MODEL AERONAUTICAL ASSOCIATION OF AUSTRALIA

2.4 GHz EQUIPMENT POLICY

MOP058

APPROVED: MAAA PRESIDENT

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Shading of text identifies changes to the previous version.

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1. INTRODUCTION

This frequency band specified for this application in Australia covers the frequency range 2.4000 GHz to 2.4835 GHz.

The use of the 2.4 GHz band for model aircraft is a developing technology and as such this document provides the current MAAA Policy and Guidance. However it is to be expected that as development continues and experience is gained that it will be subject both to refinement and possibly significant changes.

2. DEFINITIONS

ACMA	Australian Communications and Media Authority
Affiliated Member	A person properly affiliated with a Club that is properly affiliated to an MAAA Ordinary Member
Class Licence	Radiocommunications (Low Interference Potential Devices) Class Licence 2000
C-Tick	A mark attached to the unit by the manufacturer or importer indicating compliance to the mandatory Australian regulatory requirements
EMR	Electromagnetic Radiation
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute Standard
FCC	United States Federal Communications Commission
FCC ID	A number assigned for Equipment Authorisation under various FCC Rules and regulations. An FCC ID label must be found on or within the unit to indicate authorisation.
MAAA	Model Aeronautical Association of Australia Inc
MAAA Ordinary Member	A State Association properly affiliated with the MAAA Inc
RTF	Ready to Fly. A Model Aircraft manufactured and assembled by commercial business as a complete package and capable of flying as supplied

3. REQUIREMENTS

3.1 Under this policy the MAAA requires that for Affiliated Members to operate on 2.4 GHz, all equipment shall comply with Australian legislation. Unless covered by the concession detailed at 3.8, the radio control technology employed within it shall be on the MAAA accepted list. The accepted list covers only genuine products from the manufacturers stated. The details are expanded in the following paragraphs.

3.2 All equipment used for the control of model aircraft under this Policy shall conform to the requirements of the Radiocommunications Act 1992 which is administered by the Australian Communications and Media Authority (ACMA). This means that it shall conform to all technical requirements, including those for EMR/EMC, as defined in the AS/ANZ Standards and the relevant Class Licence, Radiocommunications (Low Interference Potential Devices) Class Licence 2000. This is available from the ACMA and is posted on their web site http://www.acma.gov.au/ACMAINTER.65640:STANDARD:451650419:pc=PC_297

3.3 These standards and the Class Licence are specific to Australia. The ACMA Short-range spread spectrum device fact sheet, available at http://www.acma.gov.au/WEB/STANDARD/pc=PC_1768, states the ACMA also allows operation of equipment that complies with either provisions of section 15.247 of the Rules and Regulations of the US Federal Communications Commission (FCC), or the requirements of the European Telecommunications Standards Institute Standard ETSI 300 328. See also Section 4 - Guidance.

3.4 For the user, the fact that an item of equipment has a C-Tick compliance mark applied 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. Without this compliance mark the Radiocommunications Act places the responsibility on the user to ensure that the equipment complies with the applicable standards. There are severe penalties for operation of equipment that does not comply with the applicable standards.

3.5 If equipment does not have a C-Tick compliance sticker and the user is relying on FCC or ETSI compliance marking, then the user must ensure that an FCC or ETSI label or other marking is affixed to the equipment in use and that this identifies the equipment as meeting the specific required standard as defined in 3.2. See also Section 4 - Guidance.

3.6 The operation of equipment that does not conform to the requirements of this Policy may result in the Affiliate Member having a liability in the event of a claim on the MAAA insurance policies.

3.7 Only radio control equipment conforming to specific technologies is accepted and permitted by the MAAA for aircraft use. A list of the MAAA accepted equipment is included in this document as Appendix A. In addition, this equipment shall not be used outside any limitation on the approval stated in Appendix A.

3.8 The equipment shall be installed and used in accordance with the manufacturer's instructions. This shall include any restrictions on the suitability of specific items for particular applications as recommended by the manufacturers.

Many manufacturers provide a range of products using the technology that the MAAA has accepted. There may be differences in performance between the

products sold by a manufacturer that use the same basic technology for the control of model aircraft. The reasons for the differences may include transmitter output power, receiver sensitivity, receiver antenna type, the number of receiver antennas, and the number of receivers in the installation. The latter includes those built in within the basic receiver module and through the use of satellite receivers.

Unfortunately the terms commonly used by manufacturers and modellers to describe the suitable applications (Full Range or Park Flyer for instance) do not have definitive meanings and different equipment described in such terms will not have identical performance in practice. In addition not all manufacturers provide this guidance for their products and may not declare the performance of every combination of transmitter and receiver.

For guidance, the testing that the MAAA has carried out suggests that typical products that are considered to be 'full range' by the manufacturers have a range of over 800 metres in a good installation provided there is visual contact with the model. However if the transmitter output power is less than 20 dBm (or100 mW) the range will be reduced compared to "full range" radios where transmitter powers are above 20dBm. There are two common types of receiver antennas use on 2.4 GHz. One is where the active part is a short piece of wire, typically about 25 mm long, coming directly out of the receiver. The second is a longer length of coax cable which has a similar length at the end where the coax shield is removed. This end is the active part of the antenna. If the main receiver has no satellite receiver and has either a single antenna or two antennas where the active parts cannot be moved and located away from the receiver, as can be done using the second example, then the receiver is likely to be only suitable for use at reduced distances compared to "full range" receivers. This is due to the high probability of the active part of the receiver antennas becoming shielded from the transmitter in some model orientations as discussed in 4.16. The actual range reduction depends on the specific equipment and also on the installation.

It is impossible for the MAAA to provide any more definitive guidance on range but this provides members with some basis when considering what equipment they should use. If there is any doubt then either the advice of the manufacturer or the importer should be obtained on the suitability of the equipment for the specific application.

3.9 The MAAA has reviewed the operation of accepted technology, both theoretically and practically. Based on a limited range of tests no evidence has been found that the technology would prevent operating satisfactorily in a typical flying field environment. In addition the MAAA is not able to assess the quality assurance processes of the manufacturer or the reliability of the design and these remain the responsibility of the manufacturer. The MAAA can accept no responsibility for either the actual use of the technology, as this is outside the control of the MAAA, or the reliability of the product or the impact of any product changes carried out by a manufacturer.

3.10 Due to the lower general risk of operating aircraft in accordance with MOP059, as a concession the MAAA allows radios that are not on the accepted list to operate in accordance with the following:

1. All conditions specified in MOP059, Indoor Flying, dated 09/03/2008, shall apply, except that maximum weight of a rotary wing aircraft shall be limited to

400 gms. This shall apply to all aircraft flying when radios that are not on the accepted list are in use.

2. This concession only applies to complete RTF combos supplied as a single product.

3. In accordance with ACMA requirements, if any interference is found either with the model being controlled, or any other, that is suspected to be caused by a radio that is not on the accepted list, then it shall immediately stop being used.

3.11 The user cannot control the actual frequency of operation as this is determined by the technology used within the equipment. However the MAAA still recommends that a keyboard, or similar system, identifies who the individual users of this band are. This enables all radio users to identify who has radio sets in use at any time in order to be able to verify that the complete frequency control system is valid and operating correctly. It is also recommended that Clubs use a similar system to the one used by them for the other approved frequency bands, whether this is a Silvertone© type keyboard system or otherwise. This need only identify the name of the owner of transmitters actually either in use or ready for use.

3.12 The MAAA originally specified that the maximum number of transmitters to be available for use under this MOP should not exceed 10 at the same time. This requirement has been removed but it should not be taken to mean that the MAAA consider that under all circumstances unlimited numbers of 2.4 GHz sets can be used. There are many different implementations of 2.4 GHz technology and many manufacturers have their own unique versions. These function in different ways and have their own strengths and weaknesses. Some are less prone to system degradation in the presence of multiple collocated transmitters, some provide robust fail safe capability and other technical characteristics vary.

3.13 At a typical flying field, 2.4 GHz transmitters from different manufacturers will operate and it is very unlikely that a worse case scenario will be present. Whilst the MAAA does not specify a maximum it allows individual clubs, event organisers, or anyone controlling a venue to limit the maximum number of 2.4 GHz transmitters. This number will depend on experience at similar events, experience at the venue, or on the basis of safety first. Individuals and organisers need to carefully consider the Guidance in Section 4 if setting any limits.

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4. GUIDANCE

4.1. Whilst not part of the MAAA Requirements, the following information is provided to assist users of this class of equipment.

4.2. Unlike the 36 MHz band used for model aircraft, which is almost unique to Australia, 2.4 GHz is used extensively through the world. Unfortunately the standards are not the same in each country and the Australian Standards are, in some cases, more onerous than those that apply in other countries. These standards cover not only the specific frequency band but also power output, spurious signal levels, EMR, EMC, environmental conditions and other technical parameters which are not usually specified in model radio control datasheets and which are impossible for the average user to determine.

4.3. The maximum output power levels specified in the ACMA, the FCC and the ETSI Standards vary. Generally ETSI standards specify lower maximum output powers. Whilst most equipment currently on the market have power levels lower than the

maximum allowed under ACMA and FCC Standards, users should be aware that equipment that complies with the ETSI Standards may have a lower power output than the equivalent product complying with the other Standards. If this is the case then they will give reliable operation only to a reduced range. Users of equipment marked as complying with the ETSI Standard need to be aware of this possibility.

4.4. Not all equipment currently supplied for model use is suitable for model aircraft. Equipment that is suitable for model aircraft use may have different standards of performance.

4.5. The 2.4 GHz band is a common user band. This means that many applications can use the same frequencies including, but not limited to, computer networks, hands-free phones, data links, as well as other model applications.

4.6. The Class Licence is for Low Potential Interference Devices and the output power is limited and so applications in this band are generally restricted to within the area relatively near to the transmitter.

4.7. MAAA accepted model aircraft equipment uses technology in a way that should not allow it to interfere with other equipment operating in the immediate area. This significantly reduces the possibility of interference including of course between the systems controlling model aircraft, but it is always possible that interference can occur, particularly if models are flown toward other interference sources.

4.8. Because every time a system is switched on the actual frequencies in use both locally and in the general environment may be different, the possibility of interference may vary each time the equipment is used.

4.9. The actual technology used to achieve satisfactory performance with model aircraft will vary from one manufacturer's equipment to another. The difference may be very significant. The performance of different designs of equipment may therefore vary considerably.

4.10. Equipment that is different to the one being used by any individual, whether for models or other applications, may have a much greater or lower range, due to actual output power or the gain of the antenna. Whilst the maximum output power is specified in the class licence, fixed systems, in particular, may use antennas which provide a much stronger signal in specific directions.

4.11. Aircraft modellers should be aware of possible sources of interference and look out for evidence of it happening.

4.12. Any suspicion of interference should be investigated, particularly if a pattern develops such as in a particular direction or with particular types of equipment. It should be remembered that for the reasons stated in 4.8 above there may be a pattern even if the interference does not occur every time a system is operated.

4.13. Clubs have the right to restrict the use of 2.4GHz, particularly where sources of interference have been identified.

4.14. Whist 2.4 GHz equipment has advanced technology, normal good engineering and operation practice is still needed. Whilst there may be a little more tolerance to bad practice under ideal operating conditions, under normal club conditions good practice is still required to avoid interference.

4.15. Because of the wavelength of the radiated signal from the transmitter to the receiver, there is more likely to be interference caused by metal or carbon fibre components in the airframe than with the lower frequencies used up to now. Whilst the technology may overcome the interference to some extent the user has to be aware of the possibility of "on board" generated interference. In the event that the airframe contains either significant amounts of carbon fibre or metal, or if the modeller suspects there might be a problem, then testing the range in various directions from the model whilst on the ground and comparing the range with the same antenna arrangement, at the same height and orientations, but outside the model is a wise precaution.

4.16. Other good practice issues to consider include:-

- routing of servo and other leads away from all antennas
- placement of receivers and servos away from the batteries and electrical motor power and control equipment
- careful consideration of model antenna locations and orientations
  - the directions of wire receiver antennas should be placed at 90 degrees to each other to the maximum extent possible, considering placement in all three axis, as is usually recommended by the manufacturers'
  - receiver antennas should be located, if at all possible, so that at least one has a clear view of the transmitter whatever the flight attitude. Metal components, such as the engine and wiring, should not be in the direct line of sight
  - if satellite receivers are used, take advantage of this to maximise the physical separation of the antennas
  - if compromises are unavoidable then pay particular attention to your own flight profiles and the landing approach of the aircraft as it is then both low to the ground and generally heading towards you with the engine likely to shield some parts of the rest of the model
- the strongest signal is radiated and received from the side of the transmitter antenna and the side of a straight receiver antenna. The weakest signal is radiated and received from each end of the same antennas
  - as in the case of 36 MHz this needs to be considered when the model is flying at longer ranges but it can produce a very significant reduction in range and affect performance even when the model is near to the pilot
  - pilots should think very carefully before laying their transmitter antennas sideways to try to minimise the reduction in the effective signal power in normal flight. It is very important to consider how this technique affects the landing as it may result in the model approaching from a position in line with an end of the transmitter antenna, giving a greatly reduced range
- landing is a critical situation for any loss of control, as the model is low giving no margin for recovery. A resulting crash may be near where other pilots are standing
- not flying the model close to other transmitters, particularly if some distance from your own

4.17. Some 2.4 GHz equipment has been shown to be particularly affected by brown out conditions. This is when the battery voltage, particularly in the model, drops either permanently or due to the instantaneous increase in current drain as the servos move. This can result in synchronisation between the transmitter and the receiver being lost and not recovering quickly enough. To avoid this situation, particular care has to be taken to ensure that the batteries are recharged before there is insufficient capacity left for reliable operation, batteries of adequate capacity are fitted to avoid voltage drop when the servos are working against flight loads, and

that all wiring, switches, and connectors are of adequate size for the current being handled.

4.18. Atmospheric conditions such as high humidity, fog or cloud can significantly reduce the range of 2.4 GHz equipment due to the increase in the attenuation between the transmitter and the receiver. In addition, users should ensure that neither they nor other people get between their transmitter and the model being controlled. This is due to the human body attenuating a 2.4 GHz signal much more than in the lower frequency bands.

4.19. Not all 2.4 GHz transmitters have a built in reduced power capability. This is used for range testing which is an essential safety process and is mandated by some MOP's. Other than taking the transmitter out to the maximum range of the system, which is unlikely to be generally practical, there are alternatives. One is to remove the transmitter antenna; however that is not recommended as it can cause the output circuit of the transmitter to fail. If the transmitter has a connector to enable the antenna to be unscrewed an acceptable way is to place a commercially available 20 dB attenuator, with same connector type, in place of the manufacturer provided antenna. Then determine the range at which control is lost and use this as the bench mark for future range testing. Anyone considering purchasing a system without a built in reduced power capability should address their personal application of range testing for safety, particularly if the transmitter antenna is fixed on the transmitter model they are proposing to purchase.

4.20. In the event of a modeller suspecting that there is a problem with the performance of his/her particular equipment then he/she should take it to a manufacturer approved repair station for investigation.

4.21. As the technology advances, and as operational experience is gained, the advice and requirements contained in this MOP may change.

5 2.4 GHz DOWNLINKS

5.1 2.4 GHz is also used for downlinks from a model aircraft. In some cases these are invisible to the user and are an element of the binding and the normal data transmission system. In other cases they are used for the transmission of airborne data for the information of the pilot using add on elements of the basic radio system. They are also used for video camera images.

5.2 In the case of integral, invisible, systems which are part of the normal radio these would have been evaluated in the normal MAAA assessment. It is likely that manufacturers' add on units will also use the same or compatible techniques as the basic radio. In this case normal good practice should be followed and it is likely that special precautions will be unnecessary.

5.3 Video downlinks use different technology to that used for model control. Many of the systems available do comply with Australian standards but that does not mean that they can be used with impunity on model aircraft, particularly when operating on 2.4 GHz.

5.4 Many users have found no issues with video downlinks but there are reports of mutual interference. Whilst this can be just with the video quality, there can also be interference with the model control system.

5.5 The MAAA cannot provide specific advice on what combinations will function satisfactorily. Each Radio Manufacturers' products will perform differently and with the variety of both radio control and video equipment available every situation will be different.

5.6 Normal good practice should be followed, together with any manufacturers' recommendations.

5.7 If a different frequency band is used for the video downlink, compared to that used for the radio control of the model, this will considerably reduce the possibility of problems. If this is not possible, then the video equipment should be placed in the aircraft as far away as possible from the radio control receiver with particular attention given to the location of the antennas.

5.8 As in all cases when any electronics is added to an aircraft, a range check should be carried out before and after the equipment is added. This is to determine if there is any slowing of the servo response or any interference at maximum range and that there has been no reduction in the range. In the case of video downlinks, because both the video and the control system may operate on different specific frequencies every time, and these can depend on the RF environment at the time of switch on, this check should be repeated several times under different conditions. It is particularly important to included switching on the video link after the control system is operational.

5.9 Although the highest risk of interference is with the radio control system on the same aircraft as the video link, it is also possible to interfere with systems on other aircraft when the aircraft are close together. It is recommended that this is considered when checking for differences when performing the range check.

APPENDIX A

CURRENT ACCEPTED SYSTEMS

The following technologies are accepted for radio control use in the 2.4 GHz frequency band only:

- **Only items provided by the manufacturer shown have been evaluated.**
- **Only genuine products from those manufacturers are covered by this list of currently accepted systems.**

The MAAA can accept no responsibility either for the actual use of the technology, as this is outside the control of the MAAA, or for the impact of any product changes carried out by a manufacturer.

Note in the case of either transmitters or receivers that are compatible with a propriety system of another manufacturer, the MAAA has only reviewed the product from an operational view point, using a sample provided at the time. The MAAA has undertaken no investigation of any propriety rights, including patents, of the owner of the basic technology. It accepts no responsibility for any breaches or alleged breeches of any such rights and this remains solely the responsibility of the manufacturer, retailer, and the owner of the specific product.

MANUFACTURER	TECHNOLOGY	LIMITATIONS (if any)
ASSAN	ASSAN Technology designated V2, or 'Mini Series' or 'Micro Series'	None but see guidance, particularly 4.19.
ESCALE	2.4GHz Radio Control System 242	None but see guidance.
Fly-Dream	V3 2.4 GHz	None but see guidance.
Frsky	V8 ACCST 2.4 GHz and V8 compatible systems	None but see guidance.
Frsky	TF Series receivers (compatible with Futaba FASST Technology)	None but see guidance.
Futaba	FASST	None but see guidance.
Hitec	AFHSS	None but see guidance.
Jeti	Duplex 2.4 GHz	None but see guidance.
JR	Spektrum DSM2	None but see guidance.
JR	DMSS	None but see guidance.
Multiplex	M-LINK	None but see guidance.
OrangeRX by Hextronik	OrangeRx Spektrum DSM2 Compatible 2.4GHz Receivers	See 3.8 and see guidance but note that the 6 channel version is considered 'reduced range' even if fitted with satellite receivers
Sanwa	Sanwa FHSS	None but see guidance.
Spektrum	DSM	See 3.8 and see guidance.
Spektrum	DSM2	None but see guidance.
Spektrum	DSMX	None but see guidance
Spektrum	All combinations that include any equipment using DSM technology	As for DSM
Thunder Tiger/ACE	IFh ss Frequency Hopping	See 3.8 and see guidance.

WFLY	WFLY 2.4 GHz System	None but see guidance, particularly 4.19.
Xtreme Power Systems	XtremeLink	None but see guidance.