TELEFUNKEN
RACOMS

Selective Multicoupler SMK 1000

Combining the output RF power
of several transmitters at lowest losses

Features and Technical Data

- Combines the output RF power of several transmitters at lowest losses
- Combining loss: typically 1.5 dB
- Simultaneous operation of up to five 1 kW transmitters into a single broadband antenna
- SMK 1000 is easily scalable for a different number of transmitters
- Frequency range 2.0 MHz to 30 MHz is gaplessly covered
- Minimum frequency spacing between two operating frequencies at least 10 %
- Suitable for use with all types of wideband antennas of 50 Ohm nominal impedance providing a residual mismatch of VSWR ≤ 3 in the operating frequency band
- The inherent selectivity of the SMK 1000 further reduces transmitter broadband noise, harmonics and spurious emissions
- Isolation between transmitters: typically › 20 dB
- Automatic tuning to the operating frequency is individually performed for every transmitting path
- Cooling by forced air
- Control interface based on commonly accepted standards

Technical Specifications	
Number of Tx inputs	max. 5
Input power	5 times 1.25 kW max.
Minimum frequency spacing between two frequencies	10 %
Nominal antenna impedance and maximum mismatch	50 Ohm nominal impedance up to VSWR 3:1
Insertion loss	1.2 dB average ‹ 1.5 dB in 90 % of operational conditions ‹ 2.5 dB under worst case conditions
Length of cables between Tx and SMK 1000	No limit
Length of cables between SMK 1000 and antenna	No limit
External RF power interference	SMK 1000 accepts up to 100 W
Tuning time following change of operating frequency	‹ 1 s ‹ 100 ms if Tx remains in lower frequency band
Storage of tuning position	Non volatile

Lower Band Directional Filter RFNF 1000/1	
Frequency range	2.0 to 10.0 MHz for selective path 2.0 to 12.0 MHz for main RF power line
Isolation between Tx connected to SMK 1000	typically › 20 dB; at least 10 dB under weak operational conditions (10 % frequency spacing and antenna mismatch VSWR 3:1)
Insertion loss Directional Filter RFHF 1000/1 (selective path)	1.2 dB typically, 1.8 dB max.
Insertion loss in main RF power line of RFHF 1000/1	› 0.2 dB at frequency offset ‹ 20 % › 0.5 dB at frequency offset ≥ 10 %

Upper Band Directional Filter RFHF 1000	
Frequency range	10.001 to 30.0 MHz for selective path 2.0 to 30.0 MHz for main RF power line
Isolation between Tx connected to SMK 1000	typically › 20 dB; at least 10 dB under weak operational conditions (10 % frequency spacing and antenna mismatch VSWR 3:1)
Insertion loss Directional Filter RFHF 1000 (selective path)	0.8 dB typically, 1.3 dB max.
Insertion loss in main RF power line of RFHF 1000	‹ 0.3 dB at frequency offset › 20 % ‹ 0.7 dB at frequency offset ≥ 10 %

General

The simultaneous operation of several HF transmitting lines in close co-location is a major task, for example on board naval platforms or in embassy buildings.

In conventional system design, every single radio link requires its individual antenna, usually implemented by a tuned whip antenna. This frequently results in serious interference effects between the communication lines causing unacceptable signal distortions and restricts the operation of the HF communication equipment.

The most promising approach to overcoming such restrictions is the use of broadband antennas fed by more than one transmitting line simultaneously. This requires combining the power of several transmitters upstream of the antenna feeding point.

A popular method for this task is the use of passive 3 dB power combiners. However, this approach suffers from the high losses in the RF signal path, resulting in seriously reduced link availability.

Through its product family Selective Multicoupler SMK 1000 TELEFUNKEN Radio Communication Systems offers a novel approach. Using the principle of »Directional Filter« the power of several transmitters is transferred simultaneously to the antenna with lowest combining losses. High isolation between the transmitters and reduction of unwanted emissions such as broadband noise, harmonics and spurious emissions enhance the performance of the HF communication system and provide improved availability of the HF communication links. The filter notches are so narrow that minimal frequency spacing between two operating frequencies of 10 % is sufficient.

This all goes hand in hand with a simplified system design of the communications suite. A consequently modular design of the Selective Multicoupler gives the flexibility to combine any number of transmitters within the maximum total power of 5 kW.

A later extension in the number of transmitting lines is as simple as placing additional Directional Filters in the rack and declaring their existence in the Initialisation File of the control software.

Functional Description

The Selective Multicoupler SMK 1000 is capable of combining the RF power of up to five shortwave transmitters of the 1 kW class with very low losses. A unique design based on tuneable resonant circuits is used to keep the losses extremely low.

The principle of directional filters has been implemented in the shortwave band by building notch filters capable of coping with the high power. Each directional filter provides the capability of adding an additional transmitter to the common RF power line. The end of this RF power line is connected to the wideband antenna.

The insertion loss for signals from a transmitter connected to the selective path of a directional filter to the common RF power line is typically below 1 dB. The insertion loss for an RF signal coupled through the selective path of a Directional Filter to the common RF power line is in the order of single tenth of a dB.

Due to technological limitations, Directional Filters are available either in the frequency band 2 to 10 MHz (RFNF 1000/1) or in the frequency band 10 MHz to 30 MHz (RFHF 1000). With such directional filters complete Selective Multicouplers SMK 1000 can be formed as shown in the generic diagram in Figure 1.

Several identical directional filters, the number of which depends on the number of transmitters to be combined, are used to couple the transmitter outputs to the common RF power line which finally feeds the RF energy to the broadband antenna.

Automatically controlled switches (RMX) are used to connect a transmitter either with a low band directional filter or a high band directional filter. These switches are contained in the unit Relais Matrix RMX 1000.

Experience has shown that it is difficult to implement wideband antennas covering the whole frequency range 2 to 30 MHz on smaller platforms. In such cases splitting the antenna into two bands is recommended. For such configurations a modified arrangement of the SMK 1000 may be useful as shown in Figure 2.

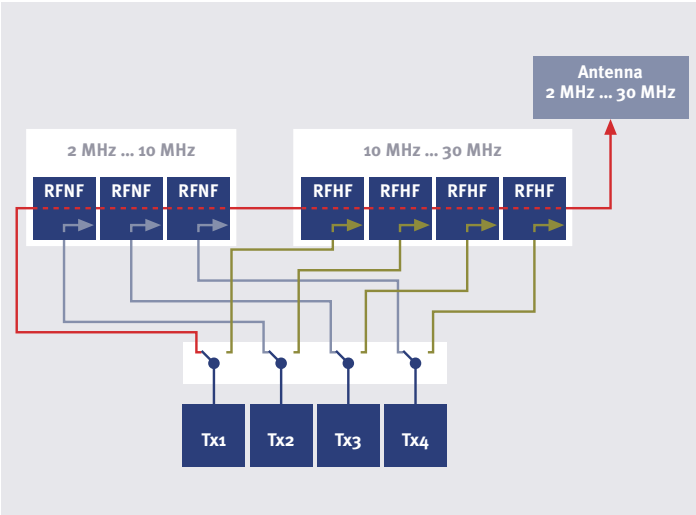

Figure 1
Generic design of a Selective Multicoupler SMK 1000 for a wideband antenna covering 2 to 30 MHz

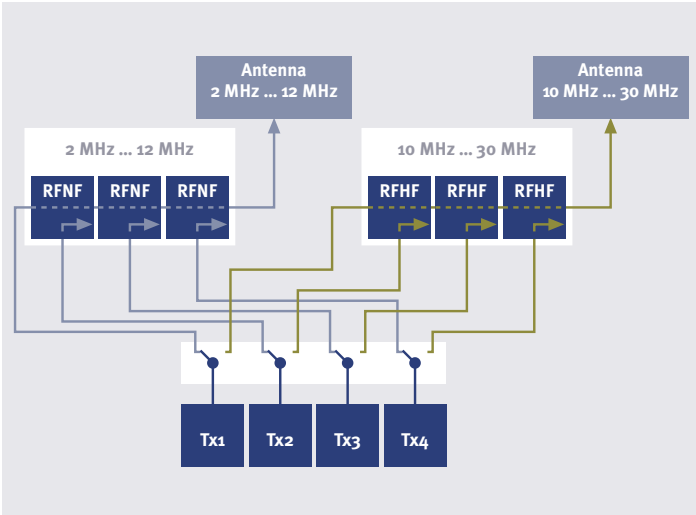

Figure 2
Generic design of a Selective Multicoupler SMK 1000 for an antenna system with split frequency bands

SMK 1000 configurations are built from seven basic modules, enabling any configuration to be set up within the limit of 5 kW nominal power in the common RF power line. This also provides the possibility of extending a SMK 1000 configuration later on if further transmitting lines have to be added. At its first installation, the 19-inch rack should be prepared for such extensions.

Other basic modules are:

- the Load Resistor Unit LAW 1000, comprising load resistors, one of which is required for each directional filter for absorber purposes.

- the Power Supply NGE 1000, which provides all internal supply voltages derived from mains input. It also incorporates an emergency power supply to bridge short power failures and ensures a controlled switching down procedure in case the primary power fails for longer than 30 seconds. This protects all RF switches in the SMK 1000 from hot switching and increases reliability and endurance. Complementary to the power supply a Mains Connecting Unit TNA 1000 is used to interface with the mains power supply. This unit also comprises a mains switch, power filters and an isolation transformer.

- the System Control Unit SST 1000, which acts as a central control and monitoring unit. It interfaces with a central control system, e.g. on board a naval platform. On the basis of the actual operating frequencies, the tuning information is forwarded to the Directional Filters and the RMX 1000 is set to the appropriate frequency band position. The SST 1000 comprises monitoring functions preventing operation at frequency spacing less than 10 % or from hot switching during the close of the tuning sequence. In such cases the relevant transmitters are commanded into a safe power-down mode. SST 1000 traces the actual system configuration. Any modification in the configuration of SMK 1000, e.g. a change in the number of directional filters, is activated in the SST 1000 by simple changes to the initialisation file. For this purpose and for maintenance purposes, the SST 1000 is equipped with an additional serial interface.

All units are built to fit the 19-inch scale. They are installed in a correspondingly sized rack. As the thermal losses are low, only cooling by forced air is required. Air intake is at the front of the units and the outlet at the rear.

Operation of the SMK 1000 does not require any special attention by an operator. Tuning of the SMK 1000 is performed automatically and in relation to the frequency of the respective transmitting line. On a naval platform, for example, such frequency information may be provided by a central communication system management unit.

The tuning sequence of the SMK 1000 does not require information on the actual antenna impedance. It uses pre-set parameters stored during the manufacturing process of each directional filter in a non-volatile memory. Such tuning parameters also reflect temperature-related variations in the elements forming the resonant circuits.

Power Supply

Supply voltage	115 VAC
Tolerance of supply voltage	+10 % to –15 %, 47 to 63 Hz
Power consumption	‹ 1800 VA
Emergency power supply	Key parts of the SMK 1000 comprise energy buffers (accumulator). These are used to enable the SMK 1000 to continue operation during short interruptions of the primary power supply. If primary power supply fails for a longer period a controlled switching down procedure is executed protecting the RF switches of the SMK 1000 and the transmitters connected. The accumulator is automatically recharged when primary power returns.

Control Interfaces

Control interfaces	One interface for Radio Control System serving for control, status information and fault indication
	Additionally a Service Interface at the front of the System Control Unit and 5 Tx Control Interfaces
Interface standard for Radio Control Interface	RS 422 (symmetrically)
Communication speed	19200 Baud
Format of control information	1 Start Bit, 8 Data Bit, no parity, 1 Stop Bit
Max. length of control cable	‹ 500 m
Service interface	For diagnosis, configuration and maintenance, accessible at the front of SST 1000
Interface standard for Service Interface	RS 232, asynchronous 19200 Baud, 8 Data Bit, no parity, 1 Stop Bit

Cooling

Cooling	By forced air
	Air intake at front of the rack
	Air outlet at rear of the rack
	Remark: For proper operation ensure undisturbed airflow next to the Selective Multicoupler

Environmental Conditions

General design criteria	SMK 1000 is built for use below deck of naval vessels
Temperature	Operation 0 °C to +55 °C Storage -25 °C to +71 °C
Humidity	In accordance with MIL-STD 810E M.507.3, Procedure I, Table 507.3-I, Category Natural 40 °C, 95 % rel. Humidity, Storage 31 °C, 88 % rel. Humidity, Operation
Vibration	In accordance with MIL-STD 810E M.514.4, Procedure I, Cat. 10 0.04 g^2/Hz, 20 Hz to 1000 Hz, from 1000 Hz to 2000 Hz falling to 0.01 g^2/Hz
Shock	In accordance with MIL-STD 810E M.516.4, Procedure I 30 g, 11 ms
EMI	In accordance with relevant CE rules EN 55022, class B; EN 6 1000-4-2 to EN 6 1000-4-6; EN 6 1000-4-11 and tested against relevant Parts of VG 95373

Dimensions and Weights

Product	W x H x D in mm	weight in kg
Directional Filter RFNF 1000/1	483 x 221.4 x 600	ca. 32 kg
Directional Filter RFHF 1000	483 x 221.4 x 625	ca. 22 kg
Relais Matrix RMX 1000	483 x 132.8 x 455	ca. 8.5 kg
Load Resistors LAW 1000	483 x 132.8 x 455	ca. 28 kg
System Control Unit SST 1000	483 x 132.8 x 510	ca. 12.5 kg
Power Supply NGE 1000	483 x 177.1 x 560	ca. 23 kg
Mains Connecting Unit TNA 1000	483 x 132.8 x 455	ca. 28 kg
Complete SMK 1000 (version for 5 Tx)	1166 x 1850 x 839 (incl. shock mounts)	ca. 650 kg

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