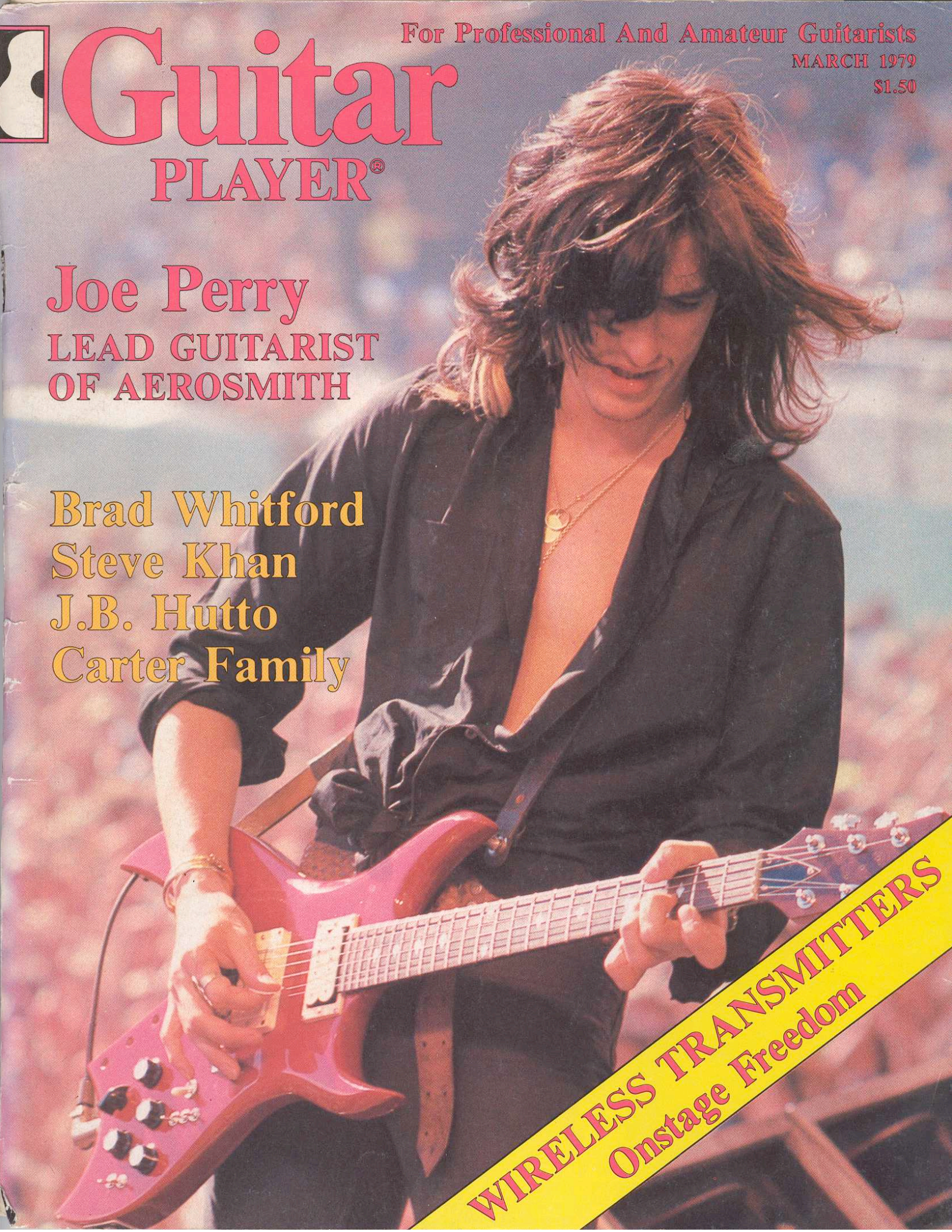
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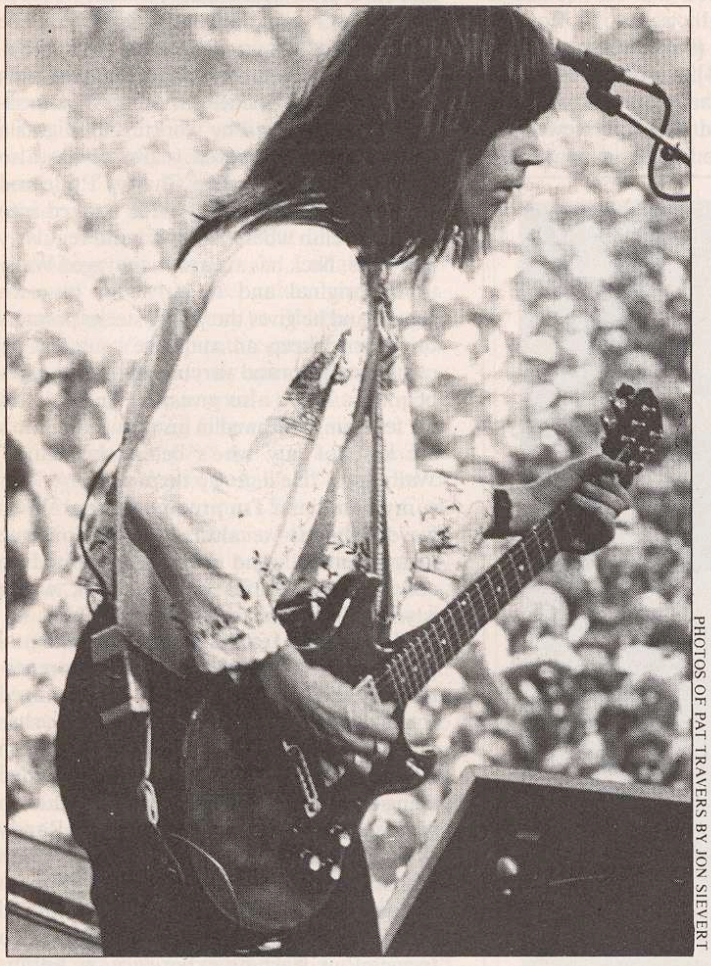
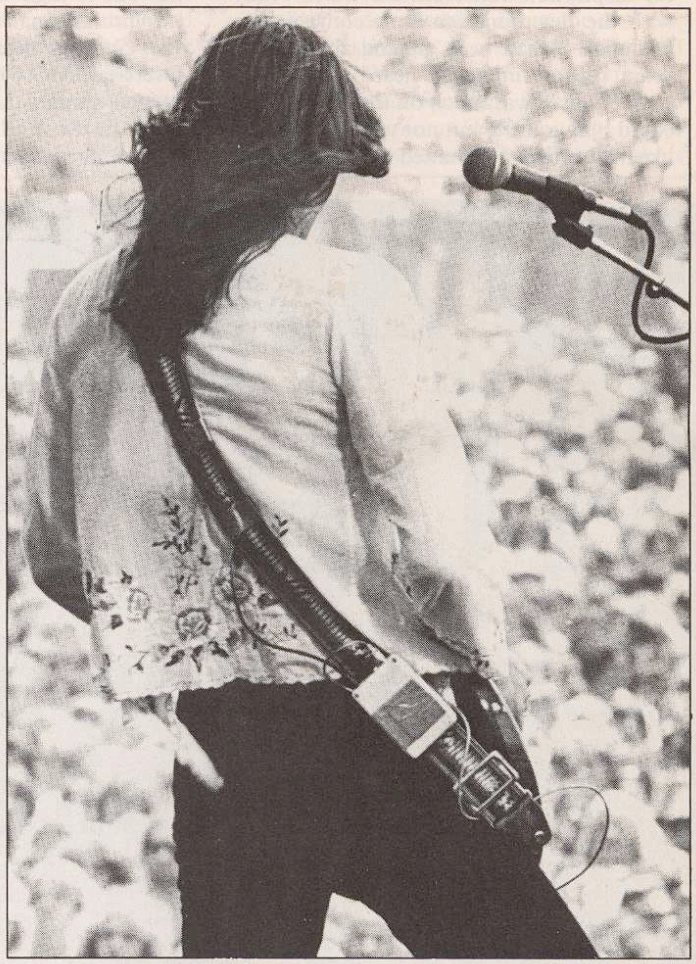
Onstage Freedom

Eliminating The Physical Link Between The Guitar And Amplifier

By Tom Mulhern





PHOTOS OF PAT TRAVERS BY JON SIEVERT

WIRELESS TRANSMITTERS FOR GUITAR

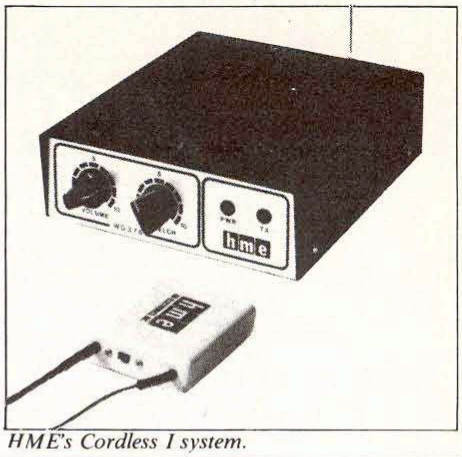
WHEN MARCONI, the Italian inventor, transmitted a few bits of Morse code across the Atlantic with the first successful radio on December 12, 1901, the bonds of wire for communication were broken. His work paved the way for everything from television to microwave ovens, and as remarkable as it may seem, his radio—and inventions that followed—helped open up new doors for guitarists. It took until the mid-1970s for Marconi's invention to have its most profound effect in the guitar realm. In 1977, cordless transmitters were fairly new to guitarists, and most concert-goers probably weren't aware of their use. But without transmitters to replace the cords that tethered them to their amps, guitarists Rick Derringer and Marc Cunningham could never have been able to throw their instruments to each other—mid-song—and continue playing. Nor could Kiss be elevated 40 feet above the stage or run the width of auditoriums. Perhaps such antics aren't important enough to convince the average picker to rush out and spend anywhere from a few hundred to a few thousand dollars, but by stepping back and taking a good look at the potential created by wireless units—aside from the purely theatrical aspects—one can begin to grasp their importance.

The first and most visible benefit of a wireless transmitter is the enhanced mobility afforded the electric guitarist. How many times have you been playing and found yourself tripping over a cord? The problem is compounded when you use one or more effects, and it can even reach crisis proportions if there are, say, two or three guitarists and a bass player onstage.

The second plus for a wireless system is that it overcomes a shortcoming inherent in cords: limited frequency response. Because of an electrical characteristic known as capacitance (storage of electricity between two points), cables act as lowpass filters—they cut out some high-frequency signals. In short runs of only a few feet, capacitance has little effect, but when you start using 20-, 30-, or 40-foot cords, the result can be a muddier sound. Not all cables have the same amount of capacitance; in fact, some possess very low characteristics in this respect. Still, all cables have *some* capacitance.

L–R: SVDS receiver, X10 transmitter, antennas.

Nasty Cordless transmitter.



HME's Cordless I system.

Manufacturers' Wireless Specifications

The specifications for the HME, Nady Systems, and Ken Schaffer Group wireless guitar systems are listed below. These are the specs provided by the manufacturers themselves, and are not the results of testing by *GP.*

HME Cordless I
(WG 475 Transmitter/WG 375 Receiver)

Frequency response: 20Hz to 15kHz ±2dB
Distortion: less than 1%
Input impedance: high
Signal-to-noise ratio: greater than 67dB
Operating radio frequency: 150 to 174 megahertz
Operating range: 20′ (adverse), 1000′ (line-of-sight)
Type of battery (transmitter): 9-volt alkaline
Battery life: 8 hrs.
Power requirements for receiver: 115 volts AC
Dimensions of transmitter: 4″x2.5″x0.8″
Weight of transmitter: 5 oz.
Dimensions of receiver: 6.75″x5.75″x2.25″
Weight of receiver: 35 oz.

HME Cordless II
(WG 675 Transmitter/WG 575 Receiver)

Frequency response: 100Hz to 7kHz ±3dB
Distortion: less than 3%
Input impedance: high
Signal-to-noise ratio: greater than 55dB
Operating radio frequency: 49 megahertz
Operating range: 50′
Type of battery (transmitter): 9-volt alkaline
Battery life: 12 hrs.
Power requirements for receiver: 115 volts AC
Dimensions of transmitter: 4.25″x2.75″x1.13″
Weight of transmitter: 5 oz.
Dimensions of receiver: 5.5″x4.5″x2.25″
Weight of receiver: 24 oz.

Nasty Cordless Blue System
(Blue Transmitter/Pro 400 Receiver)

Frequency response: 20Hz to 20kHz
Distortion: less than 1%
Input impedance: high
Signal-to-noise ratio: 95dB
Operating radio frequency: 88 to 108 megahertz (tunable)
Operating range: 250′
Type of battery: Nasty 9-volt Ni-Cad rechargeable or 9-volt alkaline
Battery life: 5 hrs. (Ni-Cad) or 20 hrs. (alkaline)
Power requirements for receiver: 115 volts AC
Dimensions of transmitter: 2.37″x3.25″x0.87″
Weight of transmitter: 4 oz.
Dimensions of receiver: 6″x4″x6.6″

[*Note: The Nasty Cordless Black System features specifications indentical to those of the Blue System, except for its signal-to-noise ratio, which is 65 to 70dB. Specifications for the Nady VHF System are not yet available.*]

Schaffer-Vega Diversity System
(X 10 Transmitter/63 EX Dual Diversity Receiver)

Frequency response: 40Hz to 15kHz ±3dB
Distortion: less than 1%
Input impedance: 50k ohms
Signal-to-noise ratio: greater than 90dB
Operating radio frequency: 150 to 216 megahertz
Operating range: up to 300′
Type of battery (transmitter): 9-volt
Battery life: 6–10 hrs.
Power requirements for receiver: 115 volts AC
Dimensions of transmitter: 3.8″x2.8″x1″
Weight of transmitter: 5 oz.
Dimensions of receiver: 3.7″x6.8″x12″
Weight of receiver: 5 lbs.

[*Note: The Schaffer-Vega B&T Single-Diversity Receiver has features identical to the SVDS, except that it does not contain two receivers.*]

Another drawback of cables—especially the cheaper ones—is that they sometimes transfer to your amplifier spurious noises from light dimmers, radio signals, power lines, or other external sources; these may distort or degrade your guitar's signal. In general, cords work quite well, but when great lengths are placed between the guitar and amp, quality may diminish.

Another aspect of a wireless unit is perhaps one of the most important: safety. When you use a cord, you leave yourself open to shock hazards (especially if your stage show entails the use of liquids such as water, simulated blood, etc.). Chances are you've already experienced such a phenomenon while simultaneously adjusting a microphone stand and holding your guitar; or you'll step up to sing and get a jolt by touching your lip to the mike.

The reason such accidents occur is that the polarity, or ground, is reversed on either the PA amp or the guitar amp. In some cases, shocks as high as 120 volts can result, and in Europe the voltage is about twice the U.S. standard. (Onstage shocks have even proved fatal in a few instances.) In any case, when you place yourself between two electrical systems, a certain amount of risk must be assumed. With a wireless transmitter, the cord (and its link to one electrical system) is eliminated. Thus, no circuit is formed when you touch a microphone or any other electrical device.

Since the 1940s, research has been sporadic on wireless transmission for musicians. Occasionally, a few systems reached the marketplace, but they were generally limited in their performance by the technology of the time. For example, in the 1940s the batteries alone were larger than today's transmitters. Among those who have ventured into the marketplace of the 1970s is The Box Maker Company [116 Mahan St., Westborough, NY 11704], which created a wireless unit with the straightforward name of The Box. It has never quite caught on like wildfire, but then *none* of these units really have. The number of wireless guitarists compared to the total number of players is so slight as to appear almost insignificant. But several influential rock groups are currently employing wireless systems, and since there seems to be a trend among manufacturers of improved products and lower prices, the potential of the new devices is vast.

One term often used by manufacturers is "diversity." This refers to the way in which a receiver compensates for dropouts (losses of signal due to reflection en route to the receiver from the transmitter). There are two schools of thought on how to approach diversity for wireless guitar systems. The first advocates *dual-receiver diversity,* which uses two receivers, each with its own antenna, to amplify the incoming signal from the guitar transmitter; a small computer determines which signal is stronger, and the system then uses it. The other type of diversity is called *antenna diversity;* it employs one receiver, but two or more antennas. Both approaches have merits, and any kind of quantitative differences between the two would be difficult to ascertain.

Another detail that manufacturers stress is whether their systems are of the tunable FM or fixed-frequency VHF type. If the device is

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FM tunable, it can operate at any frequency between 88 megahertz and 108 megahertz. Being tunable, it can be adjusted so that it operates on clear channels anywhere within that spectrum. VHF fixed-frequency systems operate on a channel preset at the factory. Low-band VHF operates between approximately 54 megahertz and 88 megahertz; high-band systems broadcast in the area of 174 megahertz to 216 megahertz. Again, manufacturers differ on the frequency at which their equipment operates with maximum efficiency.

Today, the three main manufacturers scratching the surface of this market are HM Electronics, Nady Systems, and The Ken Schaffer Group. All three have had success in getting big-name rock bands to use their products; thus, the equipment is being put through the wringer by professionals who are usually impatient with malfunctioning equipment. For wireless guitar transmitters, the stage is the proving grounds.

The following sections reflect the attitudes of spokesmen for the aforementioned three firms towards the equipment they make, the state of wireless guitar, and the impact the industry will have on music in the future. They are satisfied that the market will expand, but to what extent depends upon the receptiveness of guitarists to the idea of complete onstage freedom.

The Ken Schaffer Group

10 E. 49th St., New York, NY 10017

Electronics and radios have been an important part of 30-year-old Ken Schaffer's life. Starting out with a ham radio at the age of ten, tinkering with various electronic projects through his teens, and then becoming a recording engineer and music publicist, Schaffer has been involved with radio and/or music for two-thirds of his life. In 1975 Ken was producing special effects for the Rolling Stones; he started refining Mick Jagger's wireless microphones, attempting to better both their signal-to-noise ratios and rejection of spurious signals so as to bring them up to the standards of a good conventional mike.

Soon Schaffer realized that microphones weren't his chief interest—he wanted to make a wireless system for guitars. After two years of development, the Schaffer-Vega Diversity System was released in June 1977; it consists of an X10 Transmitter and a 63 EX Receiver. Today, the SVDS sells for $3,400.00, while its non-diversity counterpart, the Schaffer-Vega B&T, sells for $2,100.00. Most of his sales have been to professional rock guitarists, and although he sells direct to his customers, he believes that retail music stores will play an important role in the future of wireless transmitters.

Schaffer, however, points out that dealers must become more aware of wireless systems and learn the importance of different features in order to better serve guitarists. "Radios are not similar to amplifiers or digital delay lines," he says. "They're entirely different beasts. And for anybody to sell wireless transmitters for guitars, especially when the companies compete with different kinds of systems at a variety of prices, it requires a certain kind of education on the part of the store owners. Without it, no one can really recommend one system over another for any application. It requires some knowledge of the buzz words and what they mean, just as you know how to buy a hi-fi now—everybody knows what THD and signal-to-noise are. At one time, such terms were meaningless."

As Ken recollects, "wireless" had been a dirty word among audio people ever since transmitters first became available in the 1960s. Historically, they were troublesome, and musicians—particularly in the rock world—all too often had wireless systems fail during a show. "So when we first started bringing my system around," Ken recalls, "every time the sound engineers who didn't know us saw an antenna come out of a box, they would tell us to get lost, that they'd had enough trouble with wireless systems."

After the bad reputation transmitters had suffered, the reluctance of musicians and technicians to go cordless is completely understandable. Schaffer notes the difference between replacing an essential link from the guitar to the amp and dealing with an optional effect, such as a digital delay line: "If a DDL craps out in the middle of a show, hardly anybody—even the other musicians—will be the wiser. All you do is pop a button and it's out of the circuit. Even when it's *in* the circuit it's being mixed at a lower level than the main signal. If it breaks, just get it out of there, and you can deal with it tomorrow. But a wireless is not like that; if it craps out, your signal ceases to come through. And if your transmitter isn't working, not only is your guitar signal not coming through, but what your receiver gets is noise. A wireless system must work *perfectly,* because it's something that either works or it doesn't—there's no in-between. And musicians are very picky—if it's *almost* perfect, then it's not going to go onstage."

The main feature that Schaffer's system incorporates is diversity reception, which was discovered by the U.S. Navy in the 1920s. "Prior to that," Ken adds, "they didn't know that shortwave radio signals bounce off the ionosphere, and as the sun goes up and down, the ionosphere goes higher and lower. So throughout the day, you have the height of the ionosphere changing. This changes the angle at which the signal bounces off the ionosphere. If you listen to a shortwave radio, you can hear the signal actually fading out—that's because at one moment you have a good reflective path, and then in a couple of minutes the sun changes position or a storm starts, and your signal is gone.

"What the Navy found is that by taking two separate antennas and placing them at least one wavelength apart and running the feed lines back to the receiver, they could selectively switch one antenna off when it started losing the signal and switch to the other antenna. Thus, they could choose the stronger signal using a big jackknife switch. They could even have four or five antennas set up, and they'd just keep switching between them until they'd get a good signal. So even at a distance of, say, three or four thousand miles, having the antennas a couple hundred feet apart could make a tremendous difference."

Obviously a musician can't have a roadie constantly throwing a jackknife switch, so Schaffer developed an electronic diversity system—a box that has two antennas, each with its own receiver. The signals then go to the sensing portion of a comparative circuit, which determines the stronger signal and switches to it in less than a microsecond (one-millionth of a second); there has to be a 6dB difference between the intensities of the two signals before it will switch. It doesn't just switch to the strongest signal automatically, otherwise, it would be switching almost constantly.

For an extraneous signal to interfere, it would have to be (1) on the same frequency as the SVDS (or at least on a nearby frequency), and (2) much more powerful than the guitar transmitter's signal. With more than one FM signal on a single frequency, the receiver locks onto the most powerful one. The measure of a receiver's ability to reject one signal and take the other is called its *capture ratio.* "The capture ratio of our receiver is *one* dB," Schaffer states. "That means that as long as the X10 transmitter's signal is one dB louder than the interfering signal, you don't hear a trace of the interfering signal.

"To keep the receiver stable, we use a crystal [similar to those used in CB radios]. We also use special filtering circuits known as *helical resonators,* which narrow the bandwidth of the incoming signal. You can only use helical resonators if the system is crystal-controlled, because they're absolutely related to the frequency of the unit. So, changing the crystal and tuning it up; you've got to change all those helical resonators as well. In terms of operating a crystal-controlled, fixed-frequency system on the road, you just plug it in and play."

At a high volume, a loss of signal and the resulting noise can be disastrous—perhaps even deafening. For example, if the receiver loses a radio signal of this type, the problem is not going to be so bad that the guitar "disappears"; the problem is that the receiver is going to latch onto background noise. With an amp pushing 120 to 130dB in a concert, the net result will be a *loud* roar. "Now with full switching diversity," Ken

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WIRELESS TRANSMITTERS

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states, "you can't lose the signal. You just slap the antennas up vertically—10 feet apart—and you're okay. A lot of people think the further apart the antennas are, the better. I don't believe so. All you want to do is give the two antennas different points of view—different perspectives."

Ken explains that dealing with radio is more complex than using audio equipment: "With audio waves you're working with tremendously long wavelengths, so moving three or four feet on the stage is not even moving one degree through the wave. But at radio frequencies the wavelengths are perhaps six feet long. If you move six feet, then you have gone through one entire wavelength. And since you have the transmitted signal bouncing off the ceiling and the walls, it may be likely that you will move into a position where you have 180-degree cancellation [where a wave's crest meets a wave's trough]. The result is little or no signal, and the signal dropouts are almost as likely to occur if you're, say, ten feet from the receiving antenna as they are at 100 feet.

"A lot of people think that dropouts are a function of distance, and that's just not true; the distance capability of a wireless system as stated in manufacturers' spec sheets is fairly arbitrary. Receiving sensitivity, the efficiency of the transmitter and receiver antennas, and the power output of the transmitter are all factors.

"If you use a non-diversity wireless system—which means that it has one transmitter and a regular receiver with only one antenna—you will have 97% coverage of the stage. That means that three percent of the places onstage are dropout zones. In a fixed location, you can usually set up the wireless system for minimum dropouts if you have enough time. Just spend a few hours setting up the antenna, and then walk the stage to make sure you've gotten rid of the dropouts. For a band that is playing in clubs where they set up on a Tuesday night and play until Saturday, they probably have all Tuesday to do whatever they must do. So they could go in there Tuesday afternoon, and the sound technician or one of the musicians could set up the antenna, walk all over the stage, and see if there are dropouts. If there are dropouts, you move the antenna—move it three feet or two inches, but move. it."

Schaffer firmly believes in the dual-receiver diversity approach of eliminating dropouts. He has also devoted much energy to noise reduction, and at the heart of the SVDS is a *compander* (compressor and expander). It is fully adjustable, for reasons that Ken best explains: "You've got the gain control—if you advance the gain control so that it goes into the red on the meter more often, that means it will go into compression, and it will give you more sustain.

"It's a beautiful, quiet compressor; you can't hear it at all. And most people using our system with guitars set the gain on the transmitter all the way up. It's not a volume control on the transmitter; it's really a sensitivity control to match the transmitter to the instrument. It is not critical at all, and if you set it too high or too low you will probably notice the difference, but you certainly won't do anything bad to the system or to your sound. Most of the people set the gain on the sensitivity control all the way up; in so doing, they get a little more sustain—guitarists generally like that. The output of the receiver can be attenuated with the output level control. You can set the output level to be the same as if you were using a cord, or higher, or lower. Most people set it to be higher—they love the boost."

Advertising hasn't been a very important factor in selling SVDS wireless units. A major reason is that at present, only professional bands with a large amount of working capital have been able to buy the systems. "I think 95% of our sales have been by word-of-mouth," Ken explains, "because the price keeps away the market. Now, I think that if we could sell a thing like this for $1,000.00, guitarists might buy thousands of them each year. But $3,400.00 is going to cut the market down by 90 or 95%. That's why our newer products have lower prices—to make them available to more guitar players."

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WIRELESS TRANSMITTERS

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turers. Already, feedback from dealers is proving invaluable: "We're getting reports of people using TV rabbit ears [antennas] with their Cordless II systems. They connect them to the receiver and place them about 12 feet away. This gives a quasi-diversity effect and helps to displace dropouts. We also found that by placing a 150 to 250 picofarad capacitor between the wiper lug and ground lug of the guitar's volume control, scratchy noises due to radio-frequency interference are eliminated. If the guitar has a built-in preamp, the capacitor should be placed between the 'hot' lug and the ground lug of the jack. Because of the high input sensitivity of the units, pickups such as FRAPs, Barcus-Berrys, etc., can be used without preamps."

If dealers can connect with guitarists, and if feedback from manufacturers, players, and retailers is encouraged, Dale thinks that the wireless market will have steady growth. "It probably won't be as explosive as everybody would like it to be," he says. "But nonetheless, it is going to be a good business. Wireless transmitters will be of greatest interest to professional working musicians. So far, the bulk of the business has been with rock and rollers. I think that there is a low business potential in lounge bands, because they're confined to one place and they're not show band people. But the main market consists of rock and rollers, and we are now starting to get some country and soul people as well."

Regardless of the applications a guitarist finds for a wireless unit, Scott believes that it is important that people respect and maintain their transmitter/receiver system; "It's sophisticated electronic equipment, and very reliable. I think it gives a good sound and has a high-integrity radio signal, but guitarists will have to learn how to use wireless units properly, and they have to learn that there are limitations to any technical product. Take an automobile, for example; no matter how new or good a car is, there is no way you can drive it for 100,000 miles and never have some sort of failure. But if you treat it properly and follow instructions, you'll get reliable service."

Nady Systems

Box 2205, Berkeley, CA 94702

John Nady, president and founder of Nady Systems, started working on wireless transmitters for guitars as a hobby in 1968, when he was a 19-year-old student on his way to eventually receiving a master's degree in electronic engineering. His involvement with wireless increased in the next three years, and by 1971 his band was playing gigs in the San Francisco Bay Area completely cordless. "We developed our own integrated circuit chips for reliability," John says. "Around 1974 or '75 we started getting transmitters quieter and quieter, and finally reached the present point where the signal-to-noise ratio is 99dB. We finally came on the market with the Nasty Cordless in October 1977."

There are presently three Nasty Cordless systems available (all in the FM spectrum), and a fourth (VHF) is due to be released either in March or April of 1979. The Nasty Black System, listing at $329.95, is a transmitter that may be used with any FM receiver. The Nasty Blue System consists of the Blue transmitter ($599.95) and the Pro 400 receiver ($599.95). By adding a second receiver—the Pro 500—the Blue System becomes the Nasty Blue Combiner System, which has dual-receiver switching diversity; this optional second receiver costs $599.95.

According to John, the Nady VHF System will consist of a transmitter with a matched pair of receivers incorporating a crystal frequency control for stability: "It's designed for both single and diversity reception; in other words, the same receiver can be used for both purposes. We designed it so that it can be bought for less money as a single receiver, but it can be altered at the factory at some later date to accommodate dual diversity. There will be a circuit board in there with room left for additional components to expand to diversity. You get pretty good performance from a single receiver; you don't get the 100% eradication of null spots [dropouts] that you do with the dual receivers, but for the savings involved, some people don't mind getting occasional isolated null spots. We have no inside track on eliminating null spots caused

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Although the Nady Systems transmitters have a range that can be as great as 400 or 500 feet ("Some people called us up and told us that they were able to pick up 400 *yards* away"), Nady states that such distances usually are possible only in direct "line-of-sight" (without obstructions) situations. "In all wireless systems, the atmospheric conditions vary the range from day to day by as much as 30%," he says. "Such affectations are due to ionization in the air, sunspot activity, and other phenomena. At any rate, under average conditions on a semi-repeatable basis, we say that the range should be 200 to 250 feet."

A highly important factor in reducing transmission distance is not related to the equipment, but is common to all wireless uses. John explains: "The range that you can really use and still keep time with the music is about 100 feet. If you start going more than 100 feet from the receiver there is a time delay—a lag time between when you pick the note and when you actually hear it. At that distance, it takes about a tenth of a second for the sound to travel that far. That 100 milliseconds is a long delay if you're trying to keep time with the music. And if the rest of the band is onstage, or you're otherwise separated by 250 feet, you've got a third of a second delay, and that's *way* off time. You can't play and keep time with the music under those conditions. No matter how good a wireless system is, you don't want to be too far away. But it's only natural for guitarists to want to know how far the transmitter can send, and they're impressed if they hear things such as, 'It goes half a mile,' but it is actually meaningless because what you really need is 100 feet. And the only times you can possibly use more distance is when you're doing a solo where you're not really playing with anybody—when you're just doing something in which timing isn't critical."

Being a guitarist himself, Nady is acutely aware of the hassles involved with noise. If there is a lot of hiss present in a wireless system, and if the amp is turned up to a high volume in order to produce controlled feedback, the hiss is amplified along with it. At 120 or 130dB, this noise can be almost unbearable. "That's the reason why we developed a low-noise unit," John says. "I personally use it, and the way I play—the higher the gain, the better." John also mentions that noise is critical when recording: "When you press a record, you are immediately limited to a 55 or 60dB signal-to-noise ratio, so you don't want to make things worse by adding extra noises."

Nady believes that using a compressor/limiter or companding circuitry is *not* the way to go in order to reduce noise. Instead he has tried to eliminate noise at the source—in the actual transmitting circuitry—rather than attempting to clean it up later. "A compressor/limiter is used in all the other units," John states. "The amount of compression must be adjusted. But you've got to set it really carefully, or you won't have a one-to-one compression/expansion ratio. In other words, you don't always get out what you put in; it's not one-to-one. The Nastys track so that what goes into the transmitter—from the lowest possible signal to the highest—is present at the output exactly. If you want to get a compression sound, you should use a separate compressor. Every wireless system with compression/limiting starts with a basic 60 to 70dB signal-to-noise ratio, and then adds about 30 to 40dB dynamic range with compression. We try to get the full 100dB, so that you can do anything from whisper to scream and not have it overload and distort."

Nady's VHF transmitter (front) and receiver.

The Nady VHF System, which will be marketed soon, is not meant to supplant the Nasty tunable systems, according to John. "We will still recommend the tunable systems as the ones to be used by rock bands that play on tour from town to town and want to be assured of clear-channel accessibility and freedom from random local interference," he says. "Our VHF system will have similar performance characteristics to the tunable systems. Of course, some rock people will buy the VHF because they don't want to bother tuning their wireless system, little bother as that is."

John maintains that the VHF system will be best suited to fixed-location use, rather than as a piece of equipment for touring. He says that problems with VHF systems have been reported in certain towns, and he has kept a log of them, "so we can tell people if they are going to such a town that they should be prepared for trouble using a VHF system, because there is already something operating on the same channels that their system is tuned to. That's the best we can do under those circumstances, until the FCC [Federal Communications Commission] opens up with more channels."

Whether more manufacturers will start producing wireless units is yet a matter of speculation—the marketplace is still young. But John Nady believes that expansion is inevitable: "Right now, wireless units are only reaching a minute part of the potential market—perhaps only one hundredth of one percent. A lot of big-name bands have cordless units, and there's also a turnover there from one system to another. But that's not the ultimate market. The ultimate market includes everybody else, and so far, very little has gone out yet to them. In terms of potential, you must consider that thousands upon thousands of brand-new electric guitars are sold every year in the United States, plus there are all the used ones sold and traded. You can imagine that the potential market is quite large, and no doubt at some point other manufacturers will come in. When there's money there, more people will jump into it."

Whether prices will come down depends largely upon whether technological breakthroughs in electronics occur, and whether manufacturers have their units assembled offshore, such as in the Far East. Nady feels that due to the long lead time inherent in researching and developing a marketable wireless unit, the companies that are already making their mark in this field will continue to have an advantage.

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In general, the manufacturers of wireless systems for guitar are optimistic—perhaps guardedly—and they are constantly looking toward the future; in an industry that is essentially only a few years old, careful planning is an absolute necessity. With millions of guitarists out there picking, many of whom have at least considered shedding their cords, a good product can go far. Ken Schaffer sums up what he feels is the destiny of wireless transmitters for guitars: "There is a tremendous market, and I really do believe that in five to ten years, when new types of integrated circuit chips are available and larger companies get involved, most guitars will have an optional transmitter built in, and most amps will have optional receivers. Most guitar players will be wireless." ■

BRAD WHITFORD

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When first playing with Aerosmith, Brad used an old Marshall 100-watt amp and a Les Paul. The guitar's neck finally gave up the ghost, but not before Brad recorded with it on the group's first album, *Aerosmith.* This guitar was replaced with another Les Paul. For *Get Your Winds,* Brad used the Les Paul, as well as a 1960 red double-cutaway one-pickup Les Paul Jr. After Aerosmith had its Marshall equipment stolen, Whitford switched to Ampeg V-4's. "All Marshalls are so different," he comments, "and the really early ones were much better. Then they started changing little by little."

Shortly after Aerosmith's financial footing became more stable, Brad bought a 1957 gold-top Les Paul with a Bigsby tailpiece for $1,000.00. And as the group continued to gain in popularity, his guitar collection grew:

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