General Description

VHF FM TRANSMITTER

500 W to 5 kW

Single transmitter (with passive exciter standby)
Dual transmitter with passive standby
Systems with (n+1) standby arrangements

Versions:

NU 25	500 W
NU 31	1 kW/1.5 kW
NU 32	2 kW
NU 33	3 kW
NU 36	5 kW

1. Characteristics

1.1 Uses

These solid-state VHF FM transmitters are used for the transmission of mono or stereo broadcasts in the VHF range from 87.5 to 108 MHz with an RF output power of between 500 W and 5 kW. By combining two or three 500-W transmitter stages via a power coupler, a transmitter can be formed which delivers 1 or 1.5 kW; this is accommodated in a single cabinet rack. Two such 1- or 1.5-kW transmitters can again be combined via another power coupler to form a transmitter with 2 or 3 kW output power. In addition, two 3-kW transmitters can be combined via a further 3-dB coupler to form a unit with 5-kW nominal power. By changing some cable connections on the front panel, the transmitter can be modified, if required, for the transmission of two programs each with 50% of the rated output power instead of one program with full power. The 1.5-kW transmitter can, however, only be converted for operation with 2 x 500 W output power. Individual amplifier modules may be removed from the transmitter circuit (e.g. for maintenance work), connected to a dummy antenna, and switched on or off individually whilst the emission of the normal program is continued with reduced power.

These transmitters comply with the standard requirements of the Federal-German postal authorities (DBP), of the association of German broadcasters (ARD) and with the relevant safety regulations of the IEC and VDE.

The automatic switchover circuit incorporated in the switch-on unit enables operation with passive exciter standby. In conjunction with a suitable central control unit, systems can be set up, which consist of up to six primary and one standby transmitter and operate with full passive standby or in a (n+1) standby configuration. The primary and standby transmitters of such a configuration need not have the same output power. Since these transmitters are suitable both for local and remote control, they can be used in unmanned stations or in places difficult of access.

1.2 Description

(see Figs. 1-1)

a) Description of 500-W transmitter

The 500-W transmitter is the basic unit for the complete type series. It consists of the following plug-ins all of which are accommodated in a common rack:

VHF exciter
VHF amplifier, 500 W
Power supply
Voltage regulator
Switch-on unit

The crystal controlled RF signal generated in the exciter is frequency-modulated with the AF signal. A switch on the front panel permits selection of the required operating crystal. Remote-controlled selection is also possible. Since the subsequent amplifier stages have broadband characteristics, further adjustments are not required.

The RF output power of the exciter is then applied to the 500-W amplifier. This consists of a driver stage and four mutually decoupled 150-W amplifiers (transistor pairs) connected in parallel via coupling networks. The output powers of these amplifier stages are again combined so that the RF power available at the output following the harmonics filter and directional coupler is 500 W. The harmonics filter adequately suppresses all harmonics.

The directional coupler contains two separate systems, one feeding the RF checkpoint on the front panel of the amplifier, the other one delivering two voltages proportional to the incident and reflected power. The latter two voltages are rectified and applied to the monitor board in the amplifier and to the switch-on unit.

The monitor compares the DC voltage, which is proportional to the output power, with a reference voltage supplied by the switch-on unit and controls the output power of the amplifier by varying the operating voltage. If the amplifier output is mismatched, the output power is kept constant up to a VSWR of 1.5. If the VSWR is higher, the output power is automatically reduced so that the reflected power does not exceed 20 W approx. Due to the fact that the output power is adjusted by varying the operating voltage, optimum efficiency is ensured even at reduced output power.

The switch-on unit governs the switching on of the operating voltage and releases the carrier in accordance with the operating commands given (off, operation, remote control) and establishes the connection to the remote-control equipment.

The power supply section provides a filtered DC voltage to the voltage regulator and two stabilized auxiliary voltages of ±15 V for various circuits in the transmitter. The voltage regulator, a pulse-width modulated DC/DC converter, supplies the operating voltage for the RF amplifier.

The transmitter is cooled by convection using a vertical ventilation duct at the rear to expel the warm air. The fresh air enters through vertical ventilation louvres in the front panels and is conducted along the underside of the horizontal heat sinks to the air duct. The cooling effect increases with increasing temperature difference between heat sink and intake air.

b) 1- to 5-kW transmitters

A transmitter delivering an output power of 1 kW can be formed by combining two 500-W amplifiers via a power coupler. The power coupler first splits up the driving power for the two amplifiers and recombines their output powers to provide the total transmitter power. Another power coupler enables a combination of three 500-W amplifiers to form a 1.5-kW transmitter. In both cases, each 500-W amplifier requires its own voltage regulator, whilst only one power supply unit is required for the complete transmitter (different models for 1 and 1.5 kW). Each transmitter can be incorporated in a cabinet rack, which provides adequate space for supplementary equipment, such as stereocoders, relay receivers, central control unit, etc. (see also Figs 1-1).

The cabinet rack of the 1.5-kW transmitter is 100 mm deeper than that of the 1-kW model.

It is further possible to form a single transmitter with 2 kW or 3 kW output power from two 1-kW or 1.5-kW transmitters via a suitable coupling unit; these transmitters are accommodated in two cabinet racks. Again, if two transmitters with 3 kW output power are combined via a 3-dB coupler, a transmitter with 5 kW nominal output power can be formed.

c) Standby configuration

The switch-on unit is equipped with a switchover facility enabling operation with passive exciter standby. In such a configuration, two exciters are connected to the amplifier input via a power coupler. The switchover facility connects the RF signal of the primary exciter through to the amplifier. If this exciter fails, switchover to the standby unit is made fully automatically.

In transmitting systems equipped for full passive standby operation, two complete transmitters (delivering the same or different output powers) are controlled by a central control unit in such a way that the primary transmitter operates into the antenna and the standby unit into a dummy load. If the primary transmitter fails, the automatic switchover unit connects the defective unit to the dummy load and the standby transmitter to the antenna. The standby transmitter can be disconnected from the supply network for maintenance and repair, or measurements can be performed while it is connected to the dummy load.

Transmitting systems operating according to the (n+1) standby principle are equipped with up to six primary transmitters and one standby transmitter. If any of the primary transmitters fails, a central control unit automatically switches the standby transmitter into operation and connects it instead of the defective unit through to the antenna.

Transmitters already in operation can easily be converted for passive or (n+1) standby operation at any time. All that is required is a rack-mounting adapter for incorporation of the central control unit.

1.3 Specifications

Frequency range	87.5 to 108 MHz
Class of emission	F3
Stereo emissions	acc. to CCIR Rec. 450, section 2 on "pilot-tone system"
Nominal frequency deviation	±75 kHz
Maximum frequency deviation	±100 kHz

RF output

Nominal output power	500 W to 5 kW
Nominal output impedance	50 Ω

Permissible VSWR ..... any; output power is kept constant up to VSWR = 1.5; higher VSWR causes power reduction

Harmonics suppression ..... $\geq$ 70 dB

Spurious emissions ..... < 1 µW

Output connector ..... to 2 kW 7/16, from 3 kW 13/30

RF test outputs

Exciter ..... 2 V_{rms}/50 Ω

500-W output stage ..... $\leq$ 5 V_{rms}/50 Ω

Connectors ..... BNC female, 50 Ω

Inputs

AF input

Input impedance ..... $\geq$ 2 kΩ balanced or $\geq$ 600 kΩ unbalanced

input level for ±40 kHz frequency deviation ..... -6 to +9 dBm (0.39 to 2.18 V)

Steps of input attenuator ..... 5 x 2.5 dB (coarse) 11 x 0.25 dB (fine)

Time constant of preemphasis ..... 50 µs ±10% or 75 µs ±10%; can be switched off

Connector ..... lockable, 3-pole female connector (similar to DIN 41524) in rack; 3-pole line-break connector acc. to DIN 41628 on front panel of exciter

Reference-frequency input (for operation without internal crystals)

Frequency ..... 1/16 x output frequency (5.46 to 6.75 MHz)

Input voltage ..... 0.25 to 1 V/50 Ω

Connector ..... BNC female, 50 Ω

Transmission characteristics

Variation of centre frequency ..... $\leq$ 500 Hz/year or $\leq$ 1000 Hz/year (depending on crystal)

Centre-frequency shift with ±75 kHz frequency deviation ..... not measurable

Frequency response, measured without lowpass filter and without preemphasis

40 Hz to 43 kHz ..... $\leq$ ±0.1 dB
43 kHz to 100 kHz ..... $\leq$ ±0.3 dB
} ref. to 500 Hz

Frequency response, measured with 15-kHz lowpass filter and with pre- and deemphasis

40 Hz to 15 kHz ..... $\leq$ ±0.5 dB, ref. to 500 Hz

Suppression of frequencies $\geq$ 19 kHz by switchable lowpass filter ..... $\geq$ 40 dB

Crosstalk attenuation between left and right channels

40 Hz to 100 Hz ..... $\geq$ 40 dB

100 Hz to 5 kHz ..... $\geq$ 45 dB

5 kHz to 15 kHz ..... $\geq$ 40 dB

Distortion in range between 40 Hz and 15 kHz acc. to DIN 45403

with ±75 kHz frequency deviation ..... < 0.4%

with ±100 kHz frequency deviation .... < 0.6%

Intermodulation distortion between 15 and 54 kHz with ±75 kHz frequency deviation acc. to DIN 45403

2nd-order products d_2 +) ..... $\leq$ 0.2%

3rd-order products d_3 +) ..... $\leq$ 0.3%

Unweighted FM S/N ratio acc. to DIN 45405, ref. to 40 kHz frequency deviation and with f_{mod} = 500 Hz

Mono operation ..... $\geq$ 68 dB

Stereo operation with coder and decoder ..... $\geq$ 66 dB

Weighted FM S/N ratio acc. to DIN 45405, ref. to 40 kHz frequency deviation and with f_{mod} = 500 Hz

Mono operation ..... $\geq$ 70 dB

Stereo operation ..... $\geq$ 66 dB

Unweighted AM S/N ratio, ref. to 100% AM ..... $\geq$ 60 dB

Weighted AM S/N ratio, ref. to 100% AM .. $\geq$ 70 dB

Unweighted AM S/N ratio for FM operation with ±40 kHz frequency deviation, ref. to 100% AM ..... $\geq$ 52 dB

+)

$$d_2 = \frac{V\,(f_2 - f_1)}{V_{out}\ \sqrt{2}}, \qquad d_3 = \frac{V\,(2f_2 - f_1) + V\,(2f_1 - f_2)}{V_{out}\ \sqrt{2}},$$

V_{out} = rms value of complete output signal

Power supply, environmental conditions, dimensions

AC supply voltage	
500 W, 1 kW	110/120/220/240 V 47 to 63 Hz
1.5 kW to 5 kW	220/380 V, 3-phase, 50 Hz
2 kW	either 110/120/220/240 V, single-phase, or 220/380 V, three-phase
Efficiency	$\geq$ 0.5
Power factor λ	> 0.8 with single-phase AC supply > 0.9 with three-phase AC supply
$\cos\varphi$	> 0.95
Nominal temperature range	-5 to +45°C
Operating temperature range	-20 to +50°C (if heat-sink temperature exceeds +80°C, the output power is reduced)
Storage temperature range	-40 to +70°C
Permissible atmospheric pressure	650 to 1060 mbar
Permissible relative humidity	$\leq$ 95%
Dimensions	see Fig. 1-1.