

Emissions Testing
Performed
on the
Harmonix Corporation
Communications Transceiver
Model: EK6HOC3JH-SGM

To

FCC Part 15 Subpart C, 15.255

Date of Test: May 24, 25 & 26, 2000

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Report Number: J20013614

Contact: Mr. Dana Wheeler

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III - Attestation

LABORATORY MEASUREMENTS

**Pursuant To
Part 15, Subpart C
For
Intentional Radiators**

Company Name: Harmonix Corporation
Address: 1755 Osgood Street
Andover, MA 01845

Model: EK6HOC3JH-SGM

Date of Test(s): May 24, 25 & 26, 2000

Test Site Location: INTERTEK TESTING SERVICES NA INC.
70 Codman Hill Road
Boxborough, MA 01719

Site: 3C

We attest to the accuracy of this report:



Signature

Michael J. Peters

Testing Performed By:

Senior Project Engineer

Title

 7/28/00

Signature

Robert F. Martin

Reviewer

Sr. Technical Manager

Title

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I – Introduction and Summary

TO: Mr. David Russell

FROM: Michael J. Peters, Senior Project Engineer

DATE: May 24, 25 & 26, 2000

JOB #: J20013614

RE: Emissions Testing Performed on the Communications Transceiver, Model: EK6HOC3JH-SGM

On May 24, 25 & 26, 2000 we tested the Communications Transceiver, Model: EK6HOC3JH-SGM to determine if it was in compliance with the FCC Part 15, Subpart C, Section 15.255. A Production version of the sample was received on Wednesday, May 24, 2000 in good condition. We found that the unit met the Part 15 requirements when tested as received.

The following table presents the results of testing at typical frequencies. Details can be found in the referenced sections of this report.

Test	Frequency (MHz)	Measurement	Requirement	Pass/Fail	Section of FCC Rules	Section of Test Report
Fundamental Power Density	61,842.2	16.7pk/6.7ave uW/cm ²	18pk/9ave uW/cm ²	P	15.255(b)(2)	II
Restricted Band Emissions	30-40000; >40000	Table 1-3 Section X		P	15.209/15.205	X
Line-conducted Emissions	0.45-30	Table 4 Section X		P	15.207	X
Antenna Conducted Emissions – Receiver	No removable antenna					
Antenna Conducted Emissions – Transmit	No removable antenna					
Frequency Deviation Temperature	59,162,828,479	+389,014Hz - 476,541Hz	10 MHz	P	15.255(f)	XII
Field Strength Deviation Voltage	See Annex A	See Annex A		P	15.31(e)	See Annex A
Frequency Deviation Voltage	59,162,828,479	+120,230Hz -266,038Hz	10MHz	P	15.255(f)	XII

Modifications Required for Compliance

The following modifications were installed during compliance testing in order to bring the product into compliance (Please note that this list does not include changes made specifically by Harmonix Corporation prior to compliance testing):

- 1) A ferrite sleeve (Fair-Rite P/N: 0443164251) was placed around the power cord, internal to the device, in a straight through configuration.
- 2) 0.022 uF Y-capacitors were installed from each line to ground at the power input isolation block.
- 3) 0.1 uF X-capacitor was installed across each line at the power input isolation block.
- 4)

In summary, this report confirms that the Model: EK6HOC3JH-SGM is compliant with the FCC Part 15, Subpart C Section 15.255 requirements when production units conform to the initial sample. Please address all questions and comments concerning this report to Michael J. Peters, Senior Project Engineer.

II – Technical Requirements

15.1 Scope

The device is an intentional and un-intentional (based on receiver per Part 15.101 “all other receivers” declaration of conformity) radiator intended to operate in accordance with 15.255 Operation in the band 59.05 to 64.0 GHz Of Part 15 of the FCC rules without a license.

15.15 General Technical Requirements

There are no controls accessible to the user that would cause the device to operate in violation of the FCC rules.

15.27 Special Accessories

No special accessories are necessary to meet compliance requirements.

15.31(e) Variation of radiated signal level due to voltage variation

Variation of field strength level is discussed in Annex A of this report.

15.37 Measurement Standards

The measurement procedures specified by ANSI C63.4:1992 were used to setup and test the device. See Section IV of this test report for detailed description of the test procedure.

15.33 Frequency range of measurement

The device was scanned for spurious and harmonic emissions from 30 MHz to 200 GHz. Line-conducted emission measurements were made from 450kHz – 30MHz

15.35 Measurement detector functions and bandwidth

The following table illustrates the detector functions and bandwidth used to test the device.

No deviations to the following were made.

Frequency Range	Measurement Detector	Measurement Bandwidth
450 kHz to 30 MHz	Quasi-Peak	9 kHz
30 MHz to 1000 MHz	Quasi-Peak	120 kHz
1000 MHz to 200 GHz	Average	1 MHz

Note: The quasi-peak detector meets the requirements of CISPR 16.

An averaging factor was not used for the device.

15.37 Transition Provisions

Transition provisions were not applied to the device.

A separate receiver is not being certified with the device.

The device does not operate in the band 902-905 MHz.

15.201 Certification

The device is required to be certified in accordance with Part 2 of the FCC rules, Subpart J.

15.203 Antenna Requirements

The antenna is integral to the device and cannot be readily removed or replaced by the end-user.

15.204 External Radio Amplifier

The device is not an amplifier.

15.205 Restricted bands of operation

The emissions requirements below 40 GHz are the same as the general requirements of 15.209, which is the same as the requirement for emissions in restricted bands. Other than the fundamental emission, no other emissions were detected above 40 GHz. Measurements can be found in Table 1-3 of Section X of this report.

Below 1000 MHz a quasi-peak detector was employed to measure emissions

Above 1000 MHz, peak measurements were performed to and compared to the average requirement.

15.207 Conducted Limits

The device complies with the conducted emissions requirements when modified as described in the introduction.

15.209 Radiated emission limits; general requirements

Below 40 GHz, the device is required to comply with the general emissions requirements. All measurements below 40 GHz were compared with the requirement.

Detailed description of operation

The transmitter was tested using worst-case OC3 and OC12 modulation. The modulation was present during radiated emissions testing. For frequency stability and output power test, the modulation signal was removed and the un-modulated carrier was measured.

Justifications

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C63.4 (1992).

The worst case bit sequence was applied during test.

For maximizing emissions, the system was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the radiated emissions data contained in this report

Radiated emissions were tested in the range of 30 MHz to 200 GHz.

For simplicity of testing, the unit was wired to transmit continuously.

15.255 Operation in the band 59.0 – 64.0 GHz

Restrictions on Operations

(a) Operation under the provisions of this section is not permitted for the following products:

(1) Equipment used on aircraft or satellites.

(2) Field disturbance sensors, including vehicle radar systems, unless the field disturbance sensors are employed for fixed operation. For the purposes of this section, the reference to fixed operation includes field disturbance sensors installed in fixed equipment, even if the sensor itself moves within the equipment.

The device is a low power communication device. It does not fall under either category 1) or 2) above.

(d) Only spurious emissions and transmissions related to a publicly accessible coordination channel, whose purpose is to coordinate operation between diverse transmitters with a view towards reducing the probability of interference throughout the 59-64 GHz band, are permitted in the 59.0-59.05 GHz band.

The device does not operate in the 50.0 to 59.05 band. The lowest carrier frequency is 59.210 GHz.

Note: The 59.0-59.05 GHz is reserved exclusively for a publicly accessible coordination channel. The development of standards for this channel shall be performed pursuant to authorizations issued under Part 5 of this chapter.

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Power Density

The following table summarizes the power density limits for the devices operating in this band:

Type of Transmitter	Power Density		Test Distance (meters)
	Average(3) ($\mu\text{W}/\text{cm}^2$)	Peak (2) ($\mu\text{W}/\text{cm}^2$)	
NOT Field Disturbance Sensors	9	18	3
Fixed Field Disturbance Sensors (BW < 500 MHz)			
Frequency Range - 61.0 to 61.5 GHz	9	18	3
Frequency Range – 59.0 to 61.0 & 61.5 to 64 GHz	0.009	0.018	3
Fixed Field Disturbance Sensors			
Not operating under Paragraph 15.255 (b)(2)	0.1 mW(1)	9	3

- 1) Output Power measurement (distance not applicable)
- 2) Peak power density shall be measured with an RF detector that has a detection bandwidth that encompasses the 59-64 GHz band and has a video bandwidth of at least 10 MHz, or using an equivalent measurement method.
- 3) The average emission limits shall be calculated, based on the measured peak levels, over the actual time period during which transmission occurs.

The following Table summarizes the results of field strength testing:

Antenna	Fundamenta l Frequency (MHz)	Measurement ($\mu\text{W}/\text{cm}^2$)		Limit ($\mu\text{W}/\text{cm}^2$)		Pass/ Fail	Table #	Test Distance (m)
		Peak	Avg	Peak	Avg			
Patch	59,162.0	2.3	1.1	18	9	Pass	1	3
Patch	61,380.0	3.6	1.4	18	9	Pass	1	3
Patch	63,597.0	3.0	1.0	18	9	Pass	1	3
Parabola	59,845.7	16.0	6.1	18	9	Pass	2	3
Parabola	61,842.2	16.7	6.7	18	9	Pass	2	3

Spurious Emissions

(b) Limits on spurious emissions:

(1) The power density of any emissions outside the 59.0-64.0 GHz band shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in Section 15.209 of this part.

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm² at a distance of 3 meters.

(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

Spurious Emissions are summarized on Tables 1 through 3 in Section X of this report.

No emissions exceed the limits after modifications.

No emissions other than the fundamental were found >40GHz

Peak Output Power

(e) Except as specified below, the total peak transmitter output power shall not exceed 500 mW.

(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g. for frequency hopping devices).

(2) Peak transmitter output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 59-64 GHz band and that has a video bandwidth of at least 10 MHz, or using an equivalent measurement method.

(3) For purposes of demonstrating compliance with this paragraph, corrections to the transmitter output power may be made due to the antenna and circuit loss.

The output power of the transmitter is calculated based on the peak field strength readings from the previous section:

Antenna gain is calculated as:

$$G = 4\pi A_e / \lambda^2$$

Where,

G – Numeric gain, A_e – effective antenna area, λ - wavelength in meters

Using the actual area yields worst-case results (3"x5" = 0.0097 meters)

$$G = 4\pi * (0.0097) / (300/59,162)^2 = 4,740.5 \text{ (36.8 dB)}$$

The Power is derived from the field strength by the following formula:

$$P = (E * r)^2 / 30 * G$$

Where,

E – Field Strength in V/m, r – measurement distance in meters

The field strength is related to power density (s) by $s = E^2 / 377$

$$\begin{aligned} P &= ((377 * s)^{1/2} * r)^2 / 30 * G \\ &= ((377 * 2.3)^{1/2} * 3)^2 / 30 * 4,740.5 = 0.0549 \text{ watts or } 54.9 \text{ mW} \end{aligned}$$

Frequency Stability

(f) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

Since there is not specific frequency deviation tolerance other than the emission must stay in the band, the maximum frequency deviation is determined as follows using the transmitters side-band frequency:

$$\begin{aligned}\text{Maximum Frequency Deviation} &= \text{Side-band Frequency} - \text{Band Start Frequency} \\ &= 60,010 - 60,000 = \pm 10 \text{ MHz}\end{aligned}$$

For the highest frequency, the separation from the band edge to the side-band frequency is greater so the 10 MHz will be used there as well.

Measurement results are found in Section XII of this test report.

Human Exposure to RF Fields

(g) Regardless of the power density levels permitted under this section, devices operating under the provisions of this section are subject to the radio frequency radiation exposure requirements specified in § 1.1307(b), § 1.1310, § 2.1091 and § 2.1093 of this chapter, as appropriate. Applications for equipment authorization of devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Statement of compliance, and MPE calculation can be found in the attached document "Part 15MPE.doc". Calculations were performed in accordance with OET Bulletin 65, edition 97.01 and detailed in the confidential package.

Prohibition on external Phase-Locking Inputs

(h) Any transmitter that has received the necessary FCC equipment authorization under the rules of this chapter may be mounted in a group installation for simultaneous operation with one or more other transmitter(s) that have received the necessary FCC equipment authorization, without any additional equipment authorization. However, no transmitter operating under the provisions of this section may be equipped with external phase-locking inputs that permit beam-forming arrays to be realized.

No provisions exist for external phase locking of this device.

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Transmitter Identification Requirement

(i) Within any one second interval of signal transmission, each transmitter with a peak output power equal to or greater than 0.1 mW or a peak power density equal to or greater than 3 nW/cm², as measured 3 meters from the radiating structure, must transmit a transmitter identification at least once. Each application for equipment authorization must declare that the equipment contains the required transmitter identification feature and must specify a method whereby interested parties can obtain sufficient information, at no cost, to enable them to fully detect and decode this transmitter identification information. Upon the completion of decoding, the transmitter identification data block must provide the following fields.

1. FCC Identifier, which shall be programmed at the factory.
2. Manufacturer's serial number, which shall be programmed at the factory.
3. Provision for at least 24 bytes of data relevant to the specific device, which shall be field programmable. The grantee must implement a method that makes it possible for users to specify and update this data. The recommended content of this field is information to assist in contacting the operator.

Discussion of the transmitter identification feature is described in the attached documents "FCC Identifier.doc" and "FCC Letter.pdf".

Part 2

2.201 Emission Modulation and transmission characteristics

The emission designator is determined as follows

Bandwidth is measured to be:

The main carrier modulation is pulse modulation using a sequence of un-modulated pulses. Therefore the first symbol is 'M'.

The modulating signal is a single channel of digital information without the use of a modulating sub-carrier. Therefore the second symbol is '2'.

The type of information transmitted is a combination of all information types described in FCC section 2.201. Therefore the third symbol is 'W'.

The emissions designator is:

'M2W'

2.1041 Measurement Procedures

Only the measurement procedures of Part 15 are required for this device.

2.1091 Radio frequency radiation exposure evaluation: Mobile Devices

The device does not meet the definition of a mobile device (That is, it is intended to be utilized in a fixed location.) and is therefore exempt from the requirements of this section.

2.1093 Radio frequency radiation exposure evaluation: Portable Devices

The device does not meet the definition of a portable device (That is it is not intended to operate within 20 cm of a person's body.) and is therefore exempt from the requirements of this section.

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