Leaky CoaXial cable; frequently asked questions.

Revision 0.1

What 'bits' do you need to make up a length of Leaky CoaXial cable (LCX)?

This is easy. You need your length of cable, say 30m or 50m, whatever. On each end of the cable you need to fit one of the proprietary N socket connectors. Then the remote end (the end NOT connected to the Access Point) you fit a terminator onto the N socket. On the end where the AP's to go you use an appropriate pigtail to go from the N socket on the LCX to the antenna socket on the AP.

What is the WiFi Range?

This is by far the most popular question we get asked when talking about LCX (Leaky CoaXial) and it's the most difficult to answer. As we keep on telling people, you can only discuss the WiFi range of a system if you know about BOTH ends of the link. One end of the link is the LCX with its access point. The other end, the client end, might, for example, be a rubbish mobile phone. If you have a WiFi conversation then the weak point is invariably the weedy signal coming back from the client device. The problem is we don't know anything about the WiFi specification of the mobile phone or, generally, the client at the other end so it's virtually impossible to give a decent answer to this question. The other factors are the LCX end i.e. how long the cable is and how good the access point connected to the LCX is; but at least you can supply the specifications for this end of the link. So, if push comes to shove, if you insist, in the absence of any specs for the client end then I'd guess a usable distance for client from the LCX at between 10 and 25m. However this assumes line of site from the LCX to the client. Also you've got a decent AP on the LCX and you've been sensible with the length of the LCX.

So lets say you DO have the specs for the client end and you aren't afraid of the maths ;-)

If you want more details for the maths then I direct you to our more in depth article:

http://www.solwise.co.uk/downloads/files/leaky-feeder-cable-introduction.pdf

However, skimping the hard maths.....

The key information for the LCX is the coupling loss which, for our CMC50 cable that's 70dB, and the insertion loss which is 0.153dBm/m (at 2.4GHz). The coupling loss is the ratio between the RF power in the cable and what the RF power would be at 2m from the cable, and you should really already know what the insertion loss is. ;-) Next we need the RF power being inserted into the LCX by the AP. Let's say, for example, it's a decent AP (i.e. NOT HP or Cisco!) so it's got 25dBm power injecting into the cable at the source. So let's do the maths for 25m's down the cable (the total length of the cable doesn't matter... the cable could be 50m long but all we care about is the signal 25m along the cable from the Access Point). We can now calculate the signal INSIDE the cable at this point 25m along to be 21.18dBm i.e. 25dBm – 3.825dBm (which is the cable loss, 25m at 0.153dBm/m). Now, since we know the ratio of power IN the cable to the effective power 2m FROM the cable is 70dB then that makes the effective power, 2m from the cable, to be -48.83dBm (i.e. 21.18 – 70). Using simple free space loss calculation we can now work out the signal at further distances: 10m is -62.80dBm, 20m is -68.83dBm.

So the question is, is -68.83dBm at 20m a good enough signal for our client device? The

specification to look at on the client is it's signal sensitivity. Now it's real hard to find out the specs for something like an iPad BUT if, for example, we look at the specs for a semi-decent USB WiFi dongle (like the EnGenius EUB9603) then this has a best sensitivity value of -85dBm i.e. it's about 20dB better than the signal strength so there are no problems with the client device receiving the signal 20m away from the cable.

But, what about the signal going the other way? Well the reverse is much the same except the client, in this case, only has 15dBm plus the 2dBi antenna, so 17dBm total. So that's 7dBm worse than the AP. So the signal received at the AP will be 7dBm worse that the signal being received by the client. So it's -68.83 one way so it would be -75.83 when the client is sending a signal back. Checking the sensitivity of our example access point we see a signal sensitivity between -74 and -92 depending upon WiFi speed i.e. there's no problem with the access point receiving the signal back again.

So the conclusion is that the client will work fine when placed 20m from the cable, 25m down it's length. Note this assume line of site i.e. nothing in the way between client and LCX cable.

So does that answer your question?

Will it work with 11n Access Points?

Quick answer is yes BUT you have to be very careful and it depends upon which 11n mode you are using on the Access Point. One of the features of 11n is it can do multiple streams. So, for example, so-called 300meg 11n WiFi uses two streams (two antenna) with a 40MHz wide channel per stream. So, if you wanted to use LCX for 300meg 11n then you would need to run two lengths of LCX down the same stretch. So if it's in the roof of a warehouse then you need to run two lengths, maybe 20-50cms apart, of the LCX. Each length back to one of the antenna connections on the AP (Access Point). If you are going to run only single stream 11n then you can get away with a single section of LCX BUT, if your Access Point has the option of one stream (for example 150meg 11n, MSC0-7) or two streams (for example 300meg 11n, MCS8-15) you MUST ensure that you connect the LCX to the correct antenna socket i.e. the one that the Access Point is going to send out it's single WiFi stream from. Along the same lines is check that the same antenna connector is also used for 11g WiFi. You need to make sure that your network can also cope with clients wanting to send 11g WiFi (not 11n) so, if using just one antenna socket on the AP you need to check that same antenna is also used when the AP uses 11g WiFi.

What is the best Access Point?

The best Access Point is one which has a very good power output and, just as important, very good signal sensitivity. There's no point on using an AP with a shed load of output power when it can't hear the signal coming back! It's worth picking Access Points where the money's been spent on decent a WiFi interface (the hardware) rather than flashy software functions. Try to go for a business class AP rather than a cheapo SoHo unit. Typically a business class AP will have decent figures for power and signal sensitivity But at the same time good value for linear signal noise and EVM. Most cheapo SoHo access points are just based upon the hardware used for cheap client devices so they might spec with good RF power but all the other specs are poor. Also, don't be wooed by a big, posh, brand name like Cisco or HP (for example). If you look at the specs for a typical big brand AP you will often see not bad on the signal sensitivity but pretty rubbish on the RF power. Check the specs!

How long can the cable segment be?

Well we're back to question 2 really: The length of LCX you can use is influenced by several factors i.e.

1. The properties of the WiFi client that is supposed to receive the signal i.e. does it have good RF power and good sensitivity?
2. How far away is the client from the LCX?
3. What are the RF properties of the Access Point; yet again signal power and sensitivity?
4. I'm sure there are some other factors but I'll have to think some more! ;-)

If we look back at Question 2 then we were discussing a semi-decent client trying to pick up a signal 20m away from a point 25m down a length of LCX cable and the conclusion was it should work fine. In fact, as discussed, the limiting factor was the inferior capabilities of the client device – it usually is in any WiFi link! However, if you were prepared to accept a drop in throughput performance then the cable length could easily be extended 10, 20 or 30m. Then, if you were going to be sending signals to a client closer than 20m from the cable then you can increase the cable length some more. Of course things start to suffer when the client end isn't so good. For example if it's a hand held device like a phone or i*** then the WiFi probably won't be as good as you get from a decent USB dongle. In that case the distance it will work from the cable or the distance down the cable will be reduced. However, typically we say (with a decent Access Point) cable lengths up to about 50m should be okay though, tbh, I think this is probably erring on the pessimistic side.

If you want longer runs of LCX then consider using amplifiers (see below).

Can I do spurs or 'Y's on the cable?

Well yes, in theory but not to be advised. There are two issues with splitting a length of LCX using 2-1 splitter in order to send the signal down two lengths of LCX e.g. to branch off down a corridor: First off splitting the signal halfs the power on the two outputs. For example if the signal in the cable going into the splitter was 20dBm then each of the two output sections would be 3dB less i.e. 17dBm. Obviously that has an immediate impact on the length of LCX you can use and also limits the client operating distance and the data throughput rate. The other factor is taking care to ensure the client doesn't receive the signal from two sections of the LCX. So if there is the possibility that the client can pick up the signal from the main section of LCX and, because of the way the spur (coming from the splitter) is run, also from one of the LCX branches then the client can get very confused picking up the same signal from two locations: It seems to produce strange affects on the client with the signal wildly fluctuating; presumably because the client is flicking back and forth between the different parts of the LCX. By the same dint you shouldn't loop the cable such that the client is able to pick the signal up from several areas of the LCX. So don't, for example, loop it around a room.

How can I mount the cable?

LCX is quite flexible on how it can be mounted. The only important criteria is the radiating side of the LCX must be at least 10cms away from any hard, RF reflective, surface e.g. a brick wall, corrugated iron roof etc... CMC type LCX radiates from the two flat sides of the cable so, if mounted standing off from a wall then orientate it so the flats don't point at the wall. The RMC cable radiates out of one side. The back of the cable has an indicator line running up the PVC jacket which is the side that should orientate towards the wall. Please note we hope to soon have a quick fix standoff bracket that can be used to hang the cable or run the cable along a wall or ceiling; a

standoff bracket would have to be fitted approximately 1-1.2m spacing. If the cable is to be run in ceilings or floors where there are no solid surfaces near by then the cable can just be laid to direct the signal in the desired direction. Generally CMC cable is very tolerant on orientation (with the proviso for solid walls, above) and have almost 360 degree complete coverage. RMC LCX cable needs to be orientated with more care since the signal is concentrated from one side (giving a beam angle of about 180 degrees coverage from that side). The cable must be supported at distances no greater than 1-1.2m apart or it can be laid directly onto suspended ceiling tiles or plasterboard. If you need to bridge distances between buildings or to hang the cable from a warehouse roof then a catenary wire could be used with LCX fixed every metre with a nylon cable tie. Just ensure that the radiating part of the LCX is away from the suspension wire.

Is it outdoor proof?

Yes. The PVC outer jacket is good for at least 20years outdoor use however we don't advice that the connecting points are exposed.

Can I use boosters to extend the maximum length?

Yes, no problems. So, for example, you could have 50m of LCX running from the Access Point. Then install WiFi booster to continue on for an extended section. For example, if using our 2W external WiFi booster then that would typically give you another 100m extra length. You could then fit a second booster to extend again. The number of boosters you can use and the length of LCX that can be driven by the booster depends upon the data throughput rate required, the quality of the boosters, and factors such as the capabilities of the clients. Each booster adds a noise element to the signal which directly affects data throughput. With good quality boosters two boosters for 11g WiFi on an LCX segment should be fine.

What about Ofcom limits on EIRP?

Well the Ofcom calculations for EIRP are rather simplistic and as such can only be applied to the signal as calculated emitted from one point on the LCX cable. This means, taking the coupling loss figure into the calculation, then the EIRP for LCX is always low.

Typically EIRP is given as:

EIRP = Pt – Lc + Ga

where EIRP and Pt (output power of transmitter) are in dBm, cable losses (Lc) is in dB, and antenna gain (Ga) is expressed in dBi, relative to a (theoretical) isotropic reference antenna.

In the case of LCX the antenna gain is a figure which can be derived from the coupling loss.

So, what we have is

RP = (Pt – Lc) - Cl

where Cl is Coupling Loss.

So, for example, if the AP is 25dBm and the LCX insertion loss is 0.153dBm/m and the point were calculating for is 25m down the LCX, and the coupling loss is 70dB then...

RP = (25-3.825) – 70

= -48.825dBm

However coupling loss is calculated at 2m from the cable so we need to add gain back to take account of the free space loss in the 2m of air. I won't go into the maths but 2m free space loss is 53.07. So we can work backwards and say that our -48.825dBm at 2m from the LCX is like 4.245dBm at the cable. i.e. well down on the 20dBm EIRP limit for 2.4GHz WiFi. You would have to be chucking in an awful lot of RF power before you need to worry about 20dBm EIRP limits!

Can I use LCX for mobile phone signals?

Depends upon the type of LCX and also the frequency of the phone signals. Coupled mode LCX (CMC part number) is generally quite flexible on the frequency range it will support so it will usually work on the various mobile phone frequency ranges. However you need to check on things like the coupling loss at the frequency range you want to work at. Radiating mode LCX (RMC part number) is more selective on the supported frequencies, it's better on the frequencies it does support but more limited on the range. As such radiating LCX needs more reading of the specs. However, in principle LCX is ideal for transmitting mobile phone signals in enclosed areas like tunnels etc.. In fact LCX is already used in tunnels like the channel tunnel for mobile phone coverage; for those people that suffer withdrawal for the 30mins underground!

However the key issue is the legalities of retransmitting mobile phone signals. Generally it's illegal to transmit mobile phone signals. In the UK it's up to £20K fine and 12 months in the clink! I think that tends to make the theoretical details of how or if you can use LCX for mobile phones moot! :-)

Can I use LCX for frequency ranges other than normal 2.4GHz WiFi?

Yes. As mentioned in the question about mobile phone signals, there's nothing wrong with sending other frequencies down LCX cable but you need to check that the cable is 'tuned' to the frequency range you require. CMC type (coupled mode) is quite flexible with the frequencies it supports but RMC (radiating mode) is more tuned. Performance wise this means that, for the frequencies RMC does support, it give better performance than CMC but it does sacrifice flexibility on supported frequency ranges.

For example, a question often asked is what about use for 5GHz WiFi i.e. the range 5.1 to 5.8GHz. Well CMC50 cable will work for this range BUT tbh we don't have any specifications for insertion or coupling loss at these frequencies. tbh I wouldn't advise using our standard CMC or RMC cable for 5GHz. We can source a cable more geared to this range if required.