RadioCom™

Wireless Intercom Systems

Principles of RF

What it is and how it works!

What is RF?

- **RF** is short for **Radio Frequency**. Radio frequencies are part of the electromagnetic spectrum. They are different from audio frequencies because of two main factors:
- Frequency (usually higher)
- Medium of propagation (method of transmission)

Electromagnetic Spectrum

- The electromagnetic spectrum is made up of signals whose frequency can be as low as a 1 Hz (Hertz) or as high as cosmic rays.

Electromagnetic Waves

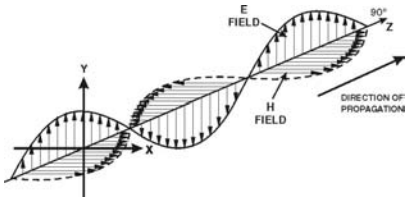
- Composed of an electric (electro) and magnetic components. These are sometimes referred to as the E field (electric) and H field (magnetic).
- 90° of separation between E and H fields.
- Depending on the frequency, the ratio of the amplitudes of the E and H fields will vary.

Field Ratios

- The higher the frequency, the stronger the E field and the weaker the H field.
- The lower the frequency, the stronger the H field and the weaker the E field.
- The field ratios are important because they control how the wave behaves and therefore can be the difference between a system working and not working.

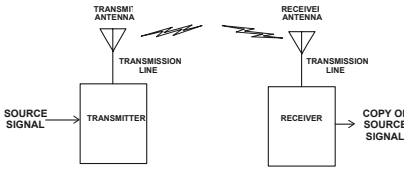
Wave Propagation

- Electromagnetic waves propagate perpendicular to the E and H fields.



Basic RF System

- A basic RF system is made up of a transmitter and a receiver.
- The transmitter encodes the information and "transmits" it.
- The receiver "receives" the transmitted signal and decodes it into its original form.



The Transmitter

- Takes the source information in (audio, data, etc…)
- Modulates (encodes) the RF wave with the information.
- Delivers the RF wave (signal) to the transmit (TX) antenna.

The Receiver

- Gathers in the RF wave (signal) from the receive (RX) antenna.
- Demodulates (decodes) the RF wave with the information.
- Outputs a copy of the original source information (audio, data, etc…)

What Happens in the Middle?

- The RF wave travels between the transmitter and receiver via the propagation path.
- The waves travel like the waves from a pebble in a pond.
  - Moves away equally in all directions
  - Each vector moves away in a straight line.
  - The signal gets weaker as it moves away.

The Inverse Square Law

- The rate at which the RF wave becomes weaker can be calculated via the inverse square law:

  $(1/D^2)$ x TX Power = Power at path end

  Where D is the distance traveled.

- Twice as far doesn't mean half as strong!

An Example

- Path Calculation A
- TX Power = 1W
- Travels 10 units
- Power at the end of the path is:
  - $(1/10^2)$ x 1W or
  - 0.01 x 1W or
  - 0.01W

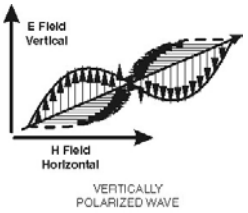
- Path Calculation B
- TX Power = 1W
- Travels 20 units
- Power at the end of the path is:
  - $(1/20^2)$ x 1W or
  - 0.0025 x 1W or
  - 0.0025W

Power vs. Distance

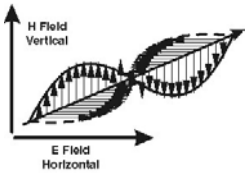
- You must increase transmitter power by a factor of four times to double the system range.
- Reducing transmitter power by half reduces system range by only $^1/_3$.
- This assumes all other factors are equal.

Polarization

- Describes the orientation of the RF wave.
- E field determines the polarization.
- If the E field is perpendicular to the Earth, the wave is vertically polarized.
- If the E field is parallel to the Earth, the wave is horizontally polarized.



VERTICALLY POLARIZED WAVE



HORIZONTALLY POLARIZED WAVE

Antenna Polarization

- Antennas are polarized in reference to the active element.
- System Antennas should be polarized in the same direction.
- Opposite polarization greatly reduces system range.

Antenna Types

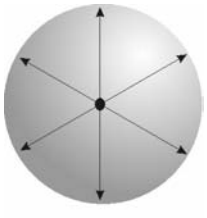
- There are two basic types of antennas:

1. Omnidirectional
2. Directional

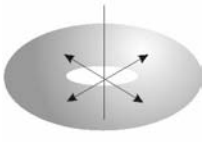
- All antennas have a driven element.

Omnidirectional Antennas

- Omnidirectional antennas transmit or receive the RF energy in all directions.
- The BTR series of wireless intercom ship with omnidirectional antennas



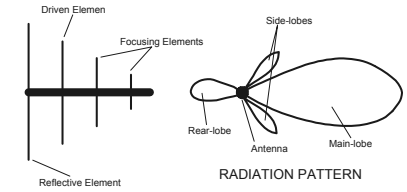
ISOTROPIC RADIATOR



DIPOLE

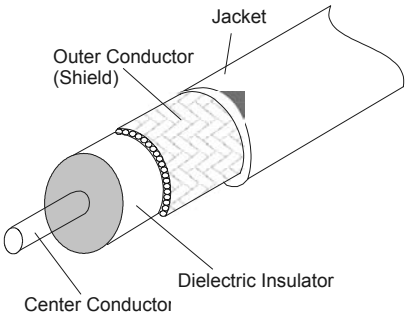
Directional Antennas

- Directional antennas transmit or receive the RF energy in a specific direction.
- Log Periodic and Yagi antennas are the most common type of directional antenna.
- Directional antennas are used to improve coverage in a specific direction.



Transmission Line

- Commonly referred to as coax.
- High quality, low loss microwave grade cable is recommended.
- Keeping the number of connections to a minimum is important!
- Total cable length should not exceed 100 feet.



Splitting Antennas

- Requires the use of a splitter. (Active or passive splitters exist.)
- Splitting antennas is recommended for receive antennas when coverage is an issue. Some signal loss will occur.
- Splitting antennas for the transmit side is only recommended in extreme cases since significant power loss will occur.
- Leaky coax can be used in certain situations.

Combining Antennas

- Sometimes referred to as community antennas
- Can be used to reduce the number of antennas in a system.
- Requires a good combiner (preferably active).
- Potential exists for intermodulation.

Polarization vs. Phase

Polarization

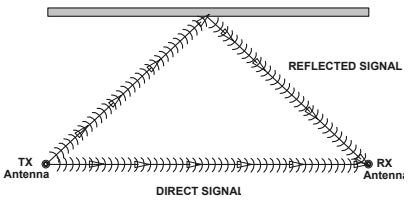
- The orientation of the electrical component (E field) of an electromagnetic wave.

Phase

- The relationship of the energy of two or more waves.

Multipath Interference

- A form of self interference.
- Reflected path interferes with direct path.
- Signals are out of phase.
- Signals are similarly polarized.
- No simple solution.



Receiver Desensing

- Transmitter energy overloads a receiver.
- Doesn't have to be exactly on receiver's frequency.
- Small amounts of power can still mean a big problem.
- Solved by separation and in extreme cases filtering.

Intermodulation

- What is it?

Intermodulation occurs when two or more frequencies mix in a non-linear device and produce a number of related frequencies known as intermodulation products (**Intermod** for short).

Intermodulation

- How does it happen?

  Intermodulation interference takes place when at least two transmitters are broadcasting at the same time on frequencies that have a definite, calculable relationship with the affected receiver.

Intermodulation

- Where does it happen?

  Intermod products are not created in the air. They are the result of the mixing of signals in non-linear devices such as transmitter output amplifiers and receiver input amplifiers or other usually active elements.

Intermodulation

- How can it be avoided?

1. Pick frequencies that are known to work in the presence of each other without creating intermod.
2. Choose equipment with well designed receivers and transmitters with appropriate passive filtering.
3. Manage the positioning of antennas and beltpacks within the system to optimize operational potential.

Intermodulation

- What should I do if I think intermod is occurring?

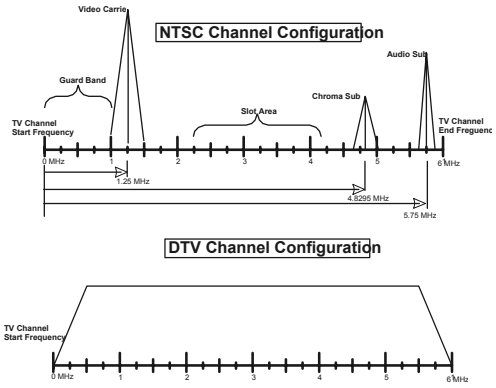
1. Try turning off one or more transmitters and see if the problem disappears.
2. Try repositioning antennas and/or equipment.
3. Gather a list of frequencies in use (i.e. wireless microphones, wireless intercom, etc…) and consult with a system engineer or other technical support person who can run an intermod calculation.

Frequency Coordination

- An important first step in setting up a system.
- A coordinated system will keep the number of returns, re-crystalings, and tech support calls to a minimum.
- Before you call gather the following info:

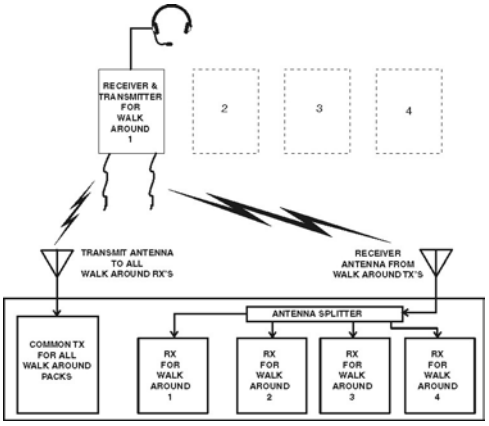
1. Address where the system will be used. If it is a traveling system say so…
2. The frequencies of any additional wireless units (microphones, intercom, etc…) that may be used in conjunction with the new equipment.

Analog (NTSC) vs. Digital (DTV)



- Wireless intercom and wireless microphones generally work by hiding in the "valleys" of the analog TV signal.
- Digital TV (DTV) signals use the entire TV bandwidth allocation and do not have "valleys" to hide in.

A Basic Wireless Intercom System



Wireless Intercom Systems

VHF/UHF

Fixed Frequency

The RadioCom BTR/TR-300

- VHF Operation
  - 154 - 216 MHz frequency operation.
- One Base Supports Up to 4 Beltpacks
  - Full partyline compatibility.
- Up to 4 Bases and 16 Beltpacks
  - Use up to 16 beltpacks in simultaneous operation in one location.

BTR/TR-300 Selling Features

- Full Duplex Operation
- Small, Rugged, Lightweight
- Operating Range
- Battery Life
- System Compatibility
- Cost Effective

Full Duplex Operation

- Natural Conversation Flow
- Can Interrupt Another User
- No "Squelch Tail"
- No Cut Off Words

Small, Rugged, Lightweight

- Weighs 13 Ounces with battery.
- Measures only 2" in depth.
- Constructed of tough polycarbonate resin for incredible strength.

More Selling Features

- Operating Range
  - Up to 2000 feet line of site, beltpack to beltpack.
- Battery Life
  - NiMH Rechargeables 17 hours.
  - Alkaline AAs 24 hours.
- System Compatibility
  - AudioCom, RTS, Clear-Com

The RadioCom BTR/TR-500

- UHF Operation
  - 520 – 760 MHz frequency operation.
- One Base Per Beltpack
  - Dual channel talk/listen.
  - Auto-switching audio channel
- Up to 16 Bases/Beltpacks
- 1,000+ feet line of site operation.

The RadioCom BTR/TR-600

- Same great features and performance as the BTR/TR-500.
- Uses 24-bit digital encryption technique.
  - 65,000 code setting that can be changed on the fly via four cipher code switches
- Slightly more system noise than BTR/TR-500 system due to encryption.

Mirrored Belt Packs

- Sometimes referred to as a tour guide setup.
- Available on models:
  - TR-300
  - TR-500
  - TR-600

Wireless Intercom Systems

UHF Frequency Agile

BTR-700 Wireless Intercom

UHF, Single Channel, Frequency Agile Communications System

BTR-800 Wireless Intercom

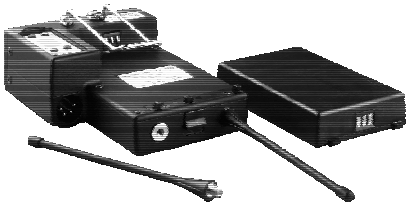
UHF, Two Channel, Frequency
Agile Communications System

Key Features

- All UHF operation
- Four beltpacks per base station
- Two intercom channels (800 only)
- Stage Announce with relay closure (800 only)
- Wireless Talk Around (ISO) (800 only)
- Cast Magnesium beltpack
- Enhanced ClearScan™ technology

TR-800 Beltpack

- Cast Magnesium
- Field replaceable antennas
- Ergonomic design
- Operates on either AA's or NiMH
- LCD Display
- Auto-Sensing headset connector



Beltpack Functionality

- Digi-Latch Talk button
- Channel Select switch
- WTA (ISO) button
  - Wireless Talk Around
- SA button
  - Stage Announce
- Level Control
- All buttons are fully programmable

Intelligent Power Control™

- Automatically reduces beltpack power 10dB from 50mW to 5mW when beltpack is in close proximity to base.
- Reduces desensing created by near/far situations
- Saves battery life.
- Reduces intermodulation

Battery Options

- Standard AA's
  - 14 hours
- NiMH rechargeables
  - 11.5 hours
  - Thermister sensor
- Modular four bay recharging system

BTR-800 Base Station

- LCD Graphical User Interface
- Single RU configuration
- Telex, RTS and Clear-Com compatible
- Integrated, dual talk/listen User Station

Graphical User Interface

- Status Screen
  - What beltpacks are doing
- Group/Channel Screen
  - Preselected, intermod free groups
- Frequency Screen
  - The actual operational frequencies

Frequency Groups

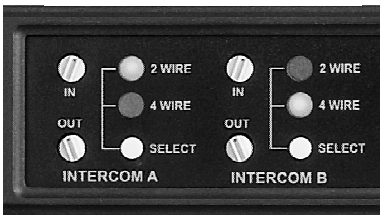
Desig	TV	Strat Freq	Use	Telex Ban	End Freq	TV	Desig
	22	518	**BTR TX**	**518**	524	**22**	
A	**23**	524	**Low**	**to**	530	**23**	**A**
	24	530	**TR Rx**	**536**	536	**24**	
	25	536	BTR TX	536	542	**25**	
B	**26**	542	**Future**	to	548	**26**	**B**
	27	548	TR Rx	554	554	**27**	
	28	554	**BTR TX**	**554**	560	**28**	
C	**29**	560	**High**	**to**	566	**29**	**C**
	30	566	**TR Rx**	**572**	572	**30**	
	31	572	BTR TX	572	578	**31**	
D	**32**	578	**Future**	to	584	**32**	**D**
	33	584	TR Rx	590	590	**33**	
	34	590	BTR TX	590	596	**34**	
E	**35**	596	**Future**	to	602	**35**	**E**
	36	602	TR Rx	608	608	**36**	
	37	608	Radio Astronomy		614	**37**	
	38	614	TR TX	614	620	**38**	
1	**39**	620	**Future**	to	626	**39**	**1**
	40	626	BTR RX	632	632	**40**	
	41	632	**TR TX**	**632**	638	**41**	
2	**42**	638	**Low**	**to**	644	**42**	**2**
	43	644	**BTR RX**	**650**	650	**43**	
	44	650	TR TX	650	656	**44**	
3	**45**	656	**Future**	to	662	**45**	**3**
	46	662	BTR RX	668	668	**46**	
	47	668	TR TX	668	674	**47**	
4	**48**	674	**Future**	to	680	**48**	**4**
	49	680	BTR RX	686	686	**49**	
	50	686	TR TX	686	692	**50**	
5	**51**	692	**Future**	to	698	**51**	**5**
	52	698	BTR RX	704	704	**52**	
	53	704	**TR TX**	**704**	710	**53**	
6	**54**	710	**High**	**to**	716	**54**	**6**
	55	716	**BTR RX**	**722**	722	**55**	
	56	722	TR TX	722	728	**56**	
7	**57**	728	**Future**	to	734	**57**	**7**
	58	734	BTR RX	734	740	**58**	

Enhanced ClearScan™

- Searches the operational 18MHz bandwidths for the best possible frequencies
- Scans all of the factory preselected groups as well as the user definable groups
- Functions from the base and the beltpack with the same button combination

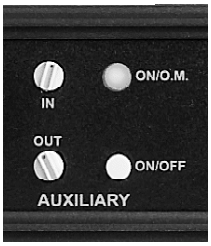
Intercom Interface

- Two separate intercom channels
- Input and Output level controls
- 2 or 4 wire intercoms
- Telex, RTS and Clear-Com compatible



Auxiliary Input & Output

- Bring in program feed or other line level source.
- Use output as squawk box monitor
- Separate in/out level controls



Integrated User Station

- Full talk/listen functionality
- Monitor or Talk to A, B or both channels
- Mic gain and level adjust

Rear Panel

Wireless Intercom Systems

Accessories

Antennas & Cable

- Directional antennas (Yagi & Log Periodic).
- Replacement base station and beltpack antennas.
- Low-loss cable in 25, 50, 75, and 100 foot lengths.
- SC-600 Antenna combiner for BTR-500, BTR-600, and BTR-700 systems.

Other Accessories

- Power supplies.
- Battery packs.
- Belt clips.

Wireless IFB Systems

VHF Switch Selectable Frequency

TT-44/TR-34

- 16 channel operation (switch selectable) 64-68 MHz.
- Accepts RTS TW, AudioCom, RadioCom inputs.
- Unbalanced audio input.
- Works with standard IFB earpieces.
- Works reliably at distances over 750 feet.
- Up to 5 base transmitters in the same environment.

Q & A

- Questions?
- Comments?
- Concerns?