

# **The Status of Evolution of 2.4 GHz**

By

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## **Introduction**

Radio sets that operate in the 2.4GHz band of frequencies are now available and several have been accepted for use by the MAAA. Inevitably this means that we will see more and more of them in use at model flying fields. There is no doubt that the spread spectrum technology in this equipment, now used for the control of model aircraft, is very exciting and it is likely that over the years it will become the norm, whether on the 2.4 GHz, 900 MHz, 5.8 GHz bands or any other band where it may be legal to operate. The safe use and operation of the technology for model aircraft is an evolving activity.

Manufacturers are justifiably proud of the products that they have invested a lot of time and money in developing, and of course each pushes the advantages of their versions in what is a very competitive market. However, they do not necessarily fully know or disclose the impact or interaction of their product on other equipments that are available, and indeed it may be a fact that no one has a total overview. One thing we do know, is that an out of control model aircraft can be very dangerous and so it is wise to be cautious while there is any doubt as to the operational safety of the various technologies.

There are some popular misconceptions about how the technology, as applied to model aircraft control, operates. One misconception is that Australian Standard for the 2.4 GHz equipment is the same standard that applies uniformly everywhere in the world. Another major misconception is to say that over two billion of these equipments can operate at the same time and there is no possibility of interference. This is different to a statement that that there is negligible possibility of another transmitter actually controlling your model.

This article will endeavour to further explain about the use of 2.4 GHz for models, but is not intended to replace the need to read the MAAA Policy, MOP 058. This covers the use of equipment in this band for the control of model aircraft. Anyone using, or thinking of using this type of equipment should carefully read and regularly check the MAAA Web page, <http://www.maaa.asn.au/mop/policy/MOP058%20-%20Policy%20-%20204%20GHz%20EQUIPMENT%20-%201-7-07.pdf>, for updates.

## **Technology**

At the time of writing, the MAAA has accepted three technologies, and the equipment using them, subject to some conditions which are in the MOP 058. All three systems operate in very different ways. Other manufacturers are almost certainly developing their own products. Until these products are on the market we will not know how they operate, but there is every chance that they will be using proprietary, but different, techniques. Until any new product is listed in the MAAA MOP as ‘Accepted’, its use is not authorised for MAAA activities. Obviously, the MAAA tries to evaluate new products as quickly as possible but often we are not provided with a sample, or much information, until the equipment is available from an Australian distributor. We then need to consider if the equipment is suitable for model aircraft use, as there are radio control implementations of 2.4 GHz technology which are not. We also need to determine how the equipment will interoperate with existing ‘Accepted’ equipment, and, if necessary, to enable appropriate restrictions to be applied to enable “safe” operations at our flying sites. Accepting equipment only means that the MAAA has done some evaluation and has not found any

significant problems which cannot be overcome; it does not mean that no problems will appear as more experience is gained in the actual use of that equipment.

As a result of discussions with the various manufacturers, the MAAA has technical information that is not available to the public and which has been provided on a confidential basis. Obviously it cannot be put in an article such as this. In some cases too much technical information may just confuse readers, so it has been kept to a minimum anyway. Anyone who seeks more information can always look at manufacturers' information or other sources that are in the public domain.

The acceptance of the Spektrum DSM2 system, like the other technologies whose description follows, is not limited in principle to a particular product, but rather to the acceptance of the general implementation in the manufacturer's radio products that use that system, except where the manufacturer places their own restrictions on its use. The Spektrum DSM system, which is very similar to the DSM2, differs in some technical details, and is only recommended by the manufacturer, and accepted by the MAAA, for Park Fliers. After switching on, a Spektrum system looks for two frequency channels that are not in use from within the whole of the band. When it finds two channels it starts to transmit on these frequencies. The receivers then lock onto them and the link is established. If it does not find two clear frequencies then the transmitter does not radiate and the complete receiver system is locked out and control is not possible. The system uses at least two separate receivers and antennas to provide alternate radio paths to improve the robustness of the link. Once locked on, the equipment operates on these frequencies no matter what external effects are present until it is switched off. The next time it is switched on, the equipment goes through the same process and may well select different frequencies.

The Futaba FASST system uses a totally different operating concept. It does not consider what any other equipment operating in the band is doing. This system changes frequency very rapidly and in less than a second will have operated several times on every part of the available 2.4 GHz frequency band. The receiver tracks the changes of transmitter frequency so it maintains what appears to the user as a continuous signal. It uses two antennas at the receiver and the receiver uses the better of the two signals by monitoring what is happening on both. Every FASST set operating will be hopping across the same frequencies in what is called a pseudo random basis. Of course at times it will hop onto a frequency which is being used, either by another FASST equipment or any other type of equipment. The section on interference describes the impact of this type of operation.

The Xtreme Power Systems technology, XtremeLink, is different again. In some ways it is similar to the DSM systems in that upon switching on it looks at the specific frequencies on which it operates to determine the best one available. It then transmits on this single frequency. The big difference between this and the other systems described in this article is that it monitors the performance of the radio link. This is achieved by having a combination transmitter/receiver in both the ground unit and in the airborne unit on the model. If the signal quality deteriorates to the point where the link might become marginal, for whatever reason - internal or external, the system changes to another frequency, if one is available, that will provide better communication at that point in time.

## **Interference**

Based on experience of the radio systems that we are used to, it may appear surprising that these 2.4GHz systems do operate together, as they also do with the many other users of the 2.4 GHz band including cordless phones, computer wireless local area networks and many other domestic and industrial applications. That is not to say that the usage is without limit

and the author understands that in some parts of Hong Kong and Taiwan the 2.4GHz band is totally unusable for anything, even with severe limitations, due to the large number of users attempting to communicate using it.

In technical terms, spread spectrum technology is designed to work simultaneously with other encodings and avoid direct collisions through complex algorithms that include randomization of the transmission times and encoding changes. Sorry this is bit of a mouthful but what it means is that the systems are designed so that more than one system can operate on the same frequency. Again this does not mean the numbers are limitless. As more transmitters access the same frequency, whether with the same or a different implementation, transmission collisions will occur more often and in technical terms this is seen as an increase in the noise floor. This does not mean that at some instantaneous point in time the systems will stop working. What happens is that the speed of control response will slow and this may be difficult to identify until there is an urgent control requirement. This is of course more critical to the control of a model aircraft than it is, say, for the time to download something from the internet. The impact of this collision issue on the different technologies in use is not the same and it is not possible to know whether the next brand of equipment, with a different implementation, will be better or worse.

For this reason the MAAA has placed a limit on the number of 2.4 GHz radio systems that can be used simultaneously at 10. With the currently accepted equipment, 10 is slightly conservative and is caused in particular by the impact of systems that use hopping technology. It is always possible that, when the use of this band for model aircraft has stabilised, this limit may be reviewed. This limit is one of the reasons why the MAAA requires that a frequency control system is used for this band, even though actual frequencies cannot be specified. The other reason for the MAAA, and also the AMA, (the US equivalent of the MAAA) requiring the continuing use of frequency control is that the discipline of always using a key, or equivalent, helps to avoid mistakes by individuals. It maintains the confidence that the number of keys inserted is still equal to, or greater than, the number of transmitters in use; a check that is still mandatory for control of the 36MHz and the other frequency bands that are used.

### **Legal Requirements**

In Australia it is a requirement of the Radiocommunications Act 1992 that all radiocommunications equipment, including model aircraft transmitters and receivers, operate in accordance with the relevant technical standards, and where relevant the class licences. Whilst it is true that 2.4 GHz is used in many countries, the requirements for its use are different in different countries. These standards cover not only the specific frequency band but also the power output, spurious signal levels, EMR, EMC, environmental conditions and other technical parameters which are not usually specified in model radio control datasheets, and for which it is impossible to expect the average user to determine. In many instances the Australian Standards are more onerous than those that apply in other countries. The author has been shown an individual slot car that is legal in the USA but which does not comply with the Australian EMC requirements, and in fact badly interferes with an electronic lap counting system.

The Radiocommunications Act is administered by the Federal Australian Communications and Media Authority (ACMA) and they will impose severe penalties on anyone who uses equipment that does not comply and who causes interference to other users. The Australian C-Tick compliance system requires that the responsibility for compliance of equipment that is either manufactured or sold within Australia is taken by either the manufacturer or the distributor. A C-Tick compliance mark applied to any equipment indicates that the importer

or manufacturer has made a declaration of conformity that the equipment complies with the mandatory obligations under the regulatory requirements, holding the appropriate test reports to the applicable standards. This is subject to audit by the ACMA.

Without this compliance mark the Radiocommunications Act places the legal responsibility on the user to ensure that the equipment complies with the applicable standards and holds supporting documentation. The fact that similar equipment may be sold in the Australian market with a compliance sticker does not guarantee that all equipment of that type or brand complies. As was stated earlier in this article, the 2.4 GHz specifications vary across most countries of the world and there may be internal hardware or software differences that are not indicated externally. These build standards may also change with time. The legal requirements are complex and can easily be misinterpreted. Whilst investigating this issue, the author found some apparent anomalies and these were only clarified by asking very specific questions of the ACMA. It is known that others have asked more general questions and received different responses, and these could have led to operating illegally.

The only reliable source for an individual to obtain information on the compliance status of equipment without an Australian C-Tick compliance sticker is likely to be the original equipment manufacturer. However, what is acceptable is a matter on which the final arbiter would be a Court of Law. While the individual user must assume responsibility for documentation, model organisations, such as clubs, which have embraced the 2.4 GHz technology, should also consider their position regarding members who do not have C-Tick compliant equipment. The MAAA Insurance Policy does not have a specific exclusion clause, and so would still respond to an injured party in the event of any insurance claim that was found to involve equipment that does not comply with the Australian standards. However the insurer always has the option to institute court proceedings to recover his costs in the event that an insured party had not acted responsibly.

## **Summary**

The following is a summary of the specific requirements of MOP 058. Everyone interested in operating 2.4 GHz equipment for model aircraft control is strongly advised to refer to the actual document regularly both for more detail and to check for updates.

- Only technologies and/or equipment that have been 'Accepted' by the MAAA may be operated under MAAA Procedures.
- A keyboard system, preferably similar to the system used for the other frequency bands, shall be maintained for 2.4 GHz.
- Only 10 off 2.4 GHz radio sets are allowed to be used at any one time on the same site.
- All equipment used must comply with the requirements of the Australian Radiocommunications Act 1992, covering both Standards and Class Licence.
- Without a C-Tick compliance mark being applied to equipment, including those equipments accepted by the MAAA, the user is personally responsible for ensuring that they have the documentation to show that the specific equipment that they are operating complies with the Act, the Standards and the Class Licence.

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