Design and Certification of ASH Radio Systems for Japan

RFM's second-generation ASH radio hybrids are being used in a wide variety of applications in Japan, operating under the Japanese BIJAKU radio regulations. This application note provides information specific to designing and certifying ASH radio systems for the Japanese market. Please refer to the ASH Transceiver Designer's Guide and the ASH Transceiver *Software* Designer's Guide for additional information. You will find the latest version of these design guides and this application note on RFM's web site www.rfm.com.

The ASH radio hybrids compatible with BIJAKU regulations are given in the table below:

Frequency	ASH Transceiver	ASH Receiver	ASH Transmitter
303.825 MHz	TR3003	RX5003	TX5003
315.000 MHz	TR3001	RX5001	TX5001

BIJAKU regulations allow a peak transmitted field strength of 500 µV/m (measured at 3 meters) for frequencies up to 322 MHz. For frequencies of 322 MHz and above, the peak transmitted field strength is limited 35 µV/m, which is too low for useful communications. Note that transmitter harmonics or other spurious emissions occurring at or above 322 MHz must comply with the 35 µV/m limit. The ASH hybrid radios listed above are easily set up to comply with BIJAKU regulations.

Compared to similar low power radio regulations in other countries, the 500 µV/m BIJAKU limit is quite low. For example, USA and Canadian low-power regulations allow 24 to 40 dB more power, and European regulations allow 50 to 54 dB more power, depending on the band of operation. The 500 µV/m limit supports operating distances of 3 to 5 m for a wide range of data rates and antenna designs. This performance is satisfactory for many home and office applications. But where maximum range is needed, very careful attention to system design is required. Here are a number of key points to achieving maximum operating range under the BIJAKU regulations:

1. Use the lowest data rate practical for the application (down to 300 bps if possible). For data rates of 2400 bps or less, you can use an external RC filter to improve the sensitivity of an ASH receiver. Refer to Figure 4.1 in the ASH Transceiver *Software* Designer's Guide and the table below:

Data Rate	R_{BBO}	C_{LPF}	C_{BBO}
2400 bps	12 K	0.0068 µF	0.1 µF
1200 bps	12 K	0.015 µF	0.2 µF
600 bps	12 K	0.027 µF	0.5 µF
300 bps	12 K	0.056 µF	1.0 µF

Use ceramic capacitors for C_{LPF} and C_{BBO}. Also for these data rates, the value for R_{LPF} on Pin 9 of the ASH radio should be set to 330K. If you are using Microchip Keeloq

control encoders and decoders, you can improve system performance by using the 2400 bps filter shown in the table above.

2. Set R_{TH1} to zero ohms to further maximize receiver sensitivity and use a software clock and data recovery method (driven from Pin 7 on the ASH radio) that tolerates continuous white noise between data transmissions. Software clock and data recovery methods such as “integrate and dump” (I&D) can provide 3 dB or more of additional system sensitivity. The ASH Transceiver *Software* Designer’s Guide discusses I&D clock and data recovery methods along with code examples. RFM also offers a firmware product, the IC1000, for this purpose. Where the very highest performance is needed, forward error correction methods can be added, such as Hamming FEC block coding.

3. Use as large an antenna “aperture” as practical. For example, a full ½ wavelength antenna at 315 MHz is about 47.5 cm in length. A well-designed antenna this size can improve reception 10 to 15 dB over a small probe antenna of 6 cm nominal dimensions.

If your system is one-way, the transmitter can be small and still easily transmit a 500 µV/m signal. Often there is room at the receiver to use an antenna with dimensions up to ½ wavelength, which will provide a very significant improvement in system performance compared to using a small antenna at the receiver.

If your system is two way, use as large an antenna a practical at both ends to maximize reception. ASH transceivers and transmitters have a wide range of transmitter power adjustment, making it possible to set the transmitter power to 500 µV/m even with an efficient antenna (for a ½ wave dipole, start with a R_{TXM} value of 330K).

For one-way or two-way systems, diversity reception can improve performance by reducing the problem of multipath nulls. See section 1.4.2 in the ASH Transceiver Designer’s Guide for additional information on this topic.

4. Take full advantage of the BIJAKU test methodology. You can make an appointment to be at the Matsube Test Lab the day your product is tested. At this point you can fine-tune your transmitter power to the 500 µV/m limit by adjusting the R_{TXM} resistor on your ASH transceiver or transmitter. Also, adjust the antenna tuning of hand-held devices for best performance *when held*, then adjust the radiated power on *a wood table* 1.5 m off the ground to 500 µV/m. This will duplicate the way the Matsube Test Lab will make the measurements. Often, your hand-held product will radiate somewhat more power when held than when placed on the test table, providing additional “real world” performance.

A point about testing. Second generation ASH radios can easily pass BIJAKU testing when correctly adjusted. However, microprocessor or other digital circuitry can cause your product to fail due to RF radiation from them. Be careful to do a “tight” digital layout and use the necessary decoupling and shielding to avoid this type of problem.

Customers using the methods discussed above report outdoor operating ranges from 15 to 30 meters or more, depending on data rate and antenna size.

Overview of BIJAKU Regulations:

RFM offers this general information on the BIJAKU regulations without guarantee of accuracy or completeness. Please consult with the BIJAKU Radio Device Section for the latest information.

BIJAKU Regulations: Postal Administration Bulletin No. 127, 13 May 1994 Revision

Japanese Radio Application Procedure for Very Low Power BIJAKU Radio Devices

Notification to Test Lab

The Matsube Test Lab suggests that you contact them prior to submitting your product or apparatus for certification. This will facilitate scheduling and testing:

BIJAKU Radio Device Section
Telecom Engineering Center Matsube Test Lab
580-2 Takatsuka Shinda, Maatsuba City,
Chiba Prefecture, Japan 270-222

Phone, FAX and E-mail for the BIJAKU certification department:

Phone: 81-3-3799-0055
FAX: 81-3-3799-1313
E-mail: e-nukanobu@telec.or.jp

Application Forms

There are two forms required from the applicant (filled out in Japanese):

Form 1-1: On this form you provide the name, corporate address, official stamp and phone/FAX numbers of the company making the application, plus the name, business address and phone/FAX numbers of the person responsible for the application (for example, an RF consultant), plus the name, business address and phone/FAX numbers of the company that will actually manufacture the product (for example, a manufacturing subcontractor). These addresses may or may not be the same, depending on specific circumstances. Also on this form you provide the category for your product (consumer, industrial, etc.), the name of your product (“Palm Pal”, etc.), and your product type (short range RF modem in PC card). Finally you provide the production serial number(s) of the sample unit(s) being submitted for certification testing, plus any special notes.

Form 1-2: On this form you specify the application of the product, the nominal operating frequency of the product, the number of RF channels used, the minimum and maximum

operating frequency details and the channels spacing. You also specify the type of modulation used (OOK, ASK, etc.), the modulation depth or modulation index, the modulation bandwidth, the communication mode being used (A1, F2, etc.), the transmission duration and duty cycle (2 seconds, 5%, etc.), plus the type, number and length of antenna(s) used in the product. Next you specify the AC voltage and number of power line phases used by the product, the type and number of non-rechargeable batteries used, and the rechargeable battery type (or brand), voltage and number being used, and if you are sending a charger with you sample product. Finally you specify the dimensions and weight of the product.

Test Sample Documentation

Documentation is required with the test sample(s), including a description of the function of each unit that makes up the product, the performance specifications, operating instructions (needed to conduct the testing), system hookup and block diagrams, detailed schematics, the bill-of-materials, and photos of the outside appearance of all the units that make up the product.

Test Samples

You must submit one sample of each type of device to be tested. More test devices may be required if requested. If the test device is AC powered, provide at least 2 m of power cord with the device. If rechargeable batteries are used, supply the batteries fully charged and also provide a charger unit. If non-rechargeable batteries are used, provide enough batteries for continuous transmission testing. Configure the test device for continuous transmission to speed testing. Also provide any cables, test fixtures or other items needed to test the product. Send the test samples(s) and the test sample documentation to the following address:

Matsube Test Lab
Telecom Engineering Center
580-2 Takatsuka Shinda, Maatsuba City,
Chiba Prefecture, Japan 270-222

Test Methods

Testing is done in accordance with Postal Administration Bulletin No. 127. The test will require 30 minutes or more of continuous transmission, so the sample unit should be configured to transmit continuously for 30 minutes or longer. Products designed to transmit intermittently should be configured to transmit one or more times each second for 30 minutes or longer. If the test sample fails to work properly, or it does not comply with the BIJAKU limits for radiated field strength, the Matsube Test Lab will notify the applicant and discuss the next steps.

Certificate

A certificate (Form 3) will be issued to the applicant if the test device complies with BIJAKU radiated field strength limits.

Return of Test Device(s)

You should arrange to pick up your test device(s) as soon as you are notified by the Matsube Test Lab that the testing has been completed.

Fees

The basic test fee is 83,000 ¥ for one test device with one frequency test, one kind of power supply and one antenna. An additional fee of 420 ¥ per minute is charged for extra test time where more than one frequency, power supply and/or antenna is tested. After received the test fee bill, you should arrange your payment to the Matsube Test Lab bank account. The applicant should pay any remittance charge from the bank.

Postal Administration Bulletin No. 127 Test Method Summary

Test Area Criteria

1. There must be no buildings and other reflective objects around the test area. In addition, within a flat elliptical space 6 m long and 5.2 m wide, there must be no metal blinds or other metal objects.

2. Spurious emissions in the test area (except the emissions from the test device): If the frequency of a spurious emission is the same as the test device, the spurious emission level must be at least 10 dB lower than the limit for the test device at that frequency.

3. From 30 MHz to 1 GHz, actual measurements made in the test area should agree within ±4 dB to the calculated results based on the antenna factor and compensation curves of the reference antennas.

Test Device Placement

The placement instructions for the test device and antenna given below are intended to provide a true indication of maximum field strength.

1. The test device should be set on top of a turntable in its normal working configuration. The turntable should be made of wood or other insulated material and should be 1.5 m in height. If the distance from the lower end of the antenna to the ground is less than 0.5 m, the height of the turntable should be raised to keep the lower end of the antenna at least 0.5 m above the ground.

2. If the length of cable connecting the antenna to the test device is longer than 1.5 m, the test device should set on the ground (or lower).

Test Equipment

(Comments on frequencies below 150 kHz omitted)

Frequency from 150 kHz to 1GHz

1. A field strength meter with a quasi-peak detector, or a spectrum analyzer which can display peak level is required.

2. A field strength meter used for any of the test frequencies should conform to the specifications showed on form No. 4 (see BIJAKU detailed specifications).

3. A spectrum analyzer used for testing must include resolution bandwidths of 10 kHz, 100 kHz and 1MHz.

(Comments on frequencies above 1 GHz omitted)

Test Antennas

(Comments on frequencies below 30 MHz omitted)

Antenna for 30 MHz to 1 GHz

1. A half wavelength dipole antenna should be used.

2. The antenna should be resonated to the test signal frequency. If the test frequency is 80 MHz or lower, the antenna length should be the same as for 80 MHz, with extra elements added to the antenna to achieve resonance.

(Comments on frequencies above 1 GHz omitted)

Test Methods

(Comments on frequencies below 30 MHz omitted)

Frequency from 30 MHz to 1GHz

1. The test device should be set on the top of a (wooden) turntable at 1.5 m above the ground, and the test antenna oriented for vertical polarization (3 m from the test device).

2. The turntable should be rotated to find the maximum field strength and left in this position.

3. The height of the test antenna should be adjusted from 1 to 4 m to find the maximum field strength.

4. The test antenna should be reoriented for horizontal polarization and steps 2 and 3 repeated

5. In the position that provides the maximum reading from either test step 3 or 4 above, adjust the resolution of the spectrum analyzer to 100 kHz and take the reading of field strength as E1, then adjust the resolution to 1 MHz and take the reading as E10.

6. The radiated field strength of the test device is recorded as the *higher* of reading 3 or 4, if the difference between the E1 and E10 from step 5 is 3 dB or less. If the difference between the E1 and E10 from step 5 is 3 dB to 7 dB, *then use the E10 reading from step 5*. If the difference between the E1 and E10 from step 5 is more than 7 dB, then take the value of *E10 and add 5 dB to it*.

(Comments on frequencies above 1 GHz omitted)

(Comments on the rest of Postal Administration Bulletin No. 127 omitted)

RFM Japanese Partners and Corporate Support for ASH Radio Technology

RFM has two key partners in Japan for ASH radio technology. Circuit Design in Nagano is RFM's Japanese distributor for ASH radio products. They also offer contract design and manufacturing services related to RFM ASH radio applications:

Circuit Design, Inc.
7557-1 Hotaka,
Hotaka-machi,
Minamiazumi-gun
Nagano 399-8303
JAPAN
http://www.cdt21.com
E-mail: circuit@circuitdesign.co.jp
Phone: 0263-82-1010
FAX: 0263-82-1020

RFM's ASH radio manufacturing partner in Japan is Morioka Seiko, world renowned for the manufacture of watches and other precision mechanical and electronic technology:

Morioka Seiko Instruments, Inc.
61-1 Aza Itabashi
No. 23 Chiwari,
Shizukuishi-cho,
Iwate-gun

Iwate 020-0596
JAPAN
Phone: 019-692-3511
FAX: 019-692-1170

RFM also provides direct support for Japanese ASH radio applications through our Pacific Rim Sales and Applications Group:

RF Monolithics, Inc.
4347 Sigma Road
Dallas, Texas, 75224
USA
Phone: 972.448.3700
FAX: 972.387-8148
E-mail: info@rfm.com