UK Civil Aviation Authority

Electronic conspicuity devices

CAP 1391

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Published by the Civil Aviation Authority, 2021

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First published 2016
Second edition December 2017
Third edition February 2021

Enquiries regarding the content of this publication should be addressed to: infoservices@caa.co.uk

The latest version of this document is available in electronic format at: www.caa.co.uk/CAP1391

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Executive summary

1. This report sets out the key outcomes of the Civil Aviation Authority (CAA) led project to develop a new industry standard for a low-cost electronic conspicuity (EC) device for use on light aircraft. It explores why such a standard is necessary, and looks at the key issues that need to be addressed to encourage more aircraft operators and owners to use EC devices. It then sets out a full technical specification that EC devices are required to meet, along with acceptable means of compliance.

Background

2. In uncontrolled airspace – that is, airspace where an air traffic control (ATC) service is not mandatory – pilots and other airspace users have long operated on a principle of 'see and avoid'. In other words, it is their responsibility to look out for other airspace users and avoid them.

3. Class G is a classification of airspace[1], commonly, although not exclusively, used in the UK by general aviation (GA) and military aircraft. There is a perception that the use of EC could reduce the risk of mid-air collision (MAC) in Class G airspace.

4. Electronic Conspicuity (EC) is an umbrella term for a range of technologies that can help airspace users to be more aware of other aircraft in the same airspace. It includes transponders and radios. At the most basic level, aircraft equipped with an EC device effectively signal their presence to other airspace users, turning the 'see and avoid' concept into 'see, BE SEEN, and avoid.' Many EC devices also receive the signals from others. This then alerts pilots to the presence of other aircraft which may assist the pilot in being able to visually acquire the aircraft and take avoiding action as necessary.

[1] Class G is the least restrictive of 8 airspace classifications described in ICAO Annex 11.

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5. Although EC devices, such as Mode S transponders, are mandatory for specified aircraft, they are not universally mandatory in the UK for light aircraft that only operate in Class G airspace. Historically, transponders have been deemed prohibitively expensive for this kind of aircraft, and in some instances added too much additional weight and/or have unrealistic power requirements for the aircraft.

6. With respect to current, available surveillance technologies, it is anticipated that an EC device could offer similar functionality to FLARM, but use Automatic Dependent Surveillance-Broadcast (ADS-B) technology. It must be recognised at the outset that since EC devices are based on ADS-B transmitter/receiver technology, they are not a substitute for a transponder and cannot be used to fulfil the requirement where the carriage of a transponder is mandatory.

7. This report focuses on EC devices intended for voluntary carriage on registered and non-registered UK Annex II[2] aircraft; non-complex EASA aircraft of <5700kg MTOM and for gliders and balloons (including those covered under ELA 1 and ELA 2) within uncontrolled UK airspace. Since these are portable devices, the EASA requirements with respect to transmitting portable electronic devices (T-PEDs) on aircraft are recognised.[3]

[2] EASA has recently announced a new Basic Regulation under which it is proposed to rename "Annex II" to "Annex I".

[3] Consolidated Regulation (EU) 965/2012 Annex VII, NCO.GEN.125 and associated AMC/GM TO ANNEX VII (PART-NCO).

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The establishment of an Electronic Conspicuity Working Group

8. Following safety recommendations made in a 2010 Air Accidents Investigation Branch (AAIB) report[4] into a collision in Class G airspace, an Electronic Conspicuity Working Group (ECWG) was established in 2014, under the auspices of the Airspace and Safety Initiative (ASI) Programme[5]. The ECWG consisted of representatives from:

- CAA
- Aircraft Owners and Pilots Association (AOPA)
- British Balloon and Airship Club (BBAC)
- British Gliding Association (BGA)
- British Hang Gliding and Paragliding Association (BHPA)
- British Microlight Aircraft Association (BMAA)
- Light Aircraft Association (LAA), and
- NATS.

4 See AAIB (2010) *Report on the accident between Grob G115E (Tutor), G-BYXR and Standard Cirrus Glider, G-CKHT at Drayton, Oxfordshire on 14 June 2009.* https://www.gov.uk/aaib-reports/5-2010-g-byxr-and-g-ckht-14-june-2009 (accessed 02.12.15).

5 The ASI was launched by the Civil Aviation Authority, Ministry of Defence and NATS in 2005. The aim of the initiative was to identify key areas for action to address the most pressing safety issues.

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9. The ECWG was tasked to examine how increased use of EC in Class G airspace could improve safety through enhanced situational awareness. It was also tasked to develop an industry standard for an EC device against which developers could build new devices that would be suitable for use in GA.[6]

10. The ECWG concluded that it would be possible to develop an industry standard for an EC device that uses radio frequency (RF) and is based on ADS-B extended squitter (ES) technology. This provides more useful information to other airspace users than other solutions, while offering low cost and low power consumption. The ECWG members considered that it might be possible to produce such a device at a cost that, combined with the potential safety benefits, could encourage a significant proportion of the GA community to adopt it voluntarily. The ECWG therefore recommended that a project be initiated to take the development of such a standard forward.

11. In autumn 2014, the CAA commenced work on this project, supported by funding provided by the Department for Transport. A number of external organisations were involved, most notably:

- NATS
- the Light Aircraft Association (LAA)
- the Aircraft Owners and Pilots Association (AOPA), and
- QinetiQ.

The purpose and structure of this report

12. This report, jointly authored and reviewed by representatives of the above organisations, sets out the key outcomes of the CAA-led project to produce a new industry standard for a low-cost electronic conspicuity (EC) device for use on light aircraft. The project sought to create conditions which will encourage the manufacture of such EC devices, with the

6 See CAA (2014) ASI ECWG *Recommendations Paper: Electronic Conspicuity in Class G Airspace* CAP 1392. www.caa.co.uk/cap1329 (accessed 22.03.16).

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ultimate aim of increasing voluntary equipage by the GA community. These are aimed at potential manufacturers of EC devices as well as the wider GA community.

- Chapter 1 provides the problem statement – the physiological and environmental limits of visual scan. It examines how supplementing 'see and avoid' could improve safety outcomes.
- Chapter 2 sets out recommendations on the minimum capability required of an EC device. It compares the EC devices being considered in this report with other airborne surveillance technologies, to show where this EC technology is 'positioned' in the market. Finally, it lists a range of features and design elements that the ECWG identified would encourage voluntary equipage by the GA community.
- Chapter 3 outlines the licensing requirements for owners/operators in relation to the use of EC devices.
- Chapter 4 summarises the obligations and responsibilities of manufacturers and aircraft owners with respect to the use of ICAO 24 bit addresses.
- Chapter 5 considers the spectrum management issues that could result from the increased use of EC devices. It explains how assurance has been provided to the National IFF/SSR Committee (NISC) that the specification for an EC device based on ADS-B technology would not lead to the manufacture of a device which could compromise the performance of air-to-air or air–to-ground safety nets.
- Chapter 6 sets out the Technical Specification Requirements, including interoperability considerations, for all EC devices. New devices, as well as existing devices, will be required to meet the Technical Specification. It also includes detailed Acceptable Means of Compliance (AMC) and associated guidance.

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13. In addition to commissioning the EC project, the ECWG recommended[7] that the separate Visual and Electronic Conspicuity Working Groups should merge to form a single Conspicuity Working Group (CWG). This was implemented in July 2015 and the CWG now sits as a sub working group within the CAA's wider Mid Air Collision (MAC) Programme. The CWG has reviewed and provided input to this report.

14. It is recognised that further work will be required in the field of EC. However, by developing an industry standard for an EC device, this document represents an important milestone for EC.

[7] See CAA (2014) ASI ECWG *Recommendations Paper: Electronic Conspicuity in Class G Airspace* CAP 1392 para 1.5. www.caa.co.uk/cap1392 (accessed 22.03.16).

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Chapter 1

Problem statement

The problem statement

1.1 Aircraft operating under Visual Flight Rules (VFR) in Class G (uncontrolled) airspace are not required to carry or use a radio, transponder or, other EC system, or communicate with Air Traffic Control. Instead, pilots and other airspace users rely on visual scanning to detect and avoid other traffic: this is known as the "see and avoid" principle. Visual scanning can however be affected by a variety of issues including: environmental conditions, aircraft design, pilot training and the limitations of the human eye.

1.2 By increasing the quality and quantity of information available to pilots, and thus increasing their situational awareness, EC devices could help reduce the risk of mid-air collision in Class G airspace.

What UK Airprox data shows

1.3 UK Airprox data indicates that late sighting or no sighting is a significant factor in risk bearing airproxes. The first issue is to establish whether there is evidence that failures of visual scan contribute to a substantial share of accidents, near-misses and other reportable incidents. In its 2012 report Class G Airspace For the 21st Century[8], the CAA recommended that an in-depth analysis be undertaken of the UK Airprox database to gain a deeper understanding of the risks of mid-air collisions within Class G airspace. This analysis could then be used to inform safety recommendations. The primary aim of the study was to investigate and

[8] CAA (2012) – Class G Airspace for the 21st Century. Accessible from https://www.caa.co.uk/Data-and-analysis/Airspace-and-environment/Airspace/Future-airspace-strategy-documents/ (accessed 02.12.15).

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document the specific causal and mitigating risk factors that increase the likelihood of a MAC within Class G airspace.

1.4 Sighting issues, i.e. a failure to see traffic or a late sighting of traffic, remain the most common causes of Airprox involving GA aircraft. However, such descriptions do not provide a full picture as to what factors led to a failure to see traffic. To secure better information in the future, an area of focus may be to extract that greater level of detail from the Airprox database and other safety data sources.

Enhancement of the visual scan

1.5 In addition to the known limitations of the human visual system, pilots operating in different aircraft, environments and tasks will have different styles and timings of a visual scan, some of which could be enhanced by EC.

1.6 Good practice recommends that pilots flying under VFR should spend most of their time looking out and scanning the airspace. However, there

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are indications that pilots spend insufficient time on visual scanning and may not optimise their scans. EC could enhance their situational awareness through augmenting their lookout.

The value of additional cues

1.7 'See and avoid' can be more robust when additional cues are available, such as those provided via an Air Traffic Service (ATS), radio or EC. As an example, an Australian Transport Safety Bureau report[9] concluded that pilots are significantly more effective at seeing and avoiding other aircraft when they receive some form of additional cue – known as 'alerted search'.

1.8 It is important to acknowledge that there are concerns that reliance on 'cued' lookout could reduce the effectiveness of visual acquisition.

- There may be a danger of focusing the pilot's attention in one area and therefore potentially either acquiring the wrong target, or missing objects that are just outside this or in different parts of the sky.
- Pilots may become over-reliant on information provided on other aircraft, or fixated on the display, at the expense of maintaining an effective visual scan.
- Pilots may falsely assume that **all** aircraft are electronically conspicuous.

1.9 It must therefore be stressed that any EC device does not replace the need for effective visual scanning.

1.10 The emergence of technologies such as FLARM and ADS-B is seen as a positive step[10] to increase pilot awareness of surrounding traffic. There are an increasing number of devices being developed. However, at present it is not known whether these will be interoperable. Active

9 Australian Transport Safety Bureau (1991) – *Limitations of the see-and-avoid principle*, Research Report ISBN 0 642 16089 9. https://www.atsb.gov.au/publications/1991/limit_see_avoid.aspx (accessed 14.12.15).

10 FLARM is in daily use in GA, and due to its effectiveness is being voluntarily purchased and fitted in significant numbers by GA pilots and aircraft owners.

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coordination of development is needed to achieve maximum interoperability which in turn will mean increased efficacy of each device.

1.11 The considered opinion of the ECWG was that 1090MHz ES is a suitably mature technology and so provides the best opportunity to develop a specification for ECs in the short term. While the development of this technological specification concerns 1090MHz ES, it does not preclude the development of other technologies.[11]

[11] As an example, the ECWG also saw merit in exploring Camera Based (CB) technology further.

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Chapter 2

Minimum suggested capability

2.1 This chapter sets out recommendations for the minimum capability required of an EC device. It defines a Basic, Intermediate and Full EC device. It compares the EC devices being considered in this report with other airborne surveillance technologies, to show where this EC technology is 'positioned' in the market. Finally, it lists a range of features and design elements that the ECWG identified would encourage voluntary equipage by the GA community.

Categories of capability

2.2 In its recommendation paper[12], the ECWG defined three categories of EC device capability: Basic, Intermediate and Full. To place the EC device in the context of current available surveillance technologies described below and define the technology to be used, these have been elaborated on for the purpose of this report. The definitions are:

- ***Basic*** *– a transmit-only device with no alerts to the carrier*: using a commercial off-the-shelf (COTS), non-qualified GPS/GNSS[13] receiver and ADS-B transmitter conforming to the specification set out in Chapter 6 of this publication. No visual or audible alerts would be available to the user.
- ***Intermediate*** *– a transmit/receive device with minimal interoperability and audible only alerts*: an ADS-B transmitter/receiver using a COTS, non-qualified GPS/GNSS receiver offering interoperability with air and ground safety nets as

[12] See CAA (2014) ASI ECWG *Recommendations Paper: Electronic Conspicuity in Class G Airspace* CAP 1392. www.caa.co.uk/cap1392 (accessed 22.03.16).

[13] This refers to generic Global Navigation Satellite Systems (GNSS) and the United States NAVSTAR Global Positioning System (GPS).

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detailed in Chapter 6 of this publication and providing audible and, possibly, visual alerts.

- ***Full** – a transmit/receive device interoperable with other air and ground safety nets with visual and audible alerts*: such a device is currently limited to secondary surveillance radar (SSR) technology and is considered outside of the scope of Chapter 6 of this publication.

2.3 The ECWG made it clear that it viewed ADS-B extended squitter technology as the most practical solution, due to the possibility of lower transmit power levels leading to lower power consumption, lower costs and the potential for interoperability with other ground and air users.

Comparison with other airborne surveillance technologies

2.4 Fundamentally, current airborne surveillance technologies consist of equipment installed on aircraft that provides:

- air-to-air safety nets, such as collision avoidance systems, and
- air-to-ground transmissions to assist in identifying the aircraft to air traffic control.

This equipment offers interoperability at varying levels across functional capabilities and ranges from Airborne Collision Avoidance System (ACAS) II and Mode S transponders, required for most commercial air transport aircraft operated in controlled airspace, to ACAS I, Traffic Advisory Systems (TAS) and Mode S transponders for aircraft that are not required to be equipped to the same level, but that are voluntarily equipped to improve surveillance capability and situational awareness. Although certification requirements still cover Mode A and C transponders, developments in airspace requirements have meant that these have been largely replaced by Mode S.

2.5 In harmony with a requirement from the Federal Aviation Authority (the US aviation regulator), from 2020, 1090MHz ES ADS-B out will be mandated

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for Europe for most commercial aircraft[14]. Specific requirements will apply to this. ADS-B out can also be voluntarily adopted for GA, provided these systems are able to report the position source accuracy and integrity metrics and overall system integrity metrics in a manner appropriate to the installation certification.

2.6 Traffic Awareness Beacon System (TABS) is a system which has been developed under an FAA Technical Standard Order (TSO)[15]. Its aim is to make GA aircraft visible to TAS, Traffic Alert and Collision Avoidance System (TCAS) I, TCAS II and ADS-B in equipped aircraft, and employs transponder and ADS-B technology.

2.7 FLARM was developed for GA use and provides an air-to-air safety net, but operates on a radio frequency spectrum outside of the aeronautical band. EC devices, in common with FLARM, offer conspicuity or situational awareness enhancement for users that cannot, are not required to or do not wish to carry transponder or collision avoidance systems, but wish to have some form of awareness enhancement because they recognise the safety benefit.

2.8 An intermediate EC device, for example, may offer similar functionality to FLARM, but operate using the 1090MHz airborne spectrum.

2.9 Since the requirement specification in this CAP covers the use of ADS-B based on downlink format (DF) 18, EC devices as specified here will not be interoperable with current interrogative airborne safety nets, such as ACAS (including hybrid surveillance), TAS or TABS, but offer the scope to provide visibility of GA aircraft to air navigation service providers (ANSPs). Use of COTS GNSS receiver chipsets and, where applicable, altitude transducers, will be acceptable on the basis that the accuracy and

14 COMMISSION IMPLEMENTING REGULATION (EU) No 1207/2011 of 22 November 2011 - laying down requirements for the performance and the interoperability of surveillance for the Single European Sky. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32011R1207 (accessed 06.12.16)

15 A TSO is a minimum performance standard for specified materials, parts and appliances used on civil aircraft. Receiving a TSO authorisation is both a design and production approval. It is not an approval to install and use the article in the aircraft.

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integrity metrics reported by the device will be suitably limited. EC devices may report barometric or GNSS altitude.

2.10 A summary comparison of current surveillance systems, as well as where EC devices sit within them, can be found in Appendix A.

2.11 It is not envisaged that an EC device will be carried or operated on an aircraft that already has an air traffic control radar beacon system (ATCRBS) or Mode S transponder installed and operating. Where this is the case, the transmitter section of the EC device must be deactivated to avoid possible interference due to non-synchronised transmissions and duplication of information transmitted by the transponder and EC device.

Motivators to encourage voluntary uptake

2.12 As stated earlier, it is not mandatory for GA aircraft in Class G airspace to have an EC device and there is no appetite, either within the ECWG or among stakeholders, to change that. Instead, the goal is to create an environment which encourages more pilots to voluntarily equip their aircraft with an EC device.

2.13 To better understand what would encourage GA pilots to voluntarily adopt an EC device, the ECWG analysed stakeholder requirements. It concluded that to encourage voluntary equipage, devices must:

- provide a definable and quantifiable benefit for the user
- be cost-effective, and
- not hinder or restrict current ways of operating.

In addition any potential negative effects of an EC device in the aircraft must be clearly understood.

2.14 The ECWG identified a set of universal or common requirements; these form a design brief that is applicable to all stakeholders and for the basic capability. Meeting these would increase the likelihood of voluntary

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uptake. The ECWG also identified additional elements that are stakeholder-specific.

Design brief

2.15 To encourage voluntary uptake from the widest cross-section of GA stakeholders, the design brief resulting from the ECWG's work is:

- **Portable**: there should be no barrier, either physical or regulatory, to moving the EC device from one aircraft to another instantly.
- **Light weight**: stakeholders identified a weight of approximately 200g including batteries could be acceptable.
- **Low bulk**: a device would ideally be no larger than approximately 140mm x 80mm x 25mm including batteries.
- **User friendly**: any EC device would be easy to operate, with minimal or no inputs required during flight. The device should not reduce 'look out' capabilities or have a negative impact upon safety.
- **Appropriate antenna fit**: the required antenna fit must be easily achievable and appropriate to the device.
- **Voluntary equipage**: the ECWG supports voluntary equipage of an EC device. There is no appetite for mandating carriage.
- **Minimal regulatory requirements**: stakeholders identified a requirement to have as few regulatory hurdles as possible. This will provide further positive encouragement for voluntary carriage.
- **Interoperable**: any system should be interoperable with as many players as possible.

2.16 The additional elements identified by the ECWG[16] to encourage voluntary uptake from the widest cross-section of GA stakeholders were:

- **Audible alerts**: audible alerts were identified as essential by most user groups. An audible alert must be unique from other inputs

[16] See CAA (2014) ASI ECWG *Recommendations Paper: Electronic Conspicuity in Class G Airspace* CAP 1392 para 1.12.ii. www.caa.co.uk/cap1392 (accessed 22.03.16).

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received by the pilot. All alerts must be timely and useful and any alert must not unduly distract the pilot from the ability to operate the aircraft or maintain good look-out practices.

- **Visual alerts**: when desired, must be user friendly on an appropriately sized and fitted display.
- **Low cost to the stakeholder**: stakeholders assessed that an acceptable cost for the most basic EC device would be approximately £250.00 including VAT. Minimal to nil through-life costs would also be desirable. Stakeholders recognise that additional functionality will result in additional cost to the stakeholder.
- **Cockpit mountable or user carried**: the EC device must be safe to carry on a person or be easily mountable onto the aircraft or in the cockpit.
- **Self-contained EC device**: some stakeholders will require an EC device that is completely separate from all other aircraft systems. However, some stakeholders may require interoperability with other devices in the cockpit. It is recognised that a device that is not self-contained may attract additional regulatory burdens.
- **Power options**: stakeholders who operate aircraft with internal power require an option to connect to the internal power source. Stakeholders without internal power assessed that a battery life of 12 hours would be acceptable and would ideally include the ability to rapidly charge the EC device.
- **Capable of operating within close proximity of handheld radios** without detriment to either system.
- **Full weather proofing and low temperature capable** to at least the same standard as the GPS systems used by walkers, as in some aircraft the equipment will be fully exposed to the elements.
- **Operable when wearing ski gloves**: in some aircraft the pilot and equipment will be fully exposed to the elements.

2.17 The CWG endorsed these recommendations but specifically concluded that the immediate need was for a technical standard that sets out

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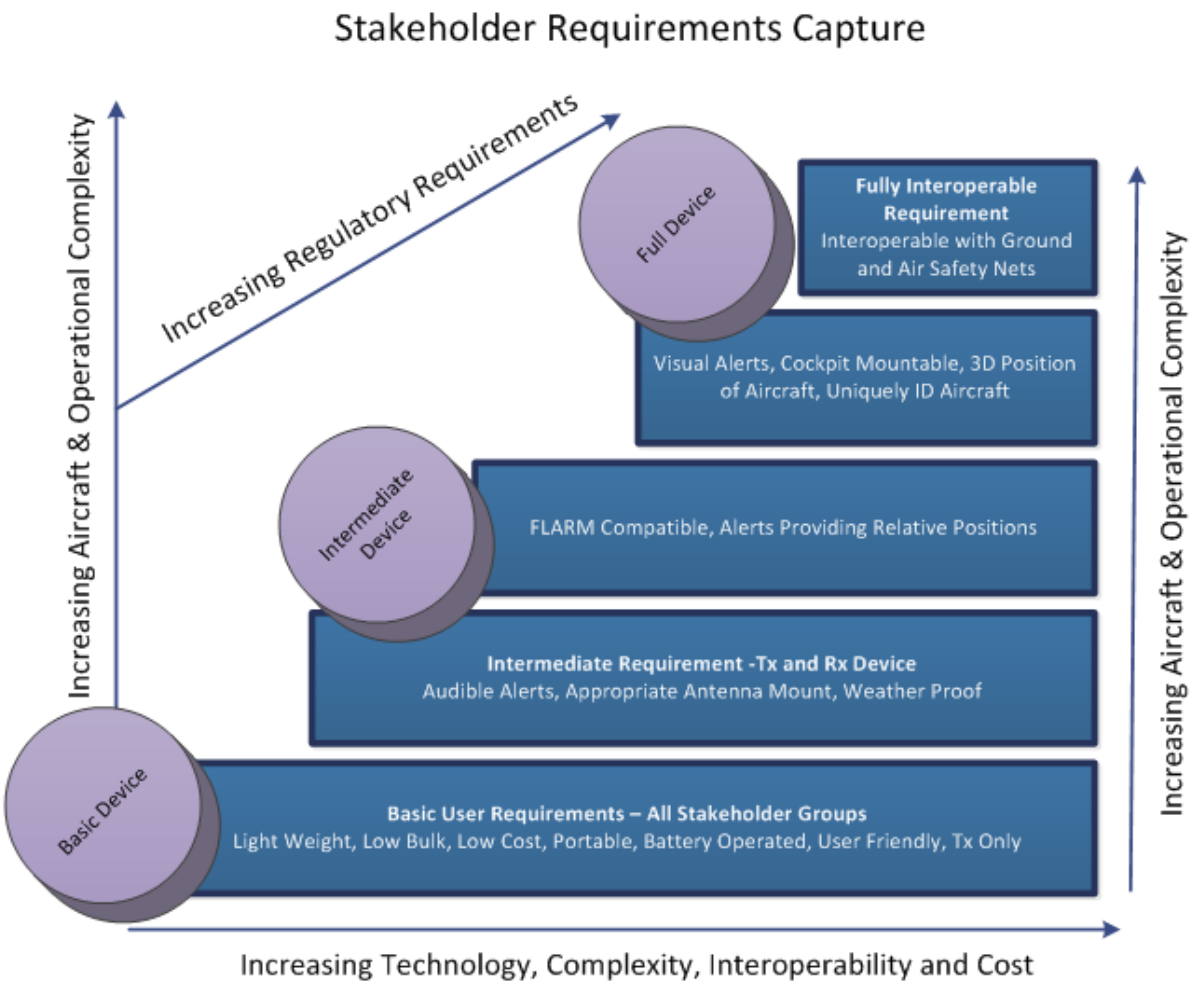
fundamental safety and operating requirements for an EC device. This need is fulfilled by the technical standard in Chapter 6 of this publication.

2.18 Figure 1 below shows how the technical requirements of an EC device increase in line with the increasing complexity of an aircraft type. The more complex the aircraft, the more important the additional features identified by the ECWG are likely to be.

Figure 1: Visual summary of capability and design brief



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Chapter 3

Aircraft owner/operator responsibilities and licensing obligations

3.1 This chapter summarises the licensing obligations and responsibilities of aircraft owners and operators if they wish to use a 1090MHz EC device on their aircraft.

3.2 It is the responsibility of the owner/operator to understand the implications of using specific EC devices. To be legally used in an aircraft, EC devices that operate on 1090MHz aeronautical frequency band require a Declaration of Capability and Conformance[17]. **It is the owner's responsibility to check whether there is a relevant Declaration for their device.**

3.3 A list of manufacturers that have provided declarations can be found on the CAA website at www.caa.co.uk/General-aviation/Aircraft-ownership-and-maintenance/Electronic-Conspicuity-devices/ along with information about any associated issues. This list will be actively maintained by the CAA.

3.4 To operate **any** radio equipment, aircraft owners/operators must hold a valid Wireless Telegraphy Act (WTA) Aeronautical Radio Licence.1090MHz EC devices are radio-transmitting equipment, so are subject to this regulation.

3.5 Approved transmitting EC devices will be included under the licensee's WTA licence as standard once notified.

3.6 The WTA licence traditionally requires anyone using any radio equipment on the aircraft to possess (or be under the direct supervision of someone

[17] See Chapter 6, paragraph 6.22.

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who possesses) a valid Flight Radio Telephony Operator's Licence (FRTOL) if one is legally required for its operation. This was because when this radio licence condition was introduced, it was assumed that all aircraft radio stations would include a voice telephony function.

3.7 Following discussions between the CAA and Ofcom, it has been agreed that, while a WTA licence is still needed, the pilot need not hold a FRTOL if the transponder is the only radio equipment on the aircraft. However, the WTA licence must be varied formally to remove the need for the FRTOL. Variations are available free of charge and on request. They must be kept with the WTA licence.

3.8 On purchasing an EC device, it is the responsibility of the aircraft owner/operator to complete the relevant application form to obtain a WTA Aircraft Radio Licence from the CAA[18]. An application can be made using application form DAP 1902 and completed online at www.caa.co.uk/DAP1902. As the EC device is intended to be portable, the applicant should annotate the Transportable Radio boxes in Section 5 of the form and does not have to specify an individual aircraft.

3.9 For further information on radio licensing, contact the Radio Licensing Section of the Safety and Airspace Regulation Group at the address below:

Radio Licensing Section, SARG
K6 Gate 6
CAA House
45-59 Kingsway
London WC2B 6TE

Tel. 0207 453 6555
Fax. 0207 453 6556

[18] The Radio licensing section of the CAA has been appointed by the Office of Communications (Ofcom) as its agent to distribute Wireless Telegraphy Act Aeronautical Radio Licences.

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Email: radio.licensing@caa.co.uk

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Chapter 4

Allocation of ICAO 24 bit address

4.1 All Mode S transponders are given a unique 24 bit address by the International Civil Aviation Organization (ICAO). This then becomes part of the Certificate of Registration for the aircraft on which the transponder is fitted. An aircraft which has an ICAO 24 bit address is known as a registered aircraft.

4.2 Because EC devices are designed to be portable, and potentially move from aircraft to another, different rules will need to apply to them.

4.3 This chapter summarises the licensing obligations and responsibilities of both manufacturers and aircraft owners. It is split into sections for convenience but both may wish to take note of all the guidance provided.

Manufacturer responsibilities

4.4 The EC device should not be pre-loaded with an ICAO 24 bit address.

4.5 The device should allow for the ICAO 24 bit address to be programmable/reprogrammable by the user. Manufacturers should put in place a means of mitigating incorrect 24 bit entry, such as a requirement to enter the 24 bit address twice. A function should also exist to clear the programmed 24 bit ICAO address, and to alert the user should no ICAO 24 bit address be entered. Full instructions on how to complete these tasks should be contained within the device operating manual.

4.6 Attention of manufacturers is also drawn to more detailed instructions and guidance contained in Chapter 6 and Annex A.

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Aircraft owners' responsibilities

4.7 Different responsibilities will apply, depending on whether the EC device is carried on a registered or unregistered aircraft. Provisions exist for the device to be used on both: however, the instructions below should be followed.

4.8 If an EC device is bought to use on an unregistered aircraft, the owner is required to contact the CAA Infrastructure Section (email: NISC@caa.co.uk) shortly after buying the device. The owner must confirm their contact details and the make, model and serial number of the EC device. The CAA will then allocate the EC device a unique ICAO 24 bit address. The address can then be used on multiple unregistered aircraft without re-programming.

4.9 If the EC device is to be used on a registered aircraft, the existing ICAO 24 bit address for the registered aircraft should always be used. It is not necessary to apply for a separate ICAO 24 bit address from the CAA. On transferring the device between registered aircraft, the EC device ICAO 24 bit address should be reset and the new aircraft's address entered into the device.

4.10 If the device is re-sold, the vendor should clear any registered aircraft 24 bit code from the device before sale. The new purchaser should contact the CAA at the above email address to allow records to be updated and a unique code allocated if necessary.

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Chapter 5

Avoiding spectrum interference

5.1 European Commission regulations state that "*spectrum used by surveillance systems should be protected to prevent harmful interferences*".[19] This means that any new radio or broadcast technologies must operate in a way that does not interfere with existing systems such as Identification Friend or Foe (IFF) and Secondary Surveillance Radar (SSR).

5.2 The ADS-B technology identified by the ECWG as the most suitable for EC devices operates at 1090MHz. In the UK, the Cabinet Office has delegated authority for frequency assignments in the Band 960-1215MHz jointly to the CAA and Ministry of Defence (MoD). Executive authority for such matters is exercised through the National IFF/SSR Committee (NISC).[20]

5.3 Unlike IFF/SSR interrogators, EC devices capable of 1090MHz extended squitter do **not** require specific NISC approval to operate, providing they comply with the requirements of Annex 10 to the Convention on International Civil Aviation Volume IV, or Standardisation Agreement (STANAG) 4193, as appropriate.

5.4 The NISC has published advice[21] that it does not intend to impose operational restrictions on such devices. However, if the cumulative effect of these types of equipment is found to have a detrimental effect on the RF environment, it may be necessary to impose approval procedures or restrictions on use.

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19 EU (2011) *Commission Implementing Regulation EU 1207/2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky*. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011R1207 (accessed 02.12.15).

20 CAA (2008) *Operation of IFF/SSR Interrogators in the UK: Planning Principles and Procedures* CAP761. www.caa.co.uk/cap761 (accessed 02.12.15).

21 See reference 20 above.

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5.5 It is therefore necessary to provide the NISC with adequate assurance that the technical specification for EC devices would not cause:

a. interference that compromises the performance of air-to-air safety nets such as TCAS or,
b. interference that compromises the performance of the ground surveillance infrastructure.

5.6 Item (b) has been addressed through a 2014 study by QinetiQ[22] which considered impacts on ground surveillance infrastructure.

5.7 However, there was still a requirement to provide assurance to the NISC that the specification for an EC device for GA would not compromise the performance of air-to-air safety nets.

5.8 To address this, the ECWG commissioned QinetiQ in 2015 to produce a research paper titled 'Impact of General Aviation Electronic Conspicuity on TCAS' into the risks of interference and how these could be avoided.

5.9 The full paper is included in Appendix D. A short summary is provided below.

QinetiQ's research into spectrum interference with TCAS

5.10 QinetiQ's study concluded that: "*EC devices such as those envisaged… will when operating at rates specified by international standards, have no effect on the operation of TCAS. They will be effectively invisible to TCAS. However, all Mode S signals that are received by the TCAS Interrogator within the window of an expected reply will need to be decoded to some extent before they can be rejected.*" Therefore "*EC devices will degrade TCAS's ability by interfering with the reception of wanted signals. If EC signals in the environment remain low in comparison to other sources of*

[22] QinetiQ (2014) *Low Power ADS-B Transceiver (LPAT) RF Environment Modelling Study - Phase 2*, QINETIQ/14/01558.

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FRUIT [False Replies Unsynchronised In Time], *the interference will be minimal.*"

5.11 The study also determined the effects of a worst-case single point of failure for an EC device on TCAS. It concluded that "*the worst credible single fault that an EC device could have* [on TCAS] *would be for the rate of ES to be well above that specified. This would not cause the TCAS system to change its behaviour, but would mean that it is more likely that a wanted signal would be garbled or lost.*"

Stakeholder feedback and follow on activity

5.12 The results of the study were briefed to the NISC on 16 November 2015. The NISC was content with the evidence presented and had no immediate safety concerns over the project.

5.13 Members of the CWG separately raised some questions about some of the data and models used in the study. In particular, some GA stakeholders commented that the numbers of GA aircraft which could feasibly use a transponder could realistically exceed the numbers used in the study models. In addition, at peak times such as at gliding competitions, the number of EC-equipped aircraft in a small geographical area could greatly exceed the assumptions modelled in terms of traffic density. These 'spikes' of activity could lead to an increase in the effects on TCAS. These concerns were noted by the NISC, but it reiterated that it considered the situation acceptable.

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