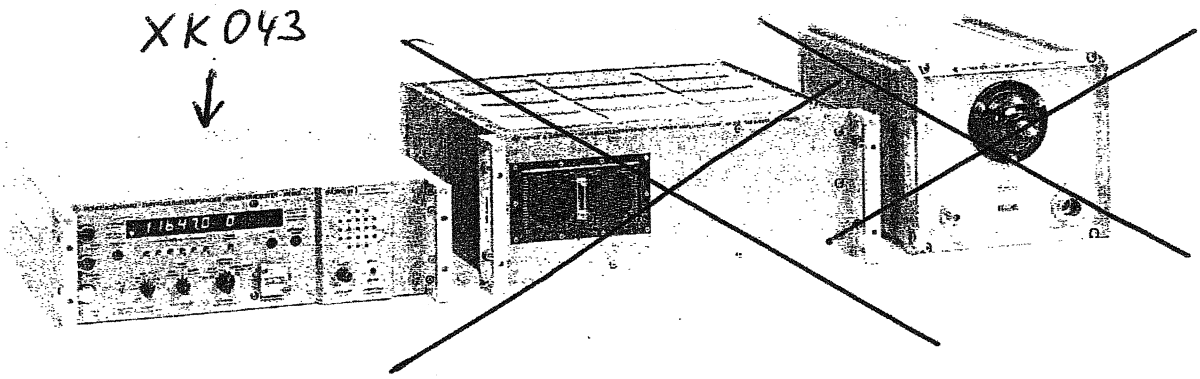
~~HF TRANSCEIVER XK 403~~



SPECIAL FEATURES

- Sturdy, rugged construction, suitable for stationary and mobile use
- Frequency range 1.5 to 30 MHz for transmission, 10 kHz to 30 MHz for reception
- 100 W CW output power, switchable to 10 W
- Types of modulation: A1, A3H, A3J (USB, LSB),
  F1, 0 to 100 bauds, shifts: ±42.5, ±85, ±425 Hz
- Matchable to rod, whip and wire antennas; suitable without antenna tuning unit for broadband antennas or emergency operation on any kind of antenna
- Ease of use through automatic functioning with indication of the operating status
- Proven reliability; easy to maintain
- Integrated test device and modular construction ensure minimum time to repair at all material-maintenance levels; compatible with automatic test systems
- Flexible power supply: 115/220 VAC or battery 19 to 31 V

Design

(see Fig 1)

The HF Transceiver consists of three units:

Receiver/Exciter	XK 043 ←
RF Power Amplifier	VK 213
Antenna Tuning Unit	FK 212 or, for silent tuning, FK 213

which can be arranged as desired so that the whole system can easily be adapted to the physical conditions at the point of use. The input/output circuitry permits different cable lengths to be used. The XK 403 is operated from the receiver/exciter, which bears all the inputs and outputs for the connection of peripherals such as a morse key, headphones, TTY, etc.

The front panel of the receiver/exciter is a plug-in and can thus also be located separately should the application demand it; commands to the receiver/exciter are then transferred over a multiwire link. The front panel, designed for manual operation of the system, can be replaced by a subassembly equipped for computer and/or remote control.

The power amplifier bears no operating elements and is maintenance-free. It should be placed near the power supply because of the higher power consumption. Broadband antennas can be connected to the power amplifier direct. All international requirements concerning out-of-band radiation are fulfilled. Wire antennas of any length are sufficient for conducting emergency operation; the output power of the amplifier is then reduced according to the mismatch that results.

The antenna tuning unit enables optimal matching to all conventional antennas. To maintain the high efficiency it should feed into the antenna over a short wire link. Due to its weatherproof construction and resistance to shortterm submersion, the tuning unit does not call for any special protection.
The antenna tuning unit is available in two versions:
one that matches the antennas by tuning accompanied by the radiation of RF power following every change of frequency (FK 212), and one that stores the settings of the tuning elements in the antenna tuning unit

together with the operating frequency for a maximum of eight channels, these channels only having to be tuned once with emission of power (FK 213).

Operational Characteristics

The HF Transceiver XK 403 is operated from the front panel of the Receiver/Exciter XK 043. Light-emitting displays provide for unambiguous indication of the operating status. The operating frequency can either be keyed in with six toggle switches or be set with a channel selector, the latter allowing the selection of eight frequencies stored in an electronic, nonvolatile memory.

In the "STANDBY" mode only the frequency standard is kept at operating temperature so that radiocommunication is immediately possible with any kind of modulation and with full frequency accuracy. This mode offers the advantage of extremely low power consumption. Permanent listening-in on communications channels is possible in the "receive" mode. In this case too the power consumption is low because the power amplifier and antenna tuning unit are cut out. Duplicate operation is possible in the "receive/transmit" mode. The rapid changeover from reception to transmission and vice versa enables smoothly functioning communications. For operation with a teleprinter this changeover can be made externally or from the front panel.

The input/output levels for the peripherals are shown in table 2. They are chosen so that all common makes can be connected up to a distance of 50 m away without having to interconnect any auxiliary circuits. This applies in particular for RTTY, even if error-correction or ciphering equipment is employed.

The BITE continuously monitors the parameters that are most important for smooth operation of the system, such as RF power, antenna tuning, frequency, supply voltages. It automatically signals any out-of-limit values. For accurate checkout an automatic test procedure can be triggered, which signals "go" if everything is in order. If a fault is present, the test result is indicated digitally. Evaluation enables localization of the fault right down to the module where it exists (see table 3).

This simple maintenance is the result of a modular concept whereby all the functions of the equipment are divided up among clearly defined subassemblies or modules, these being both mechanically and electrically defined, individually manufactured and tested, so that no interalignments are necessary once a set of equipment has been assembled.

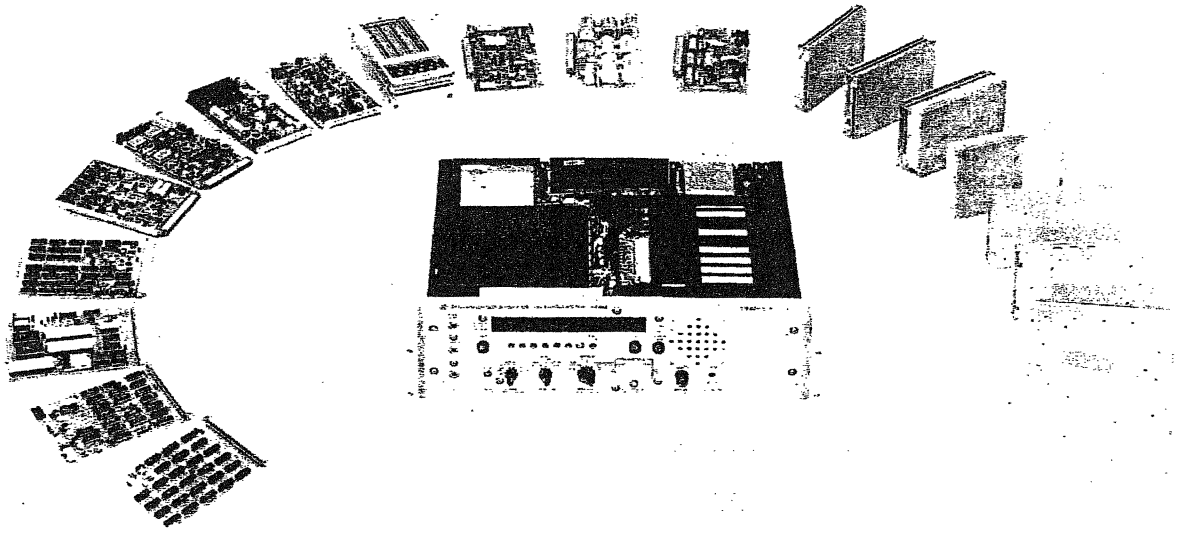


Fig 2: Receiver/Exciter XK 043 and its modules

In addition to the highly economical material maintenance throughout the lifetime of the equipment, the modular concept also brings other advantages: all the HF communications equipment, whether receivers, transmitters or transceivers, can be realized with a high proportion of completely identical modules, thus also reducing the costs and outlay for training, spare parts and testing apparatus.

Description

In addition to all control elements, the Receiver/Exciter XK 043 also embodies the whole reception path of the HF Transceiver XK 403 plus the transmission path up to a level of 20 mW. Important factors in the planning of this equipment were: the creation of a receiver representing the highest performance currently possible internationally in HF reception, and of an exciter enabling the full implementation of all operational possibilities. This led to the following characteristic features of the individual assemblies:

The synthesizer delivers all the frequencies for the various converters. Special care was devoted to achieving high freedom from noise. The noise sidebands at 140 dB down, referred to a measurement bandwidth of 1 Hz, are a guarantee for minimal interference from other radio channels during transmission.

During the reception of low-level signals the signal-to-noise ratio in the useful channel is barely deteriorated even by strong sources of interference since the mixed noise sidebands are small.

Inherent interference sources, i.e. frequencies at which spurious from the frequency synthesizer strays into the receive channel, are also negligible if they are of the order of the residual noise of the receiver, this being particularly important with antennas of low effective height.

The receiver works with a first IF of 72.03 MHz and a second IF of 30 kHz. The high first IF ensures good image suppression while the second IF is so low that the selection filter can be designed with steep slopes. The technology that is applied avoids the effects of disturbing temperatures: the crystal filters are highly selective (72 MHz) and there is a mechanical one at 30 kHz.

The same IFs are used in transmission. In principle the same considerations apply as for reception: low out-of-band radiation, negligible spurious.

For A3J and A3H transmissions the voice-frequency band is first converted to the 30-kHz IF. In A3J the highly selective, mechanical filter suppresses the carrier by $\geq$ 40 dB, and in A3H by 6 dB. For A1 telegraphy the 30-kHz IF is keyed with a keying filter in the rhythm of the morse signals, whilst in F1 an FSK stage with a centre frequency of 30 kHz is keyed by the DC character levels from the TTY. The three frequency shifts can be varied through approximately $\pm$10 %. Keying filters limit the frequency spectrum that arises during keying in both A1 and F1 modes. During keying intervals the radiated power falls below the out-of-band interference.

On the receiving side the picked-up RF signal is converted to two IFs, the selectivity being provided at 30 kHz by plug-in filter modules (mechanical filters). One of five filters, depending on the type of emission occurring, is switched in to the path. The IF filters are followed by a multistage 30-kHz AGC amplifier whose outputs pass to the demodulator for A1, A3J and A3H as well as to that for F1. For A3J and A3H the demodulator uses a crystal-controlled 30-kHz oscillation (synthesizer frequency) to produce an AF signal from the IF. For A1 the IF signal is mixed with a signal of 31.25 kHz to produce 1.25 kHz. In the demodulator for F1 the boosted 30-kHz signal is frequency-demodulated by a digital technique - already implemented with great success in the systems XK 010 - , limited and fed to a lowpass filter that is matched to the transmission speed. A subsequent keying stage produces the unidirectional signals for the direct connection of a TTY.

The power supply for the Receiver/Exciter XK 043 is handled by a converter module with input voltage of 21 to 31 V. This produces the supply voltages necessary for the subassemblies and is fitted with a transient absorber at the input plus filters for protection against interference currents. For operation of the overall system from a 115- or 220-VAC network, the Receiver/Exciter XK 043 is connected to the DC output of the power amplifier. For battery-powered operation the XK 043 can be connected by the shortest route to a 24-V source separately from the power amplifier (see Fig 1).

Specifications

1. General electrical and mechanical characteristics

1.1	Frequency range	transmit: 1.5 to 29.9999 MHz receive: 10 kHz to 29.9999 MHz
1.2	Frequency tuning	in decades, 100-Hz increments[1], preselection of any eight frequencies with channel memory
1.3	Frequency accuracy	better than $\pm 3 \times 10^{-7}$ -25 to +50°C better than $\pm 5 \times 10^{-8}$ +15 to +35°C better than $\pm 5 \times 10^{-8}$ per month
~~1.4~~	~~Transmitted power .....~~	~~100 W CW, switchable to 10 W,~~ 100 % duty cycle
1.5	Classes of emission	A1, A3J (USB & LSB), A3H F1 broad, 0 to 100 bauds, ± 425 Hz F1 narrow, 0 to 100 bauds, ± 85 Hz[2] F1 polarity switching shift internally variable by ± 10 %
1.6	Operating modes	OFF: HF transceiver disconnected STANDBY: crystal standard warmed-up, HF transceiver disconnected RECEIVE: receiver/exciter switched on for RX, power amplifier and antenna tuning unit off TRANSMIT/RECEIVE: HF transceiver switched on, T/R switchover from mike, headset, morse key or switching line disconnected (see Table 2) O = 10 W ◎ = 100 W

1) 10-Hz increments, please ask

2) internally alterable to ± 42.5 Hz,
for differing values please ask

1.7 T/R switchover ..... < 50 ms, 100 ms decay in A1

in A3J, A3H ..... through switching key on mike or headset

in F1 ..... F1 mode switch (on front panel or external)

RECEIVE:
reception of TTY characters, TTY prints received text

STANDBY:
reception of TTY characters, TTY receives only closed-circuit current

TRANSMIT:
transmission of TTY characters in mode T/R, TTY writes transmitted text

1.8 Matchable antennas .....

type	1.5 - 30 MHz	2 - 30 MHz
rod	7 - 12 m	4 - 12 m
whip	7.7 - 12 m	4.7 - 12 m
longwire	up to 50 m	up to 50 m
broadband	any	any

1.9 Aural monitoring and reception ..... aural monitoring of modulation and reception in all classes of emission with headphones and inbuilt or external speaker

1.10 IF input/output ..... present, switched over control line (see 2.16/3.14)

1.11 Electromagnetic compatibility ..... acc. to MIL-STD-461 to -463
classes IA, IB
unless expressly stated otherwise

1.12 Noise level ..... < 49 dBA

1.13 Reliability (MTBF) ..... 2000 hrs acc. to MIL-STD-781 B

1.14	Material maintenance	see Table 3
	Elapsed-time meter	in power amplifier, counter for tuning cycles in ATU
	BITE	controlled by microcomputer, digital display of results
	Testability	each module and plug-in fitted with test connectors, ATS-compatible
1.15	Availability $\frac{MTBF}{MTBF + MTTR}$	> 0.999 at site
1.16	Life	at least 15 years
1.17	Power supply	
	DC	21 to 31 V
		negative terminal earthed (protection against reversal)
		voltages > 19 V and < 32 V permissible
		voltages < 19 V and > 32 V: cutout
		consumption: ca. 14 A TX at 100 W
		ca. 2 A RX
	Permissible interference voltages on DC supply	-100 V decaying within 50 ms
		+80 V decaying within 1 s
		referred to +24 V, $Z_s \geq 0.5\ \Omega$
		superimposed AC voltage 45 Hz to 20 kHz; 2.1 V_{pp}
	~~AC .....~~	~~115/220 VAC ±15 %, 60/50 Hz~~
	Dynamic AC fluctuations ..	±18 % (including static variations)
		≤ 2 s response time
		(MIL-STD-761 B, for ships Type I)
1.18	Dimensions and weight	see Table 4
1.19	Environments	see Table 5
1.20	Peripheral interfaces	see Table 2

3. Receiver data

3.1 Input impedance ..... ca. 50 Ω

3.2 S + N/N ratio (above 100 kHz)

A1 ..... > 20 dB at 0.7 µV EMF

A3J ..... > 20 dB at 2 µV EMF

3.3 Receiving bandwidths

A1 passband ..... < 3 dB to ±75 Hz

A1 stopband ..... > 60 dB from ±300 Hz

A3J passband ..... < 3 dB from 300 to 3000 Hz (USB)[1]
from -300 to -3000 Hz (LSB)

A3J stopband ..... > 60 dB from -300 to +3600 Hz (USB)
from +300 to -3600 Hz (LSB)

F1 narrow passband ..... < 3 dB to ±150 Hz

F1 narrow stopband ..... > 60 dB from ±350 Hz

F1 wide passband ..... < 3 dB to ±500 Hz

F1 wide stopband ..... > 60 dB from ±1 kHz

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1) 3400 Hz, please ask

3.4	Automatic gain control	
	(1 µV to 1 V EMF)	< 4 dB
	Control rate	adapted to type of emission
3.5	BFO	fixed frequency 1.25 kHz
3.6	Character distortion	
	A1	< 5 % at 15 bauds
	F1	< 5 % at 100 bauds
3.7	AF distortion	< 5 % at 1 W into 5 Ω
3.8	Blocking	negligible up to 4 V EMF
3.9	IF and image rejection	> 80 dB
3.10	Other ambiguities	
	Spurious content of frequency synthesis	< 90 dB at $\Delta f \geq 40$ kHz
	Inherent noise signals ...	< 0.4 µV equivalent EMF
3.11	Crossmodulation	< 10 % for useful transmitter: 100 µV EMF interfering transmitter: 200 mV EMF m = 30 % and $\Delta f \geq 40$ kHz
3.12	Oscillator reradiation at receiver input	< 10 µV, typ. 5 µV with 50-Ω termination
3.13	Protection of receiver input	up to 50 V EMF
3.14	IF output	30 kHz, broadband preceding IF amplifier, Z_s = 50 Ω, after switchover output socket converts to IF input (see 2.16)
3.15	AF outputs	see Table 2