Introduction

360°RF has been retained to perform a design review and electrical/RF testing of a proposed Zigbee module, shown to the right. This report presents our conclusions and suggested modifications to the proposed design.

Occupied Bandwidth

The -40 dB bandwidth is just under 10 MHz, as shown in the plot on the next page. There may be issues with the FCC if the planned channel assignments are within 5 MHz of the band edges; i.e., the center of the channel should not be below 2407 MHz or above 2477 MHz, unless the duty cycle is kept very short.

The VCO did not show any unusual sidebands or spurs.

Duty Cycle

The FCC compliance lab will look at the unit duty cycle for both a Screamer and a typical unit. The data packets were 1.5 mS long. The Screamer generated 9 packets 1.5 mS long during a 39.3 mS period. This gives a duty cycle for the Screamer of 13.5/39.3 or approximately 34%. These measurements are shown on plots on the following pages.

Harmonics

Between 100 MHz and 18 GHz, no unusual emissions were detected; the second harmonic was virtually undetectable. This is quite unusual for the typical 2.4 GHz product. All harmonics up through the 6^{th} were at least -59 dBc.

Antenna

This product has an unusually well-done antenna design compared to typical 2.4 GHz products. The antenna is an 'Inverted F' with artwork on both the top and bottom layers of the PC board. Placing copper on both the top and bottom layers greatly reduces the dielectric effects of the fiberglass. Thus, variations in the E_r (dielectric constant of the PCB material) will have little effect on the tuning of the antenna.

Both the lengths of the F, and the matching section, were adjusted. Improvements, if any, were just a few tens of a dB, and well within measurement uncertainties. The antenna is on frequency and impedance-matched; no change to the antenna is necessary.

Effect of Plastic Housing

The plastic used is quite transparent to 2.4 GHz and the antenna has enough separation from the housing that there was no dielectric effect on the antenna tuning. There is no significant effect of this plastic to the 2.4 GHz signals. See the photos on the last page.

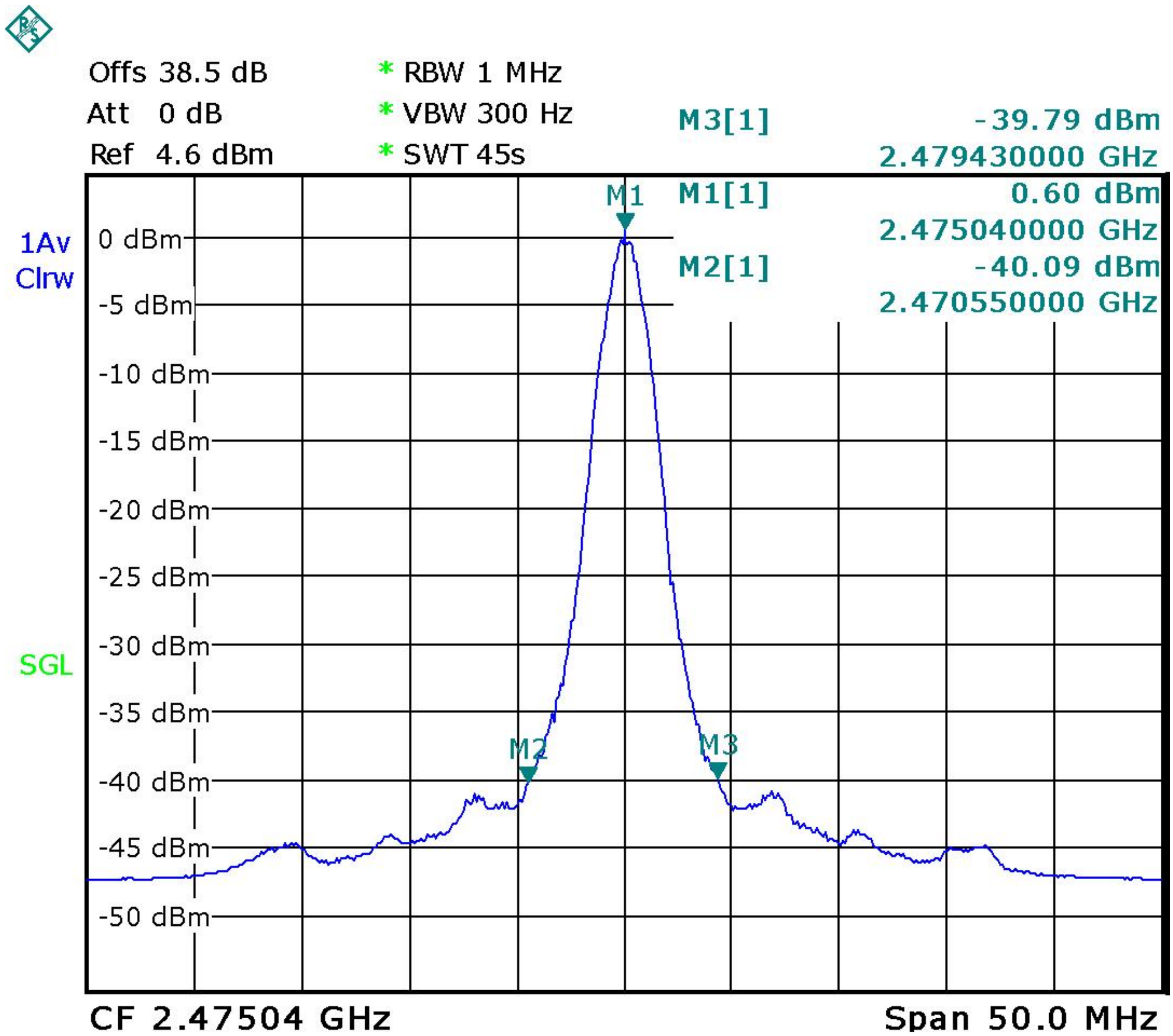
Conclusions

Unlike most 2.4 GHz products that we have tested, this one appears to have been exceptionally well designed and implemented.

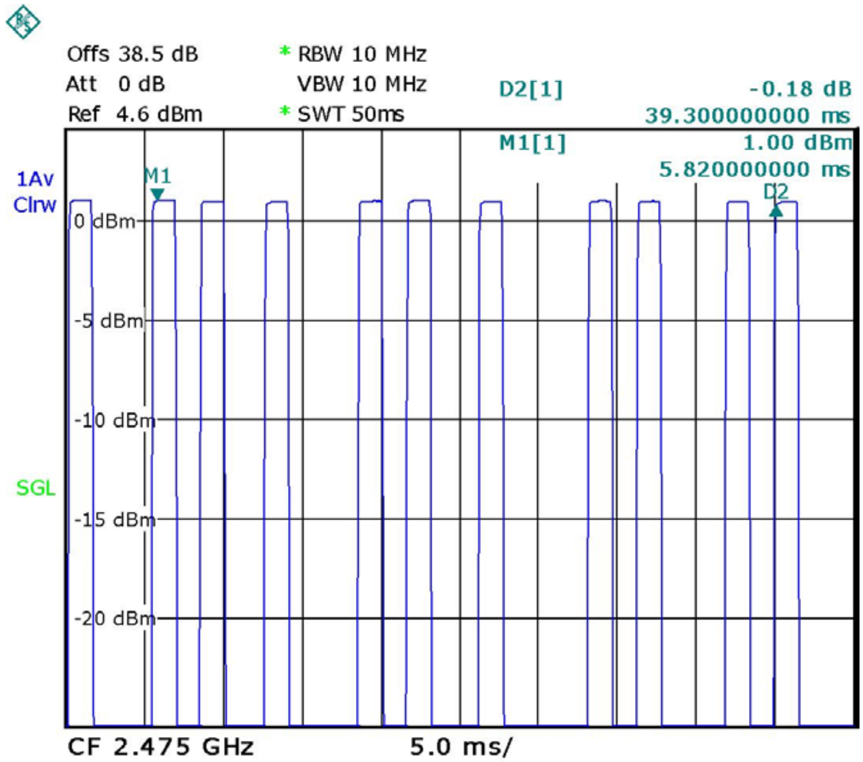
A question was raised whether, in the future, the output trace of the transmitter could be “bent” at right angles so as to facilitate addition of a power amplifier (PA) or external antenna connector, and selecting the existing F antenna or the optional PA/antenna connector using a zero-ohm resistor. The answer is yes, this should present minimal risk to the existing design. Either a zero-ohm resistor or a chip capacitor in the range of 100 to 500 picofarad can be used for this purpose. However, we should caution here that addition of a PA may completely change the emissions of the unit including the radiation pattern of the antenna. Addition of the antenna connector should not affect emissions but may change the present radiation pattern and/or radiated field strength.

Due to the lack of any measurable spurious emissions or harmonic radiation of the present design, we also do not feel that a shield will be necessary but final testing by the FCC compliance laboratory will show whether that is, indeed, the case. Thus, we recommend keeping the shield available but at this time, do not feel it will be needed.

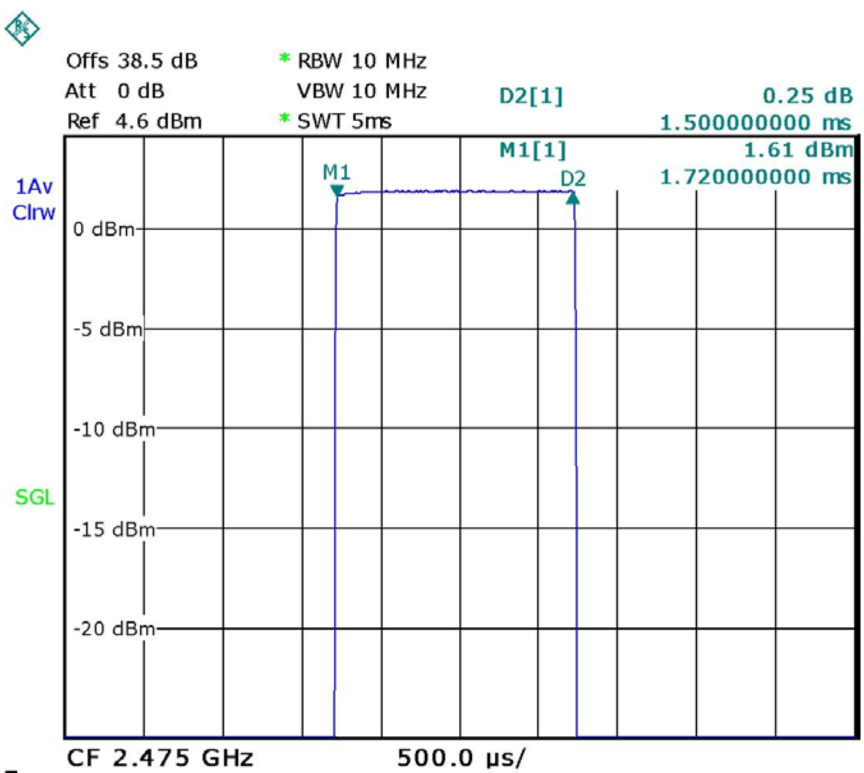
This product appears to be ready for compliance testing.

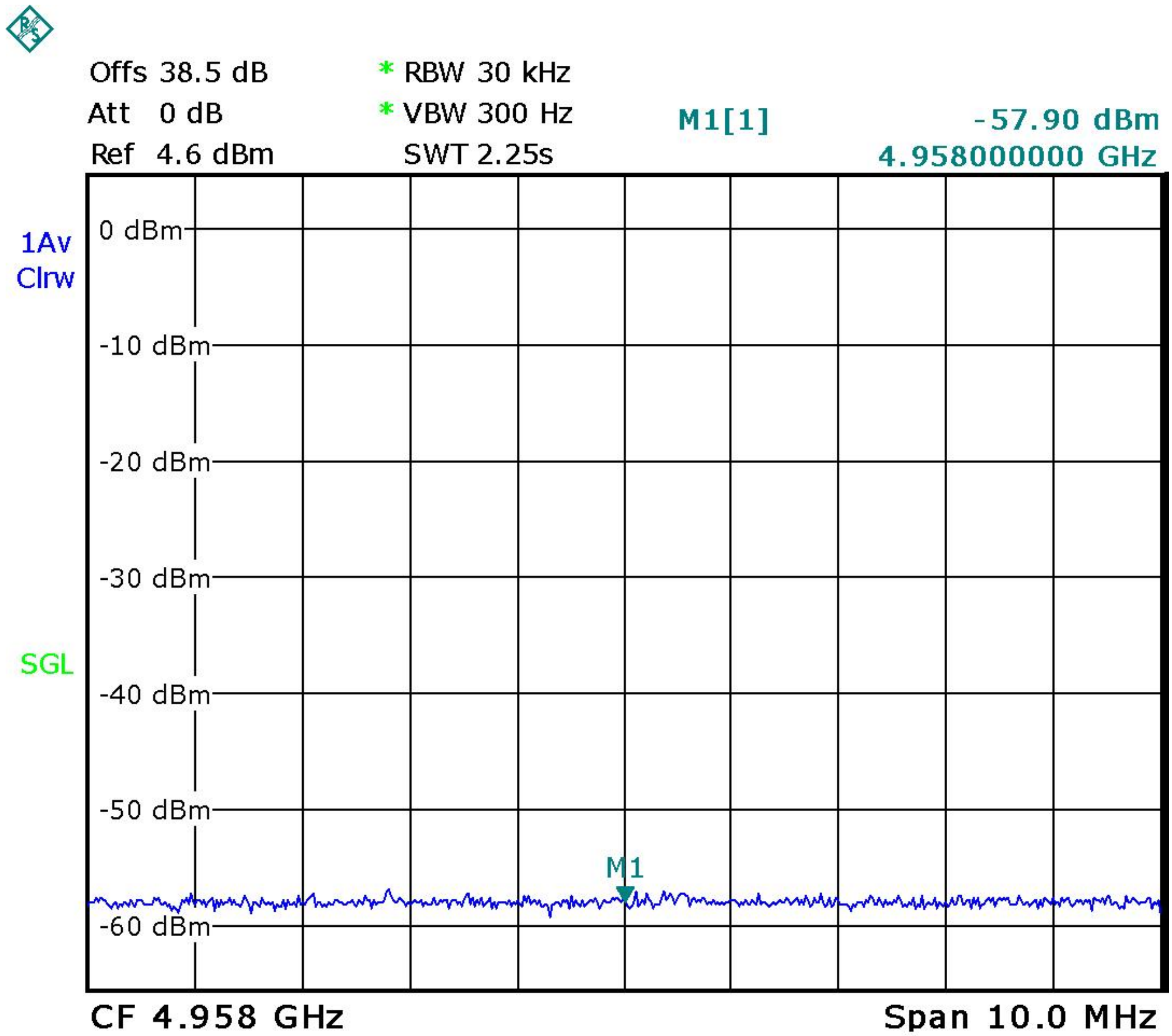


Plot of Occupied Bandwidth. The signal is just under 10 MHz wide at the - 40 dB points. Note that there are no obvious VCO artifacts such as sidebands or spurious emissions.

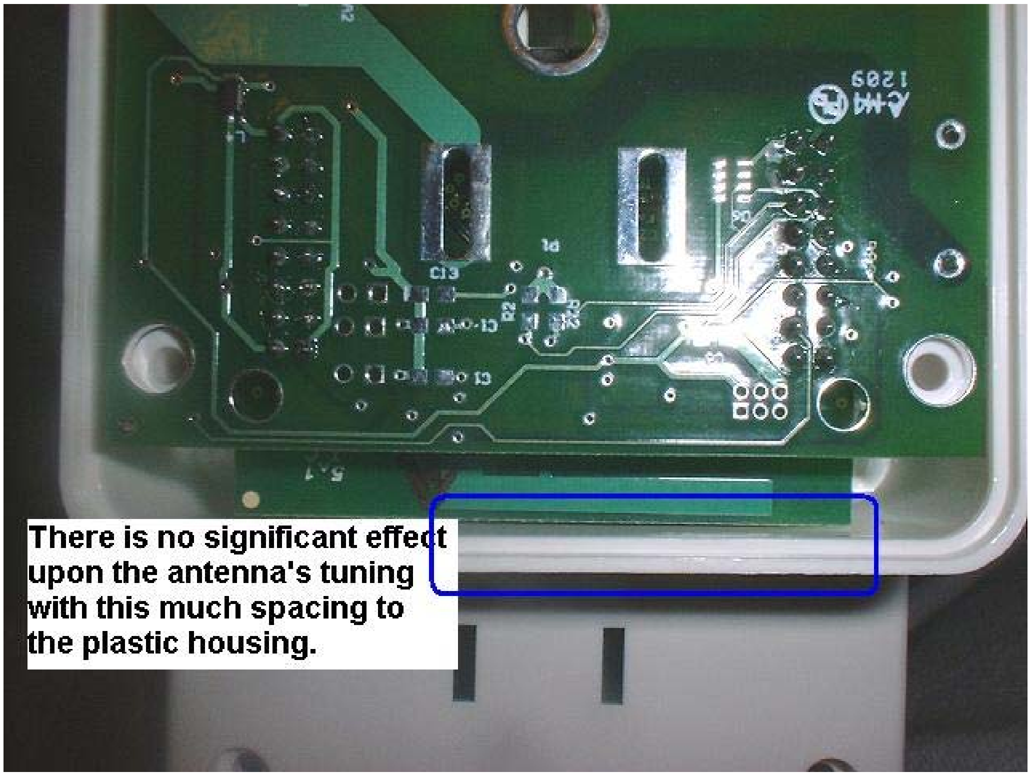


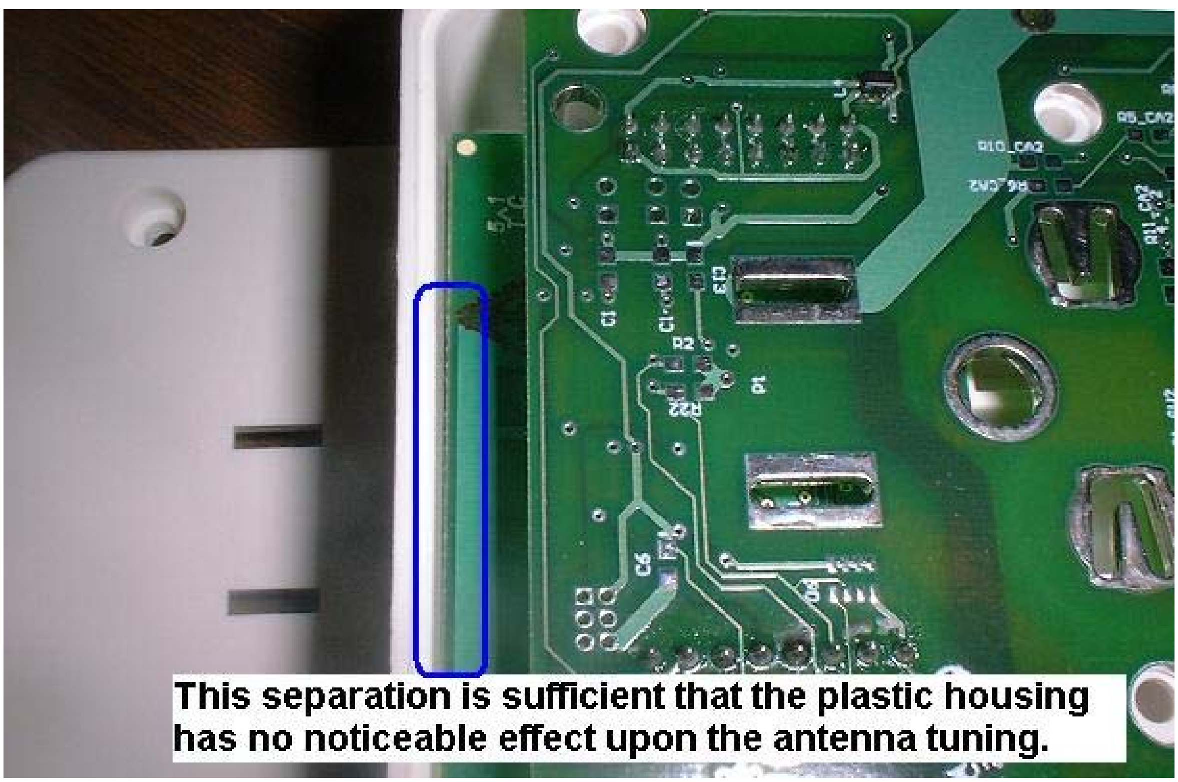
The plot above shows the time period for 9 packets to be about 39.3 milliseconds, while the plot below shows the pulsewidth of a packet to be about 1.5 milliseconds. Thus, the calculated duty cycle of the Screamer is about 34%.





The second harmonic is at least -57.9 dB down from the fundamental average level.


There is no significant effect upon the antenna's tuning with this much spacing to the plastic housing.


This separation is sufficient that the plastic housing has no noticeable effect upon the antenna tuning.