



ON TRACK TO FRMCS

SHAPING THE FUTURE OF RAILWAY COMMUNICATION

Traditional. Innovative. SOLUTIONS.







Since 1981 Funkwerk develops and manufactures train radio systems for railway companies worldwide. As a world market leader we offer customized solutions for voice and data communications via analog and digital (GSM-R/4G/5G) mobile networks on the rail.

Due to their modularity, Funkwerk communication systems are prepared for future evolutions, taking state-of-the-art technologies and standards into account, developing tailor-made solutions.

SHAPING THE FUTURE OF RAILWAY COMMUNICATION

By integrating pioneering technologies, Funkwerk has already played a key role in shaping the transition from analogue to digital train radio in the past. Today, another technological change is imminent with the introduction of FRMCS as the Europe-wide 5G-based standard for the railway communication of the future.

Funkwerk is heavily involved in the development of the standard and already manufactures a wide range of modules and devices to make new and existing systems ready for FRMCS.

This brochure provides an insight into our migration strategy towards FRMCS.

The introduction of FRMCS is the basis for the digital railway operation of the future, which is intended to increase efficiency, reliability and safety. Based on 5G radio technology, the new standard sets the course for IP-based communication by separating the transmission system from the application. FRMCS complements GSM-R and will later replace it to take the communication between vehicles and infrastructure to a new level.

We develop FRMCS components for retrofitting existing train radio systems as well as complete solutions for new vehicles. We aim to enable a seamless transition and to support individual migration paths. In this way, we create **long-term investment security** for your existing systems. Funkwerk accompanies you as a partner on your journey into the future of railway communication.

In addition to the further development of our certified systems, we put a lot of passion and motivation into the development of future solutions, such as our upcoming **MESA all:nexo®** train radio systems.

YOUR PATH TO FRMCS

Funkwerk is involved significantly in the standardisation process, development and testing for the introduction of FRMCS and is active in European committees. The EU Commission's current plans envisage creating the legal framework for the introduction and authorisation of FRMCS by 2028 and then enabling the technology rollout. The migration phase from GSM-R to FRMCS in Europe is estimated to take an additional 10 to 15 years.

Funkwerk is already developing migration concepts and solutions. The existing **MESA® product family** can be upgraded for use with FRMCS. Thanks to its modular architecture, the future-proof platform enables secure migration on your way to FRMCS. Upgrading is possible without an investment-intensive and time-consuming replacement of the entire radio system.

The future **MESA all:nexo®** platforms will support FRMCS natively and as well as legacy standards via modules that are already available.



SYSTEM SOLUTIONS BY FUNKWERK

As a supplier of onboard communication solutions, we develop and manufacture system-relevant components for existing and new vehicles as well as for the migration of existing train radio systems:

- ▶ Train radio equipment
- ▶ FRMCS gateway as interface to onboard applications
- ▶ FRMCS **MCX client applications** for voice and data communication
- ▶ Control panels/MMI (display and audio components)
- ▶ Innovative antenna systems for optimized communications

In addition to the FRMCS technology, Funkwerk also offers services for the successful integration of the system on the vehicle:

- ▶ Certification management
- ▶ Owners support for vehicle approval
- ▶ Engineering services

SECURE MULTIMODE COMMUNICATION ACROSS ALL BORDERS

Since the introduction of GSM-R in the early 1990s, we design every train radio system for multimode to ensure operation in different regions and countries, across national borders.

Due to the strict modular design and separation of our hard- and software, we are able to implement every current and future radio standard in a single system. This provides long-term support and service for your investment.

The **MESA® product family** can be configured for any kind of application using our various additional modules. From stand-alone FRMCS voice communication to fully integrated gateways, we implement options tailored to your specific needs.

Funkwerk train radio systems are designed as multimode devices to ensure operation in different regions and countries, across national borders.



THE FUNKWERK GATEWAY

Other than GSM-R, FRMCS is based entirely on IP. This increases requirements for component security (cyber security). With the introduction of FRMCS, we will provide a TSI CCS-compliant FRMCS On-board system, integrating state-of-the-art technology for information security and protection against cyber-attacks.

The Funkwerk Gateway FGW, respectively its internal variant and up to the point of a rack-based system, will support interfaces, following the UIC definition and standardization comprehensively. We are continuously involved in the standardization process by testing our systems in various pilot and research projects. These tests are the basis for the further development.

” With the introduction of FRMCS, we will provide a TSI CCS-compliant FRMCS On-board system, integrating state-of-the-art technology for information security and protection against cyber-attacks.



UPGRADE YOUR EXISTING MESA® TRAIN RADIO SYSTEM

PRESERVE YOUR EXISTING INVESTMENT

Migration to FRMCS is possible for all **MESA® Train radio systems**. We provide multiple options for your specific project needs.

The 5G-based digital radio module MTC18 with an integrated modem offers not only the already existing support of various mobile radio systems and frequency bands, but also an outstanding future viability and flexibility, as it can also easily integrate certified FRMCS modems without any problems.

- ▶ Support for a wide range of 3GPP 5G NR and LTE frequency bands
- ▶ Support for FRMCS 900 and 1900 MHz (Band n100 and n101)
- ▶ Powerful Quad-Core Arm® Cortex® CPU
- ▶ GBit Ethernet interfaces for OBAPP und OBRAD
- ▶ GNSS
- ▶ Integrated eSIM and a SIM card slot
- ▶ Wide-range power supply unit from 24 to 110 VDC
- ▶ Compliant with railway standards



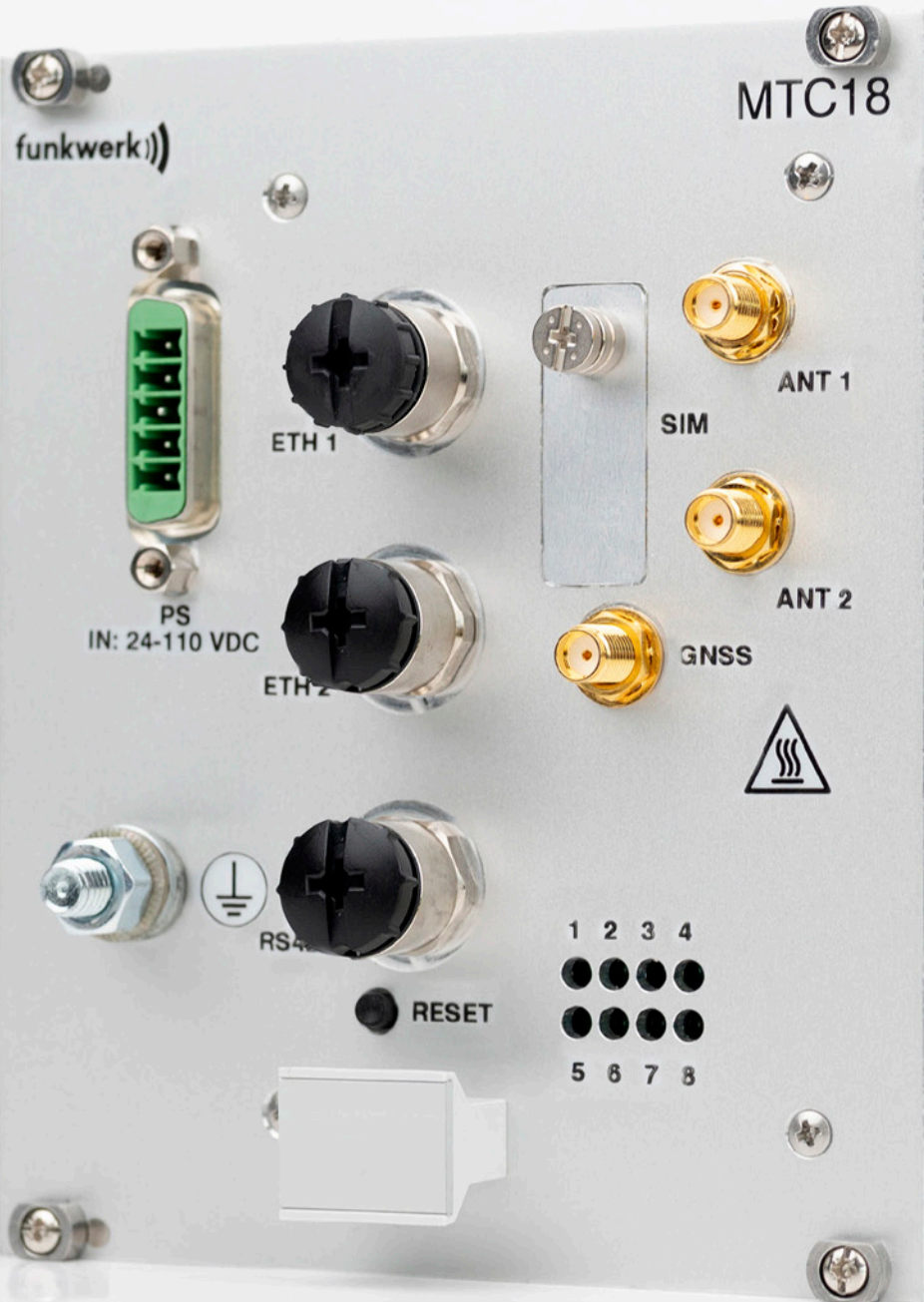
Modular design for flexible solutions



Proven and certified according to latest standards



Longterm investment protection



MESA ALL:NEXO® CONNECTING RAILWAYS

We are developing 5G and FRMCS access radio solutions for retrofitting existing train vehicles, as well as complete solutions for new vehicles. With our new **MESA all:nexo®** product series we already have innovative and proven FRMCS train radio solutions. The series is geared towards the future of rail communication and is available in various versions.

The all:nexo® series supports 5G/FRMCS natively whilst train radio systems of the series **MESA all:nexo® multimode** can be configured to be backward compatible with previous communication standards through already available GSM-R or analog radio modules.

With the introduction of FRMCS, we will provide certified TSI CCS-compliant FRMCS onboard systems. The current plans of the EU Commission envisage creating the legal framework for the introduction and approval of FRMCS by 2028 and subsequently enabling the technology rollout.

Our **MESA all:nexo® train radio solutions** are already technically capable of meeting the standard, which is still being finalised. Funkwerk is significantly involved in the standardisation process, development and testing for the introduction of FRMCS, and is active in European bodies.





MESA ALL:NEXO®

Our **MESA all:nexo®** solution is used for voice and data transmission in **public** and **private 5G networks**, including the capability for Mission-Critical Applications (MCX/FRMCS). The radio module is connected directly to the vehicle's electrical system and operated via the supplied touchscreen control unit.

Incl. power supply, handset and microphone.



MESA ALL:NEXO® COMPACT

For quick and compact installation in locomotives and driving vehicle cockpits, we have developed the **MESA all:nexo® compact**, a 5G-based cab radio, which is fully housed within a standardised double-DIN enclosure.

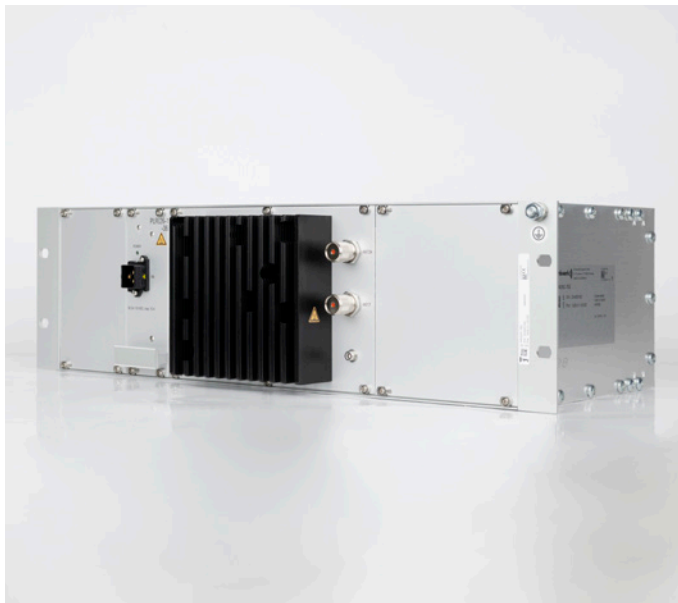
In addition to an integrated eSIM, the system can be operated with a publicly available SIM card and is designed as an all-in-one unit for permanent installation in vehicles. Thus, the MESA all:nexo® compact is also suitable for **regional public transport**.

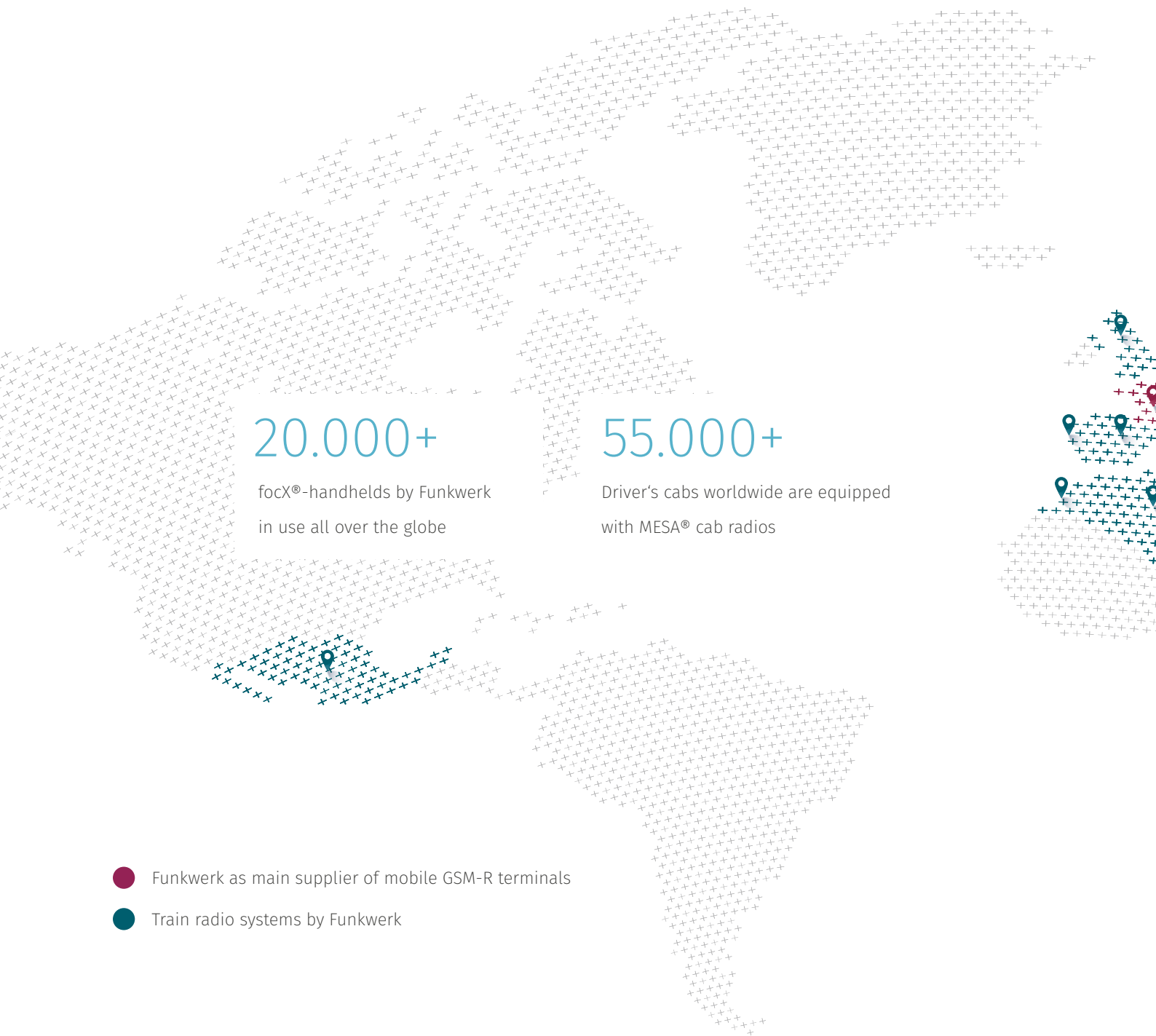
The MESA all:nexo® compact enables 3G, 4G, and 5G mobile voice and data services, including the **capability for Mission-Critical Applications (MCX/FRMCS)**.

MESA ALL:NEXO® MULTIMODE

At the heart of the **MESA all:nexo® multimode** is a modular central unit for 5G/FRMCS networks. To ensure backward compatibility with previous radio standards, the system can be expanded with further radio modules. For example, with a variety of our GSM-R radio modules for international use and/or expansion units for analogue radio. The system has a universal system architecture and is expandable via uniform and standardised interfaces and modules.

The train radio solution for the future of rail communication masters **all relevant train radio standards** in a single modular system.

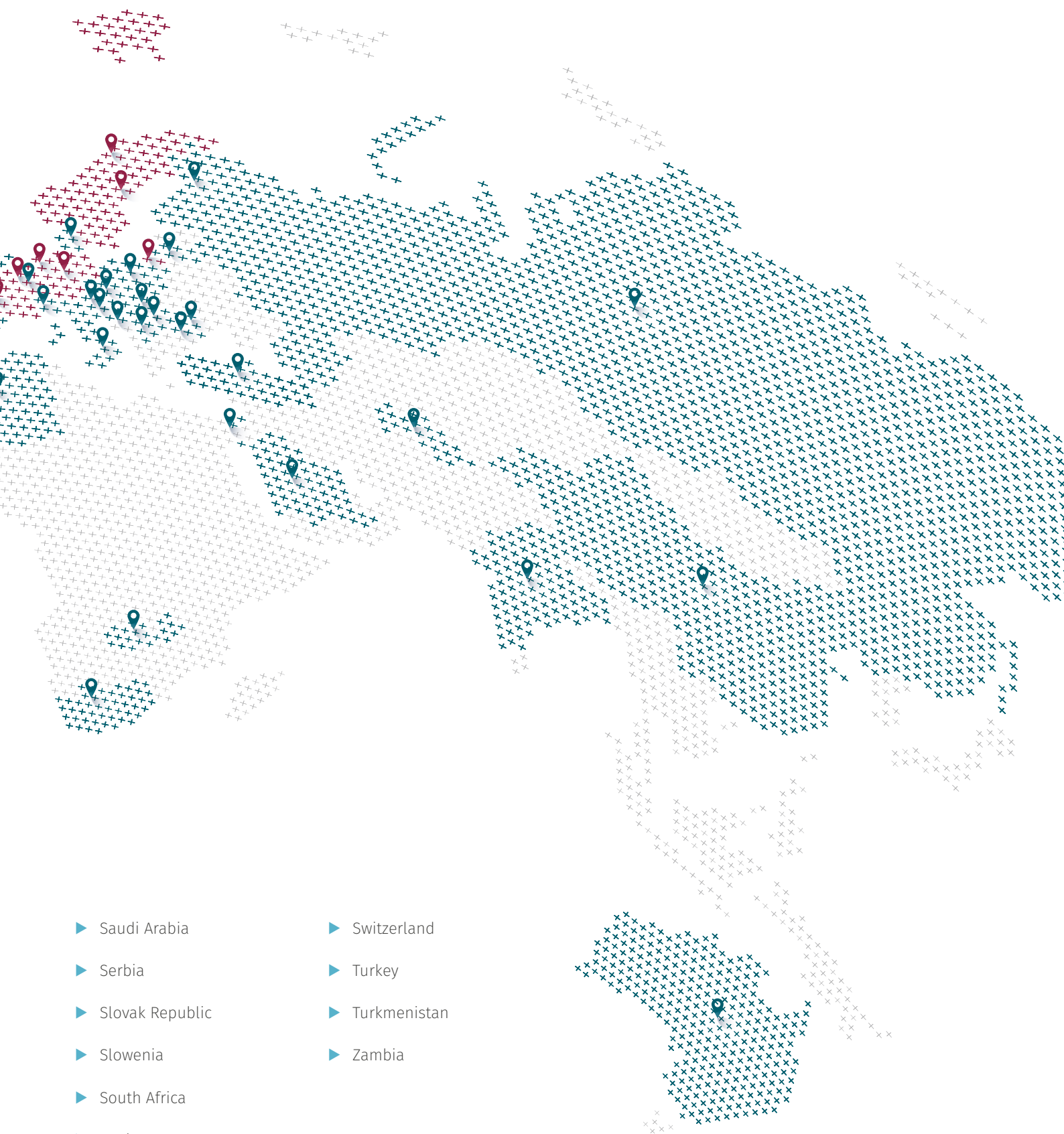




- Funkwerk as main supplier of mobile GSM-R terminals
- Train radio systems by Funkwerk

- | | | | |
|-------------|------------------|--------------|---------------|
| ▶ Algeria | ▶ Czech Republic | ▶ India | ▶ Morocco |
| ▶ Australia | ▶ Denmark | ▶ Israel | ▶ Netherlands |
| ▶ Austria | ▶ Finland | ▶ Italy | ▶ Norway |
| ▶ Belgium | ▶ France | ▶ Latvia | ▶ Poland |
| ▶ Bulgaria | ▶ Germany | ▶ Lithuania | ▶ Portugal |
| ▶ China | ▶ Great Britain | ▶ Luxembourg | ▶ Romania |
| ▶ Croatia | ▶ Hungary | ▶ Mexico | ▶ Russia |

MORE THAN 75.000 WORLDWIDE



- ▶ Saudi Arabia
- ▶ Serbia
- ▶ Slovak Republic
- ▶ Slovenia
- ▶ South Africa
- ▶ Spain
- ▶ Sweden
- ▶ Switzerland
- ▶ Turkey
- ▶ Turkmenistan
- ▶ Zambia

SOLUTIONS FOR GSM-R AND FRMCS

focX[®]2 SMARTPHONE

The robust smartphone has a dedicated GSM-R radio modem and fulfils the requirements of the EIRENE standards.

Future generations of our focX[®] smartphones will also support the **FRMCS requirements**.

The focX[®]2 supports not only GSM-R but **MCX clients** as well.



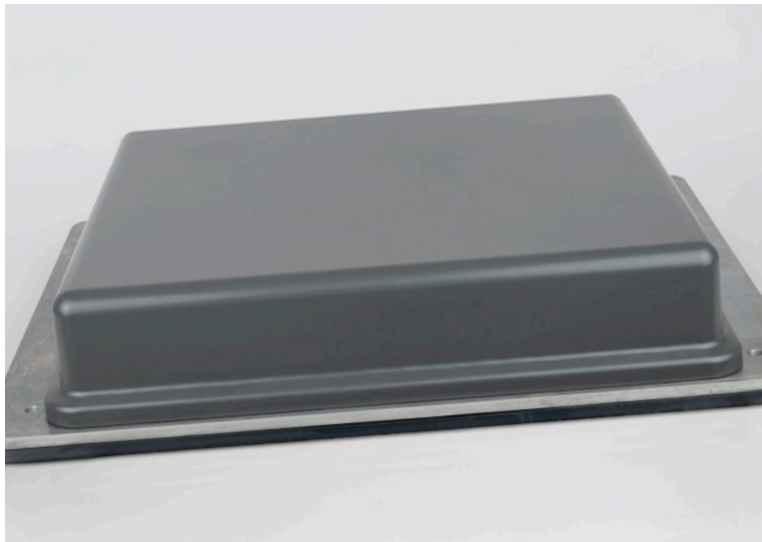
FOCX²

INTERFERENCE-RESISTANT AND EXTREMELY ROBUST

ANTENNA

With our innovative Funkwerk antenna (FANT), two GSM-R radio modules can operate within a single antenna without any interference, freeing space for mounting a dedicated FRMCS antenna, necessary for your migration toward FRMCS.

After completion of the migration process, the FANT antenna shows its full potential, supporting the entire regulated European FRMCS spectrum.



TEST EQUIPMENT

Funkwerk provides professional test equipment for commissioning and maintenance of train radio systems, including

- ▶ Antenna test equipment
- ▶ GSM-R network simulator NETSi.1
- ▶ Analogue tester ARSIS.1
- ▶ Analogue network simulator ETS
- ▶ RF power meter

IMPORTANT MILESTONE FRMCS INTEROPERABILITY

In summer of 2025, Funkwerk demonstrated an important milestone on the way to standard-compliant implementation of FRMCS. In extensive tests and demonstrations in laboratory environments as well as in the real test field of the digital railway in the Ore Mountains, Funkwerk successfully tested the IP Multipath implementation with the **TOBA gateway (FGW)**.

The focus of the tests in real operation was on the interoperability of our application with several trackside servers. The **uninterrupted switching** of data streams between the DB FRMCS network and Vodafone's public 5G network was particularly impressive.

A further step towards future-proofing Germany's digital railway.

For the virtual coupling of freight trains, Funkwerk has also been able to demonstrate that the secure transmission of control data between several vehicles in multi-traction works in the laboratory on the basis of its gateway.

Funkwerk has received **approval for extended test operation**. During this development, the cyber security requirements for the products were also tightened. The approval includes proof of compliance with these requirements. Funkwerk is thus on the way to fulfilling the requirements of the **European Cyber Resilience Act (CRA)**.





Despite the future introduction of FRMCS and its intended replacement of existing standards, GSM-R and analogue train radio will continue to exist beyond 2035 due to operational reasons.

As the leading global manufacturer and supplier of on-board railway communication solutions, we recognize our responsibility to consistently deliver GSM-R products and systems.

We have strategically invested in order to secure the long-term availability of the entire **MESA® product family** and its components.

”

Whatever communications
technology you need,
Funkwerk is your partner
and supports you with
long-term availability.

CYBERSECURITY AND CERTIFIED PROZESSES

Funkwerk's train radio systems meet cybersecurity requirements throughout the entire product life cycle, which can span several decades. This also includes decommissioning processes and the associated data destruction. We prioritise **integrated security** right from the **development phase**, continuously harden systems and offer retrofit solutions for existing systems. We also provide tailor-made cybersecurity solutions for legacy systems.

Due to our extensive experience within the domain of critical infrastructure, we offer a wide range of cyber-security expertise and service approaches. We provide staff-training and detailed documentation to raise awareness for cybersecurity issues and assist in conducting complex threat-and-risk analyses at the interface towards the vehicle and the radio interface.



To ensure our products meet the latest IT security standards, Funkwerk consistently submits its processes and products for auditing and **certification under ISO 27001**.

Additionally, Funkwerk has successfully passed an audit for train and data radio components in accordance with **IEC 62443**. This industry-standard for cyber-security is integrated into our development process, with a designated IT security manager assigned to each development project.

PRODUCT ENGINEERING ACCORDING TO IEC 62443

We employ a rigorous requirement management system to ensure our products adhere to **IEC 62443 standards**. Following a comprehensive security analysis, we define and implement appropriate measures during the development process to achieve the target security level.

We provide a detailed IT security documentation for each system, confirming compliance with the relevant standards and outlining precise specifications for the secure and compliant use of the system in accordance with IT safety regulations.

” We concentrate on integrated security right from the development phase and are certified according to **ISO 27001** and **IEC 62443**.



DAKKS-CERTIFIED TEST LABORATORY

For all products and solutions, designed for use in critical infrastructures such as rail environments, special requirements apply. Measurements, tests and examinations are therefore exceptionally important. To meet all related challenges head-on, we extensively measure, test and inspect using our in-house and state-of-the-art **DAkkS-certified** test laboratory.

Under optimal conditions, we are able to use our full expertise and technical competence to test developments, providing a wide range of accreditations in accordance with European and international railway standards.

Further, we open our doors for your individual test scenarios. This includes accompanying you from test specification, through tests during development up to certified approval testing.

All verification documents and reports are drawn up in accordance with international standards.

ACCREDITATION AND SCOPE

EUROPEAN RAILWAY STANDARDS

- ▶ EIRENE FRS/SRS
- ▶ UNISIG Subset-093 Radio Transmission FFFIS for Euroradio
- ▶ UIC Code 751-3 Analogue Train Radio

INTERNATIONAL STANDARDS

- ▶ Temperature DIN-EN-60068-2
- ▶ RED Radio Equipment Directive 2014/53/EU
- ▶ RF measurements, antennas, blocking and intermodulation

TASKS & RESPONSIBILITIES

- ▶ measurements during development
- ▶ functional validation
- ▶ quality assurance and validation of test results
- ▶ studies and analyses
- ▶ preparation and support of approval tests



”

Our laboratory has a wide range of accreditations in accordance with European and international railway standards

KNOWHOW. QUALITY. MADE IN GERMANY.

Funkwerk is the leading supplier of analogue and digital mobile train radio equipment used in more than 40 countries worldwide.

We thrive to push the technical limits further. We have driven the migration of analogue communication to digital systems in the past and we will continue to do so, by developing solutions for the efficient migration from GSM-R to FRMCS.

Our **MESA all:nexo®** modular train radio systems will mark the next step towards FRMCS, still providing support for legacy standards.

Funkwerk operates fully integrated. We develop and manufacture our products independently in Germany at our corporate headquarters at Kölleda (Thuringia). Our highly trained and experienced staff ensures a consistently high product-availability and -quality, meeting highest manufacturing- and security-standards. The team within our international sales and service organization guarantees individual customer support – throughout the entire product life cycle and beyond.

Our in-house department for homologation & approval of on-board systems certifies solutions according to the latest standards and current valid regulatory framework TSI CCS.



funkwerk



©Funkwerk. Änderungen vorbehalten. 260814

Funkwerk Systems GmbH
Im Funkwerk 5 · 99625 Köllda · Germany
funkwerk.com

funkwerk 