WMS61

&

WMS81

Wireless Microphone Systems

Introduction:

The art and science of wireless microphone design have progressed in recent years to a point where reliable and flexible performance can be taken for granted in even the most complex venues. What remains is for this level of performance to become available at competitive prices and with easier setup requirements. AKG's new WMS 61 and 81 wireless systems go a long way toward achieving these goals.

The AKG WMS61 and 81 systems embody a number of technical attributes contributing to improved performance including the following: long battery life (up to 12 hours for non-rechargeable batteries), automatic squelching via a pilot tone imbedded in the transmitter signal, complementary 2-to-1 companding circuits, diversity reception, remote monitoring of battery power, and overall ease of setup.

The WMS61 system operates in the VHF band, while the WMS 81 operates in the UHF band; otherwise, the two systems are virtually identical in execution and performance. The available frequency sets for the WMS 61 correspond to TV channels 7, 8, 9, 10, 11, 12 and 13. The available frequency sets for the WMS 81 correspond to TV channels 54, 55, 58 and 59. There are 15 adjustable frequency bands within each set. (See Ordering Information for added details on each frequency set and regional requirements.)

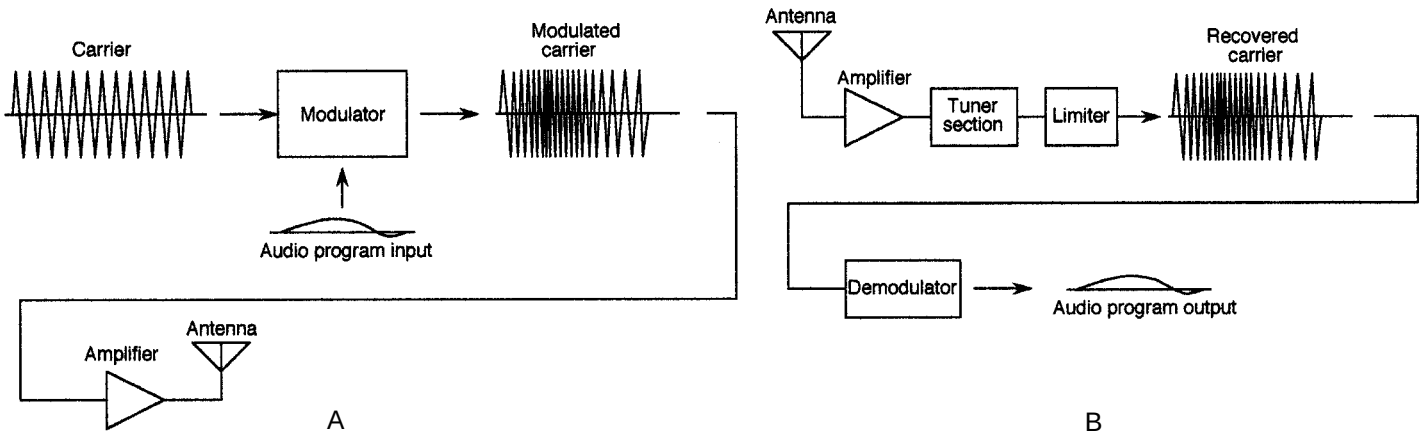
In this White Paper we will discuss performance and operational aspects of these new systems, complete with hands-on descriptions and system walk-through.

A Review of Technical Fundamentals:

Essentially, the heart of any wireless microphone is a miniature, low power FM (frequency modulation) transmitter. In fact, some of the earliest wireless microphones operated on the commercial FM broadcast band and could be picked up with a standard FM tuner! You can imagine the difficulties this caused in major cities where FM frequency broadcasting allocations were plentiful and where the use of such microphones could interfere with nearby FM receivers.

Figure 1 shows the basic flow diagram for an FM modulation/demodulation system. Here, a RF (radio frequency) carrier is generated, frequency-modulated by an audio signal, and then propagated through space. At the receiving end the carrier is picked up, amplified, limited in amplitude to remove any effects of atmospheric electrical interference, and finally demodulated to recover the audio signal.

Figure 1. Basic principles of FM transmission and reception



FM has been used for broadcast transmission of high quality audio since the mid-1950s, and its primary advantages are wide audio bandwidth and relative freedom from external electrical disturbances as compared to AM (amplitude modulation). The chief factors that determine the ultimate performance characteristics of an FM system are *RF signal* strength at the receiver and the *modulation index* (FM frequency deviation divided by modulating frequency) of the signal at the transmitter.

In time, the transmission band for wireless microphone usage was moved out to the high-band ranges of VHF (very high frequency) and UHF (ultra high frequency), where there has been ample bandwidth and, in most world areas, plenty of unused channels. Today, the wireless microphone industry is dealing with the coming of digital television (DTV), and this requires all manufacturers and users of wireless microphones to take a good look at actual TV frequency allocations on a city by city basis.

The VHF transmission range used with the WMS 61 is 138 to 250 MHz, and for the WMS 81 the UHF range is 710 to 869 MHz. The transmitting antennas are quite short, no more than about 7 centimeters (3 inches), making for very convenient operation.

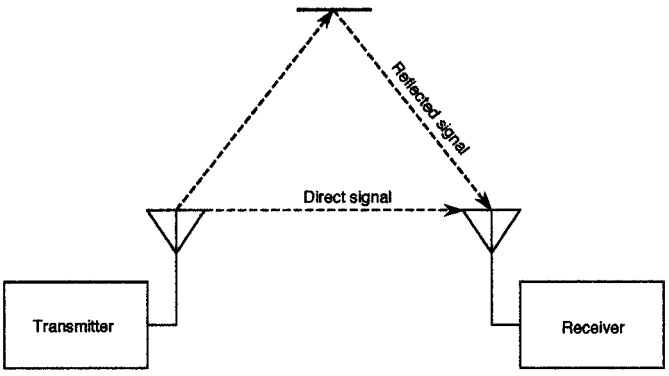
The transmitted power of wireless microphone systems is normally in the range of 10 to 50 milliwatts (mW), depending on the manufacturer and to a large extent the country of origin. This small power output is necessary to ensure that wireless microphone systems will not interfere with other communications activities, but it is sufficient to accommodate all line-of-sight activities over distances of 300 meters (1000 feet).

If the simple system shown in Figure 1 were to be directly used for wireless microphone applications, there would be two major problems*: loss of signal* due to multiple paths from transmitter to receiver as the performer moves around on stage, and the *susceptibility to noise*. We will now discuss these problems and their solutions.

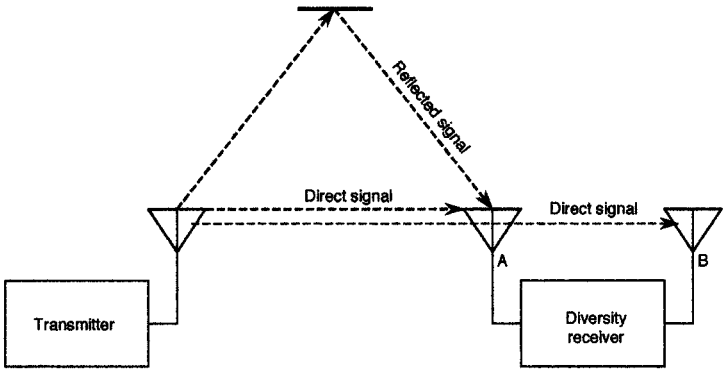
Diversity Reception: With only a single receiving antenna, as shown in Figure 2A, transmission will be lost when the direct carrier signal from the transmitter and a reflected carrier signal both arrive at the receiver out-of-phase (a phase shift of 180°), causing a virtual cancellation of the RF carrier. “Dead spots” may exist throughout the normal pickup range, with consequent muting of the microphone system.

The solution to this problem is diversity reception. In diversity reception, which is shown in Figure 2B, there are two antennas located approximately one-quarter wavelength apart. This relatively small distance is sufficient to ensure that at least one of the antennas will be in a strong signal zone at all times, thus providing the receiving system with an adequate signal. In the Series 61 and 81 receivers, both antenna signals are demodulated, and the stronger of the two is selected for further processing and delivery to the output of the system. This approach is known as *diversity reception*.

Figure 2. Operation of the diversity receiver.



A. When a direct path and a reflected path are both received at the single antenna, there may be some degree of phase cancellation, resulting in weak or no output.



B. When a diversity receiver is used, two antennas, spaced by about one-fourth wavelength, pick up the signal, and there is a very low liklihood that cancellation will take place at both antennas.

Noise Considerations: Monophonic FM broadcast transmission normally has a very high signal-to-noise ratio because of relatively high signal strength and high modulation index. In the wireless microphone area, where we are "crowding" many channels into a relatively small radiated bandwidth, the usable signal-to-noise ratio is about 60 dB — which is not good enough for critical sound reinforcement applications. It is customary to "enhance" this performance through the use of some kind of code/decode noise reduction, or *companding* system. In companding, the input signal is given a high frequency pre-emphases (or boost), compressed so that it effectively occupies a narrower dynamic range, allowing it to ride high above the inherent noise level of the total FM transmission system. At the receiving end, after the signal has been demodulated, it is expanded in dynamic range by an amount which is the exact inverse of the compression, and then followed by high frequency de-emphasis. Details of companding are shown in Figure 3, and complementary pre-emphasis/de-emphasis curves are shown in Figure 4.

This double action (code/decode) restores the original dynamic range to the signal, while at the same time pushing the transmission noise floor downward during softer moments in the program. (This same basic principle is used in Dolby noise reduction in Cassette recorders.)

Figure 3. Details of Companding (compression-expansion) processing in a wireless microphone system.

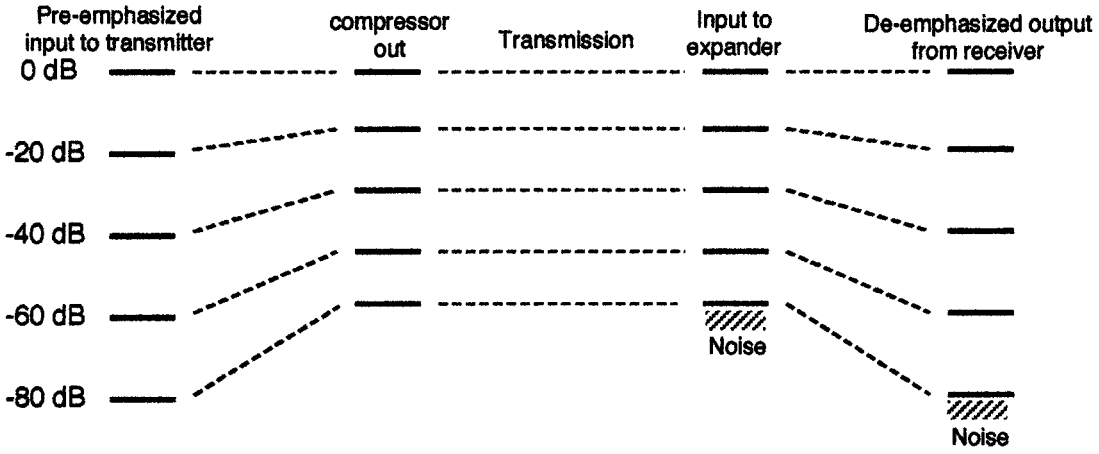
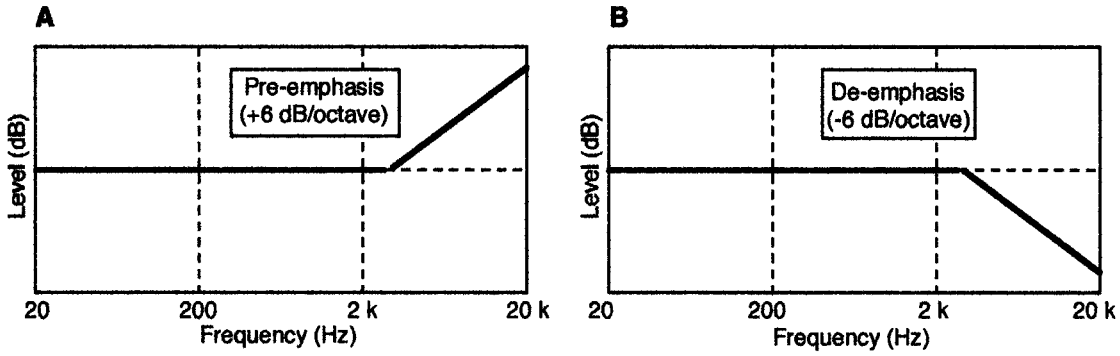


Figure 4. Compander characteristics in the WMS61/81 systems. Pre-emphasis curve in the transmitter (A); de-emphasis curve in the receiver (B).



Another technique for minimizing noise under marginal operating conditions is known as *squelching*. When the level of the incoming RF signal drops below a certain threshold, the system becomes prone to interference and may even pick up spurious signals. In older systems, the squelching threshold is a manual adjustment. The WMS 61 and 81 systems use a pilot tone sent from the from the transmitter, which "instructs" the receiver to adjust its reception level accordingly so that noises due to improper squelch action are vastly minimized. The receiver goes into muting silently, and only when the transmitted signal drops below usable level.

Basic System Description:

Both systems include handheld transmitters with a choice of five head units, a flexible bodypack with both microphone and line input capability, and a half-rack width, single rack unit receiver. The WMS 81 series also had a unique wireless receiving unit for use with portable video cameras.

A. Handheld transmitter: The HT61 and HT 81 units are virtually identical. As you hold the unit in your hand, you will note that there is no antenna pod or dangling wire. In this system a dipole transmitting antenna is contained completely within the unit. Gently turn the base of the transmitting unit counterclockwise and remove it. Also remove the black ring that fits just above the base of the unit. When you have done this you will see 4 operating controls, the battery compartment and a listing of the transmitting frequency bands and a corresponding frequency set number. Let's look at these in turn:

1. Channel selector: This is a recessed control that can only be accessed by a small flat-blade screwdriver (contained in the shipping package), and these channels are indicated 1 through 9 and A through F for a total of 15 channels. The channel number or letter must agree with the corresponding setting on the receiving unit, and the frequency set number must agree on both handheld unit and receiving units. (Note: When changing frequency on the transmitter, turn the unit OFF, set the new frequency, and then turn the unit back ON. The power must be off for the circuit to accomplish the frequency change.)

2. Gain setting: This control is just below the channel selector and is adjusted by a small screwdriver so that the optimum signal-to-noise ratio of the transmitted audio signal is achieved.

3. Power On-off: This switch is located just to the left of the gain control. When it is switched on an external red LED indicates to the microphone's user that the transmitter is operating. The red LED also serves as a modulation indicator; normal maximum peaks in the spoken signal will result in a slight increase in the brightness of the LED and thus is an indication of good transmitting level.

4. Microphone On-off: This switch is located to the right of the gain control. For normal operation this switch must be in the ON position.

5. Battery compartment: Just below all of the controls is the battery compartment. Two AA batteries will provide up to 12 hours operation; thus, it is not necessary to turn the system power on and off at any time during a normal program or performance. When the batteries need to be replaced, simply pull on the two cloth ribbons to remove them. It is important to use high quality alkaline batteries. Generic batteries of lesser quality can drop in voltage, prematurely causing the transmitter to cease operating in as little as 15 minutes.

When the batteries are in fresh condition, the red LED/status light on the microphone case will glow dimly; when the status light is illuminated brightly, there are approximately 90 minutes of battery performance left, and the batteries should be replaced as soon as possible. In the event that the status light does not light up at all, the batteries are dead and must be discarded. When installing new batteries, use extra caution to ensure that they are oriented correctly.

6. Channel listing: For convenience, the 15 individual frequency bands are listed for each set, and the master set number is located at the top of the listing.

7. Color coded rings (part number CCS-1): Included in the package is a set of color coded rings and matching rectangular snap-on color chips. These accessories help you keep track of which microphone corresponds to which receiver. For example, you can replace the black ring (the one you removed earlier) with the yellow ring, and snap its corresponding yellow rectangular chip on the lower front center of the receiving unit which is tuned to the same frequency. The color coded ring on the handheld transmitter can be rotated to expose one or more of the controls so that the user will have the flexibility of muting the microphone.

B. Bodypack transmitter: The PT 61 and 81 transmitters have exactly the same set of controls that are on the handheld transmitter. Here are descriptions of front panel controls:

1. Channel selector and gain setting: These controls are located behind the slip-off battery cover. They are to be accessed by a small screwdriver blade. When the battery cover has been replaced, the gain control is accessible through a small hole in the cover. Note that just inside the battery cover is a small screwdriver for making all adjustments on the system. Always replace this handy tool where you found it!

2. Power on-off and signal on-off controls: Looking at the body pack from the top you will see a small security cover that can be easily rotated, exposing the two switches. The gray one to the left is the signal on-off switch, and the black one to the right is the power on-off switch. When the power is engaged the LED status light will glow dimly. When the switch cover is closed, the status LED can be seen just above it, indicating to the user that the unit is functioning.

3. Color coded chip: Just below the cover on the top of the unit is a position for a color coded chip to be positioned so that matched transmit-receive sets can be easily identified.

4. Receptacle for signal input: At the top of the unit you will see to the right a jack for accepting an external microphone or instrument pickup. This 3-pin receptacle will provide 6-volt powering (on pin 3) for pre-polarized condenser microphones you may wish to use with the bodypack. There is also the accessory cable (MK/GL) for connecting electric guitars or keyboards.

When plugging a microphone into the input receptacle, line up the key on the plug to match the corresponding notch in the receptacle. The plug will then snap into place, and can be removed only by pressing the release button on the plug.

C. Receiving Unit: The SR 61 and SR 81 units have the following front panel controls and indicators, reading from left to right:

1. On-off switch. This switch applies power from a wall ac unit plugged into the power receptacle on the back of receiver.

2. Remote battery indicator: The low, mid or high status of the battery set in the transmitter is monitored remotely at the receiving unit. This enables the engineer who has been assigned the task of overseeing the wireless microphone operation to keep tabs on the status of all transmitters. Here is the code indicating battery status:

HI, MID and LO lit continuously: indicates batteries are good for at least 5 additional hours.
MID and LO lit continuously: indicates batteries are good for at least 3 additional hours
LO lit continuously: indicates batteries are good for 1 additional hour.
LO blinking continuously: indicates less than 1 hour remaining.

3. Mute indicator: When this red status light is on, the system is muted, indicating low or no RF signal from the transmitter. The squelch action operates with a pilot tone from the transmitter and requires no manual adjustment at the receiver. It is the level of this signal that automatically mutes the system, preventing a rise in noise when the RF signal is low or non-existent.

4. RF level: This consists of a set of 5 LED status lights. When RF signal strength is high, all five are lit, and proper operation is underway. When only the lowest light (yellow) is lit, there is minimal RF input to the system. This is an indication to the operating engineer to take measures, such as changing channel assignments or rearranging the antenna array, so that the RF level can be increased.

5. Diversity status, A and B: These LEDs indicate on an instantaneous basis which of the two internal diversity channels is in operation. In normal use there should be nearly random switching back and forth between the two. If one of the status lights remains on much of the time it is an indication that the operating engineer should slightly rearrange the antennas or shift to another frequency. Constant switching of the LEDs indicate the receiver is searching for the signal, and this the normal mode of operation.

6. AF level: The audio frequency level indicator shows the actual output of the receiver. Normal peak outputs should be in the range of -4 to 0 dB, with the green LEDs on, and occasional peaking of the red LED. This level may be set with the front panel volume control using the small screwdriver.

7. Channel selector: The channel selector is set with the small screwdriver and must match the channel set on the transmitter. (Unlike the transmitter, you do not need to turn the receiver off when selecting a new frequency.)

Here are descriptions of the back panel controls:

1. Antenna A and B connections. These are the BNC bayonet-type lock receptacles at the left and right edges of the back panel. Insert the two “rabbit ear” antenna elements, pointing them upward and slightly outward. Adjust the length of the antenna sections using the guide on the top of the receiver. Note that there are suggested antenna lengths for the various transmission frequency master sets that are available for the WMS 61 and 81 product groups.

2. Signal outputs: You have your choice of three operating modes:
   A. Line level unbalanced out at 1/4-inch receptacle.
   B. Line level balanced. Use XLR-M receptacle with switch in “line” position.
   C. Microphone level balanced. Use LR-M receptacle with switch in “mic” position.

3. Power in: Power for the SR 61 and 81 systems is normally by way of a wall 12 to 16 volt ac or dc power unit plugged into the power receptacle on the back of the unit. Excess wire length may be looped around one of the small brackets for strain relief. Power may also be supplied from the PS 61 or 81 through the antenna coaxial cable.

Trying Out the System: A Typical Setup:

Now that you have been introduced to the basic functions of the WMS 61 and 81 units, let's proceed with a typical setup. We'll choose the bodypack and use it with a clip-on lapel microphone such as the AKG Model CK 77 WR-L. (The L in the model number indicates that this model has the proper locking-type plug-in jack for wireless use.)

Mount the small microphone element onto the lapel clip by gently pushing the wire just below the microphone capsule into one of the notches on the lapel clip. Make sure that the microphone is oriented so that it points upward toward the user's mouth. Plug the other end of the microphone cable into the appropriate jack on the bodypack, making sure that it is locked in place. Clip the microphone onto your lapel, and select a transmission frequency on the bodypack. (Note that these numbers/letters are slightly recessed and are best seen in a fairly bright light.) Select a channel. For now, adjust the gain setting on the bodypack for full-on.

Now, going to the receiving unit, double-check to make sure that the master frequency set on the receiver matches that of the bodypack. Then, select the same channel number/letter that you set on the bodypack. Power up the bodypack. You will now note that the RF LEDs on the receiving unit are all lit, indicating that full strength from the bodypack is available. If this is not the case, check to make sure that you have actually chosen the correct receiving frequency. Once you see the green RF LEDs lit, we can move on. If you do not have the correct frequency set on the receiver, you will notice that the mute light is on and the diversity LEDs are alternating at a rate of about two times per second as the unit is searching for a non-existent signal.

Next, choose your output option at the back of the receiver. Let's pick the balanced "mic" option. Set the output switch to "mic" and plug in an XLR F cable for feeding the down-stream console. Disable phantom powering from the console, if possible.

Using the screwdriver, advance the front-panel volume control until you have enough signal output from the receiver to drive the console to the required level. You may want to adjust both the gain setting on the bodypack and volume setting on the receiver in order to get the best overall level. Make sure that you are not overmodulating the transmitter with normal speech. To determine this, talk normally and have someone listen carefully to the reproduced sound quality. If peaks are distorted, reduce the gain setting on the bodypack and make up any gain shortfall with the output volume control at the receiver.

This is basically all there is to it. As you experiment with other microphones in conjunction with the bodypack you will find that some will have more output than others, requiring that you reduce the output level of the bodypack. You can easily tell when you are close to overdriving the bodypack by observing the red LED status light at the top of the bodypack; the LED will dim slightly on peaks, indicating that you should reduce the gain.

You should also be aware that the AF level indicating LEDs on the receiver are independent of the setting of the output volume control. The volume control is primarily for adjusting the signal feed level downstream, while the LEDs indicate the audio level at the output of the demodulator. If it appears excessive, reduce the setting of the gain control on the bodypack.

Using Handheld Transmitters:

The same setup routine and precautions as we used for the bodypack apply here as well. Since a given handheld transmitter may be used by a number of speakers it is recommended that the initial checkout be made using the loudest of the speakers to ensure that the system can handle those maximum speech peaks. Softer talkers will then require that the reinforcement system operator raise input levels at the console as required.

General Usage:

As with all wireless systems operating in the VHF and UHF frequency ranges with radiated power in the 10 milliwatt range, there are certain precautions. If the receiving antennas are line-of-sight to the transmitters, and if the path is open and free of large steel structural members, clear operation up to 500 - 1000 feet is possible. Curtains do not pose an obstacle, but drywall structures may weaken the signal to some degree. It is also important that transmitters not be used any closer than about 10 feet of the receiver, since the RF input circuitry may overload slightly. When testing multiple microphones in a new venue, make sure that each transmitter/receiver pair is individually tested with the transmitter at the farthest intended position away from the receiver. In certain venues, some frequencies will work better than others, and this is your opportunity to detect a problem and fix it before it causes trouble. All of us have seen national conventions on TV where a wireless microphone has failed, or become intermittent, just because some engineer did not do the required homework beforehand.

Using the Optional PR 81 Portable Receiver:

Traditionally, the video taping of a roving announcer with a wireless microphone required a wire audio feed to the video camera. This nuisance of course limited the range of the camera and defeated much of the effectiveness of the announcer's need to move around. The PR 81 solves this problem by providing a small receiving unit that can be strapped to the battery-powered camera, thus giving both camera operator and announcer complete freedom to move as needed.

The setup of the PR 81 is much like that of the SR 81, except that the unit does have a squelch control — necessary because the unit will normally be operated in a high RF environment. See the Users Instructions for the PR 81 for added information on this model. and for specific setup instructions.

Comments on Multi-Channel Operation:

Two SR 61 or 81 units can be joined to fit into a single 19-inch rack unit. For an odd number of units, there is a blank metal panel that fills the unused space. Each complete transmitter-receiver pair, as it arrives from the factory, contains the necessary hardware to mount two receivers together, and there is a setup sheet that shows details here. Note that there is a common yoke to join the two receivers by screws at their rear panels.

In small-scale applications, individual free-standing systems may suffice. However, for increased range and to simplify large installations, a single pair of antennas may be used with multiple receivers. These booster antenna models are the RA61B (VHF) and the RA 81B (UHF).

Antenna splitters PS61 (VHF) and PS81 (UHF) are used to send antenna signals to the connected systems. Up to three splitters may be "daisy-chained" to allow a maximum of 10 multichannel receivers with only two antennas. The splitters use two input and 8 output BNC connectors to maintain the systems' diversity operation. The PS61 or PS81 splitters do not come shipped with a power cord or power supply. The reason is that power is supplied through the coaxial cable from the receivers. When it is necessary to eliminate the receivers' individual 12Vdc power supplies, a central power supply (model PSU01) may be used. The PSU01 plugs directly into the PS61 or PS81 and will power up to four receivers through the coaxial cable. That is to say, each splitter used in a multiple configuration set will required one PSU01 power supply. For detailed instructions on the setup and operation of multiple systems, refer to the PS61 or PS81 operating manual, or call (615) 360-0499 and ask for AKG technical support.

Specifications

PT61 bodypack transmitter:

Audio bandwidth:	50 Hz to 20 kHz
Modulation method:	FM
Radiated RF power:	10 mW
Frequency stability:	±10 ppm
Antenna:	Flexible, quarter-wave wire
Rated deviation:	±30 kHz
Signal-to-noise ratio:	Typical 50 dB (A weighted)
Input impedance:	220 kohms, 600 pF
Audio input:	Mini 3-pin XLR; 1400 mV for rated deviation at 1 kHz
Phantom powering:	Pin 3: 6 V/6k8 ohms
Current consumption:	170 mA/2.4 V
Power requirement:	2 AA 1.5V batteries
Battery life:	>10 hours
Dimensions:	3.62 x 2.56 x 0.79 in. (92 x 65 x 20 mm)
Net weight:	3.04 oz. (76 g) without batteries

HT 61 handheld transmitter:

Type, bandwidth and polar pattern:	See individual microphone specification sheets
Modulation type:	FM
RF radiated power:	10 mW
Rated deviation:	±30 kHz
Signal-to-noise ratio:	Typical 50 dB (A-weighted)
Current consumption:	<150 mA/2.4 V
Power requirement:	2 AA size 1.5V batteries
Battery life:	>12 hours
Dimensions:	1.4 x 9.4 in. (36 mm dia. x 240 mm)
Net weight:	9.8 oz. (245 g)

SR61 receiver:

Receiver type:	Diversity
Antenna inputs:	2 x 50-ohm BNC sockets
Modulation type:	FM
Input sensitivity:	Typical -95 dBm
Squelch threshold:	Automatic, using pilot tone (32.678 kHz)
Audio bandwidth:	50 to 20 kHz
THD at 1 kHz:	<0.4% at rated deviation
Signal-to-noise	Typical 100 dB (A-weighted)
Audio output:	Balanced XLR-M, mic/line level switchable, typical 30 dB unbalanced: 1.4” jack: 0 dBm XLR: 6 dBm
Current consumption:	220 mA typical
Power requirement:	11 to 15 V dc or ac from external power supply
Dimensions:	8.27 x 6.7 x 1.65 in. (210 x 170 x 42 mm)
Net weight:	18.8 oz. (470 g)

Accessories:

PS61:	Active, wideband antenna splitter for connecting up to 4 SR61 units or 3 SR61 units and one additional PS.
RA61B:	External receiver antenna with integrated booster, powered via cable from the PS61 antenna splitter.
PSU01:	Central power supply unit for PS61 and PS81 splitters.
SRA-1:	External directional antenna
CCS-1:	Color code indicators for easy channel recognition.
Hard Case CH 60:	For carrying a single complete system
UAM1:	Universal antenna mount for moving the antennas for 1 receiver to the front of the rack.

Specifications

PT81 bodypack transmitter:

Audio bandwidth:	50 Hz to 20 kHz
Modulation method:	FM
Radiated RF power:	10 mW
Frequency stability:	±10 ppm
Antenna:	Flexible, quarter-wave wire
Rated deviation:	±30 kHz
Signal-to-noise ratio:	Typical 50 dB (A weighted)
Input impedance:	220 kohms, 600 pF
Audio input:	Mini 3-pin XLR; 1400 mV for rated deviation at 1 kHz
Phantom powering:	Pin 3: 6 V/6k8 ohms
Current consumption:	170 mA/2.4 V
Power requirement:	2 AA 1.5V batteries
Battery life:	>8 hours
Dimensions:	3.62 x 2.56 x 0.79 in. (92 x 65 x 20 mm)
Net weight:	3.04 oz. (76 g) without batteries

HT81 handheld transmitter:

Type, bandwidth and polar pattern:	See individual microphone specification sheets
Modulation type:	FM
RF radiated power:	10 mW
Rated deviation:	±30 kHz
Signal-to-noise ratio:	Typical 50 dB (A-weighted)
Current consumption:	<150 mA/2.4 V
Power requirement:	2 AA size 1.5V batteries
Battery life:	>10 hours
Dimensions:	1.4 x 9.4 in dia. (36 mm x 240 mm)
Net weight:	9.8 oz. (245 g)

SR81 receiver:

Receiver type:	Diversity
Antenna inputs:	2 x 50-ohm BNC sockets
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Power requirement:	11 to 15 V dc or ac from external power supply
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Net weight:	18.8 oz. (470 g)

Accessories:

PS81:	Active, wideband antenna splitter for connecting up to 4 SR81 units or 3 SR81 units and one additional PS.
RA81B:	External receiver antenna with integrated booster, powered via cable from the PS61 antenna splitter.
PSU01:	Central power supply unit for PS61 and PS81 splitters.
SRA-1:	External directional antenna
CCS-1:	Color code indicators for easy channel recognition.
Hard Case CH60:	For carrying a single complete system
UAM1:	Universal antenna mount for moving the antennas for 1 receiver to the front of the rack.

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