Hardware Design Document

Technical Description of Purpletooth PT-209G Wireless Modem

Document Information

Subject:	Hardware Design Document
Title:	Technical Description of Purpletooth PT-209G Wireless Modem
Filename:	\\Server01\common\Engineering\Project\PurpletoothEthernet\Document\HardwareDesignDocument\techDes_hdd_PTUE_V23_041129.doc
Reference no.:	R-001-4820-039
Version no.:	V2.3
Status:	Released
Date:	November 29, 2004
Author:	L.M.Cheong
Revisions:	Version history

Modifications from V1.0: 1. Add IF filter and amplifier specifications (Section 2.3.1 and 2.3.2.) 2. Add the antenna description section (Section 3.)
Modifications from V2.0: 1. Revise the HTQ-2.4-10 antenna connector type (Section 3.3.)
Modification from V2.1: 1. Re-write the transmit path operation description in RF unit section (Section 2.3.)
Modification from V2.2: 1. Add a paragraph to state explicitly the TDD communication method (Section 2.) 2. State the maximum user data rate (1 Mbps) (Section 2.) 3. State the worst case duty cycle (0.132) (Section 2.)

1 Introduction

This document describes the basic operation principle of the Purpletooth PT-209G Wireless Modem.

2 Technical Description

The Purpletooth PT-209G wireless modem is an advanced communication device employing the direct sequence spread spectrum (DSSS) technology.

The communication between two modems uses the time division duplex (TDD) method that a modem is either in transmit mode (activation of the transmit path) or in receive mode (activation of the receive path) in any instance. The worst case duty cycle is 0.132.

The maximum user channel data rate is 1 Mbps.

The modem hardware system can be divided into four units, namely, the digital and interface unit; the baseband unit; the RF unit and the power supply and battery charging unit.

2.1 Digital and Interface Unit

The MCU, ML671000 from OKI, is the central controller of the whole hardware system. It is driven by a 12 MHz digital oscillator. The MCU provides an RS-232 and an USB interfaces directly. On the other hand, an Ethernet interface controller, DM9000, from DaviCom, is connected to ML671000 via the address/data buses connection to provide an RJ45 interface.

2.2 Baseband Unit

The baseband unit composes of the DSSS transceiver chip set, SX043 and SX061 from AMI Semiconductor, the de-spreader, EL4450 from Elantec, and the associated filtering and matching circuitry. The baseband signal is spread by SX043 and then sent to the RF unit for up-conversion and modulation at the transmit path. In the reverse direction, the received signal at 4.6 MHz is de-spread by multiplying at the PN sequence supplied from SX043 at EL4450. The de-spread signal is demodulated at SX061 and then read by the digital control unit.

2.3 RF Unit

The RF unit employs a transceiver, RF2938 from RFMD, as the core. For the transmit path, the spread data stream at 16 Mcps from SX043 of the baseband unit is modulated by the RF transceiver RF2938. The modulation scheme is either BPSK or QPSK according to the data rate selected (QPSK is only used in 1 Mbps, the maximum data rate case). The data stream is modulated to 374 MHz IF. The modulated signal is filtered and then feed back to RF2938 to further up-convert to 2.4476 GHz. The 2.4476 GHz signal is first filtered and then goes back to RF2938 where one stage power amplification is provided. The amplified signal is then further amplified by the last stage power amplifier, RF2163. Finally, the signal goes through the RF switch AS169 and the antenna port to outside.

At the receiver path, the signal is first amplified by two stage LNAs, HMC287 from Hittite and RF2494 from RFMD. The signal is also down-converted to the IF at 374 MHz by RF2494. It is then filtered by a SAW filter TB374GD from Tai-SAW technology and amplified by an IF amplifier, AD8367 from Analog Devices. The IF signal is further down-converted to 4.6MHz by RF2938. This 4.6MHz signal is supplied to the baseband unit for de-spreading and demodulation.

The specifications of the IF filter and amplifier are provided as follows:

2.3.1 IF SAW Filter TB374GD

Item	Unit	Min.	Type.	Max.
Center frequency, Fc	MHz	-	374	-
Insertion loss, IL	dB	-	8.5	10
Pass bandwidth, BW3	MHz	17	24	-
Amplitude ripple in Fc ± 7 MHz	dB	-	0.6	1
Group delay ripple in Fc ± 7 MHz	ns	-	40	100
Triple transit suppression	dB	30	37	-
Attenuation: (reference level from Min IL)				
Fc –100 to –33 MHz	dB	45	52	-
Fc –33 to –22 MHz	dB	40	51	-
Fc –22 to –16.5 MHz	dB	30	42	-
Fc +16.5 to +22 MHz	dB	30	41	-
Fc +22 to +43 MHz	dB	35	44	-
Fc +43 to +100 MHz	dB	40	47	-

2.3.2 IF Amplifier AD8367

AD8367—SPECIFICATIONS

(V_S = 5 V, T_A = 25°C, System Impedance Z_0 = 200 Ω, V_{MODE} = 5 V, f = 10 MHz, unless otherwise noted.)

Parameter	Conditions	Min	Typ	Max	Unit
OVERALL FUNCTION					
Frequency Range		LF		500	MHz
GAIN Range			45		dB
INPUT STAGE	Pins INPT and ICOM				
Maximum Input	To Avoid Input Overload		700		mV p-p
Input Resistance	From INPT to ICOM	175	200	225	Ω
GAIN CONTROL INTERFACE	Pin GAIN				
Scaling Factor	V_{MODE} = 5 V, 50 mV ≤ V_{GAIN} ≤ 950 mV		+20		mV/dB
	V_{MODE} = 0 V, 50 mV ≤ V_{GAIN} ≤ 950 mV		–20		mV/dB
Gain Law Conformance	100 mV ≤ V_{GAIN} ≤ 900 mV		±0.2		dB
Maximum Gain	V_{GAIN} = 0.95 V		+42.5		dB
Minimum Gain	V_{GAIN} = 0.05 V		–2.5		dB
V_{GAIN} Step Response	From 0 dB to 30 dB		300		ns
	From 30 dB to 0 dB		300		ns
Small Signal Bandwidth	V_{GAIN} = 0.5 V		5		MHz
OUTPUT STAGE	Pin VOUT				
Max Output Voltage Swing	R_L = 1 kΩ		4.3		V p-p
	R_L = 200 Ω		3.5		V p-p
Output Source Resistance	Series Resistance of Output Buffer		50		Ω
Output Centering Voltage[1]			V_S/2		V
SQUARE LAW DETECTOR	Pin DETO				
Output Set Point			354		mV rms
AGC Small Signal Response Time	C_{AGC} = 100 pF, 6 dB Gain Step		1		µs
POWER INTERFACE	Pins VPSI, VPSO, ICOM, and OCOM				
Supply Voltage		2.7		5.5	V
Total Supply Current	ENBL High, Maximum Gain, R_L = 200 Ω (Includes Load Current)		26	30	mA
Disable Current vs. Temperature	ENBL Low		1.3	1.6	mA
	–40°C ≤ T_A ≤ +85°C			1.8	mA
MODE CONTROL INTERFACE	Pin MODE				
Mode LO Threshold	Device in Negative Slope Mode of Operation		1.2		V
Mode HI Threshold	Device in Positive Slope Mode of Operation		1.4		V
ENABLE INTERFACE	Pin ENBL				
Enable Threshold			2.5		V
Enable Response Time	Time Delay Following LO to HI Transition until Device Meets Full Specifications.		1.5		µs
Enable Input Bias Current	ENBL at 5 V		27		µA
	ENBL at 0 V		32		nA

Parameter	Conditions	Min	Typ	Max	Unit
f = 70 MHz					
Gain	Maximum Gain		+42.5		dB
	Minimum Gain		–3.7		dB
Gain Scaling Factor			19.9		mV/dB
Gain Intercept			–5.6		dB
Noise Figure	Maximum Gain		6.2		dB
Output IP3	f1 = 70 MHz, f2 = 71 MHz, V_{GAIN} = 0.5 V		27.5		dBm
			20.5		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.5		dBm
			1.5		dBV rms
f = 140 MHz					
Gain	Maximum Gain		+43.5		dB
	Minimum Gain		–3.6		dB
Gain Scaling Factor			19.7		mV/dB
Gain Intercept			–5.3		dB
Noise Figure	Maximum Gain		7.4		dB
Output IP3	f1 = 140 MHz, f2 = 141 MHz, V_{GAIN} = 0.5 V		24.5		dBm
			17.5		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.4		dBm
			1.4		dBV rms
f = 190 MHz					
Gain	Maximum Gain		+43.5		dB
	Minimum Gain		–3.8		dB
Gain Scaling Factor			19.6		mV/dB
Gain Intercept			–5.3		dB
Noise Figure	Maximum Gain		7.5		dB
Output IP3	f1 = 190 MHz, f2 = 191 MHz, V_{GAIN} = 0.5 V		23.9		dBm
			16.9		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.4		dBm
			1.4		dBV rms
f = 240 MHz					
Gain	Maximum Gain		+43		dB
	Minimum Gain		–4.1		dB
Gain Scaling Factor			19.7		mV/dB
Gain Intercept			–5.2		dB
Noise Figure	Maximum Gain		7.6		dB
Output IP3	f1 = 240 MHz, f2 = 241 MHz, V_{GAIN} = 0.5 V		24.6		dBm
			17.6		dBV rms
Output 1 dB Compression Point	V_{GAIN} = 0.5 V		8.1		dBm
			1.1		dBV rms

NOTES
[1]The output dc centering voltage is normally set at $V_S/2$ and can be adjusted by applying a voltage to DECL.

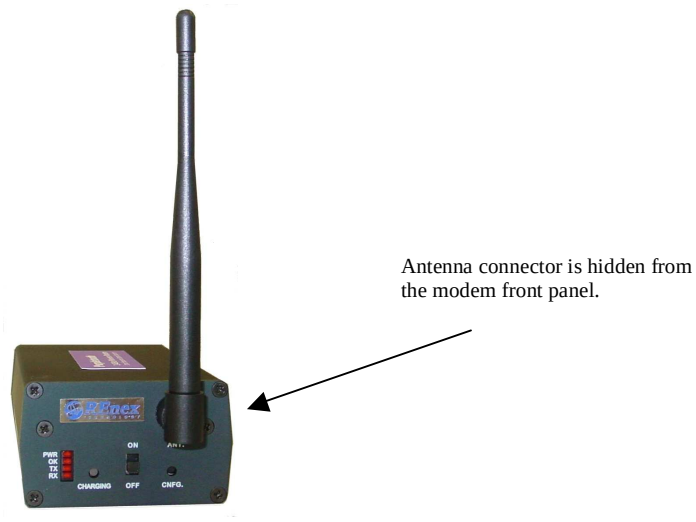
Specifications subject to change without notice.

2.4 Power Supply and Battery Charging Unit

This unit provides all the necessary supply voltages to the modem system from a single 7.4V supply from a DC adaptor or a rechargeable battery. The voltage sources provided include: 3.3V for digital, baseband and RF units; +5V and –5V for the baseband unit. On the other hand, a battery charging circuit employing charger IC, LT1510 from Linear, is installed to provide a battery supply and recharge option for users.

3 Antenna Descriptions

Three antenna options are provided in PT-209G package. These antennae are connected to the modem PCB via a standard SMA connector. However, the connection part is hidden by the front panel of the modem (indicated in the photo below) so that the connected antenna can only be detached from the modem by disassembling the modem casing and internal mechanical structure. Hence, the PT-209G modem is an integral antenna design.



The antenna specifications are tabulated as follows:

3.1 Model: RO-IK-0504

Electrical Item	Specifications	Remarks
Type of antenna	Dipole antenna	
Frequency range	2.40 ~ 2.48 GHz	
Electrical length	1 / 2 λ	
Nominal impedance	50 Ohm	
Polarization	Vertical	
V.S.W.R	Less than 2.0	
Peak gain	1.5 dBi	
Mechanical Item	**Specifications**	**Remarks**
Element	RG-316 cable	
Sleeve	Urethane	Black
Base	Nylon 66	Black
Connector	SMA male	Ni plate
Antenna total length	168 ± 3 mm	

3.2 Model: TQC-2400AIP

Electrical Item	Specifications
Type of antenna	Magnet mount antenna
Frequency range	2.400 ~ 2.483 GHz
Nominal impedance	50 Ohm
Polarization	Vertical
V.S.W.R.	Less than 1.5
Gain	7 dBi
Mechanical Item	**Specifications**

Length	300 mm
Mount	90 mm diameter magnet
Cable	300 mm
Connector	SMA male

* Manufacturer: Kenbotong Communication Ltd.

3.3 Model: HTQ-2.4-10

Electrical Item	**Specifications**
Type of antenna	Omni-directional antenna
Frequency range	2.400 ~ 2.500 GHz
Nominal impedance	50 Ohm
Polarization	Vertical
V.S.W.R	Less than 1.4
Gain	10 dBi
Mechanical Item	**Specifications**
Length	824 mm
Diameter	ϕ20 mm
Cable	500 mm
Connector	SMA male