The Companion Guide To Wireless Microphone Systems

Choose the wireless system wisely!

It's important to note that all wireless systems are not created equal. Only a very few of the products on the market today are actually designed and built by the people selling them. Many of the most popular systems are built by microphone companies that only recently began to manufacture wireless devices. Telex/EV is unique in the world of wireless. ElectroVoice has been leading the way in microphone technology for 75 years and Telex practically invented professional wireless microphones 30 years ago. All Telex and EV wireless products are the result of this vast experience and technological know how.

As more and more wireless products get into the market, more problems in installation and performance are being encountered. Often times these problems are unique to the situation and require a trained professional with considerable RF experience to solve. Telex maintains a staff of highly trained RF engineers and designers to help our dealers and customers get systems to work in the most critical and demanding applications. Wherever possible, we build things into our new products to take care of problems before they start. The key for the selling dealer is that they have a large company with plenty of experience and talent backing-up their wireless installations.

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Why Choose a Telex/EV Wireless?

All Telex and EV wireless systems are designed and built to exacting standards in our 180,000 square foot Lincoln, Nebraska facility. State-of-the-art manufacturing techniques are employed in each wireless product, form the initial CAD design, to the advanced auto-inserted surface mount printed circuit board assembly. Every Telex/EV system is tested as components and then tested as a complete system to ensure reliable field performance.

We simply design and build each system better, so we stand behind them with the best warranties in the business. All Telex and EV professional wireless systems are warranted against defects in components and workmanship for a period of three years. The Telex ProStar® and EV R-Series and NDYM® are warranted against defects in workmanship for one year, and warranted against defects in components for the life of the original purchaser.

In the unlikely event of a product failure, Telex/EV wireless service is available from the factory in Lincoln, Nebraska as well as authorized centers in Canada, Germany, Singapore, Hong Kong and several other places around the world.

Telex has been in the business of providing quality wireless communications for demanding professional events for over twenty years. We have the experience and talent to solve any wireless need. When you are designing large multiple wireless installations, you can look to Telex to provide the important frequency coordination, and system accessories for a turnkey installation.

Key Strengths

- Designed, Built and Supported in the USA
- Part Telex Pro Audio Solutions – EV Speakers & Amps, KT Processing, Midas Mixing, Telex Intercom
- VHF and UHF systems in a variety of feature/price points
- Technical assistance is only a phone call away
- Patented Posi-Phase® true diversity for dropout free audio with the best range in the business.
- Complete variety of models & accessories
- Designed and built for maximum professional performance
- Locally represented
- Competitively priced
- Superior Design, Construction and Warranty

Important Wireless Terminology

Like any other technical business, the wireless world is filled with technical jargon and concepts all its own. It is very important to understand the basics of this language, or overzealous marketing materials can easily mislead you.

The Basics

A wireless system at its most basic includes a transmitter, handheld or bodypack, and a receiver. There are many ways to get the signal from point A to point B and it is important to dispel any myths or preconceived notions that may have been picked up from various marketing materials. We will go through the more common technical terms and try to give you an objective outlook.

What is Diversity?

Diversity reception is a method of minimizing the effects of multi-path delays that create drop outs of the radio signal. This is done by combining or selecting two or more antenna sources for the same signal in order to produce a constantly usable signal. This always requires more than one antenna in different physical locations but not necessarily multiple receivers.

There are many diversity circuits used in wireless microphones on the market today, including twin receiver "switching" diversity, antenna diversity, switching antenna diversity, and the Telex patented Posi-Phase auto diversity. Each of these methods may be effective depending on the particular implementation of the circuitry by the manufacturer, provided other critical areas of the receiver circuitry are not compromised.

The term "diversity" is derived from the word diverse, which according to the American Heritage Dictionary means, *varied*, or *unlike*. In the RF world, this translates to two or more unlike sources of received signal energy at the receiver. As long as the two sources of signal are unlike or varied from each other they are diverse hence the term "diversity". These days you hear a lot of hype about some systems that claim to be "true" diversity. If this were true, there would also have to be a "false" diversity. But, by definition, any receiver using two or more varied signal inputs has diversity, so the only "false" diversity would be single antenna non-diversity. Major manufacturers may differ in their particular implementation of the diversity circuitry, but all diversity systems use different sources of received energy from two or more antennas. The term "true" diversity is meaningless from an engineering standpoint.

What is Phase Cancellation?

Phase cancellation or multipath dropout is a phenomenon where a direct radio signal and a reflected radio signal combine in the receiver. The two signals are slightly out of phase from each other due to the delay in the reflected signal. The phase difference causes the two signals to interfere with each other and cause deterioration in the quality of signal at the receiver. When the distance and geometry are just right, the signals are 180 degrees out of phase and can cancel each other completely, often referred to as a dropout.

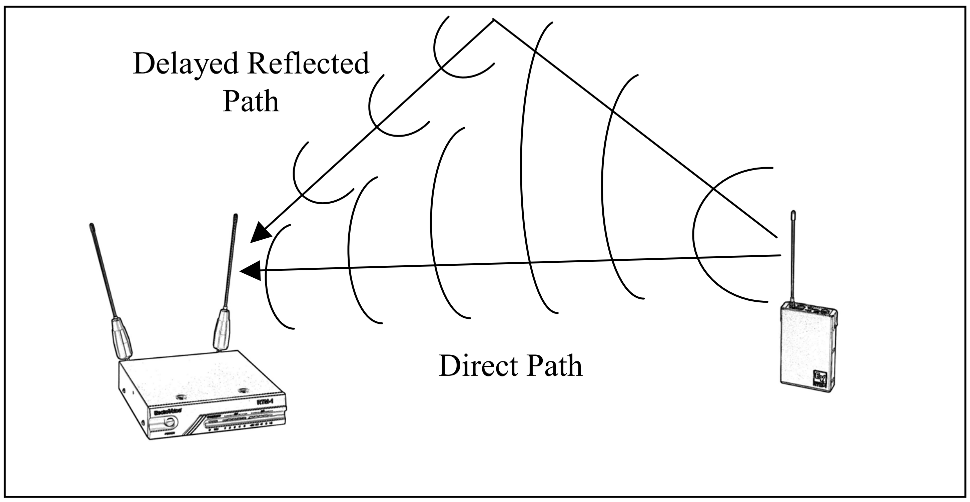
A very common example of phase cancellation or multipath dropout has occurred to most people at one time or another. If you have ever driven your car listening to your favorite FM radio station and pulled up to a stop light and noticed your radio station became fuzzy and faded away

What is Phase Cancellation? (Continued)

as you pull slowly forward, you have experienced phase cancellation. Did you notice that when you pulled your car up just a few feet the station came back to perfect reception?

The phase cancellation will only occur in those physical locations where the direct and indirect reflected waves interact. Moving a few feet (1/2 a wavelength or more) will often cause the multipath problem to disappear. A diversity system overcomes the problem without moving by having two antennas separated by a few feet. The possibility of having multipath cancellations at both locations simultaneously is very slim.

Because multipath problems are related to the geometry of the set up, it is possible to walk test the transmitters and correct potential dropouts using tools like the Sound Check Screen in the RE-1/FMR-1000 and adjusting your antenna placements. But be wary, each time you change the scenery, arena, or even add people, the mix changes.

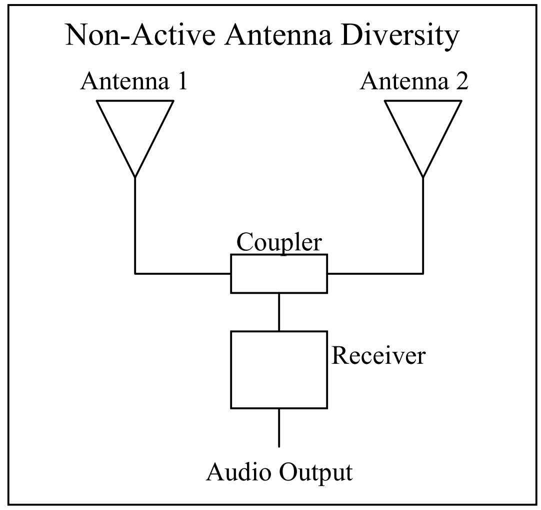


When direct radio signals and signals reflected off of a metal object, such as a steel ceiling, they produce a condition known as multipath. This condition will cause a null in the signal (drop-out) in the physical location that produces a ½ wave (180 degree) shift in the phase of the wave. Diversity reception helps to overcome this phenomenon in wireless microphone systems by using two antennas in two physical locations so the null will not affect them both at the same time.

A Quick Overview of the Various Diversity Schemes.

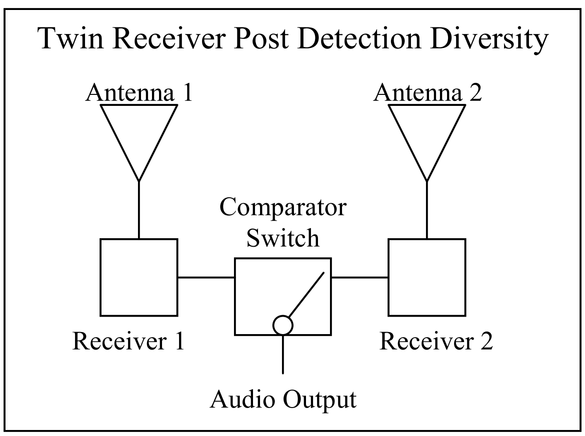
There are four basic forms of diversity circuitry on the market today; non-active diversity, twin receiver switching diversity, antenna switching diversity, and phase diversity like the Telex patented Posi-Phase® Auto Diversity. The non-patented diversity types have numerous variations depending on the manufacturer. Some designs are better than others depending on the implementation of the circuitry but they all follow the same basic principles for each type.

What is Non-Active Antenna Diversity?



Antenna diversity uses three or more antennas in widely separated areas coupled together and fed to the receiver as one signal. Phase cancellation will generally not occur at all three locations simultaneously so the system will avoid dropouts. The obvious problem with antenna diversity is that the sum of the three antennas is never as good as the best signal alone. This means that there is always a compromise in signal quality. This approach also involves a lot of extra antennas, cables, and splitters. It is time consuming to install. The most common use for antenna diversity these days is as a passive network of antennas used in conjunction with active diversity radios to cover large or difficult performance areas such as TV studio hallways, dressing rooms, and rehearsal spaces.

What is Switching Diversity?

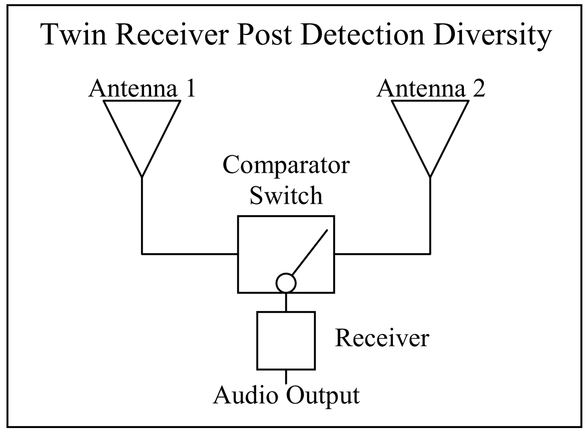


Switching is one of the most common forms of diversity used today for wireless microphones systems. The concept originated in World War II when the reliability of communications was a constant concern. There was concern about multipath dropouts plus the radio operators were often in great danger of being eliminated along with their radio gear. To solve both problems, two complete radios were placed in separate locations with a switch between them. If one radio had a dropout or was destroyed the signal would be switched to the other radio. Duplicate separate radios was not very economical but it was an effective solution.

This same principle is used in wireless microphone systems although the circuitry has become far more sophisticated since the 1940's. In the contemporary version, two antennas and two complete receivers share the same chassis. A comparator circuit monitors the receiver signals and selects the one with the strongest signal to be in the audio path. When that receiver begins to lose the signal, it switches to the other receiver. Although this can be an effective method, switching diversity can often have big problems resulting from improperly balanced receivers. The resulting imbalance can lead to noise from one of the receivers or from the comparator network getting into the audio. These designs are expensive to produce since each unit includes two complete receivers. Consequently, the manufacturer will often compromise on important circuitry areas such as RF and IF filtering to keep the price competitive. This is especially true in low cost systems. Another area of concern is that each receiver can change over time, resulting in poor performance and or frequent re-tuning service requirements.

There are several variations of this circuit type on the market today, including soft switching schemes between receivers to eliminate the harsh transients that can occur when a poor signal is suddenly replaced by a good signal. Either type of design can be effective provided the receivers are properly matched, and the filtering is not compromised.

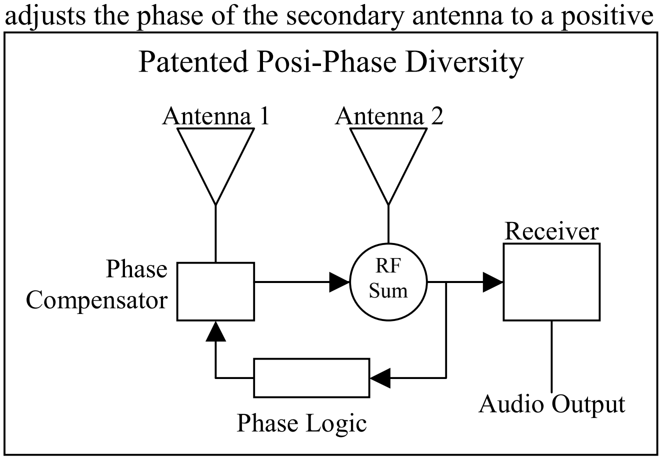
What is Antenna Switching Diversity?



Antenna switching diversity uses a single high-quality receiver, along with two isolated antenna inputs fed to a signal strength comparator. When the signal strength begins to deteriorate in the primary antenna, the comparator selects the other antenna in an attempt to improve the signal. Since this technique only requires one receiver, the receiver will often have good RF & IF filtering for the same price point as a twin receiver system. This single receiver will often provide superior performance in sensitivity, selectivity and IM rejection over multiple receiver schemes, however there is a major drawback to antenna switching. The antenna switching receiver switches blindly, meaning that as the signal degrades, it switches to the other antenna even though the current signal may be the stronger of the two. The result can be a switch to a weaker signal, added noise, and possible dropouts. This is especially true at the edge of range.

What is patented Posi-Phase Diversity?

Posi-phase diversity uses two antennas spaced apart, connected to a single high quality receiver. The antenna signals are connected internally to microprocessor circuits that monitor the phase relationship between the two antennas. Both antennas are active at all times which greatly increases the signal strength under normal conditions. In the event of a signal interruption from a partial phase cancellation (multipath) or total phase cancellation (dropout) the logic circuitry adjusts the phase of the secondary antenna to a positive condition relative to the primary antenna. This process occurs in a fraction of a second and continually adjusts the phase of the second antenna for the optimum signal. A similar patented technique is used in cellular telephones to insure their reliable operation. Telex Posi-Phase diversity is more effective and less costly to produce than switching diversity because only one high quality receiver is required. Since only one receiver is needed, we are able to concentrate on the overall receiver design on more important aspects of the receiver design such as filtering, IF circuitry, squelch and audio circuitry. Concentrating on these critical areas of a receiver design yields superior performance over switching diversity.



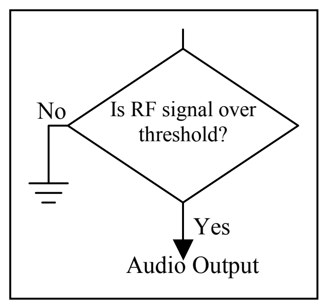
This superior performance is easily verified by a simple shoot-out with over range and audio quality tests. Generally, under the same environment Telex systems will go nearly twice as far as competitive models in a similar price range.

What is DSP Posi-Phase Diversity?

DSP Posi-Phase is the latest generation of Telex's patented diversity in the FMR-1000 and Electro-Voice® RE-1 wireless systems. This technique still monitors the signal strength and adjusts the phase of the secondary antenna to maintain the strongest possible signal at all times. The difference is that the Digital Signal Processor (DSP) gives us the ability to constantly monitor the signal strength level and make the decision to change phase based on the rate of change and relative strength of the signal instead of just a few set strength levels. The circuit can see a dropout coming through the rate of signal degradation and makes phase adjustments before they can affect the audio quality, The speed of the DSP also allows the circuit to compare the strength of signal before and after the adjustment and decide if it changed the level for the good. If the phase change did not help, it changes back and restarts the calculation without interruption of the real time signal. DSP Posi-Phase provides maximum range and reliability with a minimum of adjustments.

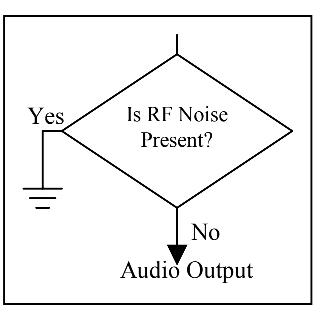
The DSP based diversity circuit also powers the Sound Check Screen on the FMR-1000 and RE-1. This screen can track actual dropouts and the RF signal level as you walk around the performance area with a transmitter. You can even take it one step further and enable a beep tone that you can route out to the monitors and it will make a tone when there is a drop and you will know right where it is. Simply adjust your antenna location and spacing, re-walk the area, and know that you have complete coverage.

What is a Squelch Circuit?



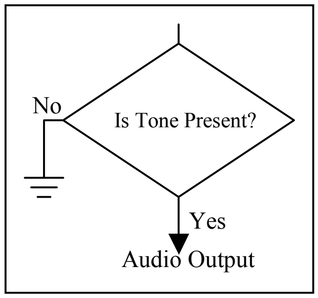
Good receiver design begins with the RF & IF filtering, but another important part of the receiver circuitry is the squelch system, or RF detection circuitry. This circuitry is the "gate" that allows the audio to turn on or off based on the RF signals entering the receiver. Simple gate squelch circuits that are commonly used in most competitive wireless receivers have a detector circuit that opens the audio path as soon as a preset level of RF energy is reached. When the signal is below the preset level, the audio path is "closed" or grounded to be very quiet. The obvious problem with a simple gate squelch is that any RF energy including distortion, hiss, harmonics from such sources as lighting dimmers, CD or DVD players, computers, digital effects and electric motors are indistinguishable from the desired signal. This extraneous RF energy will open the squelch gate just as easily as the intended transmitter. So often times the user must "crank" up the squelch level all the way up to limit the sensitivity to noise, which reduces range and performance of the system.

The Telex Posi-Squelch Auto Suppression System



Telex Posi-Squelch "true noise" circuit is totally different from a gate squelch. With the Posi-Squelch, high frequency noise in the receiver (noise present in non-coherent RF hash) is monitored and applied to an audio gate. When a non-coherent carrier signal is received, a special circuit looks for the high frequency noise present in the non-coherent signal and keeps the audio closed. As long as the noise is present, the audio gate is kept closed and no audio passes. Unlike an amplitude (gate) squelch system, the higher the amount of noise received, the tighter the audio gate is closed. The high frequency noise content of the true transmitter signal is very low. Thus, when a coherent carrier signal is received (from a real transmitter), the noise level drops below the preset level and the audio gate is opened to allow the audio to pass through to the output. The advantage to the Posi-Squelch system is that it can actually detect the difference between a true transmitter signal and plain RF noise. In addition, there is no need for an external user squelch adjustment to act as a range reducer.

What about Tone Squelch; isn't that the best?



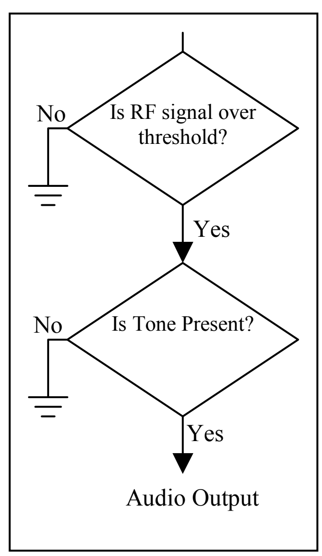
You can judge for yourself, but first you need to understand what tone squelch is used for and how it operates. In most tone-coded systems, a special sub-audible tone rides with the transmitter carrier frequency and is detected by a detector circuit in the receiver. The receiver squelch gate stays closed as long as there is no tone present in the transmission. The squelch must "hear" the tone before it will open the audio gate. This system can keep any RF signal or noise out of the system but only when the tone generating transmitter is turned off. In recent years tone-coded squelch circuitry has been added to the wireless microphone vernacular with the idea that it would somehow make the system "interference proof", or immune to other RF problems.

The main advantage of using a tone squelch is that the receiver audio path will not be open until after the transmitter has stabilized (1/10th to 1 second after power up) which makes it possible for a single switch on the transmitter to function as mute and on/off. This can also be a problem since the muting is not instantaneous. End users (like churches, schools etc.) that are looking for an instant mute function should stay away from tone-coded units.

In wireless microphones, tone-coded squelch can be used to keep the receiver quiet only when the transmitter is turned off. Once the transmitter is turned on, the tone opens the squelch gate and the receiver is susceptible to any other errant transmissions on the same frequency, even when they come from a source without the tone. Some systems feature a tone defeat switch, so that the installer can check to see if there is any RF noise present on the channel prior to installation to avoid any eventual user problems. Even with a tone-coded squelch, you never want to use a frequency that has potential interference problems, because tone squelch cannot overcome interference. The only time a tone squelch is useful is when the transmitter is turned off. Once the transmitter is on, any errant transmission will create problems in the audio, tone squelch or not.

How About Combination Squelch System?

Advanced products like the FMR-1000, RE-1 and ENG-100 use a combination of tone-code and amplitude squelch to provide maximum protection against errant signals. In this case, the tone squelch works as described in the previous section and when the tone is present the amplitude squelch remains active. If, in the unlikely event, random noise fools the tone detector, the signal at the intended frequency still needs to be high enough to register on the amplitude squelch. The back up amplitude squelch further reduces the chances that an errant signal will cause audio noise while the transmitter is turned off.

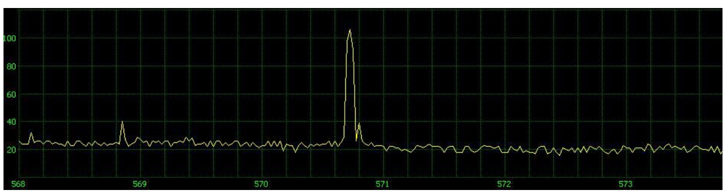


What is a Synthesized Radio?

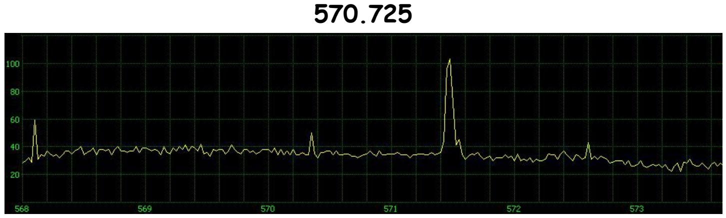
In older wireless products, a reference crystal is used to directly generate the carrier frequency. To change the frequency it is necessary to change the crystal. In a "synthesized" radio, a Phase-Lock-Loop (PLL) circuit uses a reference crystal to generate multiple carrier frequencies controlled by a voltage-controlled-oscillator (VCO). This allows the radio to change the operating frequency with a rotary switch or touch of a button. With rise in Digital TV broadcasters and other RF devices, synthesized frequency agile wireless microphones are the wave of the future.

What about Selecting Frequencies or Channels?

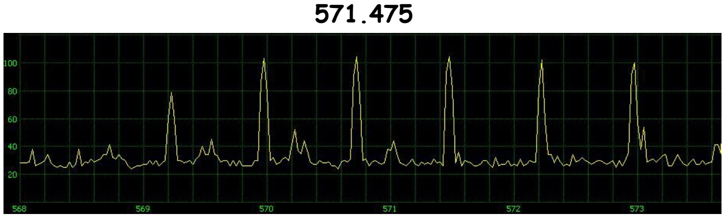
Proper frequency selection is probably the most important aspect of wireless microphone installations but it is often overlooked. Although it may sound simple, it really is a very difficult and often a time consuming process to get multiple systems to work together in one area. Many people make the mistake of assuming that as long as their system is on a different frequency than other wireless systems in the area that they will not encounter any interference. They also think that there is no limit to the number of systems that can be used simultaneously as long as each has a unique frequency. Unfortunately this could not be further from the truth.



570.725



571.475



Both

Successful system installations require a great deal more than just different frequencies all placed together. As illustrated in the sweeps to the left, when multiple transmitters operate in the same environment, the multiple RF signals interact with each other in a mathematically predictable way, creating numerous harmonics that combine with the original carrier frequency inside the receiver. These extra harmonics are referred to as inter-modulation distortion or "intermod". Intermod is generally responsible for many wireless microphone "interference" complaints ranging from noisy audio, to outright on-channel interference. A simple selection of different frequencies spaced apart from each other is not enough because the harmonic relationship between frequencies is not related just to spacing but rather to complex mathematical combinations.

Receivers are also not immune to this phenomenon because their internal local oscillator circuits can interact with other receivers and equipment in close proximity. Receiver byproducts are usually referred to as local-oscillator-harmonics.

When transmitters combine to form byproducts other than the original carrier frequency, it is important to remember that these combinations occur inside the receiver, so a good receiver design can have a dramatic effect on the extent of interference experienced. And as with most things, you get what you pay for in the quality of the receiver. Telex engineers all of our wireless products with multiple system operation in mind. Stock frequencies and pre-coordinated groups are chosen to maximize usability. Telex has developed several computer simulations that enable proper frequency selection. We also have many years experience in setting up problem free installations.

Other manufacturers have been known to take short cuts when it comes to frequency coordination. It is possible to recommend the use of some combinations if you assume that all of the transmitters will be on all of the time and have destructive interference problems when one transmitter is turned off. All Telex pre-coordinated groups are walk tested and backed by Telex's engineering group.

How Intermodulation is Calculated:

The build-up of transmitter harmonics occurs in "orders" where the first original frequencies are the first order, their byproducts combine in the second order, their by products plus the original frequencies and their byproducts combine to form the third order and so on. Normally only the odd orders are cause for concern. 3rd and 5th order conflicts will seriously degrade a system's performance while 7th and 9th orders can be tolerated in most circumstances.

Intermod Calculations:

Where $f_1 - f_4$ = the operating frequency of the systems 1 – 4
And the coefficient = the multiplier (numerical number to the left of f).

Potential Intermod Conflicts:

Order	3 Frequency System	Order	4 Frequency System
3rd	$(2f_1\text{-}f_2) = f_3$	3rd	$(f_1 + f_2\text{-}f_3) = f_4$
5th	$(3f_1\text{-}2f_2) = f_3$	5th	$(3f_1 + f_2\text{-}f_3) = f_4$
7th	$(4f_1\text{-}3f_2) = f_3$	5th	$(2f_1 + f_2\text{-}2f_3) = f_4$
		7th	$(2f_1 + 2f_2\text{-}3f_3) = f_4$
		7th	$(3f_1 + f_2\text{-}3f_3) = f_4$
		7th	$(4f_1\text{-}2f_2\text{-}f_3) = f_4$

Formula and Order Calculations:
The sum the coefficients on the left side of the equation determines the order number (ignore signs).

Examples: $(2f_1\text{-}f_2) = f_3$ $(3f_1 + f_2\text{-}f_3) = f_4$ $(2f_1 + 2f_2\text{-}3f_3) = f_4$
2 + 1 = 3   3 + 1 + 1 = 5   2 + 2 + 3 = 7

Individual coefficients determine the harmonic order
($2f_1$ = the 2nd harmonic of frequency 1)

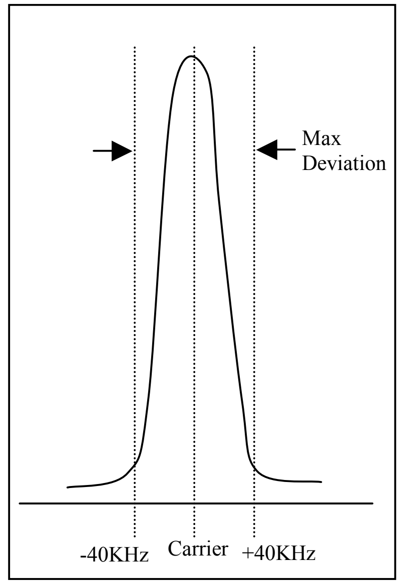
Actual Partial intermodulation of four common traveling VHF frequencies:

Primary Frequencies: f_1 = 169.505 MHz, f_2 = 170.245 MHz, f_3 = 171.045 MHz, f = 169.505 MHz

Problem	3rd Order Intermod	Problem	5th Order Intermod
1	$(2f_2\text{-}f_3)$ = 169.445	8	$(3f_2\text{-}2f_1)$ = 171.725
2	$(2f_2\text{-}f_4)$ = 168.585	9	$(3f_2\text{-}2f_3)$ = 168.645
3	$(2f_3\text{-}f_2)$ = 171.845	10	$(3f_3\text{-}2f_4)$ = 169.325
4	$(2f_3\text{-}f_4)$ = 170.185	11	$(3f_2\text{-}f_1\text{-}f_3)$ = 170.185
5	$(f_4+f_1\text{-}f_2)$ = 171.165	12	$(3f_2\text{-}f_1\text{-}f_4)$ = 169.325
6	$(f_4+f_1\text{-}f_3)$ = 170.365	13	$(3f_3\text{-}f_1\text{-}f_4)$ = 171.725
7	$(f_4+f_2\text{-}f_3)$ = 171.105	14	$(2f_1+f_3\text{-}2f_2)$ = 169.565
		15	$(2f_3+f_1\text{-}2f_2)$ = 171.105
		16	$(2f_4+f_1\text{-}2f_3)$ = 171.225

Total number of Calculations = 25
Number of Intermod Problems = 16
System Performance Unusable

Wireless "Gain" Settings



Almost every wireless microphone system has an adjustment on the transmitter that is called a "Gain" adjustment that confuses many users. This setting should really be called a Deviation Control but that would confuse most users even further. The problem with calling it a gain setting is that an end user will try to use it to set their audio level and that is not what this control is designed to do. After all, wired microphones do not have a gain control and the mixing board or amplifier must be used to control the audio levels.

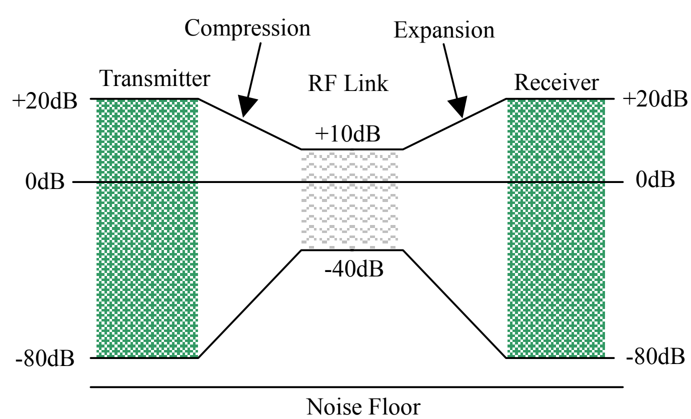
The gain setting is unique to wireless microphones and is used to maximize the signal-to-noise ratio and dynamic range whether it is used as a podium microphone, close talking singing mic, lapel, headworn, or even guitar or instrument. Frequency Modulated (FM) radios transmit audio information as changes in the carrier frequency. The bigger the changes in frequency, the better the s-to-n ratio. So if the system's maximum deviation is +/-40KHz, we want the loudest level input into the microphone to generate 40KHz deviation. With the gain set above that we would be clipping or distorting the maximum input and if it is set too low we are not getting the clearest possible signal.

To set the Wireless "Gain" properly, it should be adjusted without any audio output.

1) Before the audio connections are even made or with the PA system muted, simply sing or scream into the microphone as loudly as it will ever be used in performance in this application. (For guitar systems, turn the gains on the guitar to max and hit the hardest note that will be used in concert)
2) Then adjust the gain until the audiometer peaks in the usable range (or the over-modulation light does not come on).
3) Then make the audio connections and use the mixing board or amplifier to set the audio levels for the PA.

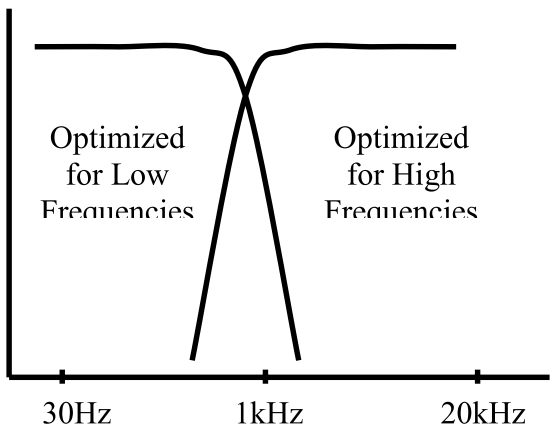
What is Companding?

The word compandor comes from the combination of Compressor and Expander. A circuit in the transmitter compresses the audio around a reference level before it is sent over the radio link. The receiver expands the audio by the corresponding amount. The companding raises the overall signal to noise level from about 60dB to over 110dB in the latest products. Without a compandor wireless microphones would be unusable due to the static and noise introduced in the wireless link.



The compressor raises the average signal level above the noise floor to provide improved signal to noise through the RF link. The expander helps to reduce noise when the is no program content (a pause in speaking or singing) by suppressing any added noise as it restores the audio to its original dynamics.

The compressor and expander must track precisely and this is best illustrated by looking at the attack and delay times. Optimizing a compandor with fast attack and delay times for high frequency content will cause distortion in the low frequencies. Slow attack and release times improve low end response but are not fast enough to track at higher frequencies. The result in all single band compandors is a compromise. This is one of the reasons that sound engineers insist that wireless microphone content is changed or “affected” compared to the same wired microphone.



Dual Band Companding

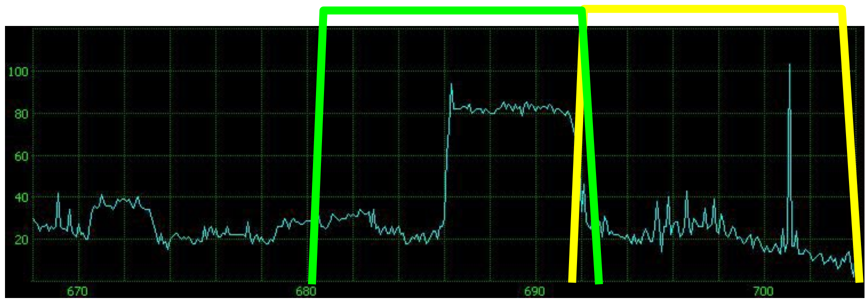
Just as PA companies separate bass, mids and high frequency content and have gone to bi- or tri-amp designs, high end wireless products are going to dual band compandors. A dual band compandor allows the low and high frequency bands to have optimized attack and release times. This produces a very flat, undistorted, smooth audio response. In fact the RE-1/FMR-1000 from Telex/EV has a response from 30Hz to 17kHz in the instrument mode that has impressed the most selective bass and lead guitar players.

What are “Front End” Filters?

Filters on wireless microphone receivers are basically band pass filters that are designed to allow in the desired signal and reject everything else. Rejection of other signals reduces noise, increases range, and increases the number of simultaneous systems that can be used in one location. These filters can be built using several different circuits including ceramics, crystals, tuned cavities, and surface acoustic waves (SAW).

Regardless of how the filter is made, it must cover the desired operating band of the receiver. For older fixed frequency crystal controlled radios, the filter could be as narrow as the designer wanted, usually 6MHz or less. For newer frequency agile systems, the filters must now be 32 or even 36MHz wide. These wide front end units use other methods to select the desired signal but the lack of filtering hurts their range, and susceptibility to interference.

Telex introduced a unique solution to the front end filter problem in the FMR-1000/RE-1. These products include dual tuned filters that switch in where required based on the frequency of the signal. This approach allows a 24MHz (or 4 TV channel) wide operating bandwidth while using 12MHz filters. Dual tuned filters improve range and rejection which allows the RE-1/FMR-1000 to use 16 transmitters in 24MHz without any problems.



What about UHF Antenna Amplifiers?

Antennas should always be place in a "line of sight" and as close to the transmitters as possible. But, antennas should also be placed as close to the receivers as possible. When circumstances require long coaxial cable runs for the antennas, UHF antenna amplifiers can be used. There are two things to keep in mind when using antenna amplifiers:

1) Antenna amplifiers should be used to make up for losses in the cables, not to extend the range of the wireless. The use of too much RF amplification can "swamp out" the sensitive front end of the receiver causing noise, squelch breaks, and distortion.
2) Amplifiers add noise and exacerbate inter-modulation problems so passive systems are always superior if the signal strength at the receiver provides adequate range.

All coaxial cable loses signal as it travels the length of the cable and the loss varies with the frequency of the signal. It is important to know the loss formula for the cable you are using so you know when and how much amplification is appropriate.

At the right is a loss table for the Telex/EV accessory coaxial cables from 25 feet to 100 feet. You can see that losses in VHF are very low while they go up quickly with frequency. Keeping in mind that every 6dB loss of signal results in half the operating range, any loss above 3dB is going to be noticeable in some applications. A slightly less expensive cable is used for the 25 foot run which is why the numbers do not go up much from 25 to 50 feet. For comparison, standard RG58 cable would have about a 10dB loss over 100 feet at 700MHz.

	Total Signal Loss in dB			
Freq MHz	CXU-25	CXU-50	CXU-75	CXU-100
100	0.61	0.62	0.94	1.25
150	0.75	0.77	1.15	1.54
200	0.87	0.89	1.34	1.78
250	0.98	1.00	1.50	2.00
400	1.24	1.27	1.91	2.55
450	1.32	1.36	2.03	2.71
500	1.39	1.43	2.15	2.86
550	1.46	1.51	2.26	3.01
600	1.53	1.58	2.36	3.15
650	1.60	1.64	2.47	3.29
700	1.66	1.71	2.56	3.42
750	1.72	1.77	2.66	3.54
800	1.78	1.83	2.75	3.67

The Telex/EV UAA-500 UHF antenna amplifier has two gain settings, 3 and 10dB of gain. So for use with the CXU-100 cable, the 3dB gain setting would be appropriate. For use with 100 feet of RG58, the 10dB setting would help make up for the loss in the cable run. Always calculate or look up the expected cable losses before using an amplifier.

What other considerations should I think about?

When selling a wireless system, consider the long-term use for the system and always sell the complete approach. That is, if the customer eventually intends to add more systems, make sure you sell them a system that will allow for the total number of future systems. Also, don't forget to look at accessories such as antenna combiners, antennas, low loss coaxial cable, and microphone choices.

Telex/EV has a complete line of wireless accessories for both VHF and UHF systems. These accessories allow the system to be tailored for the individual application and allow the user to get the most from their investment.

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