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Product Specification

802.11b/g SDIO/SPI Airborne Radio

WLRG-RA-DP600 Family

Revision: 2.4

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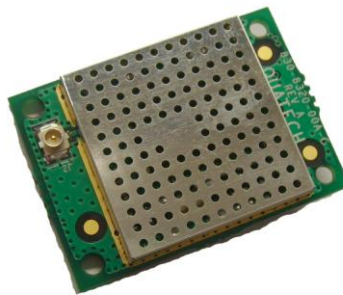
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1.0 Product Description

The WLNG-RA-DP600 family is a Marvell 88W8686 based 802.11b/g SDIO/SPI radio, designed by Quatech, to support handheld, mobile station and other power sensitive applications. The radio features the following:

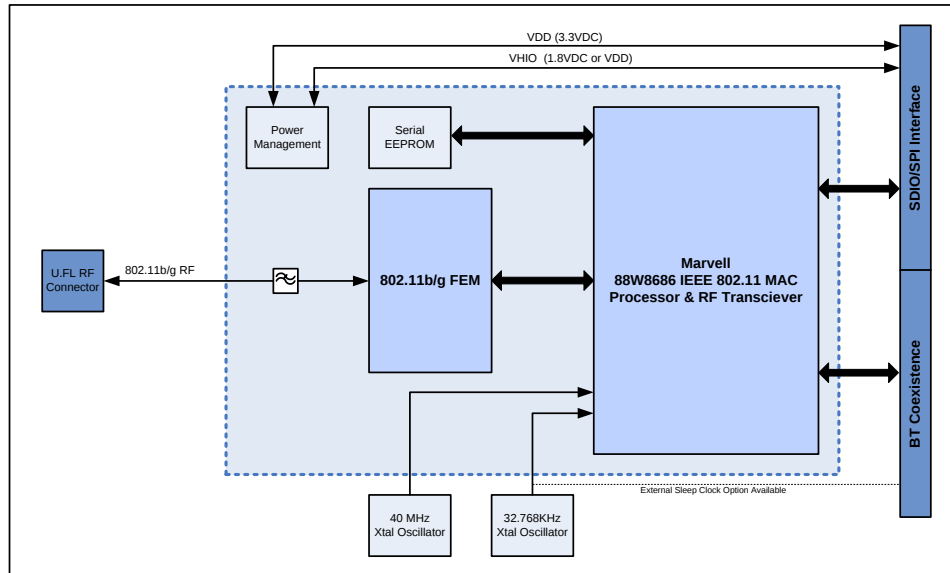
- 802.11b/g radio
- Based upon Marvell Libertas 88W8686 Chipset
- 30 pin high density SMT connector (*Molex 53748-0308*)
- Single (1) Hirose U.FL RF connector for 802.11b/g
- Supports WEP, WPA, WPA2 (Home and Enterprise) and 802.1x Supplicants
- Bluetooth Co-existence 3-wire interface through main connector
- SDIO 1.0 and Generic SPI host interface through 30 pin header
- Operating Temperature (-30°C to 85°C)
- Storage temp (-30°C to 125°C)
- Advanced Low power modes
- High vibration mounting holes
- Supports host downloaded radio firmware
- Single antenna
- Driver support for WinCE 5.0, Windows Mobile 5.0/6.0, Linux 2.6 and other embedded OS's
- Small form factor radio module (Dimensions: 29mm x 21mm x 6.0mm)

Figure 1- Lakemore Radio Example



2.0 Block Diagram

The following outlines the block diagram of the radio:



3.0 Model Numbers

The following table identifies the model numbers associated with the radio family. Please contact Quatech sales for details, quotes and availability.

Table 1 - Model Numbers

Model Number	Description	WiFi		Interface			Supply		RoHS
		802.11b	802.11g	SDIO	SPI	BT Co	VDD	VHIO	
WLRG-RA-DP601	802.11b/g, SDIO/SPI, Bluetooth Coexistence, VDD & VHIO supply (Lakemore)	•	•	• ¹	• ¹	•	•	•	•
Eval Kit									
WLEG-RA-DP601	802.11b/g SDIO/SPI Radio Eval Kit <i>WLRG-RA-DP601 radio</i> <i>SDIO Adapter Card</i> <i>Tools/Documentation CD</i> <i>Drivers (WinCE/Linux/XP)</i>								•

Notes:

1. Interface selection through pin 5 (SDIO) on main connector.
2. Radio supports external sleep oscillator option. Please contact Quatech sales for more information.
3. The Bluetooth Coexistence interface does not include RF antenna sharing option. For more details contact Quatech sales.

4.0 Pin out and Connectors

Table 2 – Radio Pin Definition

Pin	Signal	Pin I/O Type	Description
1	GND		Ground
2	GND		Ground
3	DNC		Reserved pin, DO NOT CONNECT
4	VHIO	Supply Input	Host Digital I/O Supply voltage for SDIO/SPI and Bluetooth interfaces. VHIO = 1.8VDC or VDD. Internally decoupled to GNDHIO.
5	SDIO	Digital Input	Serial Host mode. SPI = GND, SDIO = VDD
6	VHIO	Supply Input	Host Digital I/O Supply voltage for SDIO/SPI and Bluetooth interfaces. VHIO = 1.8VDC or VDD. Internally decoupled to GNDHIO.
7	DATA2	Digital I/O	SDIO Bit 2 (VHIO Domain) SDIO 4-bit: Data bit 2 or Read Wait (Optional) SDIO 1-bit: Read Wait (Optional) SDIO SPI: Reserved SPI: SPI Interrupt output (active low)
8	GND		Ground
9	GND		Ground
10	DATA1	Digital I/O	SDIO Bit 1 (VHIO Domain) SDIO 4-bit: Data bit 1 SDIO 1-bit: Interrupt SDIO SPI: Reserved SPI: Data Output
11	DATA3	Digital I/O	SPI/SDIO Card Select (Active Low) (VHIO Domain) SDIO 4-bit: Data bit 3 SDIO 1-bit: Reserved SDIO SPI: Card Select (Active Low)
12	SERCLK	Digital Input	SPI/SDIO Clock from host(VHIO Domain) SDIO 4-bit: Clock input SDIO 1-bit: Clock Input SDIO SPI: Clock Input SPI: Clock Input
13	DATA0	Digital I/O	SDIO Bit 0 (VHIO Domain) SDIO 4-bit: Data bit 0 SDIO 1-bit: Data Line SDIO SPI: Data Output SPI: SPI Device Select (Active Low)
14	CMD	Digital Input	SPI/SDIO data input for 4-Wire mode, data input/output for 3-wire mode. (VHIO Domain) SDIO Command/Response SDIO 4-bit: Command/response SDIO 1-bit: Command SDIO SPI: 4-wire = Data Input. 3-wire = Data I/O SPI: Data Input
15	VDD	Analog Supply Input	Supply Voltage (3.3VDC)
16	WLNAPU	Digital Input (Pull Down)	Card Power Up Enable from Host (active High). Internal Pull-up.
17	VDD	Analog Supply Input	Supply Voltage (3.3VDC)
18	SPI_RSTn	Digital Input	SPI Device RESET from MCU. Active Low
19	RF_ACTIVE	Digital Input	Asserted by the BT device during Rx or Tx slots that it wishes to use.
20	DNC		Reserved pin, DO NOT CONNECT
21	TXCONF	Digital Output	Transmission confirmed. Pulled low when the radio wants to prevent the BT device's use of the medium
22	STATUS	Digital Input	Pulsed if the BT device has a priority need for the slot. After that it indicates the BT radio mode (Tx or RX)
23	DNC		Reserved pin, DO NOT CONNECT
24	MCU_WAKEUP	Digital Output	MCU "wake up" request to the host. Active high. (GPIO5)
25	NC/SLEEPCLK		No connect, optional SLEEPCLK pin for host sourced sleep clock.
26	MAC_WAKEUP	Digital Input	WLAN MAC "wake-up"/interrupt from the host MCU. Active high (GPIO4)
27	UARTSIN	1.8V UART	UART Serial Input.
28	UARTSOUT	1.8V UART	UART Serial Output.
29	GND		Ground
30	GND		Ground

Table 3 - SDIO Interface Definition Table

SDIO Pin	Module Pin	SD 4-bit Pin Name	SD 4-bit Description	SD 1-bit Pin Name	SD 1-bit Description
1	11	DATA3	Data bit 3	N/C	Reserved
2	14	CMD	Command line.	CMD	Command line.
3	1, 2, 8, 9, 29, 30	VSS1	Ground (GND)	VSS1	Ground
4	4, 6	VDD	Supply Voltage (VHIO)	VDD	Supply Voltage (VHIO)
5	12	CLK	Clock from host (up to 48MHz)	CLK	Clock from host (up to 48MHz)
6	1, 2, 8, 9, 29, 30	VSS2	Ground (GND)	VSS2	Ground
7	13	DATA0	Data bit 0	DATA	Data line
8	10	DATA1	Data bit 1	IRQ	Interrupt
9	7	DATA2	Data bit 2	RW	Read/Write (optional)

Table 4 - SPI Interface Definition table

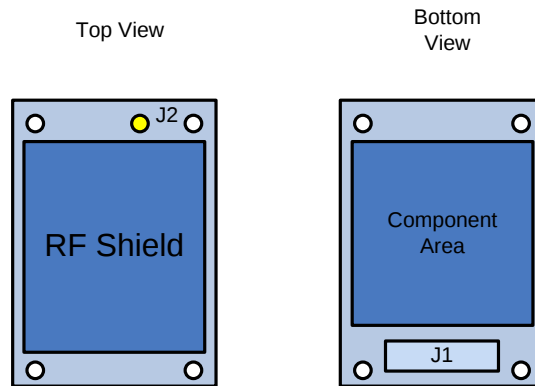
Module Pin	SPI Pin Name	SPI Description
7	DATA2	SPI Host Interrupt Request. Asserted by card to request an SPI data transfer. Interrupt output.
10	DATA1	SPI Data Output (MISO).
12	CLK	Clock from host (up to TBD MHz)
13	DATA0	SPI Card Select from host. Active Low
14	CMD	SPI Data Input (MOSI).
18	SPI_RSTn	SPI Device RESET from host. Active Low (Section Error! Reference source not found.)



1. It is recommended pins 27 and 28 be brought out to test pads or a pinned header.

There are a total of two connectors to the radio:

- J1: 30 pin Digital SDIO/SPI Host interface to radio Baseband processor.
Molex: **0537480308** (0.50mm (.020") Pitch SlimStack™ Plug, Surface Mount, Dual Row, Vertical, 3.00mm (.118") Stack Height, 30 Circuits)
- J2: RF connector for 802.11b/g antenna.
Hirose U.FL.



5.0 Electrical & RF Specification (Preliminary)

Table 5- Absolute Maximum Values¹

Parameter	Min	Max	Unit
Maximum EMU Supply Voltage	-0.3	7.0	VDC
Power Dissipation		2.00	W
Operating Temperature Range ²	-30	85	°C
Storage Temperature	-50	125	°C



1. These are absolute ratings; exceeding these values may cause permanent damage to the device.
2. Device is operational over full temperature range, however will provide reduced RF compatibility. Fully compliant temperature range -10°C to 85°C.

Table 6 – Operating Conditions & DC Specification

Symbol	Parameter	Min	Typ	Max	Units
V _{DD}	Supply Voltage	2.97	3.30	3.63	V
V _{HIO}	Host SDIO Interface supply ¹	1.62	1.86	1.98	V
I _{VHIO}	SDIO/SPI host interface supply current V _{HIO} =3.3VDC		8.4	10	mA
I _{CCTXB}	Constant transmit current (802.11b) <i>Transmitting @ 11Mb/s</i>		218	263	mA
I _{CCRxB}	Constant receive current (802.11b) <i>Receiving valid packets @ 11MB/s</i>		146	164	mA
I _{CCTXG}	Constant transmit current (802.11g) <i>Transmitting @ 54Mb/s</i>		161	276	mA
I _{CCRxG}	Constant receive current (802.11g) <i>Receiving valid packets @ 54MB/s</i>		174	200	mA
I _{SBIEEE}	IEEE Power Save Mode <i>Associated, Idle, Beacon Interval = 100ms</i>		6	9	mA
I _{SBPS}	Deep power save mode		440		μA
I _{SBFPD}	Full power down mode		160		μA



1. When V_{HIO} is not 1.8VDC, use V_{DD} parameter for signal levels (V_{HIO}=V_{DD}).

Table 7 - SDIO/SPI Interface Electrical Characteristics

Symbol	Parameter		Min	Typ	Max	Units
V_{IHSDIO}	Input HIGH Voltage	$V_{CC}=MAX, MIN$	$0.7 V_{HIO}$		$V_{HIO}+0.3$	V
V_{ILSDIO}	Input LOW voltage	$V_{CC}=MIN, MAX$	0		$0.3 V_{HIO}$	V
V_{OHSIO}	Output HIGH Voltage	$I_{OL} = 0.2mA, V_{CC}=MIN$	$V_{HIO}-0.2$		V_{HIO}	V
V_{OLSDIO}	Output LOW voltage	$I_{OL} = 6mA, V_{CC}=MIN$	0		0.6	V
I_{LSDIO}	Input Leakage Current	$V_{CC}=MAX, Input = 0V \text{ or } V_{CC}$	-1		1	μA
C_{INSDIO}	Input Capacitance			TBD		pF
$C_{OUTSDIO}$	Output Capacitance			TBD		pF

Table 8 - Supported Data Rates by Band

Band	Supported Data Rates (Mbps)
802.11b	11, 5.5, 2, 1
802.11g	54, 48, 36, 24, 18, 12, 9, 6

Table 9 - Operating Channels

Band	Region	Freq Range (GHz)	No. of Channels	Channels
802.11b	US/Canada	2.4 - 2.4835	11	1 - 11
	Europe	2.4 - 2.4835	13	1 - 13
	France	2.4 - 2.4835	4	10 - 13
	Japan	2.4 - 2.497	14	1 - 14
802.11g	US/Canada	2.4 - 2.4835	11	1 - 11
	Europe	2.4 - 2.4835	13	1 - 13
	France	2.4 - 2.4835	4	10 - 13
	Japan	2.4 - 2.497	13	1 - 13



1. Channel count denotes number of non-overlapping channels.

Table 10 - RF Characteristics – 802.11b/g

Symbol	Parameter	Rate (Mbps)	Min	Average dBm / mW		Peak dBm / mW		Units
P _{OUTB}	Transmit Power Output 802.11b	11, 5.5, 2, 1		13.2	20.1	18.2	66.1	dBm
P _{OUTG}	Transmit Power Output 802.11g	48, 54		12.8	19.1	17.3	53.7	dBm
		24, 36		12.7	18.6	17.2	52.5	
		12, 18		12.8	19.1	17.3	53.7	
		6, 9		12.5	17.8	17.0	50.1	
P _{RSENB}	Receive Sensitivity 802.11b	11		-89				dBm
		1		-92				
P _{RSENG}	Receive Sensitivity 802.11g	54		-72				dBm
		36		-78				
		18		-83				
		6		-88				
F _{RANGEBG}	Frequency Range		2412			2484		MHz



1. All values measured at T_A.

6.0 Antenna

The unit supports antenna connection through a single Hirose U.FL connector, located on the top surface of the radio next to the RF shielding.

Any antenna used with the system must be designed for operation within the 2.4GHz ISM band and specifically must support the 2.412GHz to 2.482GHz for 802.11b/g operation. They are required to have a VSWR of 2:1 maximum referenced to a 50Ω system impedance.

6.1 Antenna Selection

The Airborne radio supports a number of antenna options, all of which require connection to the U.FL connectors on the radio. Ultimately the antenna option selected will be determined by a number of factors, these include consideration of the application, mechanical construction and desired performance. Since the number of possible combinations is endless we will review some of the more common solutions in this section. If your application is not covered during this discussion please contact Technical Support for more specific answers.

The available antenna connections include:

- Host board mounted antenna
- Host Chassis mounted antenna
- Embedded antenna

In addition to the above options, location and performance need to be considered, the following sections discuss these items.

6.2 Host Board Mounted Antenna

Host board mounted requires that an antenna connection is physically mounted to the host system board. It also requires that the host board include a U.FL connector (two (2) if diversity is being used) to allow a U.FL to U.FL coaxial lead to connect from the radio to the host board. It will then require 50Ω matched PCB traces to be routed from the U.FL connector to the antenna mount.

There are several sources for the U.FL to U.FL coaxial cable these include Hirose, Sunridge and IPEX. Please contact Qatech for further part numbers and supply assistance.

This approach can simplify assembly but does require that the host system configuration can accommodate an antenna location that is determined by the host PCB. There are also limitations on the ability to seal the enclosure when using this approach.

This approach also restricts the selection of available antenna. When using this approach antennas that screw or press fit to the PCB mount connector must be used. There are many options for the antenna connector type, however if you wish to utilize the FCC/IOC modular approval the connector choice must comply with FCC regulations, these state a non-standard connector is required e.g.

TNC/SMA are not allowed (there are more that are not), RP-TNC/RP-SMA are allowed.

6.3 Host Chassis Mounted Antenna

Host Chassis mounted antennas require no work on the host PCB. They utilize an antenna type called ‘flying lead’. There are two types of flying leads; one which provides a bulkhead mounted antenna connector and one which provides a bulk head mounted antenna. The type you choose will be determined by the application.

A flying lead system connects a U.FL coaxial lead to the radio’s U.FL connector, the other end of the coax is attached to either a bulkhead mounted antenna connector or directly to an antenna that has an integrated bulkhead mount.

In either of the two cases, the use of this approach significantly reduces the antenna system development effort and provides for greater flexibility in the available antenna types and placement in the host system chassis.

When using the flying lead antenna (integrated bulk head mounting), there are no connector choice restrictions for use with the FCC/IOC modular certification. However if the flying lead connector is used, the same restrictions as identified for the Host Mounted Antenna apply.

There are many suppliers of flying lead antenna and connectors; Quatech’s Airborne Antenna product line offers a range of antenna solutions.

6.4 Embedded Antenna

Use of Embedded antenna can be the most interesting approach for M2M, industrial and medical applications. Their small form factor and absence of any external mounting provides a very compelling argument for their use. There is a downside to this antenna type and it comes with performance. Antenna performance for all of the embedded options will, in most cases, be less than that achievable with external antenna. This does not make them unusable; it will impact choice of antenna type and requires more focus on placement.

The three main embedded antenna types are PCB embedded, chip (PCB mounted) and flying lead; each has its advantages and disadvantages (See Table 11).

Table 11 - Embedded Antenna Options

Antenna Type	Features			
	Cost	Size	Availability	Performance
PCB Embedded	Lowest	Largest	Custom	Poor
Chip	Low	Small	Standard	Poor
Flying Lead	Low	Small	Standard	Fair

PCB Embedded – This approach embeds an antenna design into the host PCB. This approach is very common with add-in WiFi card (CF, PCMCIA, SDIO, etc.) as it requires no external connections and is the cheapest production approach. The lower production cost requires significant development cost and lack of performance and flexibility.

Chip – The integration of a chip antenna is simple and requires a relatively small footprint on the host system, however, it does suffer from the same limitations of flexibility and performance seen with the PCB embedded approach. There are relatively large numbers of suppliers of this type of antenna; there is also a range of configuration and performance options.

Flying Lead – This approach is similar to the flying lead solution for external antennas, the difference is that the form factors are smaller and provide a range of chassis and board mounting options, all for internal use. This approach suffers less from the performance and flexibility limitations of the other approaches, since the location of the antenna is not determined by the host PCB design. The assembly of a system using this approach maybe slightly more complex since the antenna is not necessarily mounted on the host PCBA.

6.5 Antenna Location

The importance of this design choice cannot be over stressed; it can in fact be the determining factor between success and failure of the WiFi implementation.

There are several factors that need to be considered when determining location:

- Distance of Antenna from radio
- Location of host system
 - Proximity to RF blocking or absorbing materials
 - Proximity to potential noise or interference
 - Position relative to infrastructure (Access Points or Laptops)
- Orientation of host system relative to infrastructure
 - Is it known
 - Is it static

To minimize the impact of the factors above the following things need to be considered during the development process:

- Minimize the distance between the radio and the location of the antenna. The coaxial cable between the two impacts the Transmit Power and Receive Sensitivity negatively. Quatech recommends using 1.32-1.37mm outer diameter U.FL coaxial cables.
- Minimize the locations where metal surfaces come into contact or are close to the location of the antenna.
- Avoid locations where RF noise, close to or over lapping the ISM bands, may occur. This would include microwave ovens and wireless telephone systems in the 2.4GHz and 5.0GHz frequency range.
- Mount the antenna as high on the equipment as possible.

- Locate the antenna where there is a minimum of obstruction between the antenna and the location of the Access Points. Typically Access Points are located in the ceiling or high on walls.
- Keep the main antenna's polarization vertical, or in-line with the antenna of the Access Points. 802.11 systems utilize vertical polarization and aligning both transmit and receive antenna maximizes the link quality.

Even addressing all of the above factors, does not guarantee a perfect connection, however with experimentation an understanding of the best combination will allow a preferred combination to be identified.

6.6 Performance

Performance is difficult to define as the appropriate metric changes with each application or may indeed be a combination of parameters and application requirements. The underlying characteristic that, in most cases, needs to be observed is the link quality. This can be defined as the bandwidth available over which communication, between the two devices, can be performed, the lower the link quality the less likely the devices can communicate.

Measurement of link quality can be made in several ways; Bit Error rate (BER), Signal to Noise (SNR) ratio, Signal Strength and may also include the addition of distortion. The link quality is used by the radio to determine the link rate, generally as the link quality for a given link rate drops below a predefined limit, the radio will drop to the next lowest link rate and try to communicate using it.

The reciprocal is also true, if the radio observes good link quality at one rate it will try to move up to the next rate to see if communication can be sustained using it. It is important to note that for a given position the link quality improves as the link rate is reduced. This is because as the link rate drops the radios Transmit power and Receive sensitivity improve.

From this it can be seen the looking at the link rate is an indirect way of assessing the quality of the link between the device and an Access Point. You should strive to make the communication quality as good as possible in order to support the best link rate. However be careful not to *over specify* the link rate. Consider your applications bandwidth requirements and tailor your link rate to optimize the link quality e.g. the link quality for a location at 6Mb/s is better than it would be for 54Mb/s, if the application only needs 2Mb/s of data throughput, the 6Mb/s rate would provide a better link quality.

Aside from the radio performance, there are a number of other things that contribute to the link quality; these include the items discussed earlier and choices made when looking at the overall antenna gain. The antenna gain contributes to the Equivalent Isotropically Radiated Power (EIRP) of the system. This is part of an overall measurement of the link quality called link margin.

Link Margin provides a measure of all the parts of the RF path that impact the ability of two systems to communicate. The basic equation looks like this:

$$\text{EIRP (dB)} = \text{TxP} + \text{TxA} - \text{TxC}$$

$$\text{Link Margin (dB)} = \text{EIRP} - \text{FPL} + (\text{RxS} + \text{RxA} - \text{RxC})$$

Where:

- TxP = Transmitter output power (dBm)
- TxA = Transmitter antenna gain (dBi)
- TxC = Transmitter to Antenna coax cable loss (dB)
- FPL = Free Path Loss (dB)
- RxS = Receiver receive sensitivity (dBm)
- RxA = Receiver antenna gain (dBi)
- RxC = Receiver to Antenna coax cable loss (dB)

This is a complex subject and requires more information that is presented here, Quatech does recommend at least looking at the subject and evaluating any system at a basic level.

It is then possible, with a combination of the above items and an understanding of the application demands, to achieve a link quality optimized for the application and host design. It is important to note that this is established with a combination of hardware selection, design choices and configuration of the radio.

7.0 Bluetooth Coexistence Interface

The Bluetooth coexistence interface implemented on the Airborne 802.11b/g WLRG-RA-DP600 family of radio's is a three wire configuration, designed to support the identified coexistence recommended practices in the IEEE 802.15.2 standard for the coexistence of WLAN and Bluetooth devices. This includes collaborative TDMA method described as Packet Traffic Arbitration (PTA).

The Airborne radio includes a PTA Controller integrated into the BB/MAC processor; this requires the Bluetooth device to act as a PTA slave to the PTA control module.

Table 12 - BT Interface Pin Definition

Signal	Direction	Description
RF_ACTIVE (Active High)	Input	Asserted by the BT device during Rx or Tx slots that it wishes to use.
STATUS	Input	Pulsed if the BT device has a priority need for the slot. After that it indicates the BT radio mode (Tx or RX)
TXCONF (Active Low)	Output	Transmission confirmed. De-asserted when the radio wants to prevent the BT device's use of the medium

8.0 GSPI Interface

The General Serial Peripheral Interface (GSPI) for the WLRG-RA-DP601 is detailed in the following section. The interface is powered by the VHIO (pin 4 & 6) supply as defined in Table 2.

8.1 SPI Protocol Timing

The following figures and table define the required timing for the GSPI interface.

Figure 2 - GSPI Timing Diagram

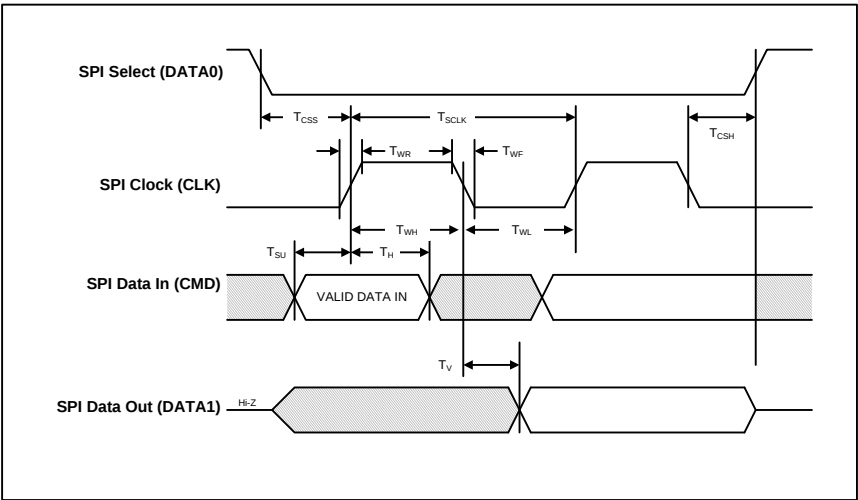


Figure 3 - GSPI Inter-Transaction Timing

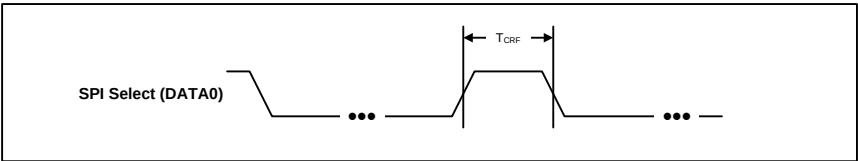


Table 13 - GSPI Protocol Timing Values

Symbol	Parameter	Min	Typ	Max	Units
T _{SCLK}	Clock period	20			ns
T _{WH}	Clock High	5			ns
T _{WL}	Clock Low	9			ns
T _{WR}	Clock Rise Time			1	ns
T _{WF}	Clock Fall Time			1	ns
T _H	Serial Data In Hold Time	2.5			ns
T _{SU}	Serial Data In Setup Time	2.5			ns
T _V	Serial Data Out Hold Time	5			ns
T _{CSS}	Chip Select Low to Clock Valid	5			ns
T _{CSH}	Clock Rise or Fall to Chip Select High	0			ns
T _{CRF}	Chip select High to Chip Select Low	400			ns

9.0 SDIO Interface

The Serial Data Input Output (SDIO) interface for the WLRG-RA-DP601 is detailed in the following section. The interface is powered by the VHIO (pin 4 & 6) supply as defined in Table 2. The interface is compliant to v1.0 of the SDIO interface standard.

9.1 SDIO Protocol Timing

The following figures and table define the required timing for the SDIO interface.

Figure 4 – SDIO Protocol Timing Diagram

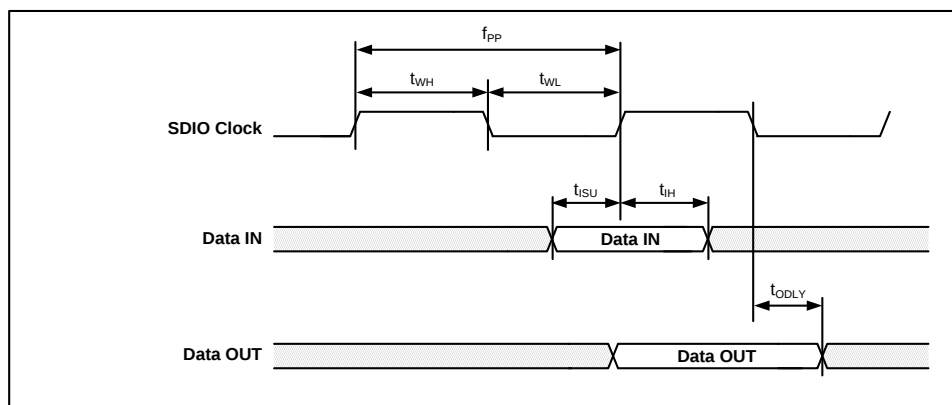


Figure 5 – SDIO Protocol Timing Diagram – High Speed

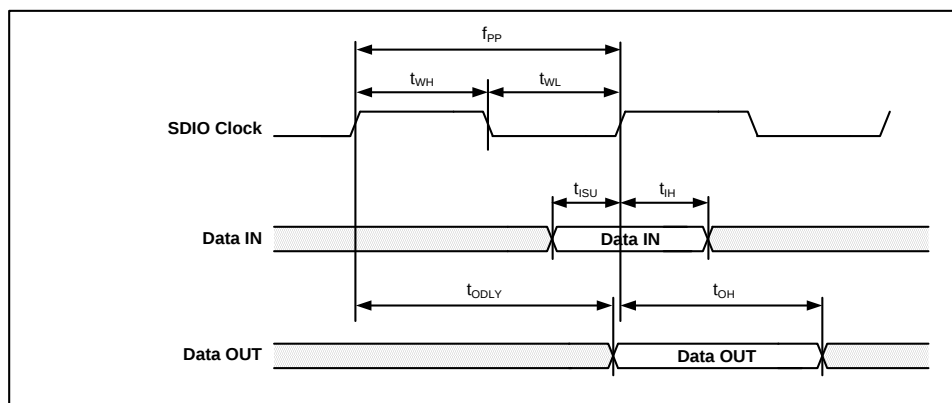
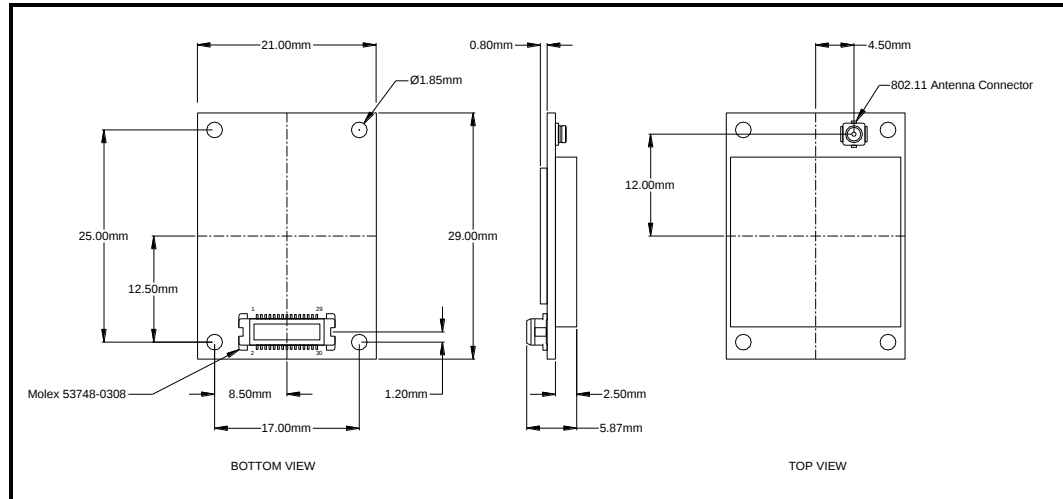


Table 14 - SDIO Protocol Timing Values

Symbol	Parameter	Condition	Min	Typ	Max	Units
f _{PP}	Clock Frequency	Normal	0		25	MHz
		High Speed	0		50	MHz
T _{WL}	Clock Low	Normal	10			ns
		High Speed	7			ns
T _{WH}	Clock High	Normal	10			ns
		High Speed	7			ns
T _{ISU}	Input Setup Time	Normal	5			ns
		High Speed	6			ns
T _{IH}	Input Hold Time	Normal	5			ns
		High Speed	2			ns
T _{ODLY}	Output Delay Time		0		14	ns
T _{OH}	Output Hold Time	High Speed	2.5			ns

10.0 Mechanical Outline

Figure 6 - Mechanical Outline



Radio Connector:	0537480308 (Molex) (0.50mm (.020") Pitch SlimStack™ Plug, Surface Mount, Dual Row, Vertical, 3.00mm (.118") Stack Height, 30 Circuits)
Board Connector:	0529910308 (0.50mm (.020") Pitch SlimStack™ Receptacle, Surface Mount, Dual Row, Vertical, 3.00mm (.118") Stack Height, 30 Circuits)
RF Connector:	U.FL (Hirose, Ultra Small Surface Mount Coaxial Connector)
Mounting Screw:	M1.6, 0.35mm pitch, 6-8mm length, Stainless Steel (McMaster-Carr Part# 91800A008)
Mounting Nut:	M1.6, 0.35mm Pitch, Hex, Stainless Steel (McMaster-Carr Part# 91828A006)
Spacer:	3mm, OD 3-4 mm, ID 2-2.5mm (Bivar Part# 9913-3mm, Nylon 3mm , 2.3mm ID, 4.7mm OD)

11.0 Design Guidelines

The WLRG-RA-DP601 is designed for integration in to a wide range of advanced electronic systems and diverse applications, the success of the integration and final performance of the complete system depends upon the integration process and hardware design, the following section provides a set of guidelines to aid in the integration of the radio.

The following guidelines address hardware design requirements for the integration of the radio under normal conditions, should your application not be able to support the listed guidelines please contact Quatech.

11.1 VDD/VHIO Power Supply

The WLRG-RA-DP601 supports a split power supply; it requires both a VHIO and VDD power supply to function correctly.

VHIO defines the power domain that supports the host interface and must be powered to support the mating interface on the host. It will support both a 1.8VDC and 3.3VDC supply rail.

VDD is the main power supply for the radio and supplies all aspects of the radio with the exception of the host interface. The VDD is a 3.3VDC supply, please refer to Table 6 for the power supply requirements.

If the SDIO interface is being used the radio supports the power specification as defined by the SDIO interface specification, no additional power supply support is required.

It is acceptable to supply VHIO from the VDD power rail if the host supports a 3.3VDC interface. The full interface specification can be referenced in Table 7.

11.2 SDIO (pin #5)

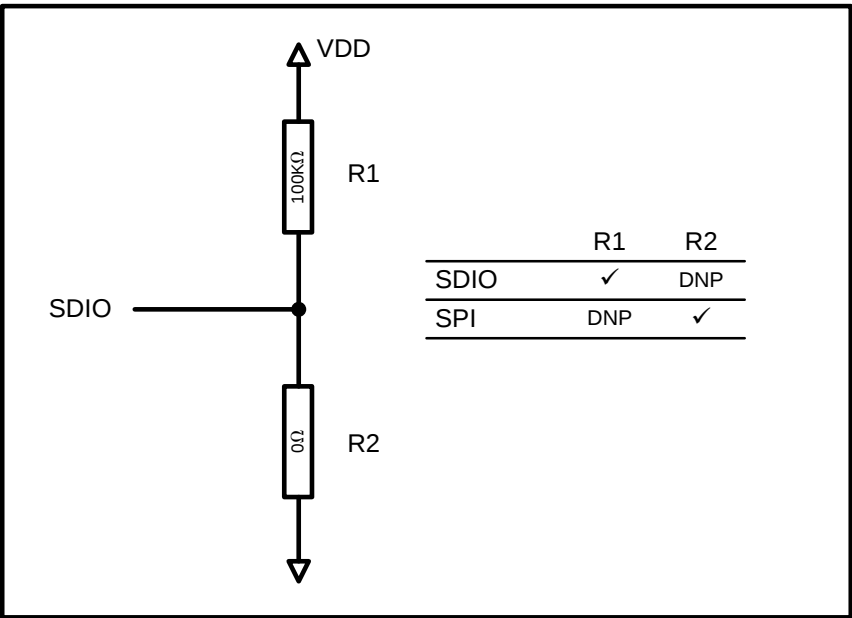
This pin defines the host interface boot definition for the radio, defining either a SDIO or SPI interface. This pin should be configured as shown in Table 15 for the radio to boot successfully.

Table 15 - SDIO (Pin #5) Configuration Options

SDIO Mode	Description
SPI	Pin must be pulled to ground.
SDIO	Pin must be pulled to VDD.

Figure 7 show the recommended network for the pin.

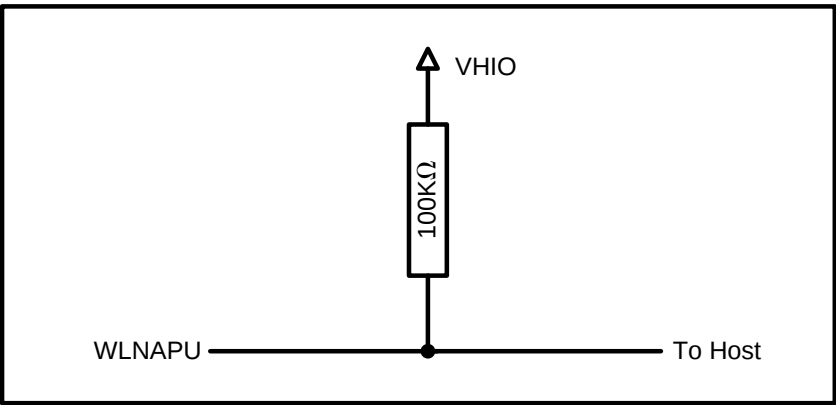
Figure 7 - SDIO (Pin #5) Configuration Options



11.3 WLNAPU (pin #16)

This pin should be pulled to VHIO through a 100KΩ resistor, as shown in Fig XX.

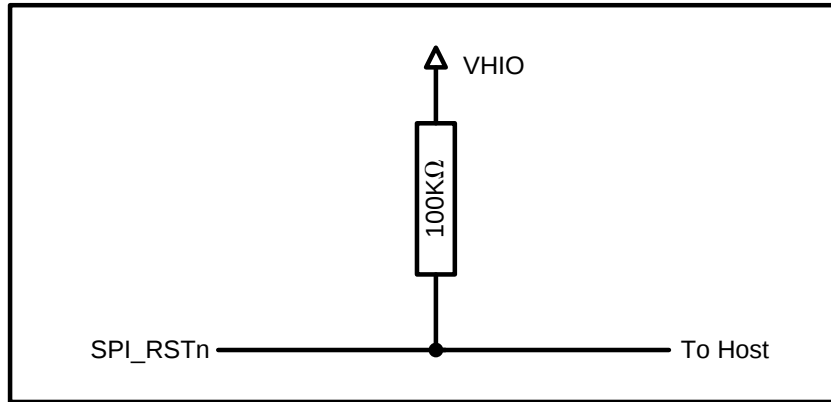
Figure 8 - WLNAPU (Pin #16) Network



11.4 SPI_RSTn (pin #18)

This pin should be pulled to VHIO through a 100K Ω resistor, as shown in Figure 9.

Figure 9 - SPI_RSTn (Pin #18) Network



11.5 Recommended PCB Layout

The following outlines Quatech's recommendations for layout of the PCB for the WLRG-RA-DP601, these are guidelines only and should serve as guidance when designing the host system board.

If there are questions relating to the guidelines please contact Quatech Technical Support.

Figure 10 - Recommended PCB Layout

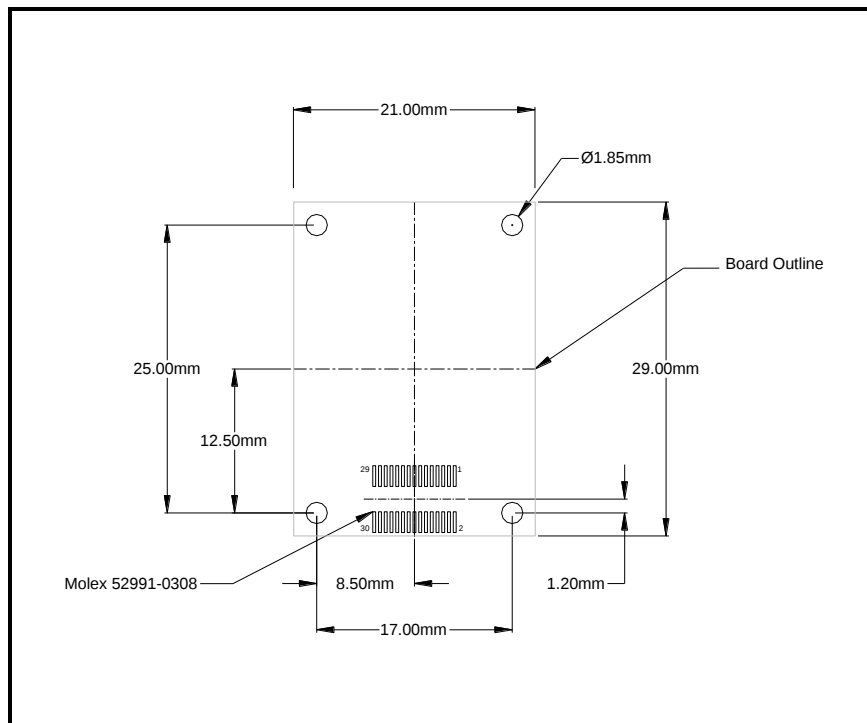
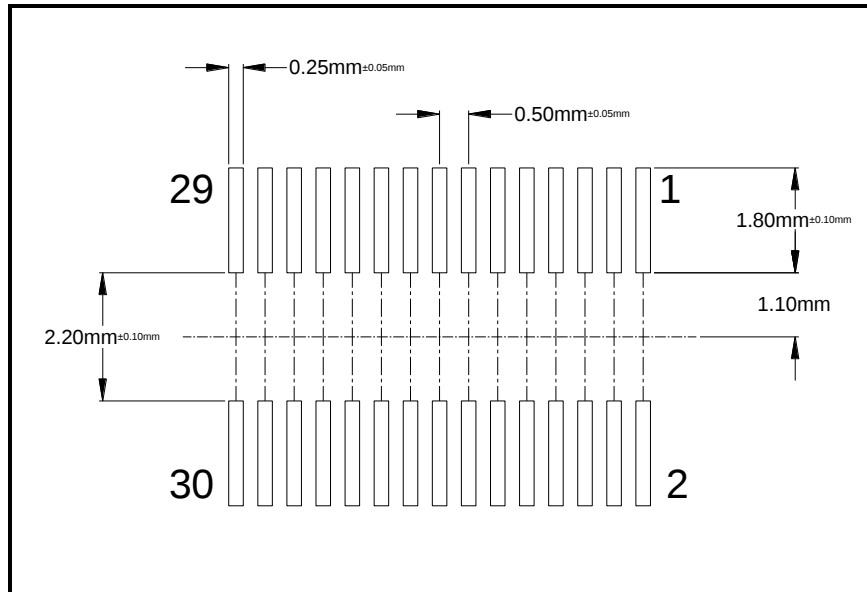


Figure 11 - Recommended Connector Footprint



11.6 Mechanical Mounting

It is recommended that mechanical mounting, other than the mated connector, be used to secure the radio to the host system. The radio includes four (4) holes specifically for this purpose. These holes are provided in the four corners and are unplated, this allows the use of metallic mounting systems without impacting the electrical performance of the unit.

The mounting holes can be seen in Fig, they are 1.85mm in diameter. A mechanical spacer will be required to maintain the physical separation of the board from the host and aid in ensuring optimal interference in the connector.

The height of the spacer should be $3\text{mm} \pm 0.1\text{mm}$. The material should not be easily compressed.

11.7 EMI/EMF Guidelines

To minimize electromagnetic interference (EMI) and radio frequency interference (RFI), pay strict attention to power and signal routing near the Radio. As much as possible, the keep-clear area below the Radio should be a solid copper ground plane. It is anticipated that the Radio will be mounted on a board with a committed ground plane. Ensure the PCB interconnect has a designed impedance of 50-75 Ohms.

To keep signal impedance as low as possible, connect the ground plane to internal ground planes by several vias. Ground signals to the Radio connector should connect directly to the ground plane below the Radio. Individual ground connections to the Radio should have a solid ground connection, preferably directly to the ground plane on the same surface side where the Radio resides. Do not connect ground pins directly to an inside layer ground plane using vias only.

Keep interconnects from the Radio connector as short as possible on the mounting layer. All inboard signals—including pin numbers—must immediately transition to a different routing layer using a via as close to the connector as possible. Outboard signals (odd pin numbers) should also be kept to a minimum length.

12.0 Certification & Regulatory Approvals

The unit complies with the following agency approvals:

Table 16 - Regulatory Approvals

Country	Standard	Status
North America (US & Canada)	FCC Part 15, Sec. 15.107, 15.109, 15.207, 15.209, 15.247 RSS-210 Modular Approval	Granted
Europe	EN60950 inc. A1, A2, A3, A4 ETSI EN 300 328 Part 1 V1.2.2 (2000-07) ETSI EN 300 328 Part 2 V1.1.1 (2000-07) ETSI EN 301 893 V1.2.1 (2002-07) ETSI EN 301 489-1 V1.4.1 (2002-08) ETSI EN 301 489-17 V1.4.1 (2000-09)	Pending
Japan	ARIB STD-T71 v1.0, 14 (Dec 2000) ARIB RCR STD-T33 (June 19, 1997) ARIB STD-T66 v2.0 (March 28, 2002)	Pending

12.1 FCC Statement

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 in a residential installation. This equipment generates uses and can radiate 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 to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for assistance.

12.2 SAR Statement

The WLRG-RA-DP601 has been tested for body-worn Specific Absorption Rate (SAR) compliance. The FCC has established detailed SAR requirements and has established that these requirements have been met while the WLRG-RA-DP601 was installed in a host representative host system.

12.3 RF Exposure Information

The radio module has been evaluated under FCC Bulletin OET 65C (01-01) and found to be compliant to the requirements as set forth in CFR 47 Sections, 2.1093, and 15.247 (b) (4) addressing RF Exposure from radio frequency devices. This model meets the applicable government requirements for exposure to radio frequency waves. The highest SAR level measured for this device was 0.993 W/kg (802.11b) and 0.442 W/Kg (802.11g).

For the limited modular approval if the device is used less than 20 cm from persons (i.e. portable) then the antenna must be mounted outside of the host. If the device is used more than 20cm from persons (i.e. mobile) then the antenna does not need to be mounted outside of the host.

Certified antennas include:

Company	Description	Part No.
L-Com	2.2 dBi Omni-directional, 2.4GHz, RP-SMA, Rubber Duck	HG2402RD-RSF

12.4 Information for Canadian Users (IC Notice)

This device has been designed to operate with an antenna having a maximum gain of 5dBi for 802.11b/g band. An antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

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 required for successful communication.

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.

12.5 FCC/IOC Limited Modular Approval

This document describes the Airborne WLN FCC limited modular approval and the guidelines for use as outlined in FCC Public Notice (DA-00-1407A1).

The WLRG-RA-DP601 is covered by the following limited modular grants:

Country	Standard	Grant
North America (US)	FCC Part 15 Sec. 15.107, 15.109, 15.207, 15.209, 15.247 Modular Approval	F4AWLRG601
Canada	RSS 210 Modular Approval	3913A-WLRG601

By providing FCC limited modular approval on the Airborne radio modules, our customers are relieved of any need to perform FCC part15 subpart C Intentional

Radiator testing and certification, except where they wish to use an antenna that is not already certified.

Quatech supports a group of pre-approved antenna; use of one of these antennas eliminates the need to do any further subpart C testing or certification. If an antenna is not on the list, it is a simple process to add it to the pre-approved list without having to complete a full set of emissions testing. Please contact Quatech Technical support for details of our qualification processes.

Please note that as part of the FCC requirements for the use of the modular approval, the installation of any antenna must require a professional installer. This is to prevent any non-authorized antenna being used with the radio. There are ways to support this requirement but the most popular is to utilize a non-standard antenna connector, this designation includes the reverse polarity versions of the most popular RF antenna types (SMA, TNC, etc.). For more details please contact Quatech.

The following documents are associated with this applications note:

- FCC Part 15 – Radio Frequency Devices
- FCC Public Notice – DA-00-1407A1 (June 26th, 2000)

Quatech recommends that during the integration of the radio, into the customers system, that any design guidelines be followed. Please contact Quatech Technical Support if you have any concerns regarding the hardware integration.

Contact Quatech Technical support for a copy of the FCC and IOC grant certificates, the test reports and updated approved antenna list.

12.6 Regulatory Test Mode Support

The WLRG-RA-DP601 includes support for all FCC, IC and ETSI test modes required to perform regulatory compliance testing. Please contact Quatech Technical Support for details on enabling and using these modes.

13.0 Change Log

The following table indicates all changes made to this document:

Version	Date	Section	Change Description	Author
A	2/11/2007	-	Internal Release	ACR
B	2/19/2007	4.0	Updated Table 2.0	ACR
1.3	3/12/2008	-	Changed revision numbering from Alpha to Numeric	ACR
		2.0	Updated block diagram to remove BT RF connector.	
		4.0	Updated Table 2.0 to reflect updated pin out. Updated Connector reference diagram to remove BT connector.	
		7.0	Updated Fig 2.0 to remove BT U.FL connector.	
1.4	3/21/2008	4.0	Updated Table 2.0	ACR
		5.0	Updated Table 6.0, 7.0 and 10 with tested values. Updated notes.	
		7.0	Updated Fig 2.0 mechanical Outline with new pin #1 identifier.	
		8.0	Added section	
		9.0	Added section	
1.5	5/8/2008	1.0	Fig 1.0 updated to actual radio image.	ACR
		8.0	Fig 3.0 was updated to reflect 10K ohm resistor and modified population table.	
1.6	6/31/2008	7.0	Added Bluetooth Coexistence Interface section.	ACR
	9/17/2008	8.0	Added GSPI Section, incremented all sections above.	
1.7	11/21/2008	Title	Updated title to include product part number	ACR
		4.0	Updated tables 2.0 and 4.0 to correct issues with SPI interface description.	
		8.1	Updated Fig 2 & 3 to reflect changes to SPI interface description.	
2.0	3/31/09	Title	Removed 'Preliminary'	ACR
		5.0	Updated Table 10 with RevB test data.	
		11.0	Typographical correction	
2.1	6/17/2009	5.0	Added Note 2 to Table 5.0	ACR
		10.4	Changed Figure reference to identify correct diagram.	
		11.0	Deleted RESETSection.	
2.2	1/31/2010	3.0	Note 1 of Table 1: Correct pin reference from pin 6 to pin 5.	ACR
		10.0	Updated mounting hardware reference.	
2.3	6/22/2010	12	Updated with FCC/IC regulatory information upon approval.	CHM
2.4	6/28/2010	12	Added SAR certification notice.	ACR
			Changed FCC/IC approval to limited modular.	