



Why does the Aprisa XE go further?

Quite often we are asked ‘What does 4RF do differently to other microwave manufacturers to get the extra distance?’ While the differences in distance capabilities of different frequency bands are often understood, the question is usually targeted at our claims of ‘going further’ than those in the same frequency bands. To answer that question we need to look at the design philosophy and resulting technology and techniques used.

Overview

The Aprisa XE has the ability to link distances often thought of as outside the reach of traditional digital microwave radio links. The first thing to say is that there is no magic! Our results are derived from a design focus on high specifications, quality and stability or as we call it ‘distance engineering’, which is the product of greater than 20 years of experience in microwave radio design coupled with the very latest components and design techniques.

Frequency bands of operation

4RF operates exclusively in the sub-3 GHz licensed bands. When compared with the use of 7 GHz and above, sub-3 GHz has significant advantages in terms of free space loss (path attenuation) and is largely free from atmospheric considerations such as rain fade:

- Sub-3 GHz frequencies support links typically two to three times longer than 7 GHz and above frequencies
- A tropical storm may introduce 80 dB of rain fade over a 50 km path at 7 GHz, while at 1400 MHz this may be as low as 3-4 dB

While there are a number of additional advantages to operating in sub-3 GHz bands, the focus of the remainder of this memo compares our performance to that of others in the same frequency bands.

Distance engineering

Distance engineering, as we call it, is a focus on highly quality design in two main areas:

- **High RF system stability:** extremely high design specifications for the RF modules combined with the latest RF componentry has resulted in a stable platform that introduces little or no distortion or ‘noise’ to the RF signal. As a result the system only has to correct for and cancel distortion in the signal from the RF path. The Aprisa platforms have a level of stability in the oscillators and RF chains not matched by any product we are aware of.
- **Signal correction techniques and FEC:** multi-tap adaptive equalization and Forward Error Correction (FEC) combine to both cancel distortion from the path such as multipath or fading, and correct any resulting errors, essentially extending the receive levels for which errorless operation can be maintained.

As a side advantage the stability and correction techniques are also the reason we can achieve much higher levels of modulation than achievable with other equipment and therefore provide higher traffic capacities in a fixed channel than any of our competitors.

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How long is 'long'?

Our longest link (and we think the longest in the world) is running at 241 km or around 150 miles in Equatorial Guinea, carrying 5 Mbit/s capacity split between Ethernet and 4-Wire analogue circuits - providing backhaul for Motorola trunked mobile base stations (P25 product).

This path is entirely over water, and is operating in a standard non protected (1+0) configuration. It has been running for an extended period, without issues and exceeding the calculated performance expectations. While not suitable for extending a cellular base station the 99.9% availability operation is more than adequate for this application. It should be noted that the availability could be improved to approach 5x9s with the use of our Hitless Space Diversity configuration (HSD) if required.

Naturally to achieve this we have a very high antenna height at one end, at approximately 2,500 m. Again a key note is that there is no magic and some difficult paths may not be suitable for linking at 20 km, so precision engineering is key to maximizing performance.

From the designers...

The following paragraphs detail some of the points of focus and techniques in the design of our RF and modem platforms. These paragraphs are direct from the RF and Digital design group managers within 4RF's R&D team.

The design target was to ensure that the implementation error or difference between the theoretical performance and actual performance of the radio was typically less than 0.5 dB. This means that any noise/distortion through the transmitter and receiver has been reduced to an absolute minimum. This gives the greatest system gain but also means that the radio does not degrade the signal performance.

All the key parts of the system were designed with this in mind. The RF synthesizers were designed with 10 dB of noise margin using the latest fractional N synthesizers to give the best phase noise and lowest spurious emissions. A key area of performance is the use of band pass duplexers with high isolation to make sure that the transmitter signal has 0 dB impact on the receiver sensitivity.

This is a crucial area as it is not just the transmitter noise floor at the receiver frequency or the transmitter signal acting as an interferer but the transmitter noise at all the receiver spurious frequencies that can de-sense the radio. To make sure that the transmitter and receiver are truly isolated these were placed on separate PCBs to achieve the highest isolation.



Aprisa XE

The Aprisa XE in brief

- Highly flexible point-to-point microwave link
- Accommodates all data, voice and IP traffic requirements on a single future-proof platform
- Industry-leading platform: goes the greatest distance, delivering the greatest capacity band
- Low total cost of ownership: technically and financially outperforms higher frequency microwave links, particularly in rural and remote areas

QAM modulations can be degraded very easily as the amplitude has to remain stable through all control loops in the receiver and transmitter. These have all been optimised and tested so that there is no degradation to the signal. Highly linear transmitters and transmitter chains are used to give the lowest distortion to output power so as to minimise the distortion to the signal. Also special attention to performance over temperature was made. Making sure that the transmitter power doesn't vary by more than +/-1 dB over the range and changes in SNR are limited to +/-2 dB. Every unit is factory tested to this specification to make sure that the radios exceed the requirement. At ambient temperature most radios with standard duplexers will have 6 dBm margin on our required sensitivity. Every additional dB of system gain makes a difference to performance.

Additional to system stability is the need to mitigate any path interference and distortion. Attention was paid to achieving the best receiver performance under strong C/I and intermodulation distortion. This meant using high IP3 amplifiers and image rejection mixers and making sure performance was balanced between the RF and modem. The modem uses a raft of performance enhancements, a Reed-Solomon block FEC code with interleaving that spreads bursts of errors over several Reed-Solomon code blocks, thus permitting a better chance of being able to correct the errors. The modem also incorporates a time-domain equalizer consisting of two parts, a Feed Forward section with a 24-tap, fractionally-spaced FIR filter and a Decision Feedback section. This gives the optimum performance for multipath interference that will be encountered on a point-to-point link. Finally the modem incorporates an I/Q imbalance correction block that is able to compensate for small imbalances in the phase, amplitude and DC offset of the base band I and Q signals introduced by slight imperfections in the analogue circuitry.

Summary

In short, a focus on distance engineering has led to an extremely stable platform. With the addition of advanced signal correction techniques this allows Aprisa to provide linking solutions over extended distances, often previously considered unachievable by point-to-point microwave radios.



Aprisa XE



ABOUT 4RF

Operating in more than 130 countries, 4RF provides radio communications equipment for critical infrastructure applications. Customers include utilities, oil and gas companies, transport companies, telecommunications operators, international aid organisations, public safety, military and security organisations. 4RF point-to-point and point-to-multipoint products are optimized for performance in harsh climates and difficult terrain, supporting IP, legacy analogue, serial data and PDH applications.

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