimized for a few channels and the new versions had to be adapted to become as broadband as possible. Special care was taken to create a broadband omni-directional characteristic so that the so-called “bad channel” effect could be avoided. This means that coverage becomes channel independent. Due to digital modulation a simultaneous overlapping of many carriers may arise, which can in turn lead to high voltage peaks on the system. This effect is known as the “Crest Factor” and must be considered when dimensioning the antenna distribution system. It is more often the high voltage peaks that limit the capacity of a DVB-T antenna system rather than the system overheating.
The implementation of vertically polarized systems for the planned broadcast of “ÜberallFernsehen” (TV Everywhere) using the DVB-T standard is becoming more common. This is supposed to create better reception conditions for mobile and portable receivers. There follows a short description of three antenna systems newly developed and especially designed by the AEB and AMB development departments for operation in DVB-T broadcast antenna systems.

**DVB-T Broadcast Antenna System K 72 20 4**

This system consists of up to 16 bays of a Superturnstile antenna for the UHF frequency band 470–860 MHz. The radiating elements are located inside a self-supporting fibreglass cylinder with a diameter of 1.6 m. This design allows an excellent omni-directional characteristic with a maximum indentation of 3 dB across the full UHF bandwidth to be achieved. The technical specification for a typical system which is required for various DVB-T projects in Germany is listed below:

<table>
<thead>
<tr>
<th>No. of bays:</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarisation:</td>
<td>Horizontal</td>
</tr>
<tr>
<td>Horizontal diagram:</td>
<td>Omni-directional</td>
</tr>
<tr>
<td>Vertical diagram:</td>
<td>with strong null-fill and downtilt</td>
</tr>
<tr>
<td>VSWR:</td>
<td>&lt; 1.2 broad-band throughout the UHF bandwidth</td>
</tr>
<tr>
<td>Power:</td>
<td>6 x 5 kW DVB-T per half antenna, ref. input of combiner</td>
</tr>
<tr>
<td>Gain at mid-band:</td>
<td>approx. 14.5 dBi ref. input of main splitter</td>
</tr>
</tbody>
</table>

Superturnstile antenna mounted inside a fibreglass cylinder
DVB-T Broadcast Antenna System
K 73 20 4

In order to also fulfil the requirements for an omni-directional radiation diagram (max. 3 dB indentation) with a vertically polarized system across the full UHF bandwidth, a specially developed system with a configuration of 8 antenna elements in each bay was developed.

This configuration also made it possible to fulfil the access and service requirements enforced by the German Broadcast Authorities and the Deutsche Telekom.

The antenna system is mounted inside a self-supporting fibreglass cylinder with a diameter of 1.6 m.

The technical specification for a typical system which is required for various DVB-T projects in Germany is listed below:

<table>
<thead>
<tr>
<th>No. of bays:</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarisation:</td>
<td>Vertical</td>
</tr>
<tr>
<td>Horizontal diagram:</td>
<td>Omni-directional</td>
</tr>
<tr>
<td>Vertical diagram:</td>
<td>with strong null-fill and downtilt</td>
</tr>
<tr>
<td>VSWR:</td>
<td>&lt; 1.2 broad-band throughout the UHF bandwidth</td>
</tr>
<tr>
<td>Power:</td>
<td>6 x 5 kW DVB-T per half antenna, ref. input of combiner</td>
</tr>
<tr>
<td>Gain at mid-band:</td>
<td>approx. 14,5 dBi</td>
</tr>
<tr>
<td></td>
<td>ref. input of main splitter</td>
</tr>
</tbody>
</table>

DVB-T antenna system, Europaturm, Frankfurt
DVB-T Broadcast Antenna System  
K 73 214

If requested by the customer, an antenna system similar in design to the K 73 20 4 can be mounted on an octagonal steel supporting structure. Each antenna element is covered with a protective radome and the power distribution cable system is installed inside the steel structure.

The requirement for an omni-directional radiation characteristic in the horizontal plane (max. 3 dB indentation) across the full UHF bandwidth is also fulfilled with this design. The electrical specification corresponds to the antenna type K 73 20 4.

DVB-T antenna system, Feldberg in the Taunus area, Germany