Murandi
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Innovative Radio Frequency Solutions

MLink Functional Circuit Description

Revision – Rev 2

Apr 30, 2014

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1 Revision History

Revision	Date	Description
Draft	Feb 10, 2014	Initial Draft
Rev 1	Feb 27, 2014	Added additional information regarding the TX power control.
Rev 2	Apr 30, 2014	Minor correction to frequency hopping description

The details of each revision are captured in Revision Details Section 6.

2 Abbreviations

Abbreviation	Description
Attn	attenuator
BW	bandwidth
dB	decibel
dBc	decibel relative to carrier power
dBi	decibel relative to an isotropic antenna
dBm	decibel relative to 1 milliwatt
FCC	federal communications commission
GPS	global positioning system
IC	Industry Canada
ISM	industrial, scientific and medical
ISR	interrupt service routine
kHz	kilohertz
LCD	liquid crystal display
LED	light emitting diode
LFSR	linear feedback shift register
LNA	low noise amplifier
mA	milliampere
mcd	millicandle
MHz	mega-hertz
mm	millimeter
msec	millisecond
mV	millivolt
PA	power amplifier
PLL	phase locked loop
ppm	parts per million
RBW	resolution bandwidth

Abbreviation	Description
RF	radio frequency
RTC	Real time clock
TBC	to be confirmed
TBD	to be determined
TRP	total radiated power
µA	microampere
TDD	Time division duplex
UART	universal asynchronous receiver/transmitter
V	volts
W	width

3 Reference Documents

1. MLink Block Diagrams – Draft, Feb 10, 2014
2. Schematics (MLINK – Rev 3.pdf)
3. Bill of Materials (MLINK – Rev 3.bom)
4. Pictures (IMG_1673.jpg, IMG_1677.jpg, IMG_1680.jpg, IMG_1682.jpg, IMG_1684.jpg, & IMG_1695.jpg)

4 Introduction

This document contains high level functional description for the Murandi Communications MLink 900 MHz transceiver as part of the FCC & IC submission.

5 Functional Description

MLink 900 is an ultra low energy efficiency, long range, half duplex transceiver operating in the 900 MHz ISM band utilizing frequency hopping with GFSK modulation.

MLink 900 can be broken down into four sub modules: ISM RF Deck (including integral antenna), GPS module (including integral antenna), Digital and Power Supply. These are shown in figure 5.1.1 of the block diagrams (Ref 1).

The ISM RF Deck can be further broken down into the following key sub modules: TX Chain (PA), RX Chain (RX RF Front End Filter, LNA, RX RF Band Pass Filter, & Attn) and common modules (Transceiver (Analog Devices ADF7023), TR Switch, & Front End Filter). Please see Figure 5.2.1 of the block diagrams (Ref 1).

Coordination of the operation of MLink 900 (radio link, power management, peripheral interface) is handled by the Firmware running on the microprocessor in the digital module. For the radio link in particular, in RX mode, the TR Switch is configured to the RX Chain where the LNA and Attn are adjusted to optimize the RF signal level into the Transceiver IC. The Transceiver IC down converts the RF signal to a 400 kHz IF and then FM demodulates it. In TX mode the Transceiver IC directly up converts the baseband signal to RF. After which the RF signal is amplified to the calibrated power by the PA, conducted through the TR switch (which is configured to the TX chain), and finally, low pass filtered before radiating from the integral antenna. Power (3VX) for the PA is provided by the regulator captured in figure 5.4.1 of the block diagrams (Ref 1). Similarly power (Vmain) for Transceiver IC incorporates several internal low drop out regulators. Furthermore to ensure that emissions are controlled, all interface lines (including power supply lines) are decoupled/filtered as they enter/exit the RF shielded area.

The RF output power is controllable in 1 dB steps over a minimum 12 dB dynamic range with a maximum conducted power up to 29 dBm. The maximum output power is limited by the saturated RF power of the PA (Ref 1 – Figure 5.2.1). Two parameters are used to control the RF output power over the dynamic range:

- Fine Control - the RF output level from the Transceiver IC (Ref 1 – Figure 5.2.1) is programmable in 0.5 dB steps
- Course Control - the bias voltage to the PA (Ref 1 – Figure 5.2.1) is controllable in 7 steps. In order to conserve energy in strong link margin environments the PA bias is reduced, reducing both the RF output power of the PA and its energy consumption.

An automated test fixture (ATE) is used to calibrate “Fine” and “Course” controls to obtain the desired RF output power level over the full dynamic range, up to maximum saturated output power.

For frequency hopping operation the 902 to 928 MHz band is divided into 288 channels with 90 kHz separation. The top 8 channels and bottom 8 channels are not used to avoid the edges of the 902 to 928 MHz band, and a few channels are avoided due to interference concerns, leaving a minimum of 249 channels. Using these 249 channels multiple approximately orthogonal pseudorandom hopping sequences are implemented each using 53 - 63 non overlapping channels. The pseudorandom sequences are generated using a LFSR polynomial which guarantees that no frequency is repeated twice within the sequence. The fastest hopping rate is 5 Hz maximum with a dwell time of 0.4 ms maximum on any one channel in a 20 second period.

For the GPS module, the GPS RF signal is received by the integral GPS antenna, band pass filtered and then input to the GPS IC (Skytraq Venus638FLPx-L) where is it decoded, generating location data and a once per second signal (P1PPS).

6 Revisions