OMESH Networks

OPM15 Application Note: Antenna Configuration

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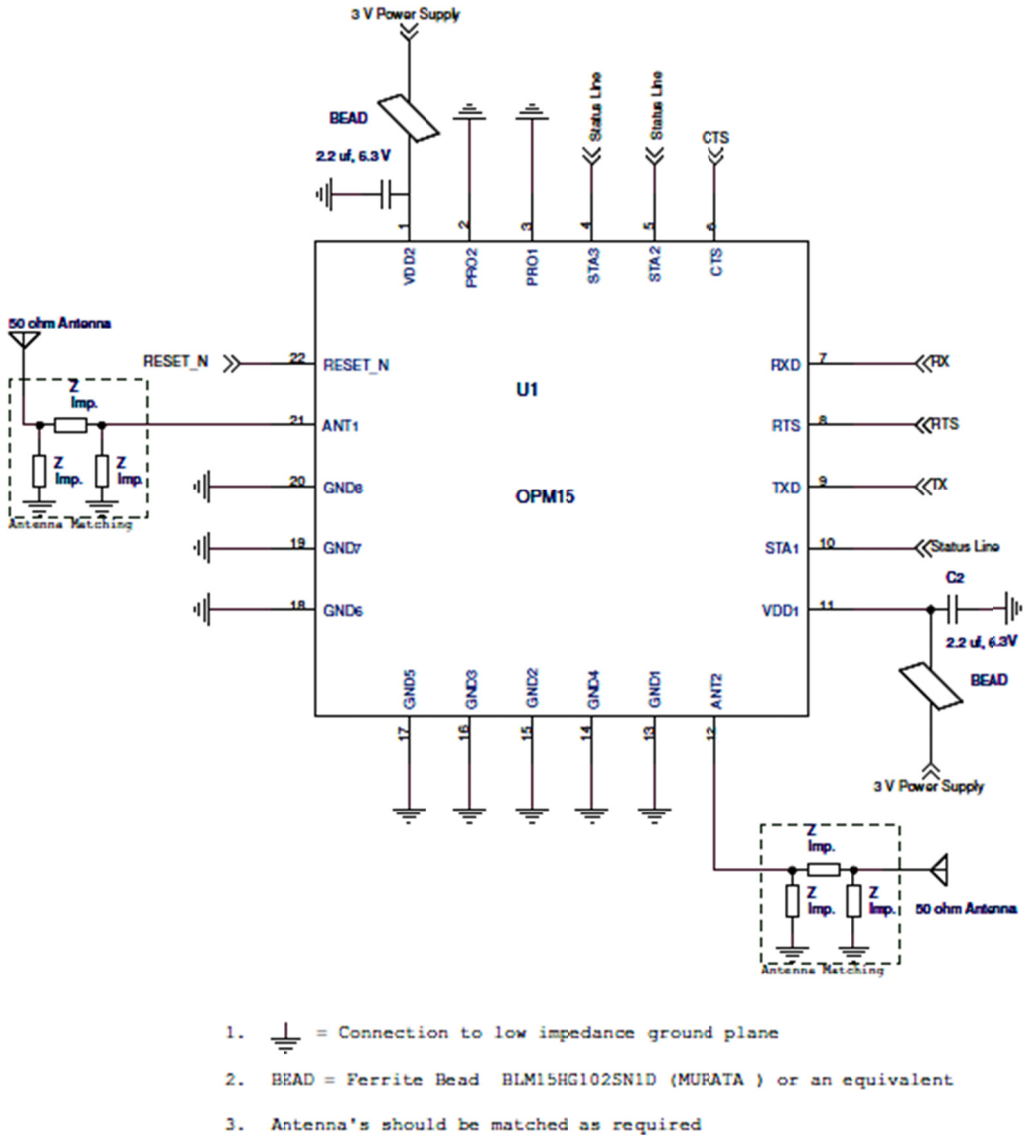
1.0 Introduction

OPM15 is a large-scale cognitive wireless networking module, providing great flexibility for a wide range of applications. Powered by the OPM optimized radio design and networking stack, the result is a fully integrated module providing a complete system for dynamic wireless networking for real-time and high-performance communications. The module has the following attributes: 1) dynamic drop-and-play (supporting station mobility); 2) real-time communications over unlimited number of wireless hops; 3) low power consumption and small footprint; 4) compatible with the 802.15.4 standard; 5) tolerant of interference in unlicensed spectrum.

This document describes the antenna configuration and calibration of OPM15 radio.



1. ⏚ = Connection to low impedance ground plane
2. BEAD = Ferrite Bead BLM15HG102SN1D (MURATA) or an equivalent
3. Antenna's should be matched as required

Figure 1 – Typical Application of OPM15-E Radio

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2.0 Antenna Configuration of OPM15

OPM15 radio has two antenna ports: ANT1 and ANT2. In the radio operation, one antenna is used for data transmission; the other antenna is for controlling and spectrum sensing. The radio uses this special architecture to realize opportunistic spectrum selection at millisecond level, and opportunistic routing at per-packet level. It is recommended to use the same antenna part for both ANT1 and ANT2.

Application design shall aim to maximize the separation between the two antennas in configuration, so as to minimize the mutual interference between ANT1 and ANT2. This will also help to increase the link budget of a single-hop transmission, i.e., the range of single hop. The antenna separation can be identified by feeding a signal with certain power level to one antenna, and reading the coupling power level of the same signal on the other antenna. The power-level difference is the antenna separation.

In OPM15 radio calibration (e.g., when the radio is powered on) [1], the calibration process physically measures radio noise floor and the two-antenna separation. The measurements are used for configuring radio parameters in OPM15 operations. Therefore, the radio shall be re-calibrated if its antenna configuration is changed. The calibration also maximizes the effective range of the radio in any specific antenna configuration.

For example, by using dipole 2.4GHz antennas with OPM15-E Carrier Board, the following shows the best and the worst configurations in terms of antenna separation.

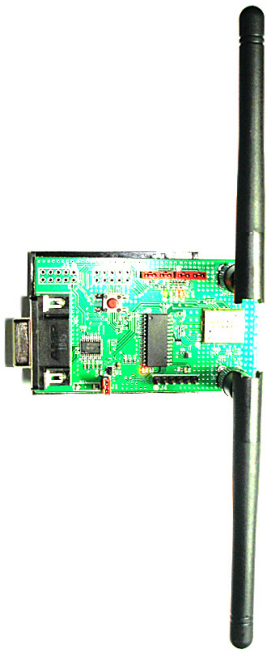

Figure 2– Best Dipole-Antenna Configuration for OPM15-E Carrier Board

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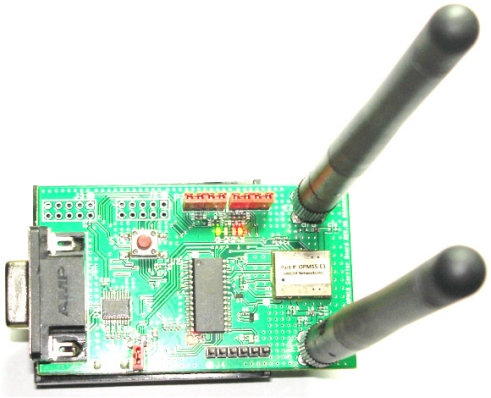

Figure 3– Worst Dipole-Antenna Configuration for OPM15-E Carrier Board

Particularly in the above figures, the best configuration represents about 30dB space separation between ANT1 and ANT2; and the worst configuration represents about 10dB separation. And this translates to around 10dB [(30-20)/2] difference in single-hop link budget, after radio calibration and optimization. Any more distance or metallic shield between the two antennas can further improve the separation. For OPM15-E radio, the single-hop link-budget can improve with higher antenna separation by a halved ratio in dB, up to a maximal 35dB separation between ANT1 and ANT2.

3.0 Antenna Separation and Calibration Data

The antenna separation can also be approximately determined by radio calibration data, without direct measurement on a spectrum analyzer. The calibration data is defined in [1]:

> BYTE 0: Noise Floor in dBm
> BYTE 1-16: RSSI in dBm on data radio when the second radio is transmitting on {5,3,1,-1,-2,-3,-4,-6,-8,-10,-12,-14,-16,-18,-20,-22} dBm

In the bytes 1-16, locate the largest signed number less than or equal to 0xdc. If the index of this number (now named as Separation Index) is 16 (at the end of the array), the antenna separation is about 10dB. If the Separation Index is less than 16, locate the corresponding transmitting power in the array on {5,3,1,-1,-2,-3,-4,-6,-8,-10,-12,-14,-16,-18,-20,-22} dBm. The difference between the corresponding power and -22dBm, plus 10dB is the antenna separation.

For example, a typical calibration data of the configuration in Figure 2 is: {0x96 0xe2 0xe0 0xde 0xdc 0xdc 0xdc 0xdb 0xd9 0xd8 0xd6 0xd4 0xd2 0xd0 0xce 0xcc 0xca}, which represents about 30dB antenna separation.

A typical calibration data of the configuration in Figure 3 is: {0x96 0xf9 0xf6 0xf4 0xf2 0xf1 0xef 0xed 0xeb 0xea 0xe8 0xe5 0xe3 0xe1 0xdf 0xde 0xdc}, which represents about 10dB antenna separation.

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The calibration data for API 3.1.0 is a little different than API 3.2.0. The Separation Index in 3.1.0 is located by the noise floor plus two. For example, if the calibration data is {0x96 0x9A 0x9B 0x9C 0x9C 0x9B 0x9B 0x9A 0x9A 0x9A 0x9A 0x99 0x99 0x98 0x97 0x97 0x97}, the Separation Index can be determined by the index of 0x98 which represents -16dBm in the transmitting power array. Therefore, the antenna separation is about 16dB (22-16+10).

4.0 Antenna Configuration Reference Designs

OMESH Networks has designed numerous antenna configurations as references to your application, including for example ceramic chip antennas (Digikey Part #553-1674-2-ND).

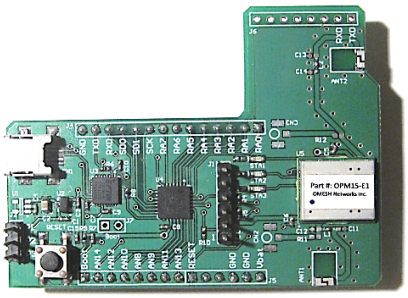

Figure 4–OPM15-E Chip Antenna Reference Design

5.0 References

[1] OMESH Networks, “OPM15 Software API Guide”, version 3.2.0, available from **http://www.omeshnet.com/omesh**, Oct 10, 2011.

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