

**KSG-4500  
UHF REPEATER**

**PRELIMINARY  
INSTALLATION  
AND  
OPERATION MANUAL**

**KENWOOD**

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# ***INTRODUCTION***

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## ***KSG-4500 UHF REPEATER***

### ***Product Description:***

The KSG-4500 UHF Repeater is a single-channel, 100 Watt, continuous duty, self-contained repeater intended for use in UHF trunking systems or as a standalone conventional repeater. The basic version of the KSG-4500 includes an internal CTCSS / DCS signaling unit which allows the repeater to function as a conventional community repeater. Units configured for use with external conventional or trunking controllers have the internal signaling unit removed. The KSG-4500 is available in both wide and narrow bandwidth models in the following sub-bands:

KSG-4500-1	450 – 470 MHz
KSG-4500-2	470 – 490 MHz
KSG-4500-3	490 – 512 MHz
KSG-4500-4	406 – 430 MHz

USA Type Acceptance: ALHKSG-4500G-1  
Canada: 282 195 307A

The KSG-4500 uses certain components and assemblies adapted from the Kenwood 20-series products, including the venerable TKR-820 desktop repeater. Certain component changes have been made to enhance the performance of these subassemblies and allow their interface with other new components to achieve a continuous duty, fully integrated 100 W unit.

The KSG-4500 is designed for continuous operation at full power, even under the most adverse conditions. KSG-4500s feature internal high efficiency power supplies (115 – 230 VAC) and a power amplifier with a massive heat sink cooled by two chassis-mounted high volume fans, thermostat controlled. The KSG-4500 is designed to power external trunking and conventional controllers through the rear interface connector. The KSG-4500 features internal DC or tone wireline remote control and an internal battery backup float charger (options, available mid-1998).

KSG-4500s feature internal circuit breakers for DC circuits. A high performance AC filter and surge protector is designed into the AC entrance connector which uses a standard computer-type AC cable. A chassis-mounted ground connector is mounted on the rear panel. The KSG-4500 uses a BNC connector for the receiver input and a type N connector for the transmitter output. This prevents damage from inadvertent cross-connection between the transmitter output and a receiver multicoupler port. The KSG-4500 is supplied with 4 rubber screw-in feet for desktop applications.

KSG-4500s are designed for ease of maintenance. Programming and all low level audio and RF adjustments are done through the hinged front panel. Programming requires the use of a KPT-20 programmer or a KPT-50 programmer and a laptop.

For more information, call Kenwood Systems Inc. at 1-800-TRUNKING.

## ***Scope of This Manual:***

This manual is intended for use by experienced technicians familiar with similar types of commercial grade communications equipment. This manual is preliminary and is intended to provide installation and operation information pending the release of the complete manual, currently in production (Feb 1998). Since certain components are similar to those used in the TKR-820 (TX-RX Unit, Signaling Unit and Display Unit), this preliminary manual is to be used in conjunction with Kenwood TKR-820 Service Manual B51-8050-10, available from Kenwood Communications Corp.

## ***Ordering Replacement Parts:***

When ordering replacement parts or equipment information, the full part identification number should be used. This applies to all parts whether components, kits, subassemblies or chassis parts. If the part number is not known, include the chassis or kit number of which it is a part and a sufficient description of the required component for proper identification.

Order all parts from:

Kenwood Systems, Inc.	1-800-TRUNKING (800-878-6546)
4317A FM 2351	
Friendswood, TX 77546	(281)-996-4780 v      281-648-9009 fax

## ***Safety:***

The following safety precautions are recommended:

- DO NOT transmit if someone is within 3 feet (1 meter) of the transmit antenna. Observe all personal exposure and RF radiation hazard rules and guidelines.
- DO NOT transmit until all RF connectors are verified secure and any open connectors are properly terminated.
- TURN OFF and DO NOT operate this equipment near electrical blasting caps or in an explosive atmosphere.
- All equipment should be properly grounded before power-up for safe operation.
- This equipment should be serviced only by qualified technicians.
- UNPLUG this equipment when servicing. Hazardous voltages are present at all times when the unit is plugged into commercial AC power.
- BE CAREFUL when working with high current DC supplies or batteries. Observe all charging precautions and environmental safety regulations when working with storage batteries. DO NOT smoke near charging batteries.

- This equipment is designed to automatically generate RF energy and can do so at any time without prior indication or notice. To prevent serious damage, care must be taken to provide proper loading for the RF amplifiers. DO NOT operate this equipment until proper loads have been connected to the RF amplifiers and their combining equipment.

KENWOOD SYSTEMS, INC. ASSUMES NO RESPONSIBILITY FOR DAMAGE OR INJURY RESULTING FROM THE IMPROPER INSTALLATION, HANDLING OR USE OF THIS PRODUCT.

### ***Pre-Installation Considerations:***

*General:* This equipment is very sensitive and can be easily damaged by static electricity, electrical transients or lightning. Proper grounding and lightning protection is essential. Be sure to properly ground the equipment to a single point ground using the ground point on the rear of the equipment. Install coaxial lightning protectors on all antenna lines. Additional protection on AC and phone lines is strongly recommended. Lightning protection equipment and installation materials are available at nominal cost. Contact Kenwood Systems Inc. for further information.

Every attempt has been made to pre-program, test and configure the KSG-4500 and its ancillary equipment based on the information provided with the initial order. Please refer to the individual controller manuals and other system documentation for more details.

*Individual units:* Unpack the unit from its shipping container and check for accessory items. If any item is missing, please contact Kenwood Systems, Inc. immediately.

*Complete systems:* Complete systems are shipped fully integrated, complete and ready for installation. All controllers are shipped with *no* user programming installed, with the exception of trunking ID codes 100 (dispatch test) and 200 (interconnect test), unless otherwise instructed. All area bits are set to 0 and standard channel distribution format is used (example: channels 1, 5, 9, 13 and 17 for a 5-channel trunked system).

Complete systems vary greatly in features, configurations and mounting. Carefully examine the system for completeness and shipping damage. If you have any questions, please call Kenwood Systems, Inc. before attempting to install the equipment.

Complete systems are HEAVY. Be sure to use adequate personnel, proper equipment and techniques to safely handle and install the system. To prevent the possibility of the system tipping and causing damage, personal injury or death, all racks MUST be secured to either the wall or to the floor. Mounting and stabilizing kits are available at a nominal cost. Contact Kenwood Systems Inc. with your mounting requirements.

### ***Licensing Requirements:***

In the USA, the Federal Communications Commission requires a station license for each radio installation. The licensee is responsible for ensuring compliance with the terms and conditions of the grant. No station may be placed into operation without a valid license.

### ***Factory Installation, Programming Assistance:***

Factory installation, system programming assistance and onsite training are available at nominal rates. Please contact Kenwood Systems Inc. for a quotation.

# INSTALLATION AND OPERATION

## KSG-4500 UHF REPEATER

### **Installation:**

The KSG-4500 is intended for installation into a standard 19" equipment rack or cabinet. It occupies 7" of vertical space (4 RU) and requires approximately 15" of depth, including cable bend radii.

Connect the type N connector on the rear panel to an inline wattmeter and a suitable 50Ω load or antenna capable of safely handling 100 W continuously. Connect the BNC receiver input to an output port of the receiver multicoupler or to the receive side of the duplexer. Caution: Low cost reject-only duplexers (such as used internally with the TKR-820) are NOT capable of safely handling the 100 W of the KSG-4500.

Connect the KSG-4500 to a source of 115 VAC AC power (230 VAC optional, indicated by a label on the rear panel). The KSG-4500 requires approximately 3A from the AC source (1.5A at 230 VAC), depending on options and external controller loads. Once connected to AC, the KSG-4500 should power up and illuminate the front panel Power LED. Verify that adjustment of the Volume and Svc Squelch controls causes the Carrier LED to illuminate and audio to be heard through the speaker.

If the unit is to be used with an external controller, connect the controller using the supplied cable to the DB-15 on the KSG-4500's rear panel. Note: Most external controllers use discriminator audio and are unaffected by the setting of the front panel Svc Squelch control. An internal data squelch control is provided in these controllers.

Caution: When the unit is powered, it may generate RF energy at any time and can do so without prior indication or notice. To prevent serious damage, care must be taken to provide proper loading for the RF amplifiers. DO NOT operate this equipment until proper loads have been connected to the RF amplifiers and their combining equipment.

Press the front panel Test switch. The Transmit LED should illuminate and the wattmeter should indicate 100W of RF power. Note: Output power is pre-set at the factory at 100W (or per instructions) and should indicate 100W onsite, depending on the wattmeter accuracy and the accuracy of the load impedance. The power output adjustment is sealed to prevent inadvertently setting the output power beyond its rating.

At room temperature, both rear fans should be OFF. These fans are controlled by a thermostat mounted inside the power amplifier. Brief transmissions do not generate sufficient heat to trigger the thermostat. When the unit is keyed continuously, both fans should start approximately 3-4 minutes after initial PTT assuming a 72°F room temperature. However, it is normal in a hot, unairconditioned site for the fans to run continuously. No harm is done, as the fans are rated for years of continuous service.

Caution: It is imperative that the cooling inlets and exhaust ports remain unobstructed. When the fans are in operation, cool air is drawn into the repeater through the fan grilles and exhausted after cooling the RF amplifier's heat sink through the rear

openings on both sides of the cabinet. The KSG-4500 is designed so that as the fans pressurize the cabinet, a portion of the cooling airflow is directed across the power supply and exhausted by the front openings on both sides of the cabinet. Therefore, it is very important that the top cover and the hinged front door remain closed during normal operation.

## ***Operation:***

The KSG-4500 is a single channel 100 W UHF repeater. Its operation is similar to other UHF repeaters with the exception that it is intended to power an external controller through the DB-15 connector on the rear panel.

*Basic Conventional:* In basic conventional operation, an internal KMS-5 signaling board is used to control the action of the repeater. Upon receiving a correct CTCSS or DCS signal, the transmitter is keyed, the repeat audio path is enabled by the signaling board and sub-audible CTCSS or DCS modulation is added to the transmitted audio. The Svc Squelch control on the front panel sets the repeater squelch level. Note: The internal signaling board is supplied only in the basic repeater configuration (CWID is an option). In all other configurations, the board is removed and bypassed by a set of jumpers. The internal signaling board is mutually exclusive with external controllers.

*External Conventional:* In a configuration using an external conventional controller, the controller's internal squelch is used to control the action of the repeater and the front panel Svc Squelch is unused. As in the basic conventional, above, receipt of a correct CTCSS or DCS signal causes the unit to repeat, the major difference being the location and expanded capabilities of the external controller.

*External Trunking:* In configurations using external trunking controllers, the action of the repeater is controlled by the operating protocol of the trunking controller and the local area network formed by the other channels in the system. In UHF trunking, one or more channels which are completely free of co-channel users are designated as the home channels, all others (those *with* co-channel interference) are designated as trunk-to channels to be used when available. A carrier detect logic line indicates presence or absence of a carrier, with the controller determining whether the channel is available in the trunking pool by the receipt of valid or non-valid ID codes or CTCSS tones. When occupied by co-channel users (non-valid codes), the channel is removed from the pool of trunk-to channels available in the system for assignment. It is customary that idle channel packets are not used in UHF trunk-to pool channels to minimize interference to others operating on the same channel. Idle channel packets, once required to initialize a radio joining the system, are no longer required.

Refer to the appropriate service, installation and programming manuals for the external controller for more information.

# ***MAINTENANCE***

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## ***KSG-4500 UHF REPEATER***

### ***Maintenance:***

The KSG-4500 uses certain components and assemblies from the Kenwood 20-series products, including the TKR-820 desktop repeater. Certain component changes have been made to enhance the performance of these subassemblies and allow their interface with other new components to achieve a continuous duty, fully integrated 100W unit. This Installation and Operation manual is a preliminary manual intended to be used until the complete Service manual is available. In this interim, please refer to the TKR-820 manual for tuning and maintenance instructions for the TX-RX Unit, the Signaling Unit and the Display Unit.

*General:* The KSG-4500 is designed for ease of service. Access to the TX-RX Unit, the Signaling Unit and the Display Unit are through the hinged front door:

- *Display Unit:* The Display Unit is mounted to the hinged front door. To access the display unit, open the hinged front door. The Display Unit contains most of the low level audio and logic circuits for the repeater. The programming port is on top of the Display Unit PCB and faces outward when the door is open.
- *Signaling Unit:* To access the Signaling Unit (if so equipped), open the hinged front door and remove the 11 screws holding the front shield cover on the TX-RX Unit. The Signaling Unit is now accessible inside the TX-RX Unit.
- *TX-RX Unit:* To access the modulation, frequency, VCO adjustments, etc., open the hinged front door and remove the 11 screws holding the front shield cover on the TX-RX Unit. Remove the Signaling Unit (if so equipped). All adjustments are now accessible from the front. In case the TX-RX Unit requires repair or access to the back side, remove the cabinet top cover, disconnect the Receiver input BNC90, loosen the 4 screws holding the side brackets and slide the unit upward in the keyhole slots, then lift clear. It is not necessary to completely remove the 4 keyhole screws.

Reassembly is a reverse of the above procedures.

Access to other areas of the repeater requires removing the top cover, held in place by 6 Phillips head screws, 3 on each side. The KSG-4500 is arranged so that the TX-RX Unit and the power supply are mounted on either side of an intermediate chassis, secured into the KSG-4500 by 6 Phillips head screws, 3 on each side. Similarly, the power amplifier is mounted by 6 Phillips head screws, 3 on each side. Both the intermediate chassis and the power amplifier can be removed in less than a minute for replacement. Preliminary information on the remaining subassemblies and on interfacing the KSG-4500 to external controllers is provided as follows:

- *KSG-31027 Switching Power Supply:* The power supply used in the KSG-4500 is a high-efficiency switching power supply which delivers a nominal 13.8 VDC at 27



Amps (400 Watts), continuous duty. This power supply is an extremely compact, very rugged design, capable of providing years of reliable service. By moving an external jumper, the power supply can be configured for operation on either 115 or 230 VAC, 50 – 60 Hz. The power supply incorporates an EMI filter and an end-mounted fan. EMI is further filtered by the AC inlet filter module to ensure the lowest possible conducted and radiated spurious emissions, important in modern communication facilities.

The AC input to the KSG-4500 is protected by a 6 Amp circuit breaker located on the rear panel near the AC inlet filter module. The DC output of the power supply is protected by a 25 Amp circuit breaker in the RF power amplifier circuit, and a 6 Amp breaker in the low power circuits. Both DC circuit breakers are mounted to the intermediate chassis, accessible through the hinged front door. Note: All circuit breakers are trip-type circuit breakers and are not used as switches as in KSI power distribution panels.

To remove the power supply from the KSG-4500, unplug the KSG-4500 from its AC source, then remove the top cover and open the hinged front door. Remove the 6 screws holding the intermediate chassis to the KSG-4500 cabinet. Gently tip the intermediate chassis forward and release the two straps that hold the power supply to the intermediate chassis. Disconnect all wires and slide the power supply away from the intermediate chassis. Re-assembly is a reverse of the above procedure.

Caution: There is no AC switch used on the KSG-4500. When plugged into a source of AC power, the unit is powered and "live." The DC power supply is capable of delivering 400 W of DC *continuously*. Use extreme caution when working with tools around the power supply while it is ON. Do not open the power supply; there are *no* user serviceable parts inside. Opening the power supply voids its warranty. Replacement power supplies, if needed, are stocked at KSI.

- *KSG-24100-XX RF Power Amplifier:* The RF power amplifier in the KSG-4500 requires 10 mWatts of drive (nominal) from the TX-RX Unit to produce its rated maximum 100 Watts output power. The power output is adjustable over a range of approximately 40 to 100 Watts (set at the factory per order specification). The KSG-24100 series power amplifier is rated for continuous duty and requires external forced air cooling. Forced air cooling is provided by two high volume fans mounted to the rear of the KSG-4500 cabinet controlled by a thermostat inside the amplifier. The amplifier is NOT to be operated without forced air cooling. It is imperative that the cooling inlets and exhaust ports remain unobstructed and the top cover and front hinged door remain closed during operation.

To remove the amplifier from the KSG-4500, unplug the KSG-4500 from its AC source, then remove the top cover. Remove the 6 screws holding the power amplifier to the KSG-4500 cabinet. Lift and tip the amplifier to the rear. Disconnect all wires and cables and lift the power amplifier away from the cabinet. Re-assembly is a reverse of the above procedure.

Caution: When the unit is powered, it may generate RF energy at any time based on the action of the controller and can do so without prior indication or notice. To prevent serious damage or injury, care must be taken to provide proper loading for

the RF amplifiers. DO NOT operate this equipment until proper loads have been connected to the RF amplifiers and their combining equipment.

Output power is pre-set at the factory at 100W (or per instructions) and should indicate 100W onsite, depending on the wattmeter accuracy and the accuracy of the load impedance. The power output adjustment is sealed to prevent inadvertently setting the output power beyond its rating.

The RF amplifier is capable of delivering 100 W of RF continuously. Use extreme caution when working with tools around the amplifier while it is ON. Do not open the amplifier; there are no user serviceable parts inside. Opening the amplifier or adjusting its power (without factory approval) voids its warranty. Replacement power amplifiers, if needed, are stocked at KSI.

# ***INTERFACING THE KSG-4500***

## *KSG-4500 UHF REPEATER*

### ***External Controller Interface:***

The KSG-4500 uses standard signal levels to interface with external controllers at a DB-15 connector located on the rear panel. Pre-fabricated cable assemblies are available from Kenwood Systems, Inc. for most popular controllers. In all cases, the KSG-4500's PTT line should be keyed using a dry contact closure (relay). Some controllers' FET keying transistors provide unreliable keying due to their limited saturation capability.

Pinout of the rear chassis DB-15 is as follows:

DB-15 Pin	Function	Notes
1	+13.8 VDC, 2 A	DC source for external controller, 2A max
2	Ground	DC return for external controller
3	(reserved)	
4	(reserved)	
5	Speaker Audio	Speaker audio, controlled by volume control
6	(reserved)	
7	Transmit Audio	Transmit audio from external controller
8	(reserved)	
9	Ground	Chassis ground
10	Squelch Logic	RUS logic line, HI = RX Unsquelched
11	PTT	PTT line, Low = Transmit
12	(reserved)	
13	Transmit Data	Transmit data input from external controller
14	PTT Common	Logic and Signal Common
15	RX Detector	RX Detector output to external controller

### ***For More Information:***

Contact Kenwood Systems Inc. or your local Kenwood sales representative. All holders of preliminary manuals will be updated with complete KSG-4500 service manuals as soon as they become available.

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# **SPECIFICATIONS**

## **KSG-4500 UHF REPEATER**

### **Configurations, Options:**

The KSG-4500 is supplied with an internal KMS-5 conventional controller unless otherwise specified in the order. This basic configuration allows 8 CTCSS / DCS tones and is programmed using the repeater's programming port, a KPT-50 and a computer. KSG-4500s ordered for use with an external controller do not include the internal KMS-5 conventional controller. Options include tone or DC wireline remote control, CWID (internal conventional controller), DC battery backup and a wall mounting frame.

### **General:**

Frequency Range:	KSG-4500-1	450 – 470 MHz
	KSG-4500-2	470 – 490 MHz
	KSG-4500-3	490 – 512 MHz
	KSG-4500-4	406 – 430 MHz
Number of Channels:	1	
Channel Spacing:	25 kHz or 12.5 kHz (12.5 kHz PLL step)	
Input Voltage:	115 / 230 VAC, 50 – 60 Hz, 3A / 1.5A nom	
AC Power Consumption:	350 W (max)	
Power Supply:	Internal, high-efficiency switching	
DC Backup:	Available as Option	
Duty Cycle:	100% at full rated output power	
Cooling:	Internal forced air, thermostat controlled	
Mounting:	19" rack or desktop (feet incl with unit)	
Mounting Position:	Any	
Dimensions:	7.0" H (4RU) X 19.0" W X 14.0" D	
Weight:	35 lbs	
Cabinet Color:	Black painted, textured	

### **Receiver:**

RF Input Impedance:	50 $\Omega$
RF Input Connector:	BNC female
RF Sensitivity:	0.25 $\mu$ V 12 dB SINAD
	0.35 $\mu$ V 20 dB Quieting
	0.15 $\mu$ V Squelch Sensitivity
Modulation Acceptance:	$\pm$ 7 kHz (25 kHz version)
	$\pm$ 3.5 kHz (12.5 kHz version)
Selectivity:	-80 dB
Intermodulation:	-75 dB
Spurious and Image Rej:	-85 dB
Audio Power Output:	4 W at 8 $\Omega$
Audio Distortion:	< 3% at 1000 Hz
Frequency Stability:	0.00015% from -30°C to +60°C

## *Transmitter:*

RF Output Impedance:	50 $\Omega$
RF Output Connector:	Type N-female
RF Power Output:	100 W, adjustable to 40 W
Duty Cycle:	Continuous, 100 %
Spurious and Harmonics:	-70 dB
Modulation:	Direct FM, 16KOF3E, 11KOF3E
Audio Distortion:	< 3% at 1000 Hz
Frequency Stability:	0.00015% from -30°C to +60°C