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APPLICATION NOTE **AN2**

Configuring A Radio Link

AV010303/1-000

REV. X0 3/03/01

Edited by Eli W

AN2 - Configuring a Radio Link.

1. Introduction.

   This application note focuses on the criterions used to configure a **point to point** radio link operating at frequencies from the high UHF band up to the license free 5.8GHz ISM band:

   Operation at these frequencies offers a limited number of channels at one location, requires a line of sight from the antenna of the transmitter to the antenna of the receiver and is prone to interference and interruptions, such as: multipass distortion, fading because of the changing location of the transmitter from the receiver, humidity in the air and moving obstacles that obscure the line of sight.

   The overcome these obstacles, the following steps need to be made:

   - Defining the site needs.

     - Number of transmitters that need to operate at the same location.

     - Range from the transmitter to the receiver or the receiver antennas.

     - Any obscuring elements that may interfere with reception.

     - Available power sources.

     - The availability of a professional operating crew.

     - The time allowed to set the system up.

   - Selecting a frequency band
   - Selecting a receiver
   - Selecting antennas
   - Selecting accessories

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1. Defining the site needs.

   Every location has it's own specific requirements. Some of these are:

   a) How many cameras (transmitters) will be operating at the same location at the same time. There is a limit of 4 legal channels on the 900MHz band, about 4-8 on the 2.4GHz band and 8 on the 5.8GHz band.

      Every camera/transmitter requires one of these channels.

   b) The range from the transmitter to the receiver or the receiver antennas.

      Assuming all transmitters have the maximum legal power limit, the range defines the location of the receiver antennas and the gain of these antennas.

   c) Obscuring elements that may interfere with reception.

      One must remember that operation at these frequencies requires a line of sight from the transmitter to the receiver and that any large metal objects along the way, behind the transmitter, on both sides of the transmitter to receiver pass and behind the transmitter may introduce multipass distortion (Ghosting).

   d) Available power sources.

      Does the site have power? What kind of power? 110VAC? 230VAC? Batteries? How much power is available?

      If one needs to operate a lot of equipment on batteries all day long, they will require recharging at predefined periods. Does this impact the shooting?

   e) The availability of a professional, trained, operating crew at the site.

      Some of the equipment (Like high gain antennas) requires a trained person to be installed properly. This is no problem with a fixed site, like a studio or a receiving van.

      There is no use buying high end equipment if one does not install it properly.

   f) The time allowed to set the system up.

      A smart system requires time to set up properly, run the cables from the receivers to the antennas and then install the antennas on masts or other fixtures that span up high.

   g) Budget limitations.

      Needless to say, but everyone has some budget limitations.

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2. Selecting a frequency band.

a) **UHF.**

UHF is the frequency spectrum allocated to broadcast TV channels from 450MHz to 802.5MHz in the USA and up to 865MHz elsewhere in the world. The standard modulation is VSB (AM with one sub-carrier suppressed). There are 55 available channels with only a few in use at any particular location.

UHF has the following advantages:
Multiple channels at one location (over 25)
Little multipass distortion.
Range less susceptible to weather.
With VSB modulation, can be received by an ordinary TV.

UHF has the following disadvantages:
Requires an FCC site permit in the USA
Does not support broadcast quality video.

b) **900MHz ISM license free band.**

This band spans from 900MHz to 928MHz. The standard modulation is FM, which offers a slightly better picture quality over VSB. This band offers up to 4 channels at one location.

900MHz has the following advantages: Popular in the security industry.
Lower cost.

900MHz has the following disadvantages: Used by cordless phones, spread spectrum wireless LAN and other services, causing some interference in heavily populated areas.

In the USA, FCC limits output power to 10mW.

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c) **2.4GHz ISM license free band.**
This band spans (In the USA) from 2.4GHz to 2.83GHz. Under certain limitations, it can be extended from 2.35GHz to 2.483GHz. This band offers up to 4 (7) channels at one location. Equipment operating in this band is either FM modulated or Spread Spectrum modulated (SS) (There is a variety of SS methods, such as DSSS and FHSS that are not compatible with each other).

2.4GHz has the following advantages: Legal power of 250mW (In the USA)
Lower cost because of mass production of various components.

2.4Ghz has the following disadvantages: Used by microwave ovens, cordless phones, wireless LAN and other services, causing some interference in heavily populated areas.

Requires a line of sight to operate.

Range affected by humidity in the air.

d) **5.8GHz ISM license free band.**
This band spans from 5.775GHz to 5.875GHz (to a total of 8 channels, each with a 20MHz bandwidth). Equipment operating in this band is either FM modulated or Spread Spectrum (OFDM/COFDM/WOFDM) modulated.

5.8GHz has the following advantages: Few users (In 2001)
When operated in OFDM, 8 channels, each with a capacity of 4 video transmitters in TDM, to a total of 32 channels.
Low susceptibility to multipass distortion with OFDM modulation.
Small transmitting antennas.

5.8GHz has the following disadvantages: Very poor performance in FM mode, because of severe multipass distortion problems.

No availability of low cost OFDM equipment (For 2001).

Requires a line of sight to operate.

e) **Other bands.**
AValon RF can modify its off-the-shelf equipment to operate in other band, in accordance with customer requirements.

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3. Selecting a transmitter / receiver combination.

   The selection of a transmitter/receiver combination depends on the type of service needed. There are four types of service:

   a) Transmitter at fixed location, receiver at fixed location.

      A fixed/fixed installation is done with proper planning by a professional crew with time on their hands. A simple receiver will do the job. Good antennas will improve the signal to noise ratio and reduce multipass.

      An AValon TX620 with either a DX602 two way or DX604 four way true diversity receiver offers redundancy. If one tuner fails, there is a backup tuner to provide un-interruptible service.

   b) Transmitter at fixed location, receiver mobile.

      Example: A receiver on a boat tuning in to a TV broadcast station. A DX404 UHF receiver with 4 directional antennas, each pointing 90 degrees away from each other, provides far superior service to a single receiver with an omnidirectional antenna.

   c) Transmitter mobile, receiver at fixed location.

      Example: Electronic News Gathering (ENG). The camera crew moves around the scene while the receiver is the news van parked nearby.

      An AValon TX620 transmitter with a DX604 4 way true diversity receiver with four directional high gain receiving antennas pointing to the general direction of the transmitter with a wide fanout angle tracks the transmitter and reduces multipass distortion.

   d) Transmitter mobile, receiver mobile.

      Example: A police Helicopter transmitting to a police patrol car (Or cars). Both the transmitter antenna and receiver antenna have to be small and rugged.

      A TX620 transmitter in the helicopter transmitting to a DX604 4 way diversity receiver equipped with a 4 way corner antenna provides high quality long range service.

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4. Selecting an antenna.

In general, one wants an antenna as small and lightweight as possible for mobile service and as smart as possible for fixed service.

The offering of various antennas for use at 400MHz-6GHz is enormous. The scope of this text is limited to the standard, most popular, antennas offered by AValon RF although many other antennas are available.

a) Omnidirectional ¼ wave whip antennas.

The AX501 and AX601 are ¼ wave whip antennas. They radiate in a 360 degree horizontal pattern with a 180 degree vertical pattern and have no gain.

They are useful as both transmitting and receiving antennas in mobile applications.

b) Omnidirectional 5/8 wave whip antennas.

The AX502 and AX602 are 5/8 wave whip antennas. They are slightly larger than the ¼ wave whips, offer a gain of 3.5dbi and have a radiation pattern of a donut, covering a 360 degree horizontal pattern and a narrow 20 degree vertical radiation pattern.

They offer increased operating range in mobile applications but are limited to sites where the tilt of the transmitter does not change while operating.

c) Narrow angle (Directional) high gain antennas.

The AX511 and AX611 are directional “flat” antennas. They offer high gain and narrow receiving angles, substantially increasing the operating range while reducing multipass distortion.

They can be used as transmitting and receiving antennas in fixed/fixed service and receiving antennas in mobile/fixed service.

They are particularly effective when used with the DX504 and DX604, as explained in AN-3. Avalon has a greater selection of this type of antenna, each with different fanout angles and gain

NOTE

The higher the gain, the higher the size, weight and cost of the antenna.

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d) Special antennas.

Avalon RF offers two types of special antennas:

- DX654 2.4GHz 4 way smart corner antenna.

  The DX654 is designed for highly mobile applications where long operating range and signal quality (Multipass) are important.

  The DX654 is a 8” round mushroom like antenna that includes 4 90 degree corner antennas, covering 360 degrees in the horizontal plane and 180 degrees in the vertical plane.

  This antenna has a built-in microprocessor, compass and RF switches and can maintain a transmitting (Or receiving) direction as the platform circles around.

  Examples:

  Helicopters in ENG applications transmitting to a TV station.

  Racing cars circling an oval track.

- Diversity motorized tracking antenna for long range outdoor service.

  See AN4

- Diversity motorized tracking antenna for short range indoor service.

  See AN4

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5. Selecting optional accessories.

   AValon RF offers the following accessories:

   a) 110VAC/220VAC power adapters.

      All of AValon products are designed to operate off batteries. To operate them off the power line, one needs a BX series 110VAC or 230VAC to 12V regulated power supply.

      All BX series power supplies are linear, for low noise operation and come ready with the proper mating connectors.

   b) A 2 way and 4 way antenna splitter.

      The CX502 (900MHz band) and CX602 (2.4GHz band) are two way antenna splitters.

      The CX504 (900MHz band) and CX604 (2.4GHz band) are four way antenna splitters.

      These splitters divide the signal coming from the antenna to 2 or 4 outputs, each output getting ½ or ¼, respectively, of the antenna signal, allowing connection of one antenna to multiple diversity receivers, usually installed in a rack.

      Examples:

      Two antennas, hooked up to two CX504 serve four DX502's.

      Four antennas, hooked up to a CX604 serve four DX604's.

   c) Smart antennas.

      All AValon products are shipped with ¼ wave whip antennas. For special applications, we offer a wider selection of antennas, as described in section 4 above and in AN-4.

   d) A remote control for the DX504/DX604 receivers.

      The R128 is a Palm Pilot® PDA with AValon's custom software that controls via an infra red IRDT link up to 128 DX404, DX504 or DX604 diversity receivers at a single location.

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5. Selecting optional accessories (Cont'd).

   e) Desktop to rack-mount conversion kits.

      AValon is offering two conversion kits:

      - Mounting two DX504 or DX604 in a 19" Retma rack. The space needed for both diversity receivers is only 1U high.

      - Converting a dual DX504 or DX604 from the Retma drawer back to the desktop version.

   f) Custom interconnection cables.

      AValon has in-house capability to manufacture custom power, video and audio cables for all it's products.