BOOTH, FRERET & IMLAY, LLC

ATTORNEYS AT LAW

ROBERT M. BOOTH, JR. (1911-1981)
JULIAN P. FRERET (1918-1999)
CHRISTOPHER D. IMLAY

14356 CAPE MAY ROAD
SILVER SPRING, MD 20904-6011
WWW.IMLAYLAW.COM

TELEPHONE: (301) 384-5525
FACSIMILE: (301) 384-6384
CHRIS@IMLAYLAW.COM

January 11, 2017

Via E-mail and U.S. Mail
Ricardo.Durham@fcc.gov

Mr. Ricardo Durham, Acting Chief
Spectrum Enforcement Division
Enforcement Bureau
Federal Communications Commission
445-12th Street, S.W.
Washington, D.C. 20554

Re: Urgent Complaint of Equipment Authorization and Importation Violations, and of Potential Interference to FAA Radar and Amateur Radio Facilities.

Greetings, Mr. Durham:

This letter and the accompanying **Exhibit A** set forth what we view as an extremely urgent complaint to the Commission with respect to a series of audio/video transmitters intended for use and used in unmanned aircraft, and marketed ostensibly as Amateur Radio equipment. Specifically, ARRL, the national association for Amateur Radio (ARRL) has become aware of the apparently unlawful importation, marketing, sale and deployment of unlicensed radio frequency products constituting intentional radiators and operating in a licensed radio service, on frequencies used for NAVAID (TACAN / DME, etc.); Air Traffic Control Radar Beacons, Mode S; TCAS Air Route Surveillance Radars; GPS and GLONASS L1. This is in ARRL's view a potentially very dangerous interference issue, and it is respectfully requested that the products referenced in the attached Exhibit be investigated; that they be removed from the marketplace immediately; and that the importers be subjected to normal sanctions.

Video transmitters are routinely and increasingly mounted on unmanned aircraft (drones). Some of these transmitters, including the models referred to in the attached Exhibit, operate on the frequencies 1010, 1040, 1080, 1120, 1160, 1200 and 1280 MHz. These video transmitters are being marketed ostensibly as Amateur Radio equipment, but of the listed frequencies on which the devices operate, only one, 1280 MHz, would be within the Amateur Radio allocation at 1240-1300 MHz. Furthermore, the 1280 MHz frequency would be *impractical* for Amateur Radio use since this channel would be in conflict with the GLONASS (Russian GPS) CDMA 1202.5 MHz channel. In the United States, GLONASS is used by several government agencies for radiolocation. This frequency is also in commercial use within the U.S. for the same purpose.

Operation of the devices on three of the other "channels" on which they operate would have a far more significant impact. The frequency 1010 MHz is used for aeronautical guidance in the TACAN/DME aircraft radio navigation band. However, it is the potential use of 1040 and 1080 MHz that represents the greatest threat to the safety of flight. These two frequencies are in direct conflict with the ATC (Air Traffic Control) transponder frequencies. In this case, the

transponder is interrogated at 1030 MHz with a response from the aircraft at 1090 MHz when those aircraft are operating in what is termed MODE-A or MODE-C transponder. As noted in Appendix C to Exhibit A, *there is no shared spectrum between these uses and Amateur Radio below 1240 MHz.*

The use of transponders is required on these frequencies for all aircraft operating above 18,000 feet and within 30 miles of all major airports. Additionally, the newest form of digital ATC information for aircraft is transmitted at 1082 MHz. Since both the TACAN/DME and the ATC Transponder systems operate with a 10 MHz bandwidth, the use of an unlicensed airborne transmitter on a drone can cause serious issues with the integrity of ATC radar systems.

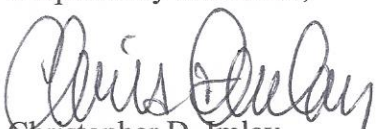
According to the Exhibit attached, the target market for these devices is the drone hobbyist, not licensed radio Amateurs. The device, due to the channel configuration, has no valid Amateur radio application. And since transmitters operating in an Amateur allocation are being marketed to non-licensees, many of these devices will be used on an unlicensed basis in Amateur spectrum. The operation of these devices will cause harmful interference to properly licensed Amateur stations. While these transmitters are marked as appropriate for Amateur use, they cannot be used legally for Amateur Radio communications.

It is apparent to ARRL that these devices do not have proper FCC equipment authorization under Part 15. The rules require low power intentional radiators such as these to be certified. The specified frequencies of operation would preclude the required FCC certification by any basically qualified and knowledgeable TCB.

Of most concern is the capability of the devices to cripple the operation of the ATC secondary target/ transponder systems. These illegal transmitters represent a significant hazard to public safety in general and the safety of flight specifically.

For the foregoing reasons, and per the explanation in the Exhibit attached, ARRL, the national association for Amateur Radio, requests that the Commission investigate this matter without delay and provide remedies that will protect aviation and Amateur Radio as well.

Respectfully submitted,



Christopher D. Imlay
General Counsel, ARRL

Cc: Julius Knapp, OET
Laura Smith, Esquire, EB

EXHIBIT A

Illegal Drones Threaten Public Safety

By Mike Gruber and Jerry Ramie on behalf of
ARRL, the national association for Amateur Radio

Introduction

Despite their relatively recent introduction to the consumer market, the surge in unmanned aircraft sales known as drones has been dramatic. The FAA predicts the combined total commercial and hobbyist sales to increase from 2.5 million in 2016 to 7 million by 2020. Of that total, sales for commercial purposes are expected to grow from 600,000 in 2016 to 2.7 million by 2020. Small hobbyist drone sales may grow from 1.9 million in 2016 to as many as 4.3 million by 2020.[1]

Hobbyist uses have so far included such things as racing and photography. These will no doubt continue to expand with such technologies as 4k cameras, Bluetooth and GPS.

Drones and FCC Rules

Radio control of hobbyist drones and associated equipment is typically conducted pursuant to Part 15 of the Commission's Rules. As an example, the radio control signals from a typical consumer drone covered from 2.411 to 2.463 GHz when measured in the ARRL Laboratory. Part 15 allows up to 1 watt of peak envelope power for wideband digital signals in specified Part 18 ISM bands. In this case, 2.450 GHz +/- 50.0 MHz is an ISM band. It should be noted that Part 18 rules prohibit the transmission of intelligence. Drones must therefore still operate under Part 15 but are allowed by the Part 15 rules a higher output power if the Part 15 device is operating in an ISM band.

Some drones are also being sold as Amateur radio equipment operating under Part 97. Some Amateur frequencies are set aside for radio control purposes. However, the operator must have a valid Amateur radio license in order to use this equipment. Under the Commission's Part 97 rules, the maximum transmitter power must not exceed 1 W. Furthermore, there must be a label indicating the station call sign and the licensee's name and address on the station transmitter.

See Appendix A for some of the more important FCC Part 97 rules with regard to radio control operation conducted under Part 97.

Unfortunately some of the drones and associated equipment found by ARRL are blatantly illegal at multiple levels. Particularly alarming are some of the television transmitters for use on drones. Rated at six times over the legal power limit, *and on critical air navigation transponder frequencies*, these devices represent a real and dangerous threat to the safety of flight, especially when operated from a drone platform that can be hundreds of feet in the air. Other violations are described later in this document.

[1] www.faa.gov/news/updates/?newsId=85227

Illegal Marketing of Drone TV Transmitters that Operate on Amateur and FAA Radar Frequencies

In November of 2015, the ARRL EMC Engineer Mike Gruber, W1MG became aware of the marketing of video transmitters for installation on airborne drones that operate on amateur radio frequencies. While the marketing of radio equipment that obviously is not tested for FCC rules compliance is nothing new, these devices are far more than a nuisance for the operators on the 23 cm (1240-1300 MHz) band. In fact, the operation of these transmitters does carry the distinct possibility of causing harmful interference which would result in a serious safety of flight issue for aircraft operations.

One example is the Lawmate 1.2 GHz, 8-channel 1000 mW (1-watt) AV transmitter for drones, which is now being marketed by several vendors. As Appendix B shows, these transmitters are capable of operating on the following frequencies: 1010, 1040, 1080, 1120, 1160, 1200 and 1280 MHz.

Although 1280 MHz is in an Amateur band, this channel would be in conflict with the GLONASS (Russian GPS) CDMA 1202.5 MHz channel. Here in the United States, Glonass is used by several government agencies for radiolocation. This frequency is also in commercial use within the US for the same purpose.

Operation on three of the other "channels" would have a far more significant impact. For example, 1010 MHz is used for aeronautical guidance in the TACAN/DME aircraft radio navigation band.[2] However, it is the potential use of 1040 and 1080 MHz that represents the greatest threat to the safety of flight. These two frequencies are in direct conflict with the ATC (Air Traffic Control) transponder frequencies. In this case, the transponder is interrogated at 1030 MHz with a response from the aircraft at 1090 MHz when those aircraft are operating in what is termed MODE-A or MODE-C transponder. **As noted in Appendix C, there is no shared spectrum with Amateur Radio below 1240 MHz.**

The use of transponders is required on these frequencies by all aircraft operating above 18,000 feet and within 30 miles of all major airports. Additionally, the newest form of digital ATC information for aircraft is transmitted at 1082 MHz. Since both the TACAN/DME and the ATC Transponder systems operate with a 10 MHz bandwidth, the use of an unlicensed drone transmitter can cause serious issues with the integrity of the ATC radar system.[3]

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[2] TACAN/DME is used for direction and distance measurement in military aircraft and the DME is used for distance measurement equipment in large commercial aircraft operating in the instrument flight environment. Most importantly TACAN/DME is used for approach to landing navigation at airports and it is used for navigation aids in the departure, en-route and arrival/approach segments of aeronautical instrument navigation. The Airman's Information Manual (AIM) has several chapters on the details of electronic navigation. Any interference to these aeronautical navigation systems creates a very serious safety of flight issue.

[3] While we do not have solid numbers for the sensitivity of the radar ground station on 1090 MHz, the 1030 aircraft receivers are typically -70dBm for 50% reply with 3 MHz bandwidth not less than -3 dB, -10 at 10 MHz and -50 at 25 MHz. The pulse from the transponder has a rise time of 0.1 us and the pulse from the ground station is less. Hence, a 10 MHz bandwidth for the receivers is a valid claim.

See Appendix C for pertinent spectrum information from the FAA and FCC concerning these frequencies. Appendix D also provides a more complete discussion of the potential impact to aircraft navigation systems caused by these devices.

The channels chosen for operation of these airborne transmitters demonstrate a disregard by the manufacturer of the established and legal assignments of frequency allocations. The Commission should take immediate action with respect to the marketing of these transmitters. Several facts supporting this complaint are:

1) The target market for these devices is the drone hobbyist - not the radio amateur. The device, due to the channel configuration, has no valid amateur radio application. And since transmitters operating in a ham band are being operated by non-hams, many of these devices are and will be used on an unlicensed basis in Amateur spectrum.
2) The use of these devices will cause undue interference to properly licensed amateur stations.
3) While these transmitters are marked as appropriate for "ham" use, they cannot be used legally for Amateur purposes.
4) Since these devices operate on critical aeronautical frequencies, Amateur Radio could be erroneously blamed if there is a problem.
5) The transmitter in this example (shown below) is not appropriate for unlicensed Part 15 use on any of the available channel settings.
6) It is quite obvious that these devices do not have proper FCC equipment authorization under Part 15. The rules require low power transmitters such as these to be Certified. While the state of FCC equipment authorization is not known for certain, the specified frequencies of operation would preclude the required FCC Certification by any knowledgeable TCB.
7) Finally and most importantly, given the capability of the devices to cripple the operation of the ATC secondary target/ transponder systems, these illegal transmitters represent a significant hazard to public safety in general and the safety of flight specifically.

These transmitters and amplifiers are being offered online by a number of internet vendors. A quick online perusal of vendors indicates that there is no shortage of suppliers of these devices:

- www.getfpv.com/fpv.html
- www.readymaderc.com/store/index.php?main_page=index&cPath=11&zenid=8be5bec447599f85ef884721a0c92d8e
- www.hobbyking.com/hobbyking/store/__540__543__FPV_Aerial_Video_Telemetry-Video_Tx_Rx.html

An example of the internet direct marketing of transmitters for drone television transmitters one only has to look as far as the "Hobbyking.com" website where the Lawmate transmitter is available for $89, and a companion 6-watt amplifier is available for $79.

www.hobbyking.com/hobbyking/store/__77815__Lawmate_1_2GHz_8CH_1000mW_Wireless_AV_Transmitter_for_FPV_CCTV_Camera.html

Figure 1 – The Lawmate 1.2 GHz 8CH Wireless AV Transmitter for FPV CCTV Cameras

This device is capable of operating at all four frequencies previously mentioned in this section 1010, 1040, 1080 and 1280 MHz. Consider that the maximum power allowed for this device is 1 watt under both Parts 15 and 97. This is six times the FCC limit when operated with the companion amplifier. When further you consider that this device will potentially be operating from a platform that is at high altitudes, the situation becomes alarming.

See Appendix E for additional drones that were for sale on the Internet at the time of this investigation.

ARRL Laboratory Measurements

In order to fully assess these products, the ARRL Laboratory purchased two samples of the 1.08 - 1.26 GHz TV transmitters from Hobby King. Hobby King had them shipped by air from China, but readily sold them to Ed Hare, the ARRL Laboratory manager. See Appendix F for the paperwork, which in addition to everything else, clearly demonstrates a marketing violation.

Mr. Hare found that the product carried no FCC ID number. He couldn't find anything in the certification database that looked to be this product. Since it operates at 500 mw to 1000 mw on 8 channels, only two of which are in the ham bands, there is no way that this can be legal.

Each sample was then tested for spectral purity. See Figures 2 and 3. ATV 1 TX failed during this testing so only only ATV 2 TX (the larger of the two samples) was tested for frequency and power output. The rated power output for both transmitters is 1,000 mW.

Channel	Channel Freqency	Measured frequency	Measured Output Power
CH 1	1.080 GHz	1.079.970 GHz	400 mW
CH 2	1.120 GHz	1.119.967 GHz	430 mW
CH 3	1.160 GHz	1.159.965 GHz	500 mW
CH 4	1.200 GHz	1.199.964 GHz	750 mW
CH 5	1.010 GHz	1.009.971 GHz	710 mW
CH 6	1.040 GHz	1.039.970 GHz	710 mW
CH 7	1.280 GHz	1.226.506 GHz	600 mW
CH 8	1.280 GHz	1.224.000 GHz	500 mW (Unstable frequency)

Conclusion: These devices are illegally operating at critical radio navigation frequencies. As such, they represent a real and significant thereat to the safety of flight.

Spectral Plots

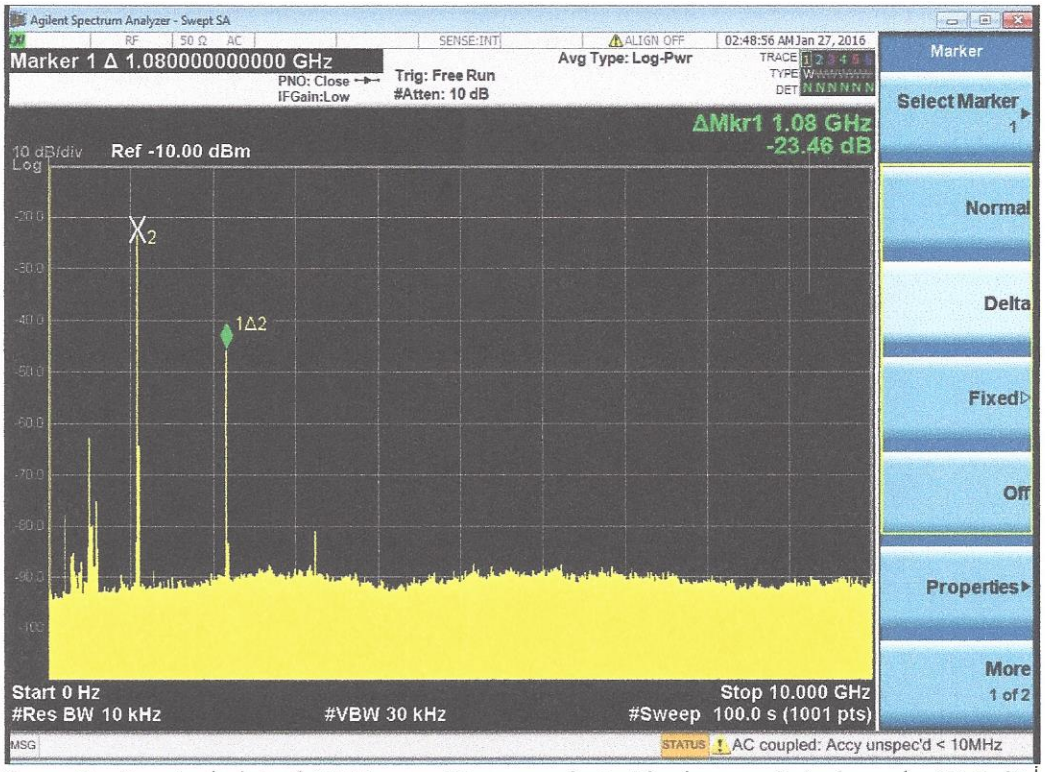

Figure 2 – Spectral plot of ATV transmitter sample 1. The harmonic is down by 23.5 dB.[i]

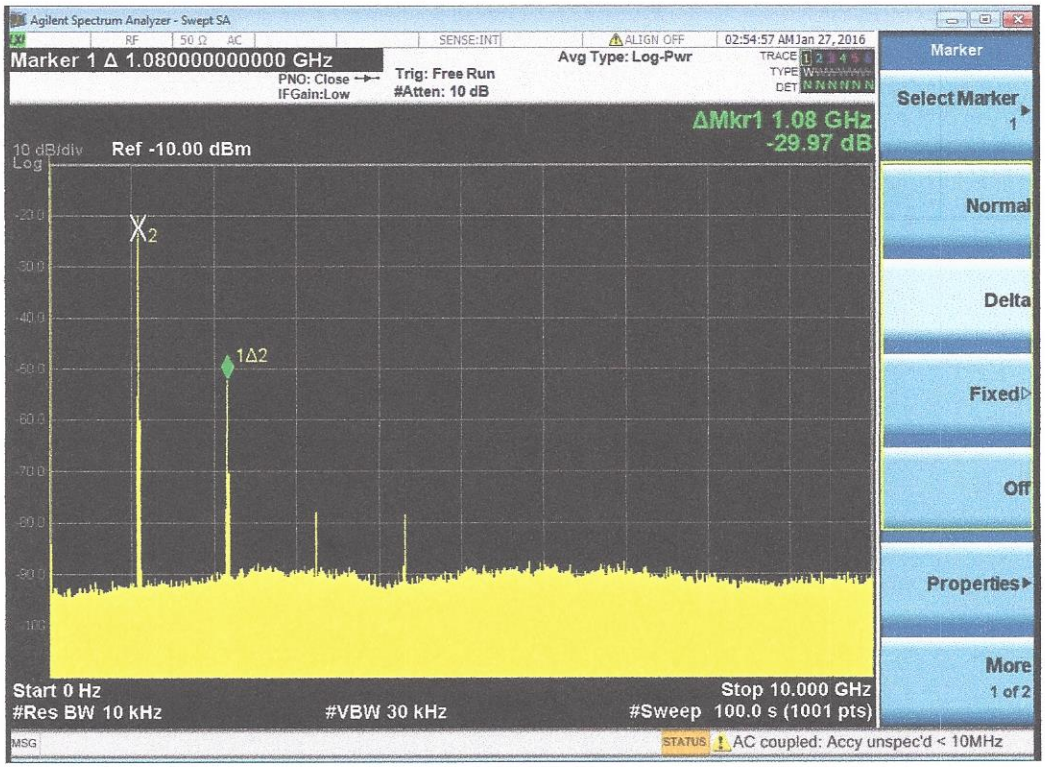

Figure 3 – Spectral plot of ATV transmitter sample 2. The harmonic is down by 30.0 dB.

Note: Regarding Figures 2 and 3, our step attenuator is not rated for the frequency of the

harmonics measured. They may be higher than indicated on our spectrum analyzer.

Conclusion

It is only a matter of time until Amateur operations will be affected in large numbers by these transmitters. Interference with the integrity of the FAA's ATC transponder radar system, however is far more likely now, with obvious public safety implications. Previous ARRL complaints concerning the improper marketing and sale of non-compliant devices have not been responded to, even when the subject devices dramatically exceeded the legal emissions limits. This situation, however is quite different. This product presents a serious risk to safety of air commerce and to the public. As such, this should be a matter of urgency by the Commission.

Recommendation

The Commission should take immediate steps to preclude the importation, sale and marketing of these devices as quickly as possible.

List of Appendices

1) **Appendix A** – Part 97 Rules Regarding Radio Control

2) **Appendix B** – Additional Examples of 1080 MHz and 1.2 GHz Transmitters for Drones

3) **Appendix C** – Pertinent FAA and FCC Frequency Allocations

4) **Appendix D** – The Potential Impact of Illegal to Aircraft Radio Navigation Systems

5) **Appendix E** – Hobby King Web Page Information for the Lawmate transmitter and companion 6-watt amplifier

Appendix A

Part 97 Rules Regarding Radio Control

§97.215 Telecommand of model craft.

An amateur station transmitting signals to control a model craft may be operated as follows:

(a) The station identification procedure is not required for transmissions directed only to the model craft, provided that a label indicating the station call sign and the station licensee's name and address is affixed to the station transmitter.

(b) The control signals are not considered codes or ciphers intended to obscure the meaning of the communication.

(c) The transmitter power must not exceed 1 W.

[54 FR 25857, June 20, 1989, as amended at 56 FR 56171, Nov. 1, 1991]

§97.217 Telemetry.

Telemetry transmitted by an amateur station on or within 50 km of the Earth's surface is not considered to be codes or ciphers intended to obscure the meaning of communications.

[56 FR 56172, Nov. 1, 1991. Redesignated at 59 FR 18975, Apr. 21, 1994]

Appendix B

Additional Examples of 1080 MHz and 1.2 GHz Transmitters for Drones

At the time of this investigation, eBay has over 70 sellers of these devices. Some are the same as Hobbyking's offering - 1 watt output and several channels that cover 1280 MHz and the Aircraft ATC Transponder frequencies. A search using "fpv 1.2 GHz" found close to 100 online offerings:

www.ebay.com/itm/1-2Ghz-800mW-Wireless-8CH-Transmitter-12-Receiver-for-Displayer-Moor-FPV-OSD-NEW-/361232990390?hash=item541b2a00b6:g:bCYAAOSwv0tU98Y-

www.ebay.com/itm/LawMate-1-2GHz-8CH-1000mW-Wireless-AV-Transmitter-VTX-TM-121800-for-FPV-Camera-/181763666158?hash=item2a51f570ee:g:lk0AAOSwZVhWSvHZ

www.ebay.com/itm/1-2GHZ-200mW-4CH-Wireless-Transmitter-A-V-Video-Audio-FPV-Monitoring-Fr-RC-Quad-/252133261211?hash=item3ab4503f9b:g:Gt4AAOSwA4dWHwc~

At the time of this investigation, a search on Amazon.com for "1.2 GHz fpv transmitter" brings up over 900 matches. At least 10% of those were offering the 1-watt version that covers the ham band and transponder frequencies. The search was concluded after looking at the first 50 results that seemed to cover the frequencies of most concern. The ones we found do, in fact, have switch-programmable frequency selections for Amateur, DME-TACAN and ATC (air traffic control) "Radar."

It should be further noted that the vast majority of transmitters offered are only compliant to Part-15 in the proper 2.4 and 5.8 GHz bands, with the notable exception of these "1.2 GHz" models.

Appendix C

Pertinent FAA and FCC Frequency Allocations

1. FAA Frequency Allocation for Spectrum Used by Illegal Drone Transmitters

The FAA's band and frequency allocation for the support of aviation can be found at the following FAA Web page:

www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/safety_ops_support/spec_management/engineering_office/rfb.cfm

In addition, the frequencies of concern and described in this report are provided in the following table. This information is taken from the above referenced FAA's Web page:

Radio Frequency Bands Supporting Aviation

Frequency	Band Name
960 - 1215 MHz	NAVAID (TACAN / DME, etc.)
1030 & 1090 MHz	Air Traffic Control Radar Beacon; Mode S; TCAS
1215 - 1390 MHz	Air Route Surveillance Radar; GPS and GLONASS L1

2. FCC Part 97 Frequency Allocation for 23 cm Band

The 23 cm Amateur Radio Band shares some spectrum with the above FAA frequency allocations. Frequency sharing requirements are described in §97.303 paragraphs (b), (d) and (o) shown below. **There is no FAA/Amateur shared spectrum below 1240 MHz:**

Wavelength band	ITU Region 1	ITU Region 2	ITU Region 3	Sharing requirements, see §97.303, paragraph:
23 cm	1240-1300 MHz	1240-1300 MHz	1240-1300 MHz	(b), (d), (o)

§97.303 Frequency sharing requirements.

(b) Amateur stations transmitting in the 70 cm band, the 33 cm band, the 23 cm band, the 9 cm band, the 5 cm band, the 3 cm band, or the 24.05-24.25 GHz segment must not cause harmful interference to, and must accept interference from, stations authorized by the United States Government in the radiolocation service.

(d) Amateur stations transmitting in the 430-450 MHz segment, the 23 cm band, the 3.3-3.4 GHz segment, the 5.65-5.85 GHz segment, the 13 cm band, or the 24.05-24.25 GHz segment, must not cause harmful interference to, and must accept interference from, stations authorized by other nations in the radiolocation service.

(o) Amateur stations transmitting in the 23 cm band must not cause harmful interference to, and must accept interference from, stations authorized by:

(1) The United States Government in the aeronautical radionavigation, Earth exploration-satellite (active), or space research (active) services;

(2) The FCC in the aeronautical radionavigation service; and

(3) Other nations in the Earth exploration-satellite (active), radionavigation-satellite (space-to-Earth) (space-to-space), or space research (active) services.

Appendix D

The Potential Impact of Illegal Devices to Aircraft Radio Navigation Systems

The antennas used on aircraft for these systems are basically 1/4 wave mounted to the bottom skin of the fuselage. In the case of an aircraft in close proximity to a drone, there is an additional interference issue caused by the Side-Lobe Suppression (SLS) portion of the system.

In the Secondary Aircraft Radar (SAR) system, the interrogation is sent at a 400-600 Hz rate from the radar ground station on 1030 MHz. The old system used 3 pulses for interrogation. However, the new upgraded system uses 4 pulses for the interrogation as follows:

- The first pulse (P-1) is sent from a sweep antenna.
- The second pulse (P-2) is sent -10db down from the first with an Omni antenna above the sweep antenna.
- The third pulse (P-3) varies between two possible spacing's:
    - P-0 which causes the transponder to send the 4 octal numbers from the front panel (Mode A or squawk code), or…
    - The 4 octal numbers from the encoding altimeter.
- The fourth pulse is sent when the interrogation is for a Mode-S transponder, which responds on the same frequency digitally with GPS and unique aircraft transponder ID data.

There are other details in the system - BUT if there is a signal present when the P-2 pulse is sent, this activates the SLS (side lobe suppression) which mutes the transponder reply. The transponder may then see the Omni antenna at the same level as the sweep antenna. The transponder is then in a side-lobe and should not respond.

IF a transponder sees a signal at the same time as the P-2 pulse, it will prevent the transponder from responding. These systems are very brittle and susceptible to poorly operating transponders. In fact, some manufacturer's designs have been problematic when their transponders are subject to the new P-4 signal for mode-S.

The -70 dBm level is the FAA-TSO standard for a 50/50 reply from the transponder. While this is a relatively strong signal, there should be no other signals on these frequencies, period.

Appendix E

Hobby King Web Page Information for the Lawmate transmitter and companion 6-watt amplifier

A compact 1000mW 1.2GHz A/V transmitter module designed for FPV use. An excellent quality unit that has 8 selectable frequencies and audio/video outputs. This transmitter will give you excellent range and very good video clarity.
It utilizes a "Digital Phase Lock-Loop Circuit" without temperature drifting problems. It also features a highly integrated circuit board for ultimate reliability.

Selectable channels: 1080 1120 1160 1200 1010 1040 1280 1280GHz

Features:

- **Compact size**
- **Exceptional range**
- **Excellent video clarity**
- **Highly integrated circuit**
- **Uses "Digital Phase Lock-Loop Circuit" with no temperature drift.**

Specs:
Transmission Frequency: 1.2GHz
Output Power: 1000mW
Channels: 8
Input Voltage: 5V
Modulation Deviation: 2.8MHz FM modulation
Sub-Carrier Frequency: 5.5MHz
Video Input: Impedance = 75ohms
Audio Input: Vp-p
Operating Temperature: -10C~+40C
Weight: 27.5g (transmitter only)
Weight: 76g (transmitter, antenna and supplied A/V lead)
RF Output Connector: SMA
Dimensions: 60 x 25 x 11mm

Note:
Please check with your local authorities regarding operation of this equipment before you purchase. Regulations on power output, usable frequencies and licenses to operate vary from region to region.

Appendix F

Hobby King Purchase documents

Hello, Edward Hare

This is an email to inform you that we have received your order and it has been sent to the warehouse print queue for dispatch.

YOUR ORDER ID IS: 20013095673

Your order will be shipped to;
Edward Hare
225 Main St
Newington, CT 06111, US
UNITED STATES
Ph:8605940318

If you wish to check your address, please log into our website and click on the order in your account section.

You can contact support by logging into our website and submitting a ticket.

ALWAYS QUOTE YOUR ORDER ID WHEN YOU EMAIL US

To check on the status of your order please log into your account at www.HobbyKing.com

Regards
www.HobbyKing.com

If you have any issues or questions regarding our products or service, please feel free to contact us at our support center.