CAT FIRE

Understanding Radio Communication

TRINITY DIGITAL

Table of contents

Contents

CATFire – Understanding Radio Communication

Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS, FEATURES, FIRMWARE AND ITS FEATURES, SOFTWARE AND ITS FEATURES, DOCUMENTATION AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE.

Errors and Omissions Excepted (E&OE).

Revision history

Revision	Changes
1	First
2	Correct spelling mistakes.

Radio reception

This document attempts to explain further about wireless communication and how to use it successfully.

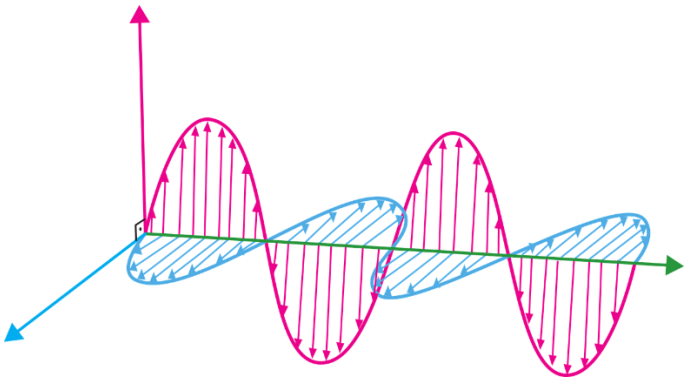
But it can be summed up quite simply:

"If the antennas of all CFTFU-X16 units can physically 'see' the antenna of the CFCIU-1, they are oriented the same, at a similar elevation, and within range: it will work."

More often than not this is not practical, so having a little understanding of radio communication can help in getting the best from CATFire.

Waves

Radio consists of electromagnetic 'waves'. These waves propagate through space as a continuous coupling of electrical energy and magnetism (electro-magnetic).

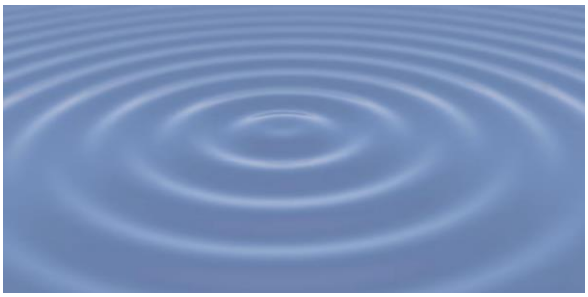


Red: Electric field

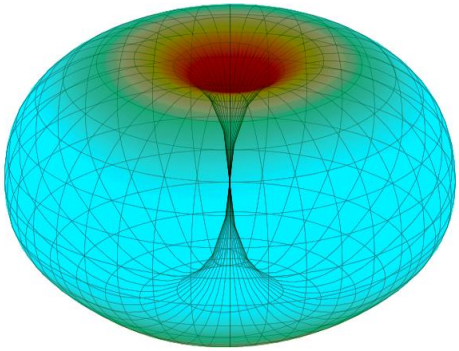
Blue: Magnetic field

Green: Wave direction

Think of them as ripples propagating across the surface of a pond.



In our case, however, instead on just the surface of a pond, they can ripple in many more directions around the antenna in a kind of donut shape.



In the above picture the antenna would be pointed vertically upwards – which is usually always the case for the antennas supplied with CATFire.

You can see there is almost a void at the top and bottom – this is where the signal coming from the antenna is weakest.

You can imagine that trying to point the ends of antennas at each other will cause a very weak signal indeed – you are pointing donut holes at each other.

As the waves progress outwards the wave will get weaker until the receiver can no longer see that wave – just like ripples on a lake will eventually fade to nothing.

Obstacles

As the wave propagates through medium (air, solid objects such as hedging, trees, buildings, water, wood, concrete, glass etc.) energy in the wave is absorbed in the material making it weaker still reducing the range.

We have all heard the term “atmospheric interference” when thinking about television reception – air consists of many gasses and moisture, these are affected by temperature and air pressure making them lighter or denser and therefore absorbing less or more radio energy.

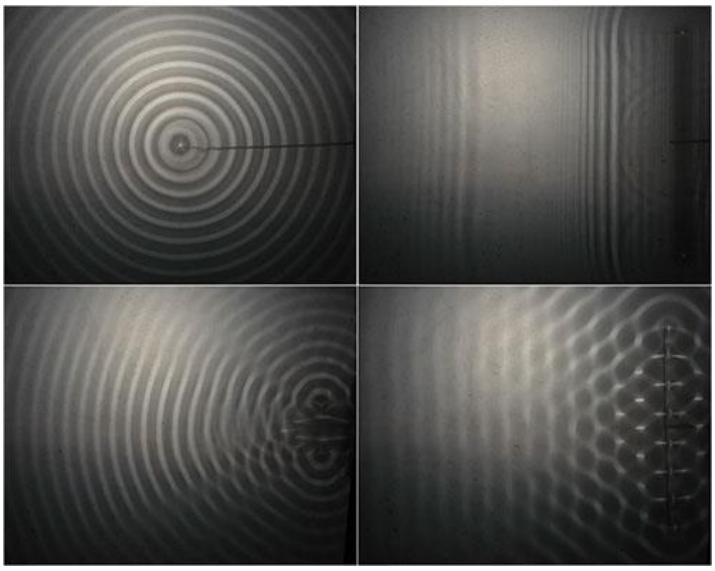
Reception can wax and wane throughout the day as these factors change – which is why it is important to keep within the operating parameters of CATFire.

Reflections

Metal will block radio waves from propagating through it and will cause the wave to reflect off it, just like light being shone onto a mirror. Remember light is also an electromagnetic wave.

Waves travelling forward can be affected by these reflections.

This is analogous to ripples on a waters surface hitting the sides of a lake and bouncing back – affecting the waves still heading towards the waters edge.



Reflections causing interference

These reflections upset the ripples travelling forward, causing ‘dead spots’ in the ripples – i.e. no radio signal at all.

This is like driving in a car listening to the radio. You stop at some traffic lights and the reception goes bad. You find yourself edging forward in the car to regain the radio station!

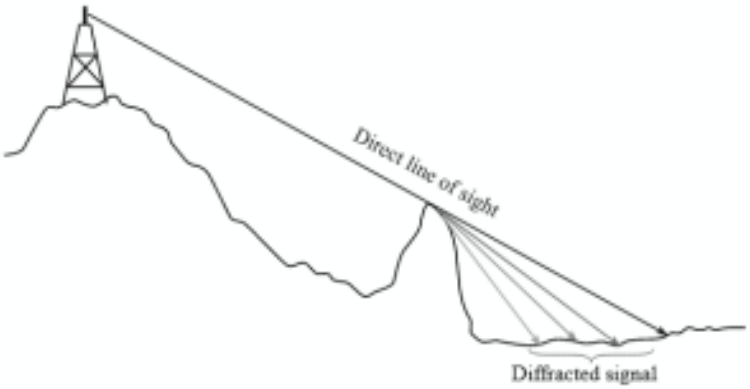
Or maybe moving a portable tv antenna a little to regain the picture.

In these simple examples the antenna is sitting in a dead spot caused by reflective interference, moving a firing unit may also improve its reception especially if nearby units are getting a better signal.

In fact, many materials not just metal can cause radio waves to reflect.

Diffraction

Radio waves can also be *diffracted* by an object causing spotty reception behind that object – leading you to think you have good reception but struggle to get good reception at other positions nearby, again moving units may fix the issue.

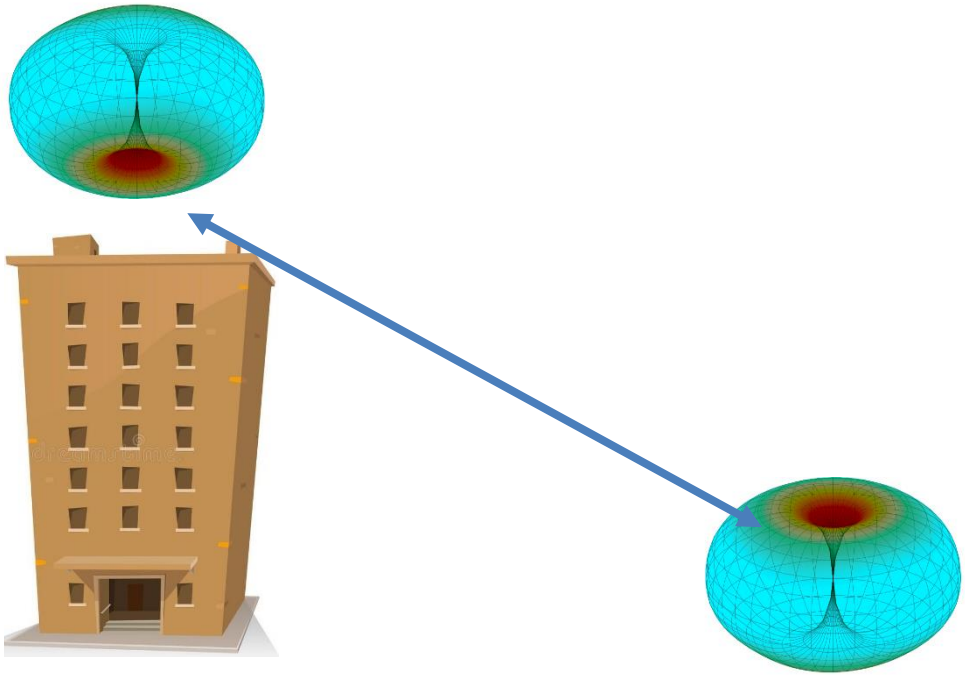


Mismatched antenna elevation

Thought should be put into where the firing units are to be placed and where the control position is (computer and CFCIU-1).

Think again back to our donut:

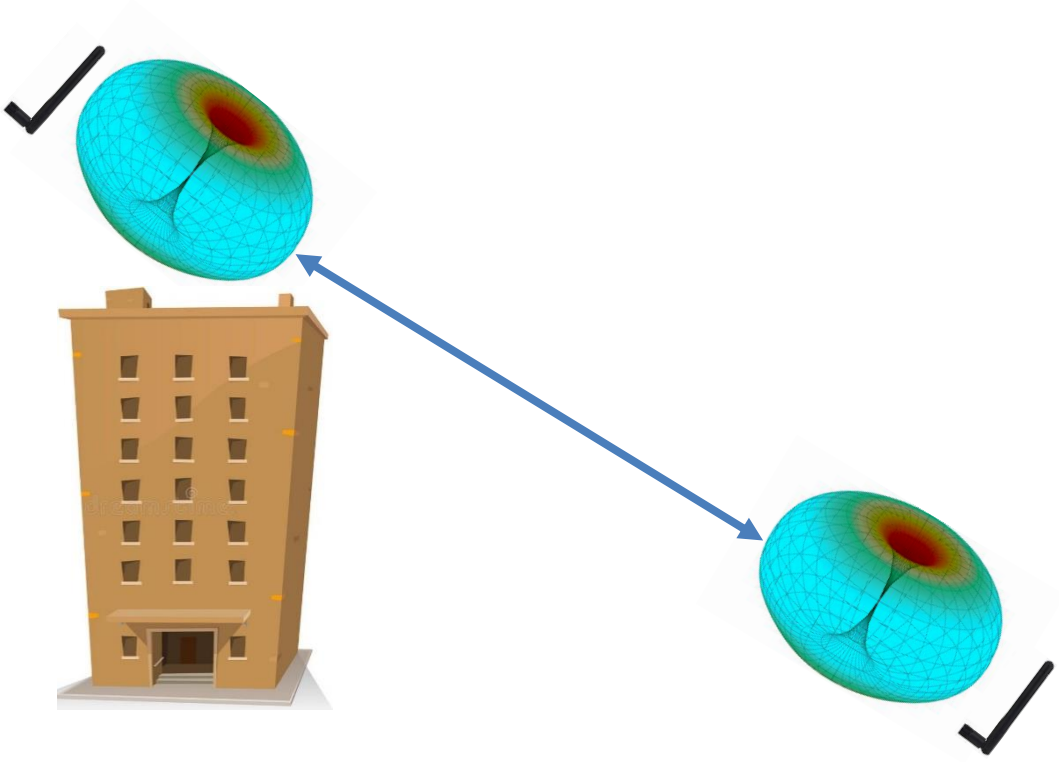
You can see in the above picture that the antennas are at the same elevation and so the strongest radiation patten is matched.



Now we have a control position located on the ground talking to a firing unit on a rooftop.

You can see that the donut shape radiation patten now has its weaker regions facing each other, coupled with the physical building too and you might have reception difficulties.

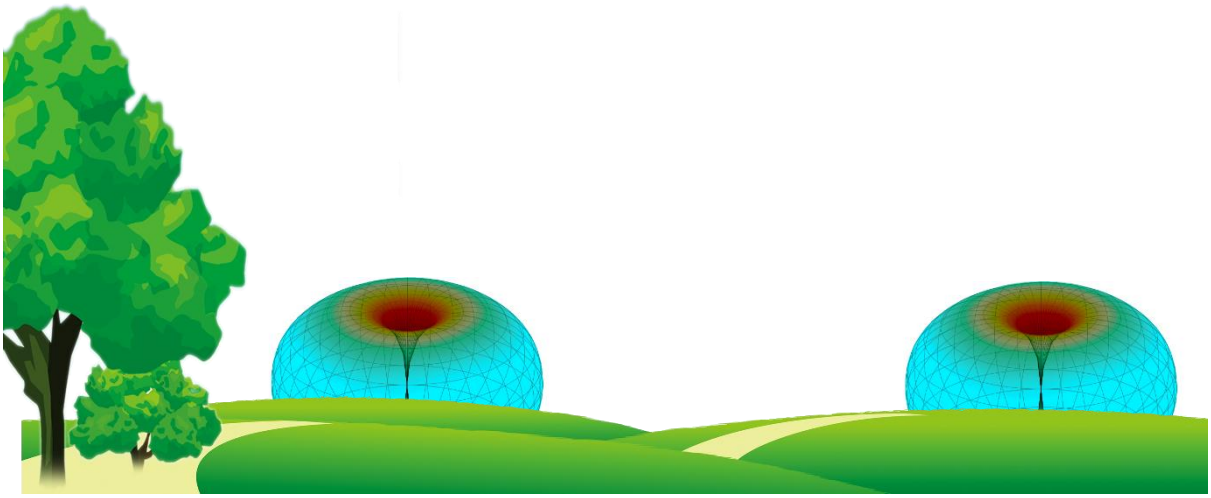
In this scenario it may be better to angle the antennas slightly.



Raising units

We have said that with a vertical antenna the signal strength weakens toward the top/bottom holes of the donut.

When units are placed on the ground most of the pattern is absorbed by the ground:



Usually this isn't an issue, however where firing units are obscured by equipment (racks etc.) and uneven elevation of the ground the signal can weaken.

On tricker sites it may be better to stake into the ground wooden posts and fix the firing units to it – reticulating the antenna so that they remain vertical, keeping the firing units and the CFCIU-1 roughly at the same elevation and clear of obstacles.

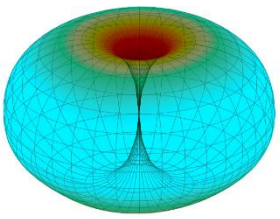
Some also find that using simple plastic crates to raise the firing units off the ground work well.

Raising units also has the advantages that the units are at a more comfortable working height and you can observe the safety indicator and hear the bleeper better too.

Antenna gain – understanding its effect – using different antennas

Many people believe that an antenna with a high gain is somehow 'better' than a lower gain antenna. That, somehow, they will get a stronger signal with a higher gain antenna.

Think back to our donut:



If the radio waves came out of the antenna in a perfect sphere with no weaker spots at all (no donut hole) you might think it has a high gain – in fact its gain would be zero (0 dB).

The antennas supplied with CATFire are not perfect – none are – but we keep the gain low to be as near to perfect as possible – so you get a good even reception and transmission all around the antenna, minus those donut holes of course, which are the reason the antennas are not 0dB and have a slightly higher than zero gain.

So what is antenna gain?

The higher gain an antenna has the more *directional* it is.

An extreme example would be an antenna that emits its waves laser-beam like (transmit) and an antenna that only accepts energy in a single narrow tunnel (receive).

All of that energy is concentrated in one spot. Its gain is very high because the antenna concentrates the signal it has in a narrow space.

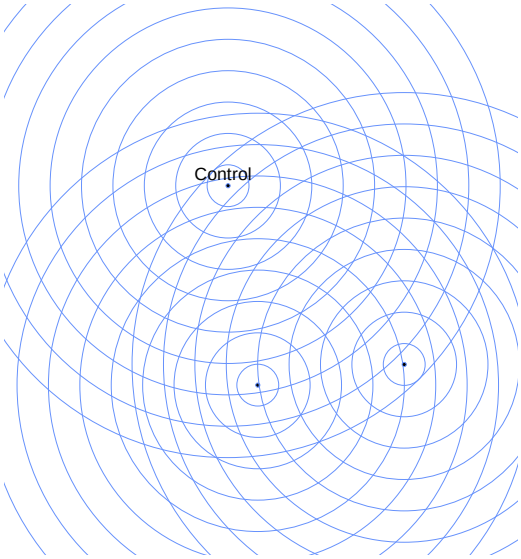
The downside to such high gain is the antennas would have to be in perfect alignment – very difficult to achieve on a firing site with multiple firing units all spaced out trying to communicate back to its CFCIU-1 interface unit.

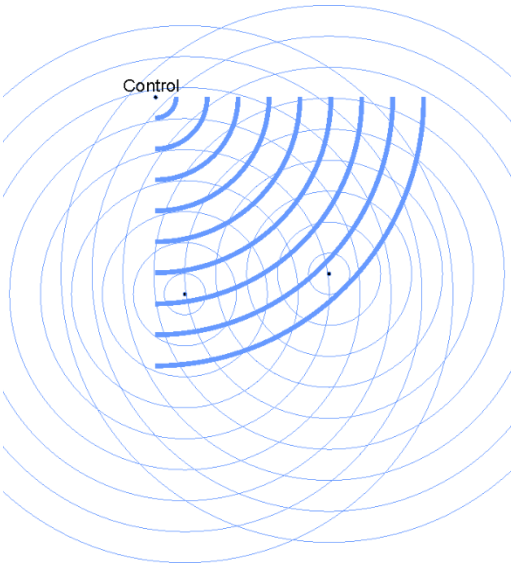
Remember: an antenna cannot create more energy than what is put into it. But it can focus that energy.

When using different antennas with CATFire you should be aware of the antenna gain and its radiation pattern (how those waves emit from the antenna or are expected for input to the antenna).

A higher gain antenna might be useful at the control position – where your control computer and the CFCIU-1 is – but it is rarely useful on the firing units themselves which tend to be placed somewhat ad-hoc and need to receive and transmit in all directions as best they can.

You could imagine a slightly more directional antenna concentrating energy toward the firing site CFTFU-X16 units – so wasting less energy emitting where there are no firing units.





The diagram on the left is using a low gain omni-directional antennas like supplied with CATFire.

The diagram on the right shows the control position using a higher gain (directional) antenna – its energy focussed across the firing site. CFTFU-X16 units get a stronger signal from the CFCIU-1.

Remember that this kind of antenna needs to be suited to the firing site layout.

Remember also to get a good idea of the radiation pattern from such an antenna – typically the pattern is focussed into a cone shape, which is not shown on this diagram, here showing as a simple horizontal plane.

Site assessment

When visiting a customer site to inspect it for risks and what is possible for the show it is also the perfect time to assess for radio signal issues too.

Radio reception must be a part of your assessment – not for safety – but rather for successful delivery of your show.

It can be beneficial to take your Computer, CFCIU-1 and one or more CFTFU-X16 units and test practical positioning to ensure there are no radio reception issues.

Other trades

CATFire uses a stated 868MHz radio frequency. It has 70 channels around this frequency and actively hops between these during operation.

The exact frequency band taken up by these 70 channels are 863 MHz to 870 MHz.

So you can see that CATFire uses far more frequencies than just 868MHz.

As part of your site assessment, you should also test for radio conflict issues too – check with your client what radio systems they have and especially what may be operating periodically – you can bet that equipment will be running when you are trying to fire your show!

Also, when you expect to work with other trades such as lighting, sound etc. check with those trades what radio equipment they will be using.

Some radio microphones will conflict with the CATFire radio band so it's especially important to check this.

Obtain information about not just the stated frequency of their equipment but the *band* of frequencies they use and ensure that they can be re-tuned to a frequency outside of that used by CATFire.

Example:

1. A sound engineer gives you a frequency of their microphone of 862MHz and states a *bandwidth of* 2MHz
2. Assume this 2MHz is centred around the frequency, so in this example the band used would be 861 to 863MHz
    a. NOTE: It is always better to get the exact frequency range used by the equipment, assuming the bandwidth is centred around the frequency stated is not always correct.
3. CATFire uses a band from 863 MHz to 870 MHz
4. **This would conflict with CATFire communication!**

If you do experience communications issues due to radio 'conflict' this can show up as being a good radio signal quality (dBm) but a poorer communications quality – i.e. when the signal does get through it's a strong signal, but otherwise the communications are being corrupted by other signals leading to missed control messages.

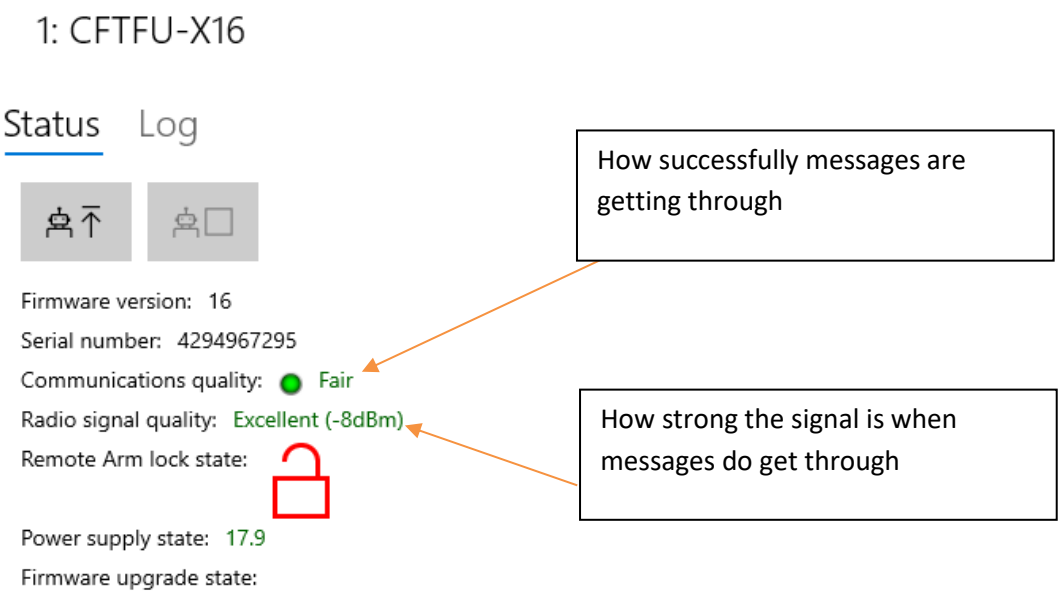
Continued on the following page…

In the example below you can clearly see the CFTFU-X16 is reporting a strong Radio signal quality (-8bBm is excellent) but only Fair communications quality.

In this example we have placed the CFTFU-X16 unit next to the CFCIU-1 but have activated a microphone that operates in the 863 MHz to 865 MHz range.

CATFire is detecting communications problems as it hops through its 70 channels – occasionally conflicting with the microphone. In fact CATFire in this test is cycling from Fair to Excellent communications quality as it attempts to avoid the microphone.

It should be noted that CATFire communication is exceptionally robust – even in the noisiest radio environments CATFire can operate and fire successfully - and did so in this test.



NOTES