Users Manual

Wireless Autani Transceiver (WAT) 1000119-01

Fully Integrated IEEE 802.15.4 Transceiver Module

Document Number: 80016

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Version	Date	Changed By	Revision Description
1	3-Feb-2009	JAD	Initial Release
2	10-Feb-2009	JAD	Added FCC notes
3	11-Feb-2009	HMM	Added Note numbers and -01 to title page

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1. Description

The Wireless Autani Transceiver (WAT) provides a cost-effective RF transceiver for 2.4 GHz IEEE 802.15.4 wireless networks. The WAT is based on the Ember EM250 System-on-a-chip (SoC) and it has been designed to support larger, denser, sleepier, more mobile, secure, and resilient wireless networks.

Features

- Design for EmberZNet networks
- Miniature footprint: 1.000” x 0.800”
- Integrated PCB antenna
- 16 RF channels
- Integrated hardware support for Ember development environment
- Non-intrusive debug port (SIF)
- AES 128-bit encryption
- Low power consumption
- Constant RF output power over 2.1V - 3.6V voltage range
- FCC (V8NWAT1000119) and IC (7737A-WAT1000119) certified
- 128kB Flash Memory
- 5kB SRAM
- 16-bit XAP2b microprocessor
- 16 general purpose inputs and outputs (GPIO)
- UART, SPI, and I2C interfaces
- Integrated ADC with 12-bit maximum resolution

2. Ordering Information

Part Number	Ordering Number	Description
WAT1000119 IEEE 802.15.4 Module	1000119-100	Wireless Autani Transceiver

3. Specifications

3.1 Absolute Maximum Ratings

Note: Exceeding the maximum ratings may cause permanent damage to the module

Parameter	Value	Unit
Power Supply Voltage (V_{DD})	3.6	V_{DC}
Voltage on any digital pin	V_{DD}+0.3, Max 3.6	V_{DC}
Storage Temperature Range	-40 to 125	^{o}C

3.2 Recommended Operating Conditions

Note: Operating conditions outside those listed here may cause inappropriate behavior.

Parameter	Min	Typ	Max	Unit
Power Supply Voltage (V_{DD})	2.1		3.6	V_{DC}
Ambient Temperature Range	-40	25	85	^{o}C
Logic Input Low Voltage	0		20% V_{DD}	V
Logic Input High Voltage	80% V_{DD}		V_{DD}	V

3.3 Electrical Specifications

Parameter	Min	Typ	Max	Unit
General Characteristics				
RF Frequency Range	2.400		2.4835	GHz
Data Rate		250		Kbps
Processor core frequency		12		MHz
Flash Memory		128		kB
SRAM		5		kB
Power Consumption				
Transmit Mode		35.5		mA
Receive Mode		35.5		mA
Processor Only Mode		8.5		mA
Sleep Mode			1	uA
Logic Characteristics				
Logic Input High	80% V_{DD}		V_{DD}	V
Logic Input Low	0		20% V_{DD}	V
Logic Output High	82% V_{DD}		V_{DD}	V
Logic Output Low	0		18% V_{DD}	V
Output Source Current			4	mA
Output Sink Current			4	mA
Logic High Input Current			0.5	uA
Logic Low Input Current			-0.5	uA
Input Pull-up Resistance		30		kΩ
Input Pull-down Resistance		30		kΩ

4. EM250 Peripherals and Capabilities

The WAT Module provides 16 GPIO ports that are shared with alternate functions within the EM250 SoC. The alternate functions can be used on a variety of different GPIO. All GPIOs are configurable as input, output, or bi-directional and have an internal pull-up or pull-down.

The WAT Module offers two serial controllers, a multi-channel 12-bit Analog-to-Digital converter (ADC), and two16-bit timers. Serial Controller SC1 can be configured for SPI (master only), I2C (master only), or UART. Serial Controller CS2 can be configured for SPI (master or slave) or I2C (master). The ADC can be configured to provide anywhere from 5 to 12 bits of precision on 4 single-ended channels or 2 differential channels in addition to monitoring the supply voltage. The 16-bit timers have configurable clock sources, a loadable start point, two output compare registers, two input capture registers, and can be configured to operate up/down counting, single shot counting, and pulse width modulation (PWM).

The WAT Module provides access to the SIF module programming and debugging interface.

Please consult the EM250 datasheet for detailed information about using the peripherals.

WAT Module Pin Assignment

Pin #	***Name***	***Type***	***Description***
1	Ground	GND	Ground
2	Ground	GND	Ground
3	Ground	GND	Ground
4	V_{DD}	V_{DD}	Power Supply Input
5	RSTB	DI	Processor Reset, active low
6	GPIO11	DI/DO	GPIO, SC1-CTS, SC1-SPI_CLK, Capture Input A of TMR2
7	GPIO12	DI/DO	GPIO, SC1-RTS, Capture Input B of TMR2
8	GPIO0	DI/DO	GPIO, SC2-SPI_MOSI, Capture Input A of TMR1
9	GPIO1	DI/DO	GPIO, SC2-SPI_MISO, SC2-I2C_DATA, Capture Input A of TMR2
10	GPIO2	DI/DO	GPIO, SC2-SPI_CLK, SC2-I2C_CLK, Capture Input B of TMR2
11	GPIO3	DI/DO	GPIO, SC2-SPI_SS, Capture Input B of TMR1
12	GPIO4	DI/DO/AI	GPIO, ADC0, PTI_EN
13	GPIO5	DI/DO/AI	GPIO, ADC1, PTI_DATA
14	GPIO6	DI/DO/AI	GPIO, ADC2, External Input of TMR2, External Enable of TMR1
15	GPIO7	DI/DO/AI	GPIO, ADC3GPIO8

16	GPIO8	DI/DO/AO	GPIO, ADC Reference Output, External Input of TMR1, External Enable of TMR2, IRQA
17	GPIO9	DI/DO	GPIO, SC1-Tx, SC1-SPI_MOSI, SC1-I2C_DATA, Capture Input A of TMR1
18	GPIO10	DI/DO	GPIO, SC1-Rx, SC1-SPI_MISO, SC1-I2C_CLK, Capture input B of TMR1
19	SIF_CLK	DI	SIF Programming Interface Clock
20	SIF_MISO	DO	SIF Programming Interface Data Output
21	SIF_MOSI	DI	SIF Programming Interface Data Input
22	LOADB	DI/DO	SIF Programming Interface Load Strobe
23	GPIO16	DI/DO	GPIO, TMR1 Output B, Capture Input B of TMR2, IRQD
24	GPIO15	DI/DO	GPIO, TMR1 Output A, Capture Input A of TMR1, IRQC
25	GPIO14	DI/DO	GPIO, TMR2 Output B, Capture Input B of TMR1, IRQB
26	GPIO13	DI/DO	GPIO, TMR2 Output A, Capture Input A of TMR1
27	Ground	GND	Ground
28	Ground	GND	Ground

Unused GPIO should be left unconnected. The EM250 should be configured to hold unconnected GPIO in a known state.

DI = Digital Input

DO = Digital Output

AI = Analog Input

AO = Analog Output

V_{DD} = Power Input

GND = Ground

5. Antenna

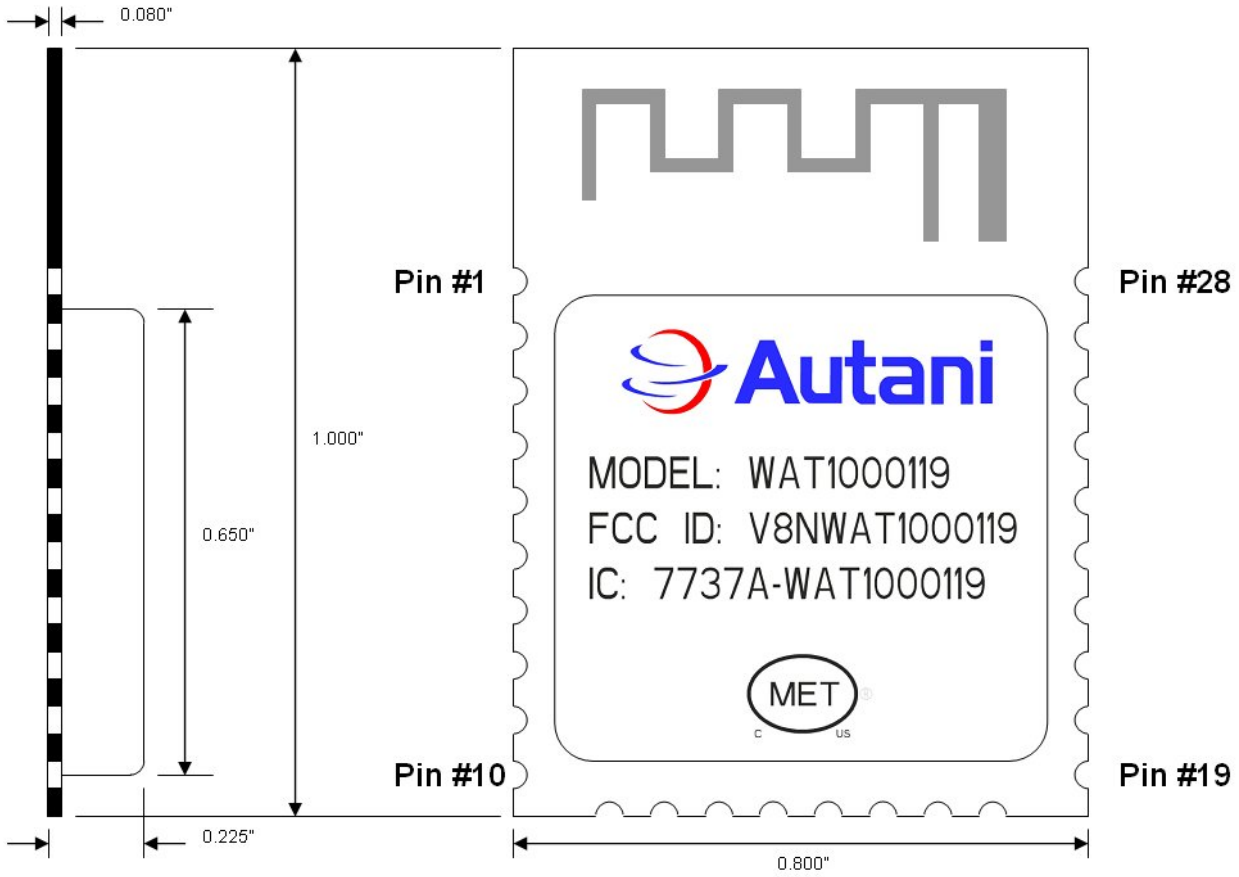
WAT Module includes an integrated PCB trace antenna. The PCB antenna employs a meandering F-antenna design that is very compact and supports omni-directional signal radiation. To maximize the antenna efficiency an adequate ground should be provided on the base board. The position of the module on the base board and overall design of the product enclosure contributes to the antenna's performance.

Here are some guidelines to help ensure antenna performance:

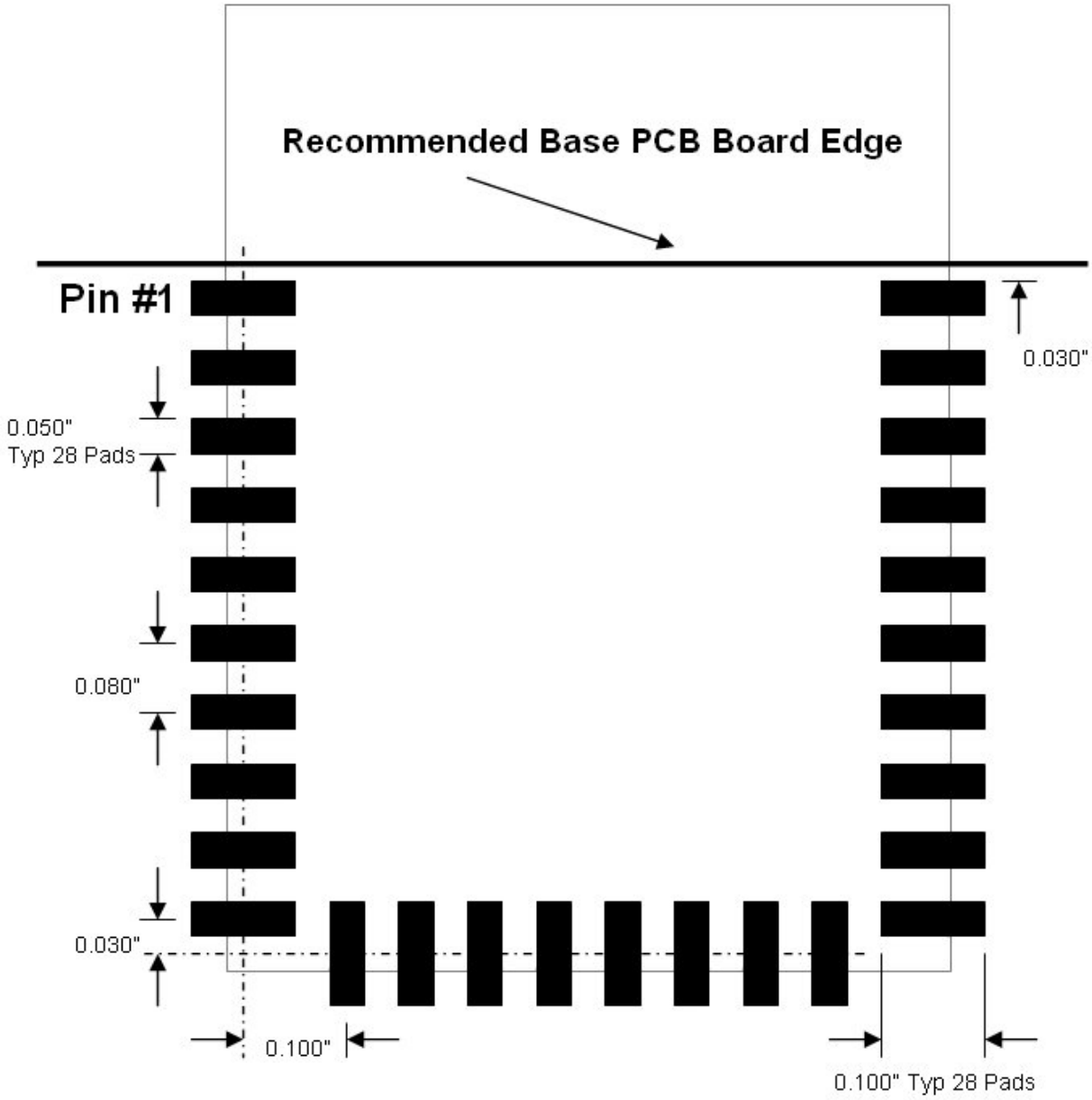
- Keep all copper (planes and traces) away form the antenna portion of the module
- Keep the antenna away from metal parts (i.e. enclosures, large heat sinks, etc…)
- Keep internal wiring and other components away from the Antenna
- Do not place the antenna inside a metal enclosure
- Keep plastic enclosures ½ in. or more from the antenna

6. Dimensions

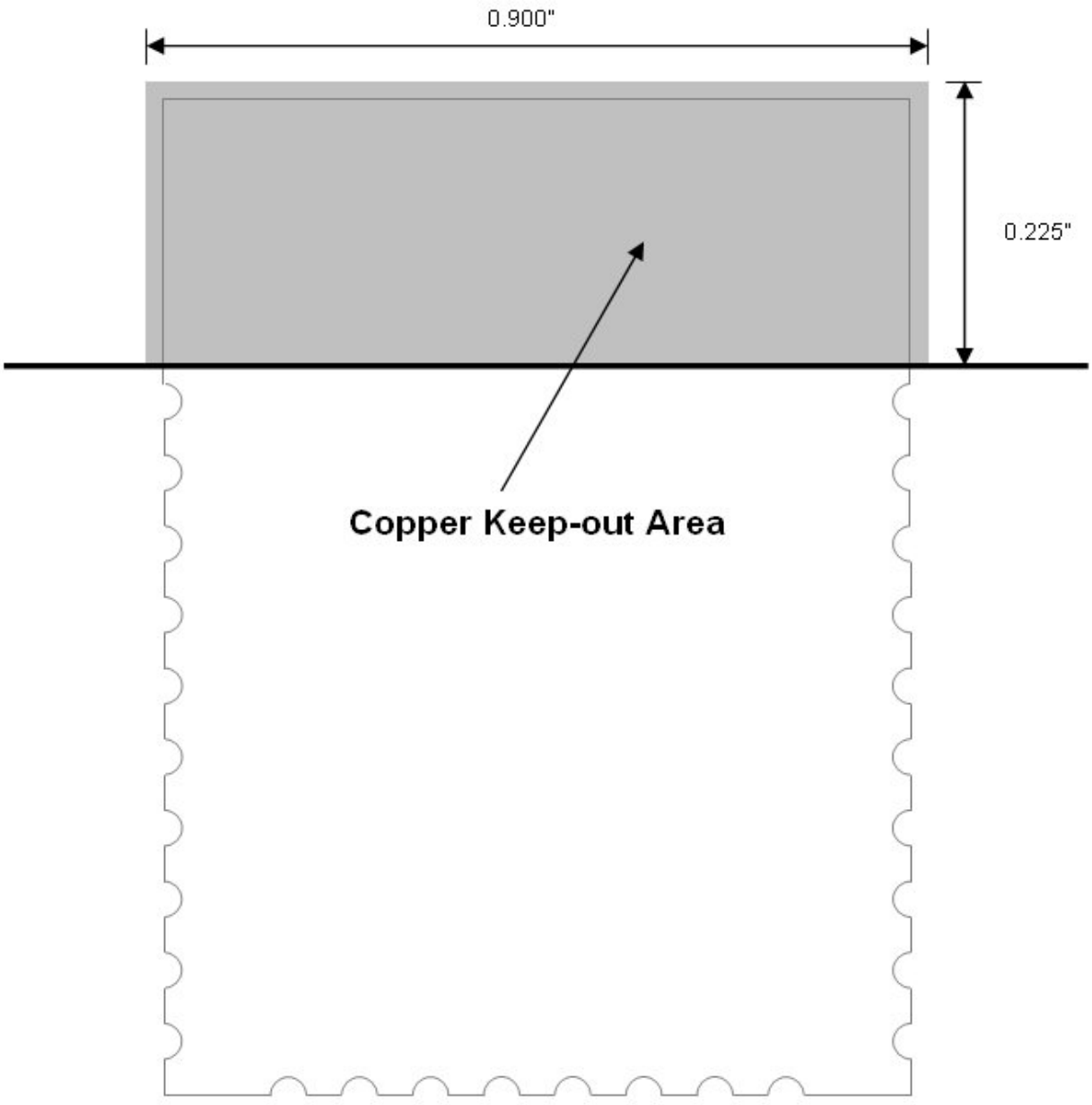
6.1 WAT Module



6.2 Recommended Land Pattern



6.3 Keep-out Area



For maximum antenna performance hang the antenna keep-out area over the edge of the base board. Placing a ground plane on the layer directly beneath the WAT Module will allow you to run traces under this area. The WAT board can be placed on a base board without antenna overhang as long as all copper is kept away from the antenna keep-out area.

7. Certifications

7.1 FCC – United State

The WAT Module complies with Part 15 of the Federal Communications Commission rules and regulations. To continue compliance with Part 15 the end user MUST include a visible label on the outside of the final product which indicates the internal radio module is FCC approved. The exterior label can use wording such as: “Contains FCC ID: V8NWAT1000119”. To meet the section 15.209 emissions requirements in the restricted bands of section 12.205, the transceiver transmitter power for the EM250 can be set no higher than +3.0 dBm for all channels. Any modifications to the WAT Module may violate the rules of the FCC and make operation of the module unlawful. The user is responsible for obtaining compliance for unintentional radiators on the final product.

NOTE 1: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and radiates radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

NOTE 2: The WAT Module complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. The WAT Module must be installed and/or operated with a minimum distance of 8 in. (20 cm.) between the antenna and people.

NOTE 3: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

7.2 IC – Canada

The WAT Module is IC certified. The labeling requirements for Industry Canada are similar to those of the FCC. A visible label must be placed on the outside of the final product clearing indicating the IC Labeling of the internal WAT Module. The user is responsible for the end product complying with ICES-003 (Unintentional Radiators).

8. Processing

!!WARNING!! The WAT Module contains extremely sensitive electronic circuitry. Handle board with proper ESD protocol at all times.

8.1 Reflow Soldering

A convection soldering oven is recommended. Preheat the assembly at a rate of 3°C/sec and stop at a final temperature of 150-200°C. Limit time above solder paste liquid temperatures to 20-40 seconds, do not exceed 260°C. Allow the assembly to cool at a rate no greater than 6°C/sec. Use of "no clean" solder is highly recommended as all cleaning methods carry some risk of damaging the module and its markings.

8.2 Repeat Reflow Soldering

Repeated reflow after the WAT Module has been populated is discouraged.

8.3 Wave Soldering

If wave soldering is required on the base board due to the use of leaded components, it is recommended that only a single pass is used.

8.4 Hand Soldering

Hand soldering is possible but should be done with care to avoid excessive heat application to the WAT Module.

8.5 Optical Inspection

After soldering the WAT Module to the base board, an optical inspection is recommended to check for the following:

- Accurate alignment and centering of the module over the pads.
- Appropriate solder joints.
- Unintended solder bridges.

8.6 Module Rework

The WAT Module can be unsoldered from the base board. Take care not to overheat the module. Never attempt to rework the module itself, any such attempts will invalidate any manufactures warranty and potentially cause the module to violate FCC and IC specifications.

8.7 Alterations

Any and all alterations to the WAT Module are highly discouraged and are completed at the consumer's risk. Such actions will invalidate any manufactures warranty and potentially cause the module to violate FCC and IC specifications.

9. References

[1]. EM250 Datasheet (http://www.ember.com/pdf/120-0082-000_EM250_Datasheet.pdf)

[2]. FCC Part 15 (http://www.fcc.gov/oet/info/rules/part15/PART15_07-10-08.pdf)