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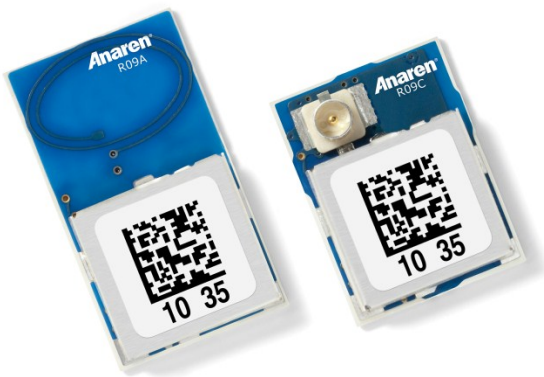
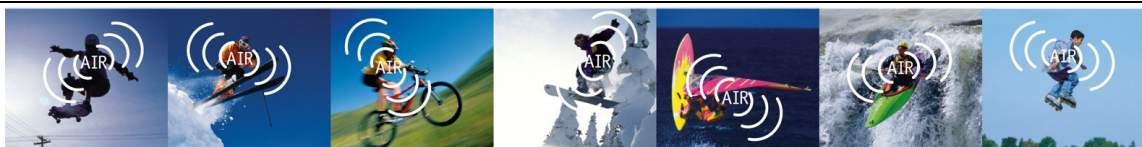# Anaren Integrated Radio

A1101R09x User's Manual

Release Date 05/08/12

Anaren Integrated Radio

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USER'S MANUAL
Models A1101R09A and A1101R09C

Contents

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1. Overview

The A1101R09A and A1101R09C are surface mount modules – each with an integrated crystal, internal voltage regulator, matching circuitry and filtering. The A1101R09A has an integral antenna, whereas the A1101R09C utilizes an external antenna through a U.FL connector (see Table 2). The modules operate in the US 902 – 928MHz ISM band and are ideal for achieving low power wireless connectivity without having to deal with extensive RF, antenna design and regulatory compliance, allowing quick time to market. The modules are 100% tested to provide consistent performance.

The A1101R09A and A1101R09C have received regulatory approvals for modular devices in the United States (FCC) and Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSS-Gen. The modular approval allows the OEM or end user to place either an A1101R09A or an A1101R09C with an approved antenna inside a finished product without having to perform costly regulatory testing for an intentional radiator. Section 2.3 has information on the requirements for the end user/integrator must fulfill to use the modules without intentional radiator regulatory testing.

The A1101R09A and A1101R09C are based on the CC1101 transceiver IC from Texas Instruments. All control lines for the transceiver are provided at module level for full control of its operation. Please see the CC1101 data sheet (www.ti.com) for how to control the modules.

The A1101R09A measure 9x16x2.5mm and A1101R09C measures 9x12x2.5mm. The modules are footprint compatible with each other.

1.1. A1101R09A

The A1101R09A has an integral antenna, providing high efficiency and near omni-directional radiation pattern. This approach offers the lowest system cost when the application allows collocation of radio and antenna.

1.2. A1101R09C

The A1101R09C has a compact antenna connector that allows for locating the antenna away from the module due to form/function or in order to exit a metal enclosure, see Figure 7 – Figure 10 for more information on antenna location and enclosure considerations.

1.3.   Features

Features:

- Frequency range: 902-928 MHz
- Ultra small package size
  ➢ A1101R09C : 9mm x 12mm x 2.5mm
  ➢ A1101R09A : 9mm x 16mm x 2.5mm
- Impedance controlled multi-layer PCB
- Shielded Package
- 1.8 to 3.6 V operation
- SPI Interface
- RoHS Compliant
- LGA Footprint
- Low Power Consumption
- Regulatory approvals for FCC
- Digital RSSI output
- Programmable channel filter bandwidth
- Programmable output power up to +10 dBm
- High sensitivity (–104 dBm at 1.2 kBaud, 1% packet error rate)
- Low current consumption (14.4 mA in RX, 1.2kBaud, input well above sensitivity limit)
- Fast startup time: 240us from SLEEP to Rx or Tx mode
- Separate 64 byte Rx and Tx FIFOs
- Data Rate: 1.2 – 500 Kbit/Sec
- Programmable data rate from 1.2 to 500 kBaud
- Sleep state: 0.2µA
- Idle State: 1.7mA

Benefits Summary:

- Operating temperature -40 to +85C
- 100% RF Tested in production
- Common footprint for all family members
- No RF engineering experience necessary
- Only requires a 2 layer PCB implementation
- Excellent receiver selectivity and blocking Performance
- Suited for systems compliant with FCC CFR47 Part 15.247a2 and 15.249 (US) and Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSS-Gen.
- No regulatory "Intentional radiator" testing required to integrate module into end product. Simple certification labeling replaces testing.

1.4.   Theory of Operation

The A1101R09A and A1101R09C are for low power wireless applications in the US 902 – 928MHz ISM band. The devices can be used to implement a variety of networks, including; point to point, point to multipoint, peer to peer and mesh networks.

The A1101R09A and A1101R09C both interface to an application microcontroller via an SPI bus. Physical and MAC layer functionality are accessed via the SPI bus through addressable registers as well as execution commands. Data received, or to be transmitted, are also accessed through the SPI bus and are implemented as a FIFO register (64 bytes each for Tx and Rx).

To transmit, a frame of data is placed in the FIFO; this may include a destination address. A transmit command is given, which will transmit the data according to the initial setup of the registers. To receive data, a receive command is given, which enables the unit to "listen" for a transmission; when such a transmission occurs, it places the received frame in the FIFO. When neither transmit nor receive is required, the device can enter either an Idle mode, from which it can quickly re-enter receive, a transmit mode, or a low power sleep mode from which a crystal startup is required prior to transmit or receive operation.

Below is a block diagram for each of the A1101R09A and A1101R09C modules.
- Antenna
  - The antenna couples energy between the air and the AIR module. For applications where installations are done by an end user (non-professional), an omni-directional antenna pattern is desired such that the application will work equally well in any direction. Similarly for peer to peer or point to multipoint applications an omni-directional pattern is desired such that all nodes have a fair chance of communicating. The A1101R09A module has an integral antenna that is near omni-directional, whereas the A1101R09C has approved antenna options ranging from near omni-directional to shaped front/back patterns (useful for inline, professional installations). Note that the end radiation pattern depends not only on the antenna, but also on the ground plane, enclosure and installation environment.
- Filtering
  - Filtering removes spurious signals to comply with regulatory intentional radiator requirements.
- Matching
  - Matching provides the correct loading of the transmit amplifier to achieve the highest output power, as well as the correct loading for the receive LNA to achieve the best sensitivity.
- Physical
  - The physical layer provides conversions between data, symbol and RF signal.
- MAC
  - The MAC layer is part of the Logical Link Layer and provides frame handling, addressing and medium access services.
- Microcontroller Interface
  - The microcontroller interface exposes registers and commands for the physical and MAC layers to a microcontroller.
- Power Management
  - Power management ensures a stable supply for the internal functions, as well as providing means for a low power sleep mode (in which case, most of the transceiver is power off).
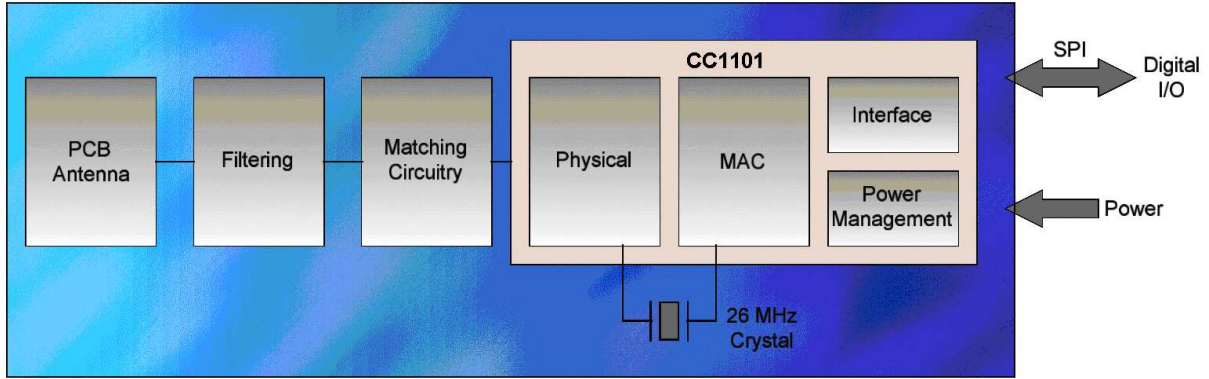
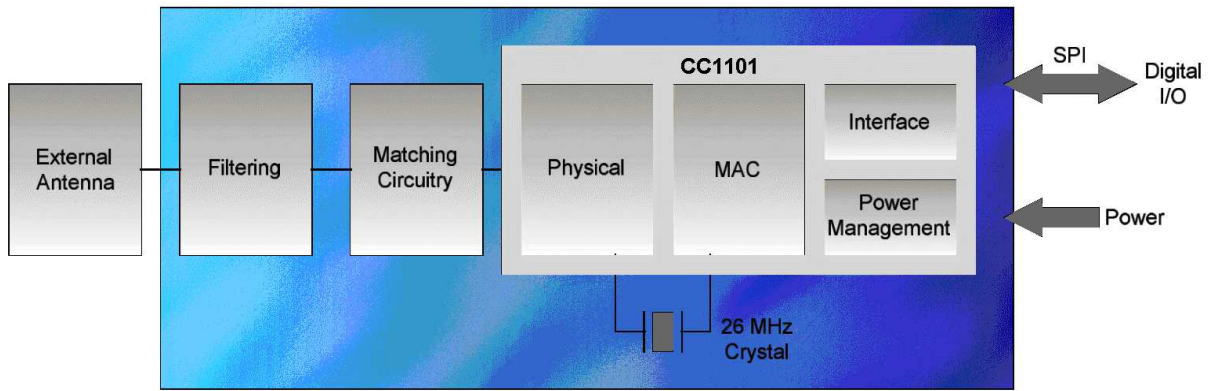*Figure 1 The functionality of the A1101R09A, using an integral antenna*

Figure 2 The functionality of the A1101R09C, using an external antenna.
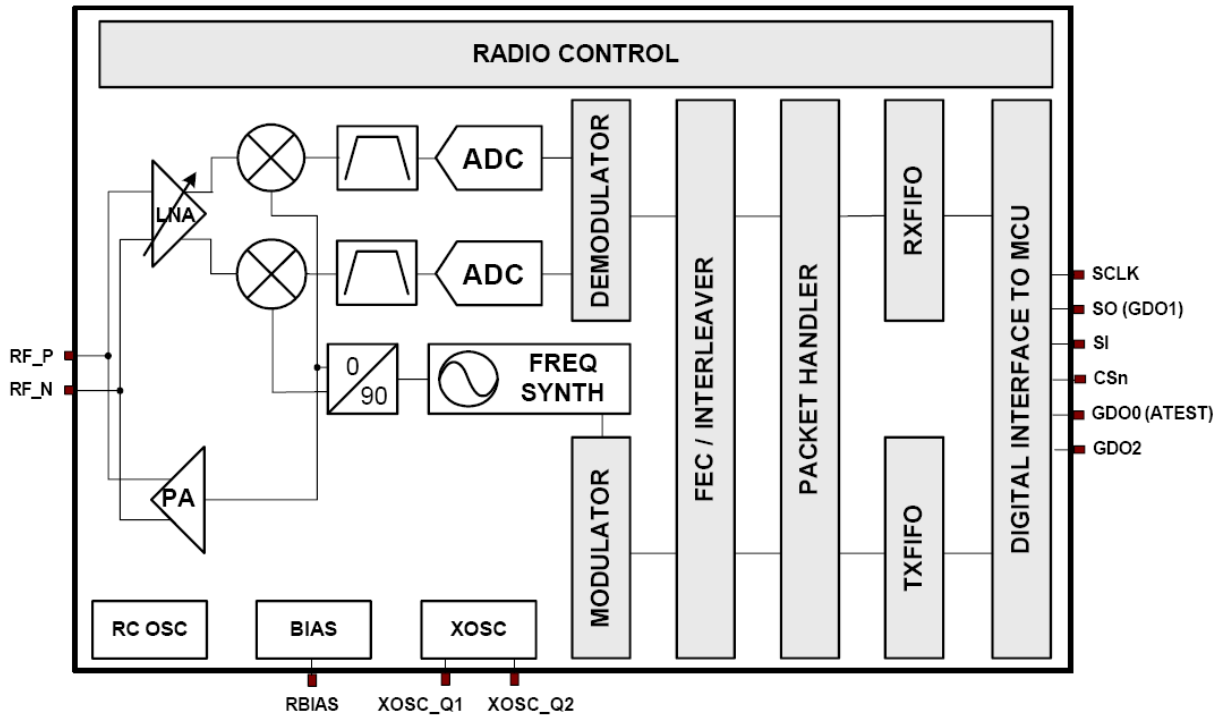
Figure 3 Transceiver IC block diagram.

1.4.1. Typical Flow

After initial setup of registers for desired behavior, the normal operation flow diagram is shown in Figure 4. In applications of infrequent data transmissions, the transceiver would be in "sleep" mode to save power. From there it would awaken and then enter "idle" mode. As part of the wake up process the crystal oscillator is started (~240µs) and the digital microcontroller interface is powered up. Before transmit or receive, the frequency synthesizer needs to be started ("FS_Wakeup") and, having been powered off (or idle for a while), the control loop of the VCO/PLL needs to be calibrated ("calibrate").

A data frame is loaded into the transmit FIFO and the "TX" mode is entered. The transceiver will transmit the data and enter "idle" mode after completion. When transmit is complete "RX" mode is entered to wait for the acknowledge frame. Once a frame is received, the transceiver will again enter "idle" mode. If no acknowledge frame is received within a given timeout, the data frame would be re-transmitted. If the acknowledge frame indicates that the data was received, the next data frame will be transmitted. After the last data frame has been transmitted successfully, the transceiver will again be put in "sleep" mode.
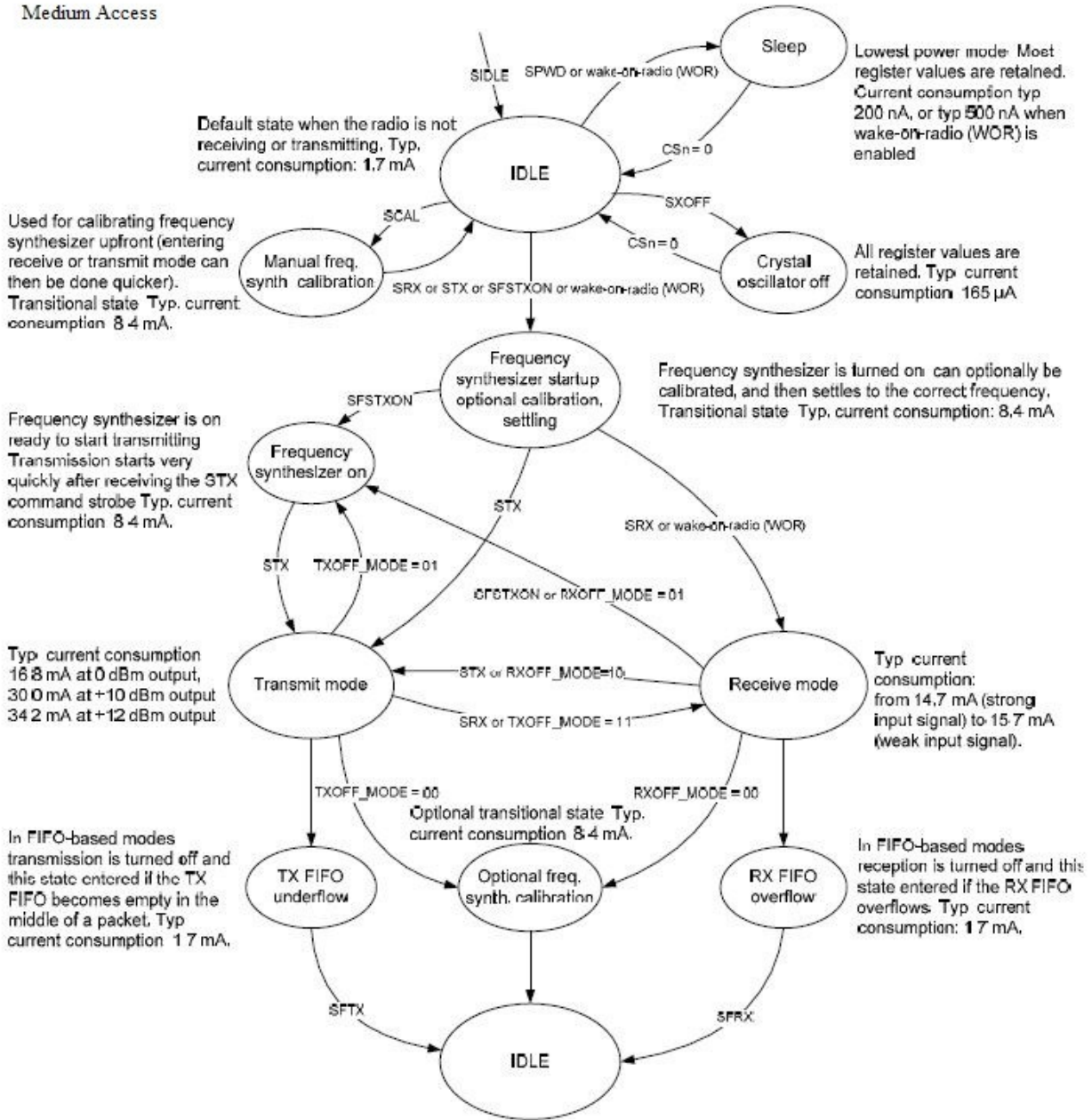
Medium access

Figure 4 Transceiver state diagram

1.5. Applications

Ultra low-power wireless applications, operating in the 902-928 MHz ISM band.

- Wireless alarm and security systems
- Industrial monitoring and control
- Wireless sensor networks
- AMR – Automatic Meter Reading
- Home and building automation
- Existing applications where simple upgrade to wireless is desired

1.6. Configuration

Table 1 lists the radio module configuration parameters, and the level of configurability by the user.

Legend:

Certification is valid for any value choosen
Use the provided certified settings as other may degrade performance
Any modification of this value is a violation of the certification and the customer is responsible for optaining their own certification
Unused/undocumented function. The provided default value must be written. No assumption should be made on the value read from this field
Read only register (burst mode read only, command strobes otherwise).

Table 1 Configuration Parameters

Register Name	Register Address (Hex)	Retained during sleep	7	6	5	4	3	2	1	0
IOCFG2	00	1	0	GDO2_INV	GDO2_CFG					
IOCFG1	01	1	GDO_DS	GDO1_INV	GDO1_CFG					
IOCFG0	02	1	GDO0_TEMP_SENSOR_ENABLE	GDO0_INV	GDO0_CFG					
FIFOTHR	03	1	Reserved	ADC_RETENTION	CLOSE_IN_RX		FIFO_THR			
SYNC1	04	1	SYNC_MSB							
SYNC0	05	1	SYNC_LSB							
PKTLEN	06	1	PACKET_LENGTH							
PKTCTRL1	07	1	PQT			0	CRC_AUTOFLUSH	APPEND_STATUS	ADR_CHK	
PKTCTRL0	08	1	0	WHITE_DATA	PKT_FORMAT		0	CRC_EN	LENGTH_CONFIG	
ADDR	09	1	DEVICE_ADDR							
CHANNR	0A	1	CHAN							
FSCTRL1	0B	1	0		0	FREQ_IF				
FSCTRL0	0C	1	FREQOFF							
FREQ2	0D	1	FREQ[23:22]=0		FREQ[21:16]					
FREQ1	0E	1	FREQ[15:8]							
FREQ0	0F	1	FREQ[7:0]							
MDMCFG4	10	1	CHANBW_E		CHANBW_M		DRATE_E			
MDMCFG3	11	1	DRATE_M							
MDMCFG2	12	1	DEM_DCFILT_OFF	MOD_FORMAT			MANCHESTER_EN	SYNC_MODE		
MDMCFG1	13	1	FEC_EN	NUM_PREAMBLE			0		CHANSPC_E	
MDMCFG0	14	1	CHANSPC_M							
DEVIATN	15	1	0	DEVIATION_E			0	DEVIATION_M		
MCSM2	16	1	0			RX_TIME_RSSI	RX_TIME_QUAL	RX_TIME		
MCSM1	17	1	0		CCA_MODE		RXOFF_MODE		TXOFF_MODE	
MCSM0	18	1	0		FS_AUTOCAL		PO_TIMEOUT		PIN_CTRL_EN	XOSC_FORCE_ON
FOCCFG	19	1	0		FOC_BS_CS_GATE	FOC_PRE_K		FOC_POST_K	FOC_LIMIT	
BSCFG	1A	1	BS_PRE_K		BS_PRE_KP		BS_POST_K	BS_POST_KP	BS_LIMIT	
AGCCTRL2	1B	1	MAX_DVGA_GAIN		MAX_LNA_GAIN			MAGN_TARGET		
AGCCTRL1	1C	1	0	AGC_LNA_PRIORITY	CARRIER_SENSE_REL_THR		CARRIER_SENSE_ABS_THR			
AGCCTRL0	1D	1	HYST_LEVEL		WAIT_TIME		AGC_FREEZE		FILTER_LENGTH	
WOREVT1	1E	1	EVENT0[15:8]							
WOREVT0	1F	1	EVENT0[7:0]							
WORCTRL	20	1	RC_PD	EVENT1			RC_CAL	0	WOR_RES	
FREND1	21	1	LNA_CURRENT		LNA2MIX_CURRENT		LODIV_BUF_CURRENT		MIX_CURRENT	
FREND0	22	1	0		LODIV_BUF_CURRENT_TX		0	PA_POWER		
FSCAL3	23	1	FSCAL3[7:6]		CHP_CURR_CAL_EN		FSCAL3[3:0]			
FSCAL2	24	1	0		VCO_CORE_H_EN	FSCAL2				
FSCAL1	25	1	0		FSCAL1					
FSCAL0	26	1	0	FSCAL0						
RCCTRL1	27	1	0	RCCTRL1						
RCCTRL0	28	1	0	RCCTRL0						
FSTEST	29	0	FSTEST							
PTEST	2A	0	PTEST							
AGCTEST	2B	0	AGCTEST							
TEST2	2C	0	TEST2							
TEST1	2D	0	TEST1							
TEST0	2E	0	TEST0[7:2]						VCO_SEL_CAL_EN	TEST0[0]
	2F									
PARTNUM	30	1	PARTNUM							
VERSION	31	1	VERSION							
FREQOFF_EST	32	0	FREQOFF_EST							
LQI	33	0	CRC_OK	LQI_EST						
RSSI	34	0	RSSI							
MARC_STATE	35	0	MARC_STATE							
WORTIME1	36	0	TIME[15:8]							
WORTIME0	37	0	TIME[7:0]							
PKTSTATUS	38	0	CRC_OK	CS	PQT_REACHED	CCA	SFD	GDO2		GDO0
VCO_VC_DAC	39	0	VCO_VC_DAC							
TXBYTES	3A	0	TXFIFO_UNDERFLOW	NUM_TXBYTES						
RXBYTES	3B	0	RXFIFO_OVERFLOW	NUM_RXBYTES						
RCCTRL1_STATUS	3C	0	RCCTRL1_STATUS							
RCCTRL0_STATUS	3D	0	RCCTRL0_STATUS							
PATABLE	3E	1	PATABLE							
FIFO	3F	0	TXFIFO/RXFIFO							

2. Approvals and Usage

The A1101R09A and A1101R09C have been designed to meet most national regulations for worldwide ISM-band use. In particular, the radio modules have been certified to the following standards.

2.1.   Product Approvals

2.1.1. USA (Federal Communications Commission, FCC)

The A1101R09A, with integrated antenna, as well as the A1101R09C, used with the antennas listed in Table 2 below, have been tested to comply with FCC Part 15 - 15.247(a2) and 15.247(b) and 15.249 "Intentional Radiators." The devices meet the requirements for modular transmitter approval as detailed in FCC public notice DA 00-1407 Released: June 26, 2000. The A1101R09A and A1101R09C module can be integrated into a finished product without obtaining subsequent FCC approvals.

(15.19a3) The modules comply 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.

Table 2 Approved Antennas

Item	Part Number	Manufacturer	Type	Gain
1	Integral part of A1101R09A	Anaren	Integral Antenna	2
2	66089-0906	Anaren	Monopole whip, 6mm lead	3
3	66089-0930	Anaren	Monopole whip, 30mm lead	3

2.1.1.1.   FCC Labeling Requirements

The A1101R09A and A1101R09C modules have been labeled with their own FCC ID number and if the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

Contains Transmitter Module FCC ID: X7J-A10040601

-or-

Contains FCC ID: X7J-A10040601

This device complies with Part 15 - 15.247(a2) and 15.247(b) and 15.249 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.

2.1.1.2.   End User Manual

The end user manual should include the following statement:

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.

2.1.1.3.   RF Exposure

All transmitters regulated by the FCC must comply with RF exposure requirements. OET Bulletin 65 "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields" provides assistance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC). The bulletin offers guidelines and suggestions for evaluating compliance.

If appropriate, compliance with exposure guidelines for mobile and unlicensed devices can be accomplished by the use of warning labels and by providing end users with information concerning minimum separation distances from transmitting structures and proper installation of antennas.

The following statement must be included as a CAUTION statement in manuals and OEM products to alert end users of FCC RF Exposure compliance:

To satisfy FCC RF Exposure requirements for mobile and base station transmission devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

If the A1101R09A and A1101R09C module is used in a portable application (antenna is less than 20 cm from persons during operation), the end user is responsible for performing Specific Absorption Rate (SAR) testing in accordance with FCC rules 2.1091.

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2.1.2. Canada (Industry Canada, IC)

The A1101R09A and A1101R09C modules have been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSS-Gen.

From section 3.2 RSS-Gen, Issue 3, December 2010, Modular Approval for Category I Equipment or Category II Equipment:

"Modular approval permits the installation of the same module in a host device or multiple host devices without the need to recertify the device. Equipment certification for a modular device may be sought for either Category I equipment or Category II equipment.

Transmitters designed as modules for the installation in a host device may obtain equipment certification as a modular device provided that the applicable RSS is met and the following conditions in this section are met."

In section 7.1.2 Transmitter Antenna, it has been mentioned that the user manuals for transmitters shall display the following notice in a conspicuous location:

Notice: *Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry 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 (e.i.r.p.) is not more than that necessary for successful communication.*

Avis: *Sous la réglementation d'Industrie Canada, ce transmetteur radio ne peut fonctionner qu'en utilisant seulement une antenne d'un type et d'un maximum (ou moins) de gain approuvé pour l'émetteur par Industrie Canada.   Pour réduire des potentielles interférences radio pour les autres utilisateurs, le type d'antenne et son gain doivent être choisis de sorte que la puissance isotrope rayonnée équivalente (PIRE) ne dépasse pas ce qui est nécessaire pour une communication réussie.*

2.1.2.1. IC Labeling Requirements

From section 3.2.1 RSS-Gen, Issue 3, December 2010, Labeling Requirements for the Host Device:

The host device shall be properly labeled to identify the modules within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning.

From section 5.2, RSS-Gen, Issue 3, December 2010, Equipment Certification Numbers and Labels: Every unit of Category I radio apparatus certified for marketing and use in Canada shall bear a permanent label on which is indelibly displayed the model number and Industry Canada certification number of the equipment model (transmitter, receiver, or inseparable combination

thereof). Each model shall be identified by a unique combination of a model number and a certification number, which are assigned as described below in this section.

The label shall be securely affixed to a permanently attached part of the device, in a location where it is visible or easily accessible to the user, and shall not be readily detachable. The label shall be sufficiently durable to remain fully legible and intact on the device in all normal conditions of use throughout the device's expected lifetime. These requirements may be met either by a separate label or nameplate permanently attached to the device or by permanently imprinting or impressing the label directly onto the device.

The label text shall be legible without the aid of magnification, but is not required to be larger than 8-point font size. If the device is too small to meet this condition, the label information may be included in the user manual upon agreement with Industry Canada.

Label:

Contains IC: 8975A-A10040601

Notice: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Avis: Cet appareil est conforme avec Industrie Canada RSS standard exempts de licence (s). Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement du dispositif.

For more information, see: Industry Canada http://www.ic.gc.ca/.

2.1.2.2.   RF Exposure

All transmitters regulated by IC must comply with RF exposure limits as set forth in RSS-102, Issue 4, section 4, "Exposure Limits". Furthermore RSS-102, Issue 4, Section 2 "Certification Requirements", provides assistance in determining the specific requirements for compliance. If appropriate, compliance with exposure guidelines for mobile and unlicensed devices can be accomplished by the use of warning labels and by providing users with information concerning minimum separation distances from transmitting structures and proper installation of antennas.

The following statement must be included as a CAUTION statement in manuals and OEM products to alert users of IC RF Exposure compliance:

Notice: To satisfy IC RF Exposure requirements for mobile and base station transmission devices, a separation distance of 20 cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at closer than this distance is not recommended. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Avis: Pour répondre à la IC d'exposition pour les besoins de base et mobiles dispositifs de transmission de la station, sur une distance de séparation de 20 cm ou plus doit être maintenue entre l'antenne de cet appareil et les personnes en cours de fonctionnement. Pour assurer le respect, l'exploitation de plus près à cette distance n'est pas recommandée. L'antenne (s) utilisé pour cet émetteur ne doit pas être co-localisés ou fonctionner conjointement avec une autre antenne ou transmetteur.

2.2. Potential Interference Sources

- Alarm systems
  - These typically use low duty cycles and are therefore easy to avoid using acknowledge/retransmit methods
- Car alarms (internal motion sensors)
- Video surveillance
  - These are typically operated on a fixed channel determined at installation time and can be avoided by using clear channel assessment. It may be useful to change the channel used by the video surveillance equipment also, if possible.

2.2.1. Time critical data

If the user requires specific time critical data throughput that cannot tolerate the delays of potentially many re-transmissions, the user is encouraged to implement an environment-aware algorithm that periodically monitors/scans the frequency band and maintain a list of "best available" channels.

2.3. Approved Usage

These radio modules can be used in a variety of physical layer configurations; the following restricts the use to maintain compliance with the above referenced certification bodies.

The user is encouraged to use minimum power required to establish a link, thus minimizing interference.

Changes or modifications to the module and/or operation outside the limits set forth below are prohibited and could void the user's authority to operate the modules.

Uses of these radio modules are limited to the following frequency ranges and modulation settings. Using the radio modules outside of these limitations are prohibited and could void the user's authority to operate the modules. The user should use one of the register configurations listed below.

Anaren provides register setting files for optimal performance and compliance for each of the data rates given in the following at www.anaren.com.

Anaren Integrated Radio

2.3.1. USA & Canada

Within the USA and Canada, the modules have been approved for use as digitally modulated transmitters, for which they must have a minimum occupied bandwidth (6dB bandwidth) of 500kHz. In addition, the spectral density may not exceed 8dBm/3kHz and the total output power including antenna gain may not exceed 1W. Table 3 shows configurations that are compliant with this use and the expected performance.

Table 3 FCC Approved configurations with max. allowed output power

Modulation	Datarate (kB)	6-dB BW (kHz)	PSD (dBm)	Power Table (Hex)	$F_o$min (MHz)	$F_o$max (MHz)
2-FSK	1.2	530	6.84	0xCB	902.49985	927.58578
2-FSK	38	535	6.88	0xCA	902.49985	927.58578
2-FSK	250	540	3.68	0xC0	902.49985	927.58578
MSK	425	515	1.26	0xC0	902.8093	927.28586
MSK	500	585	1.35	0xC0	902.8093	927.28586

In order to meet the band edge requirements, the center frequency of the operating channel has to be chosen between **$F_o$min** and **$F_o$max**. Also, the power levels provided in Table 3 are the max allowed power levels for each configuration, however, the user is encouraged to use minimum power required to establish a link in order to minimize interference. For available power levels from the module, please refer to Table 4.

It is encouraged to use a medium access technique which should include addressing of individual transceiver nodes; and should include a combination of a clear channel assessment, transmit and detect, or a frequency hopping method. This ensures that the un-licensed band can be shared with other systems/applications.

Table 4 Output Power vs. PA Table Value

Power (dBm)	PA_TABLE (Hex)	Power (dBm)	PA_TABLE (Hex)	Power (dBm)	PA_TABLE (Hex)
12.5	0xC0	7	0xCE	-3	0x64
12	0xC1	5	0x80	-4	0x56
11.5	0XC3	4.5	0x81	-5	0x67
11	0xC4	4	0x85	-6	0x8F
10.5	0xC5	3.5	0x87	-7	0x38
10	0xC7	3	0x88	-8	0x2A
9.5	0xC8	2	0x8B	-9	0x29
9	0xC9	1	0x8C	-10	0x35
8.5	0xCB	0	0x70	-15	0x24
8	0xCC	-1	0x61	-20	0x19
7.5	0xCD	-2	0x5B		

3. Electrical Characteristics

3.1. Absolute Maximum Ratings

Under no circumstances must the absolute maximum ratings given in Table 2 be violated. Stress exceeding one or more of the limiting values may cause permanent damage to the device.
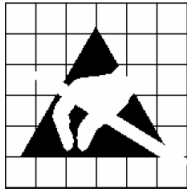
(ESD symbol)	Caution! ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.
(Moisture sensitive symbol) MSL 3	Caution! This assembly contains moisture sensitive devices and requires proper handling per IPC/JEDEC J-STD-033

Table 5 Absolute Maximum Ratings

Parameter	Min	Max	Units	Condition
Supply voltage	-0.3	3.9	V	All supply pins must have the same voltage
Voltage on any digital pin	-0.3	VDD + 0.3 max 3.9	V	
Voltage on the pins RF_P, RF_N and DCOUPL	-0.3	2.0	V	
Voltage ramp-up rate		120	kV/µs	
Input RF level		+10	dBm	
Storage temperature range	-50	150	°C	
Solder reflow temperature		260	°C	According to IPC/JEDEC J-STD-020C
ESD		750	V	According to JEDEC STD22, method A114, Human Body Model (HBM)
ESD		400	V	According to JEDEC STD22, C101C, Charged Device Model (HBM)

3.2. Operating Conditions

Table 6 Operating Conditions

Parameter	Min	Max	Units	Condition
Operating temperature	-40	85	^{o}C	
Operating supply voltage	1.8	3.6	V	All supply pins must have the same voltage

3.3. Pin Out

The A1101R09A and A1101R09C radio modules share a common pin-out and foot print, that is also shared by Anaren modules using other frequencies -- thus enabling easy changeover from one to another, e.g. if changing the frequency, antenna scheme, or adaptive antenna tuning is desired. Below the common footprint are shown.

Top View

Anaren

DNC 1	24 DNC
DNC 2	23 DNC
DNC 3	22 DNC
NC 4	21 NC
NC 5	20 NC
NC 6	19 NC
Vdcoup 1 7	18 Vdd
GND 8	17 GND

9 SCLK
10 MISO / GDO 1
11 MOSI
12 _CSN
13 GDO0
14 GDO2
15 Vdcoup 2
16 NC
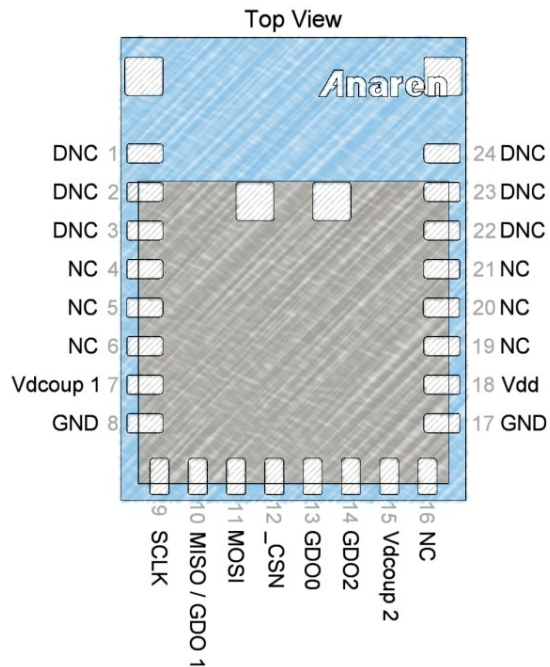
NC = NO Connection. Pin is NOT connected internally.

DNC = Do Not Connect. Internal connection used during assembly, do not connect.

Figure 5 Pin Out.

Table 7 Pin Descriptions

Pin #	Pin Name	Pin Type	Description
1	DNC	NC	Internal GND connection used during testing, not recommended to connect to main GND.
2	DNC	NC	Internal RF output connection used during test. Connecting this pin to anything will require recertification for intentional radiators.
3	DNC	NC	Internal GND connection used during testing, not recommended to connect to main GND.
4	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
5	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
6	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
7	Vdcoup1	Analog	Optional decoupling of the modules internal Vdd supply. It is recommended to not connect anything to this pin. In particular noisy environment this pin can be used to further reduce the noise on the modules internal Vdd, please see section 3.5 for further information.
8	GND	Ground	One of two primary ground pins
9	SCLK	Digital Input	SPI bus clock signal
10	MISO/GDO1	Digital Output	SPI bus data out from radio when CSN is low, and general purpose I/O pin when CSN is high
11	MOSI	Digital Input	SPI bus data into radio
12	_CSN	Digital Input	SPI bus select (active low)
13	GDO0	Digital I/O (Analog output)	General purpose port
14	GDO2	Digital I/O	General purpose port
15	Vdcoup2	Analog	Optional decoupling of the modules internal Vdd supply. It is recommended to not connect anything to this pin. In particular noisy environment this pin can be used to further reduce the noise on the modules internal Vdd, please see section 3.5 for further information.
16	NC	NC	No Connect, the pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
17	GND	Ground	One of two primary ground pins
18	Vdd	Power Supply	Power supply pin
19	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
20	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
21	NC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
22	DNC	NC	Internal GND connection used during testing, not recommended to connect to main GND.
23	DNC	NC	Pin is not connected internally, but is reserved for future expansion. It is recommended not to connect this pin to anything.
24	DNC	NC	Internal GND connection used during testing, not recommended to connect to main GND.

Anaren Integrated Radio

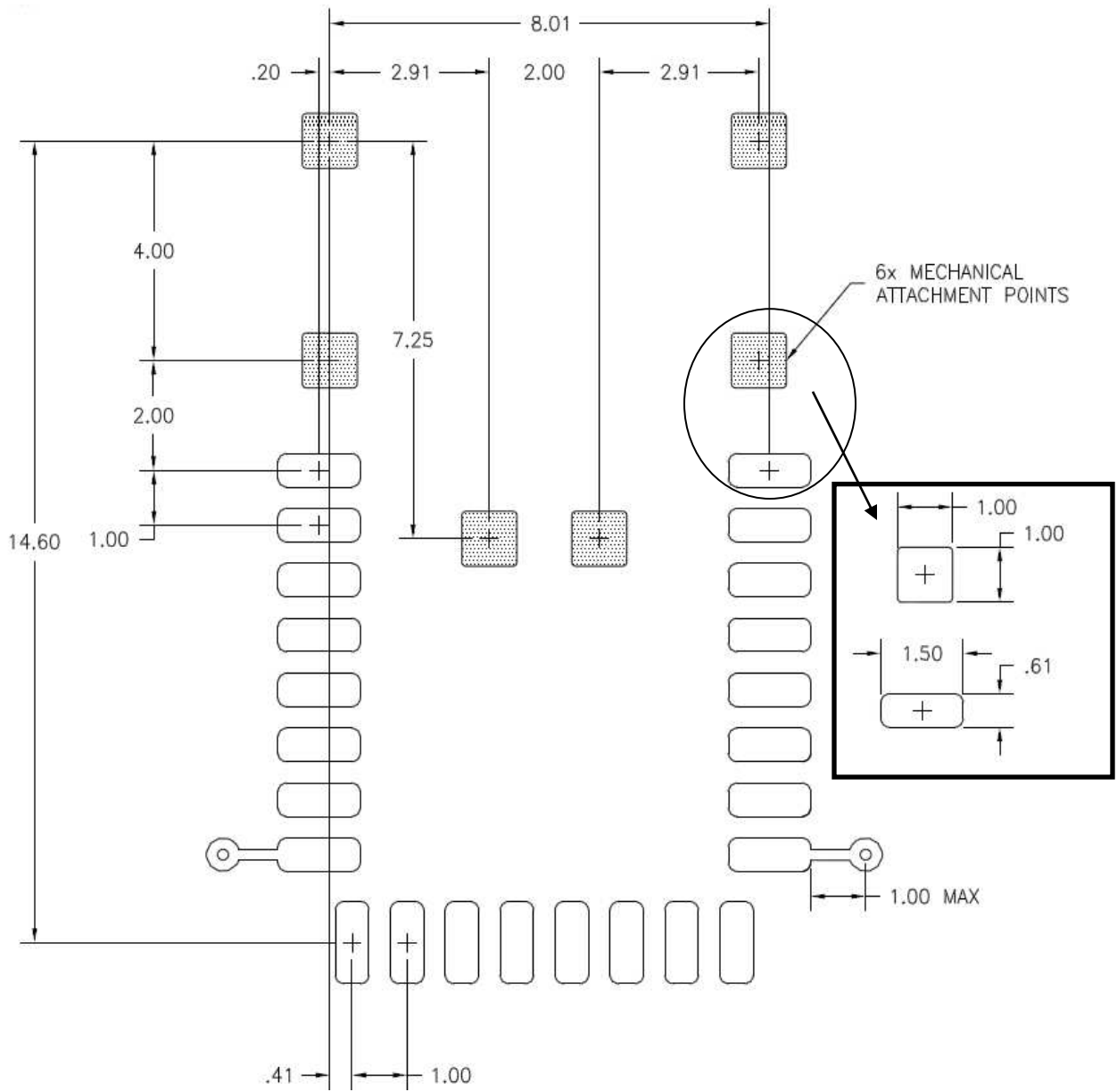### 3.4.   Recommended Layout (dimensions in mm)
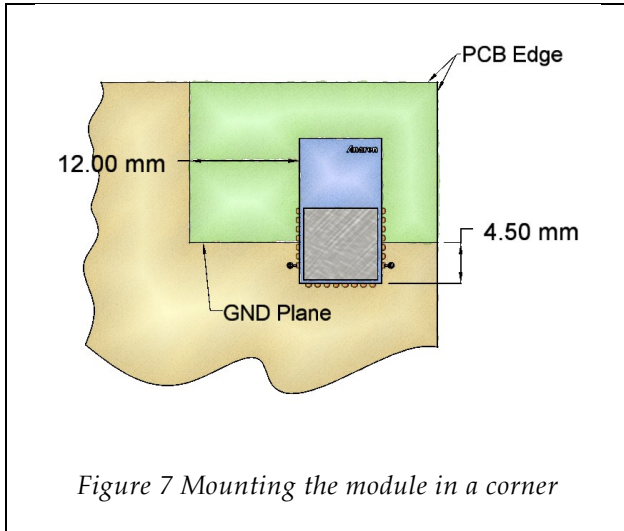

Figure 6 Recommended PCB layout.

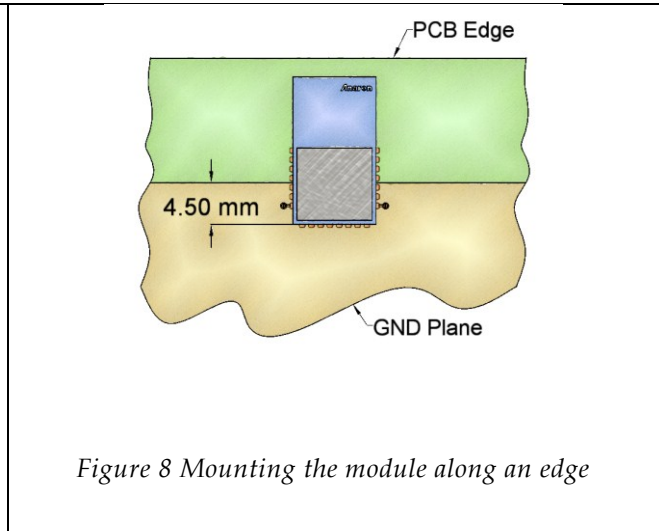*Figure 7 Mounting the module in a corner*
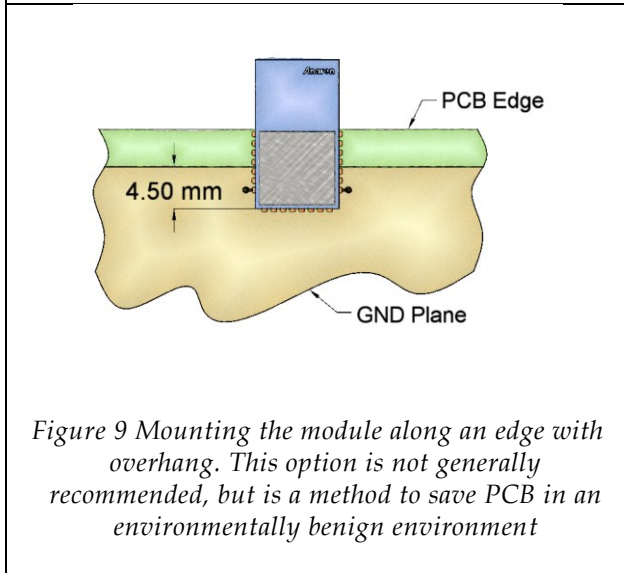

Figure 8 Mounting the module along an edge

Figure 9 Mounting the module along an edge with overhang. This option is not generally recommended, but is a method to save PCB in an environmentally benign environment
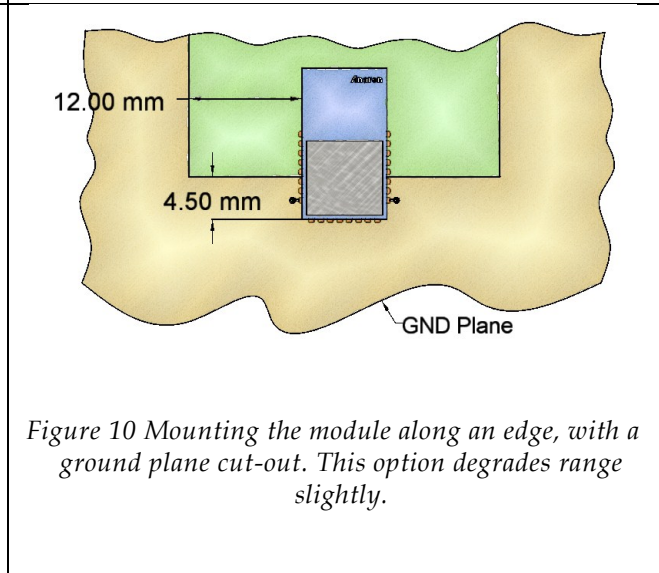

Figure 10 Mounting the module along an edge, with a ground plane cut-out. This option degrades range slightly.

3.5.   Power Supply Considerations

Noise on the power supply line reduces the sensitivity of a receiver and modulates onto a transmitter's signal, both of which causes a degradation of link quality and hence a reduction in range.

The A1101R09A and A1101R09C radio modules each have an integral ferrite bead in the supply line from pin 18 (Vdd) and decoupling capacitance to reduce any noise on the incoming power supply line. This arrangement will eliminate most supply voltage noise. In particularly noisy environments (switching regulators, motor controls, etc.), it may be necessary to add additional noise reduction means.

Pin 7 (Vdcoup1) is connected to the modules internal supply line after the ferrite bead and decoupling capacitors and can be used to probe the noise at module level. The noise level measured on pin 7 should not exceed 120mVpp when in transmit or receive mode; it may however exceed this value when setting up or accessing data to/from the FIFOs, while not actively transmitting or receiving.

If the level measured is exceeding the above limit, steps should be taken to ensure maximum range, including:

- Adding decoupling capacitance to pin 7 (Vdcoup1).
- Adding additional filtering in the supply line.

Adding an LDO in the supply line (the TPS731xx low Dropout Regulator from TI is recommended).

4. Mechanical and Process

4.1. Radio Module Details (dimensions in mm)

4.1.1. A1101R09A

Figure 11 A1101R09A dimensions

4.1.2. A1101R09C

Figure 12 A1101R09C dimensions

Anaren Integrated Radio