Locus OS2401

802.11b MiniPCI Radio Module with Amplifier

User's Guide

LOCUS

June 17, 2003

REGULATORY APPROVALS

United States FCC & Industry Canada rules

Compliance Statement

The following statements must be included in the product documentation for the end device in which the radio module is embedded:

> 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.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Product Labeling

This radio module is labeled with an FCC ID number and a Canadian Certification Number. If this label is not visible when installed in an end-device, the outside of the device MUST also display a label referring to the enclosed OS2401. Use wording on the label similar to the following:

> "Transmitter Module FCC ID: OQ7OS2401, Canada 3656AOS2401".

OR

> "This device contains Transmitter Module FCC ID: OQ7OS2401, Canada 3656AOS2401"

CAUTION: Changes or modifications to this radio module not expressly approved by its manufacturer, Locus, Inc., may void the user's authority to operate the equipment.

NOTES:

- Only approved antennas and power amplifier listed in this manual may be used with the OS2401.
- The OS2400 Radio Module does not need to be re-authorized for compliance with Part 15,C intentional radiation (15.247 spread spectrum rules) or Part 15, B unintentional radiation. However, if the device into which the module is inserted contains any frequency sources (oscillator, clocks, etc.) it will have to be verified according to Part 15, B unintentional radiation to make sure that it does not unintentionally radiate.

Antenna spacing requirements for user safety

<u>It is important to keep the radio's antenna a safe distance from the user.</u> To meet the requirements of FCC part 2.1091 for radio frequency radiation exposure, this radio must be used in such a way as to guarantee at least 20 cm between the antenna and users. Greater distances are required for high-gain antennas; for more details, see the *Choosing the Antennas* section. The FCC requires a minimum distance of 1 mW $*cm^2$ power density from the user (or 20 cm, whichever is greater).

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF fields in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

Copyright

Table of Contents

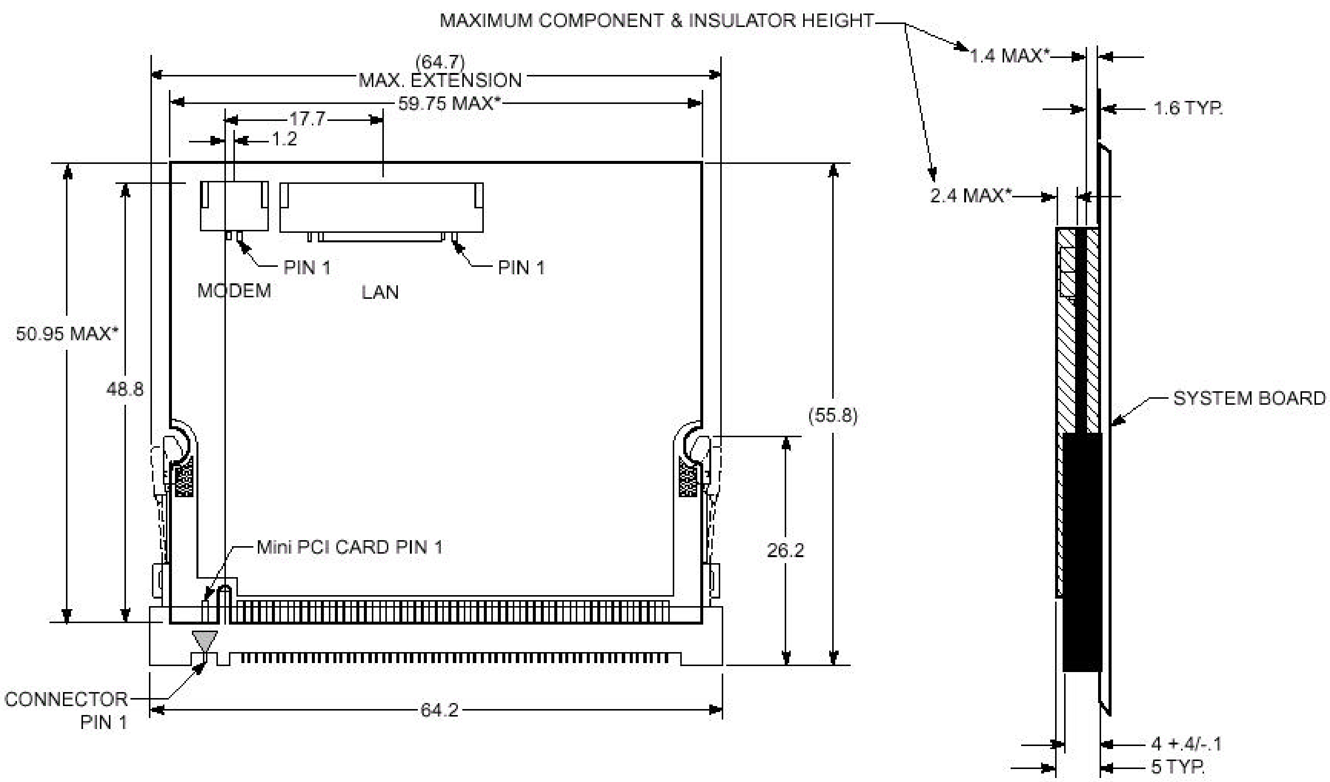
Product Overview

The Locus OS2401 is an 802.11b MiniPCI radio that has been approved by the FCC for use with an external amplifier. The MiniPCI radio can be integrated into industrial devices to provide 802.11b wireless connectivity.

Module Integration

Module Physical Dimensions

The diagram below shows the dimensions of a MiniPCI TypeIIIA card.



Module Connections

Mini-PCI Port

Digital connection is through Mini PCI type III defined by the *Mini PCI Specification* document published by the PCI Special Interest Group. As a recommendation, the Molex 67315-0011 can be used.

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	TIP	2	RING	63	3.3V	64	FRAME#
	Key		Key				
3	8PMJ-3[3, 4]	4	8PMJ-1[3, 4]	65	CLKRUN#	66	TRDY#
5	8PMJ-6[3, 4]	6	8PMJ-2[3, 4]	67	SERR#	68	STOP#
7	8PMJ-7[3, 4]	8	8PMJ-4[3, 4]	69	GROUND	70	3.3V
9	8PMJ-8[3, 4]	10	8PMJ-5[3, 4]	71	PERR#	72	DEVSEL#
11	LED1_GRNP	12	LED2_YELP	73	C/BE[1]#	74	GROUND
13	LED1_GRNN	14	LED2_YELN	75	AD[14]	76	AD[15]
15	CHSGND	16	RESERVED	77	GROUND	78	AD[13]
17	INTB#	18	5V	79	AD[12]	80	AD[11]
19	3.3V	20	INTA#	81	AD[10]	82	GROUND
21	RESERVED	22	RESERVED	83	GROUND	84	AD[09]
23	GROUND	24	3.3VAUX	85	AD[08]	86	C/BE[0]#
25	CLK	26	RST#	87	AD[07]	88	3.3V
27	GROUND	28	3.3V	89	3.3V	90	AD[06]
29	REQ#	30	GNT#	91	AD[05]	92	AD[04]
31	3.3V	32	GROUND	93	RESERVED	94	AD[02]
33	AD[31]	34	PME#	95	AD[03]	96	AD[00]
35	AD[29]	36	RESERVED	97	5V	98	RESERVED_WIP[5]
37	GROUND	38	AD[30]	99	AD[01]	100	RESERVED_WIP[5]
39	AD[27]	40	3.3V	101	GROUND	102	GROUND
41	AD[25]	42	AD[28]	103	AC_SYNC	104	M66EN
43	RESERVED	44	AD[26]	105	AC_SDATA_IN	106	AC_SDATA_OUT
45	C/BE[3]#	46	AD[24]	107	AC_BIT_CLK	108	AC_CODEC_ID0#
47	AD[23]	48	IDSEL	109	AC_CODEC_ID1#	110	AC_RESET#
49	GROUND	50	GROUND	111	MOD_AUDIO_MON	112	RESERVED
51	AD[21]	52	AD[22]	113	AUDIO_GND	114	GROUND
53	AD[19]	54	AD[20]	115	SYS_AUDIO_OUT	116	SYS_AUDIO_IN
55	GROUND	56	PAR	117	SYS_AUDIO_OUT GND	118	SYS_AUDIO_IN GND
57	AD[17]	58	AD[18]	119	AUDIO_GND	120	AUDIO_GND
59	C/BE[2]#	60	AD[16]	121	RESERVED	122	MPCIACT#
61	IRDY#	62	GROUND	123	VCC5VA	124	3.3VAUX

The signal CHSGND is a chassis ground contact and is connected on the Mini PCI Card via a spring contact clip.

Antenna Port

Two antenna port connections (for diversity) are provided. The radio uses SMT Ultra Miniature Coax Connector, Hirose, CL331-0471-0-10 (U.FL-R-SMT). The interface board contains two of these connectors as well.

The radio is connected to the interface board through a Hirose cable. The preferred part number is U.FL-2LP-5016-A-150.

Antennas and Amplifier Use

Bi Directional Amplifier

A Bi-Directional Amplifier may be needed if an application requires long lengths of coaxial cable to reach the antenna. The amplifier is designed to put maximum transmit power right at the antenna and boost the received signal primarily to overcome the cable loss. Only the RF Linx 2400LX-0.5W approved amplifier may be used.

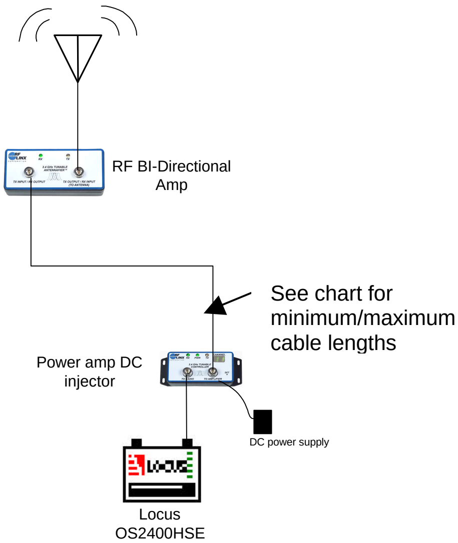
Note: The RF Linx 2400LX-0.5W shall be marketed only in the system configuration with which the amplifier is authorized and shall not be marketed as a separate product.

The amplifier is designed to operate with a coax cable loss between the radio and amplifier of 6.5dB to 20dB. Within this range, the output of the amplifier is always 1/2W regardless of the input level. The amplifier may not be used with a cable loss of less than 6.5dB. <u>The use of a cable less than 6.5dB will result in violation of 47 CFR Part 15 Rules under which the equipment has been authorized</u>. With more than 20dB cable loss the amplifier will not turn on.

See the chart below for the minimum and maximum lengths of various cable types required when the Bi-directional amp is used.

Antenna Cable Type and lengths					
Cable Type	*Cable loss/100' (dB)*	*Minimum length (ft)*	*Loss (dB)*	*Maximum length (ft)*	*Loss (dB)*
LMR195	18.2	36	6.5	109	20
LMR400	6.9	94	6.5	289	20
LMR600	4.4	148	6.5	454	20
LDF4-50A	3.9	167	6.5	512	20
LDF5-50A	2	325	6.5	1000	20

Proper installation of the amplifier and its power supply is shown below. The DC injector should be located by the radio, and the amplifier should be at the antenna. The Bi-directional amp is weather proof and can be mounted outdoors. See Bi-Directional amplifier instructions for more details.



Choosing the Antennas

Antenna section is dependent on whether the Bi-Directional amplifier is being used or not. The minimum distance column in the tables below dictates how far the antennas must be separated from users for safe exposure limits according to FCC Part 2.1091.

Approved Antennas

Antennas Approved for Use without Bi-Directional Amplifier

When the module is connected directly to an antenna, the following antennas may be used:

Antenna Type	Pattern	Locus Part No.	Antenna Gain dBi	Connector	Typical Use*	Minimum Distance cm
½ Wave	Omni	540-0003	2	SMA-RP	Mobile	20
½ Wave, art.	Omni	540-0002	2	SMA-RP	Mobile	20
Collinear Array	Omni	540-0036	3	SMA-RP	Mobile	20
Collinear Array, art.	Omni	540-0005	5	SMA-RP	Mobile	20
Collinear Array	Omni	540-0006	8	N-RP	Mobile	20
Collinear Array	Omni	540-0037	9	N-RP	Mobile	20
Collinear Array	Omni	540-0038	12	N-RP	Mobile	20
Patch	Directional	540-0010	8	SMA-RP	Fixed	20
Patch	Directional	540-0011	11	SMA-RP	Fixed	20
Patch	Directional	540-0034	13	N-RP	Fixed	20
Patch	Directional	540-0035	19	N-RP	Fixed	34
Yagi	Directional	540-0009	13	N-RP	Fixed	20
Parabolic	Directional	540-0017	15	N-RP	Fixed	21
Parabolic	Directional	540-0018	19	N-RP	Fixed	34
Parabolic	Directional	540-0008	24	N-RP	Fixed	61

Antennas for Use with Amplifier

When the module is used in conjunction with the Amplifier, the antennas are limited to those below:

Antenna Type	Pattern	Locus Part No.	Antenna Gain dBi	Connector	Typical Use*	Minimum Distance cm
½ Wave	Omni	540-0003	2	SMA-RP	Mobile	20
½ Wave, art.	Omni	540-0002	2	SMA-RP	Mobile	20
Collinear Array	Omni	540-0036	3	SMA-RP	Mobile	20
Collinear Array, art.	Omni	540-0005	5	SMA-RP	Mobile	20
Collinear Array	Omni	540-0006	8	N-RP	Mobile	20
Collinear Array	Omni	540-0037	9	N-RP	Mobile	20
Collinear Array	Omni	540-0038	12	N-RP	Fixed	23
Patch	Directional	540-0010	8	SMA-RP	Fixed	20
Patch	Directional	540-0011	11	SMA-RP	Fixed	21
Patch	Directional	540-0034	13	N-RP	Fixed	26
Yagi	Directional	540-0009	13	N-RP	Fixed	26

Note: To prevent high gain antennas from being used with an amplifier, Parabolic antennas will not be sold if the user is ordering an amplifier.

* Mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20cm is normally maintained between radiating structures and the body of the user or nearby persons. In the context, the term "fixed location" means that the device is physically secured at one location and is not able to be easily moved to another location. For fixed locations a separation distance of at least 1m is normally maintained between radiating structures and the body of the user or nearby persons.

Antenna Descriptions

When selecting antennas to install with the OS2400-HSE in the U.S. and Canada, you can only use models that are specifically approved by the U.S. Federal Communications Commission (FCC) and Industry Canada. See *Approved antennas* for more details.

You must also consider three important electrical characteristics when selecting antennas:

- Antenna pattern
- Antenna gain
- Antenna polarity

Antenna pattern

Information between radios is transferred via electromagnetic energy radiated by one antenna and received by the second. More power is radiated in certain directions from the antenna than others, a phenomenon known as the antenna pattern. Each antenna should be mounted so the direction of strong radiation intensity points toward the other antenna(s) to which it is linking.

Although complete antenna patterns are three-dimensional (3D), a two-dimensional (2D) slice of the pattern is often shown because the antennas of interest are often located horizontally from one another, along the ground rather than above or below each other.

A slice taken in a horizontal plane through the center (or looking down on the pattern) is called the azimuth pattern. A vertical plane slice, which is seen from the side, is the elevation pattern.

An antenna pattern that has equal or nearly equal intensity in all directions is omnidirectional. In two dimensions, an omnidirectional pattern is a circle. An antenna is considered omnidirectional if one of its 2D patterns is omnidirectional. (No antenna has an omnidirectional pattern in 3D.)

Beam width is an angular measurement of how strongly the power is concentrated in a particular direction. Beam width is a 3D quantity, but it can be broken into 2D slices just like the antenna pattern. The beam width of an omnidirectional pattern is 360°, because the power is equal in all directions.

Antenna gain

Antenna gain is a measure of how strongly an antenna radiates in its direction of maximum radiation intensity compared to how strong the radiation would be if the same power were applied to an antenna that radiated all of its power equally in all directions. Using the antenna pattern, the gain is the distance to the furthest point on the pattern from the origin. For an omnidirectional pattern, the gain is 1, or equivalently 0 dB. The higher the antenna gain is, the narrower the beam width, and vice versa.

The amount of power received by the receiving antenna is proportional to the transmitter power multiplied by the transmit antenna gain, multiplied by the receiving antenna gain. Therefore, the antenna gains and transmitting power can be traded off. For example, doubling one antenna gain has the same effect as doubling the transmitting power. Doubling both antenna gains has the same effect as quadrupling the transmitting power.

Antenna polarity

Antenna polarization refers to the direction in which the electromagnetic field lines point as energy radiates away from the antenna. In general, the polarization is elliptical. The simplest and most common form of this elliptical polarization is a straight line, or linear polarization. Of the transmitted power that reaches the receiving antenna, only the portion that has the same polarization as the receiving antenna polarization is actually received. For example, if the transmitting antenna polarization is pointed in the vertical direction (vertical polarization, for short), and the receiving antenna also has vertical polarization, the maximum amount of power possible will be received. On the other hand, if the transmit antenna has vertical polarization and the receiving antenna has horizontal polarization, no power should be received. If the two antennas have linear polarizations oriented at 45° to each other, half of the possible maximum power will be received.

Antenna Types

Whip antenna

You can use a 1/2λ straight whip or 1/2λ articulating whip (2 dBi) antenna with OS2400-HSE radios. These antennas are the most common type in use today. Such antennas are approximately 5 inches long, and are likely to be connected to a client radio (connected directly to the radio enclosure). These antennas do not require a ground plane. Articulating antennas and non-articulating antennas work in the same way. An articulating antenna bends at the connection.

Collinear array antenna

A collinear array antenna (shown at left) is typically composed of several linear antennas stacked on top of each other. The more stacked elements it has, the longer it is, and the more gain it has. It is fed in on one end.

The antenna pattern is torroidal. Its azimuthal beam width is 360° (omnidirectional). Its vertical beam width depends on the number of elements/length, where more elements equal narrower beam width. The antenna gain also depends on the number of elements/length, where more elements produce higher gain. Typical gain is 5 to 10 dBi.

The antenna polarity is linear, or parallel to the length of the antenna.

Yagi array antenna

A yagi antenna is composed of an array of linear elements, each parallel to one another and attached perpendicular to and along the length of a metal boom. The feed is attached to only one of the elements.

Elements on one side of the fed element are longer and act as reflectors; elements on the other side are shorter and act as directors. This causes the antenna pattern to radiate in a beam pointed along the boom toward the end with the shorter elements. The pattern and beam width depend on the overall antenna geometry, including the number of elements, element spacing, and element length, but they are generally proportional to the length, where longer length produces a narrower beam. Sometimes the antenna is enclosed in a protective tube that hides the actual antenna geometry.

The antenna gain also varies with antenna geometry, but generally is proportional to the length, where longer length produces higher gain. Typical values are 6 to 15 dBi. The antenna polarity is linear (parallel to the elements, perpendicular to the boom).

Parabolic reflector antenna

A parabolic reflector antenna consists of a parabolic shaped dish and a feed antenna located in front of the dish. Power is radiated from the feed antenna toward the reflector.

Due to the parabolic shape, the reflector concentrates the radiation into a narrow pattern, resulting in a high-gain beam.

The antenna pattern is a beam pointed away from the concave side of the dish. Beam width and antenna gain vary with the size of the reflector and the antenna construction. Typical gain values are 15 to 30 dBi.

The antenna polarity depends on the feed antenna polarization.