LUTRON®

PRELIMINARY

For Your Information ...

APPLICATION NOTE #85

Understanding RF Communication - PATH LOSS

Overview

Radio waves attenuate as they travel through space. Referred to as path loss, this is the difference between the power transmitted from the signal source and the power received at the signals destination. Even though this application note will reference Lutron's RadioRA® Wireless Home Lighting Control System the knowledge can be applied to any Radio Frequency (RF) device.

IR Mapping

Radio Frequency Power

Many devices are required to meet Part 15 of the FCC code which states that a transmitter can not radiate more than 1 microwatt of power. High quality devices like Lutron's *RadioRA* lighting control receivers can decode as little as 30 billionths of the original signal or 0.0000000003 Watt. That is comparable to -75dB of path loss.

Understanding Decibels (dB)

Path loss is commonly measured by decibels (dB). Decibels are a way to represent the ratio of transmitted to received power. Used to simplify calculations, decibels allow basic addition to achieve summations rather than more complicated ratio mathematics. Signals sent from a transmitter are measured in POWER (Watts). The ratio of transmitted to received power is represented in decibels (dB) by taking the ratio's logarithm and multiplying by 10. **10 x LOG (Power received /Power transmitted) = Path loss in dB.**

Obstacles

RF Propagation through surfaces and even air will attenuate the signal. Different structures and materials provide different levels of path loss as do different distances between transmitter and receiver.

Typical Surface losses:
Doors and Windows = -2dB
Standard walls = -3dB
Concrete Wall = -13dB
Aluminum Siding = -20dB
Metals = -26dB

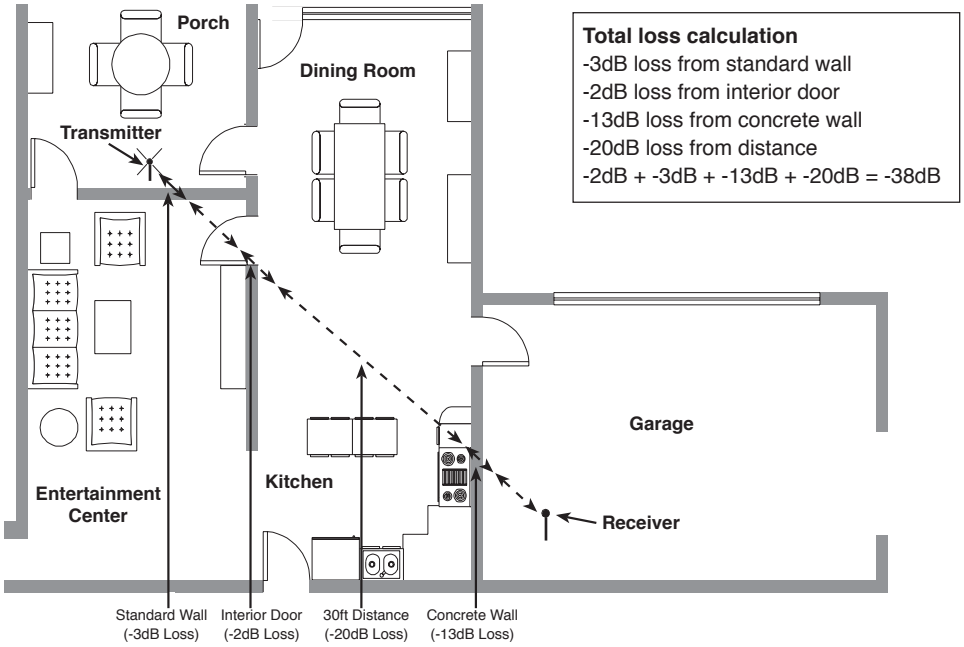
Typical RF distance losses:
10ft = -10dB
30ft = -20dB
100ft = -30dB
300ft = -40dB
1000ft = -50dB

Application

Determining Path Loss

1. **Identify surfaces between Transmitter and Receiver**
   Thinking of a straight line between transmitter and receiver identify all the surfaces the signal must pass through and the makeup of that surface. An example may be a standard wall made of drywall and wood studs, a wood interior door or a garage wall made of concrete (see Figure 1).
2. **Calculate loss of each surface**
   Using the example above the standard wall would have approximately a -3dB loss, the interior door would have approximately a -2dB loss, and the concrete wall would have approximately a -13dB loss.
3. **Calculate distance loss**
   Measure the distance between the transmitter and receiver and add the loss from radiation through air. In the example on the next page (see Figure 1), the transmitter is 30ft from the receiver, representing an approximate -20dB loss.
4. **Add the losses**
   The summation of surface losses are -3dB + -2dB + -13dB = -18dB. Adding a distance loss of -20dB a total of -38dB path loss is accumulated between the transmitter and receiver.

Figure 1 - Example Calculation



Determining Best Path

Finding the best path is not a function of only distance but of distance plus surface obstructions. The following examples are of GOOD and BETTER paths where distance is not the prime factor.

Figure 2 - Room Placement Example

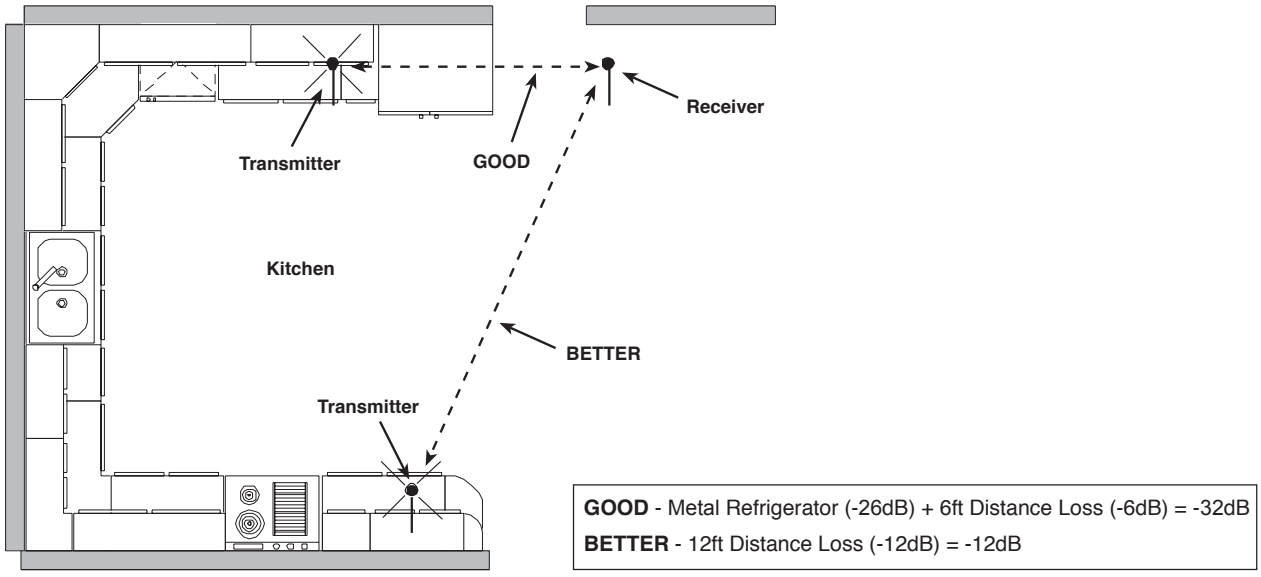


Figure 3 - Floor Placement Example

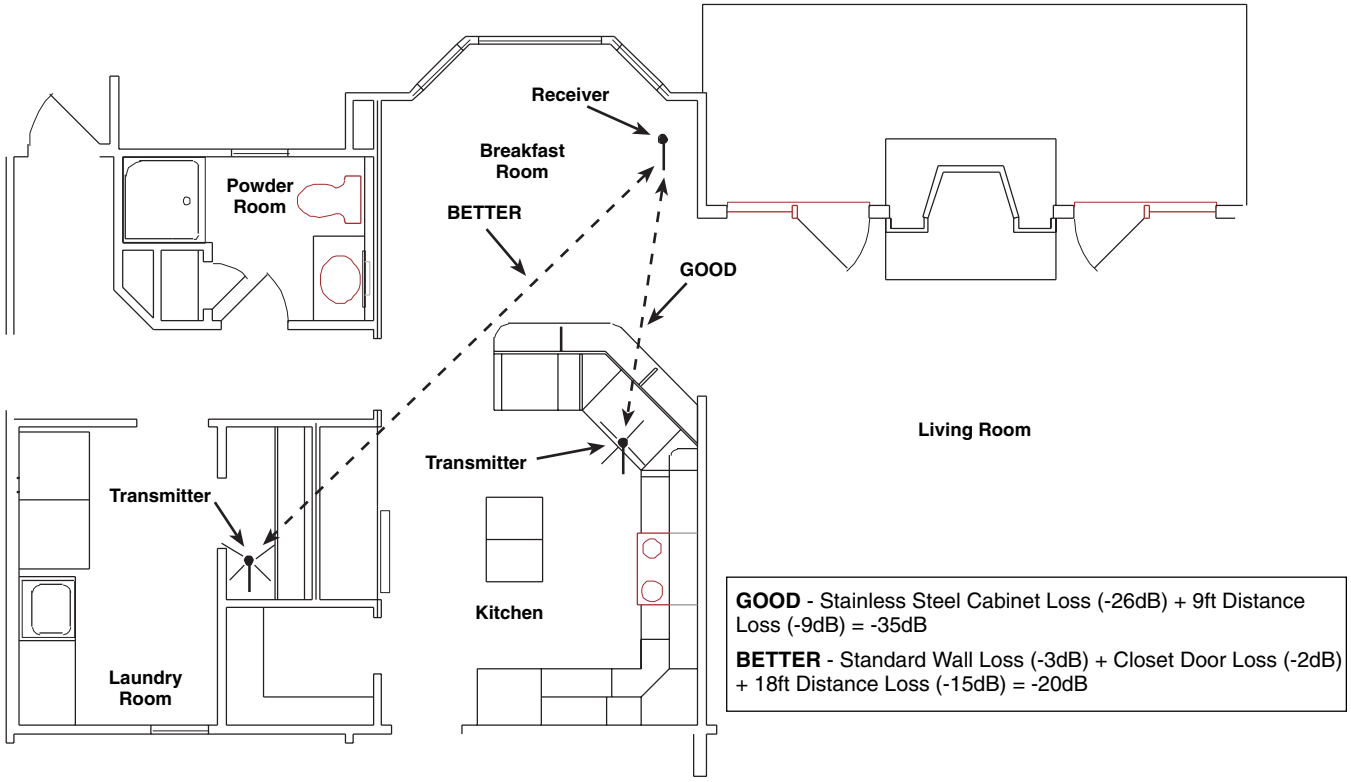
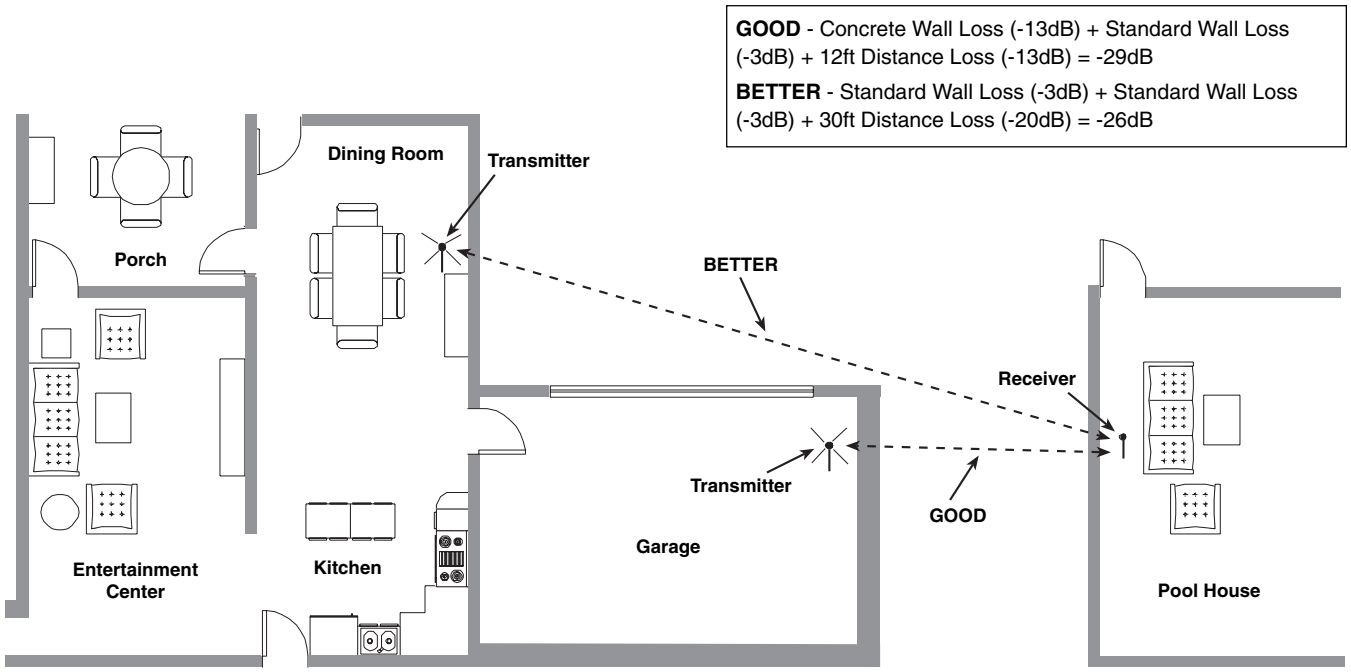


Figure 4 - Area Placement Example



Conclusion

Path losses are a consideration when installing any type of RF system. With proper attention to placement, surfaces, and distances, installers can better guarantee proper functionality of all transmitters and receivers in the system. The best assurance that your RF system works to its fullest potential is the knowledge to setup the equipment to receive the best signal possible.

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