MN3310 Design Guidelines

micro modular technologies

1 Introduction

This document contains important technical information, design notes and helpful hints to assist the designer in achieving first time success in bringing up a design using the MN3310 GPS Receiver module. It contains design examples and suggestions on a wide variety of topics, including power supply connections, RF interface, shielding and filtering requirements, antenna considerations and other important subjects.

2 Power Supply

The MN3310 GPS Receiver Module is designed to operate from a single 3V power supply. Either a switching power supply or a linear supply can be used to provide the 3V power. Sufficient decoupling on the power supply is necessary to ensure good performance. It is recommended that the 3V power supply be filtered by 10uF tantalum capacitor. The decoupling capacitor should be placed as close as possible to the module's power supply pin.

If a switching power supply is used, it may be necessary to increase the value of the tantalum capacitor to eliminate switching power supply ripple.

It should be noted that the DC supply must be clean. If there is any coupled AC noise (particularly centered around L1), it is carried directly into the input of the MN3310 and could reduce the sensitivity.

2.1 Ground Plane

To ensure optimal RF performance, the user should provide a solid ground plane underneath the module. Sufficient via holes on the ground plane should be used to connect the ground plane on the top side to the board ground plane.

The module does not use separate grounding for RF, power and digital signals. It is NOT recommended that the user split the ground plane connecting the module to the power supply. This is because the user may introduce unwanted ground loops if separate RF ground and power ground is used.

3 Sleep Mode

The standard software does support a software-based sleep mode. The receiver is placed into sleep mode by issuing the NMEA sleep command (please refer to the Orion NMEA manual). All navigation processes are stopped, the RF circuit is put into a low power state, and the baseband processor is halted. The current consumption of the MN3310 will drop to approximately 2 mA exclusive of any current being drawn on the antenna port.

The MN3310 will awaken from sleep mode whenever a transition occurs on the RX0 or RX1 input pin. Thus it is possible to send a NMEA command to waken the MN3310, but as the first character is lost (the first transition is actually lost to the software), the receiver will awaken, but not respond to the command.

4 RF Interface

The MN3310 GPS Receiver Module accepts a standard L1 GPS C/A code signal (from a passive or active antenna) on the RF Input pad of the module. In addition the RF Input provides a DC path to the V_ANT pin. If using a passive antenna, the antenna must appear as a DC open. If not, the V_ANT pin should be grounded.

Using the MN3310 GPS Receiver with an active antenna requires special precautions. If the active antenna has high gain and is placed close to the MN3310, then excessive RF gain could cause oscillation between the antenna and the MN3310. This can be prevented by making sure the MN3310 is well shielded from the active antenna. In addition, a DC block and simple Pi-pad attenuator in the RF line would reduce the gain. Power can be restored to the active antenna by using a 68nH inductor from +3 volts to the antenna line. This inductor must be well bypassed on the DC supply side with at least a 27pF capacitor to ground.

5 Shielding and Filtering Requirements

The MN3310 is designed to receive a GPS signal that can be as low as -150dBm. Any source of interference near the frequency of the GPS signal could potentially jam the MN3310 and disrupt reception of the signal.

For proper system design, the GPS antenna needs to be shielded from any potential jamming source. For that reason, in most designs it makes more sense to shield the digital portion of the product rather than the RF portion. This keeps the digital noise from radiating into the antenna and/or antenna feed lines.

It is important to note that the GPS signal level is well below any regulatory emissions requirement for EMI and EMC. Thus, while a product meets FCC class B or CISPR 22, it is possible that the emissions from the product will still seriously impact the MN3310 performance.

Excessive interference into the MN3310 via the antenna can result in low to very low reported C/Nos of the satellite signals and subsequent excessive TTFF times. Assuming an 18mm square patch antenna with good LNA, the reported C/Nos should be in the high 40s and low 50s. If the values are below this, then interference should be considered a problem and resolved. This can also be checked by substituting an external active antenna and moving it closer to and away from the device and noting the change in reported C/Nos. If any improvement in signal is noted as the external antenna is moved away from the device, then additional shielding of the digital electronics is required.

If the product contains an RF transmitter, then care must be taken to prevent overloading the front end of the MN3310 if simultaneous operation is required. This overloading can come from several sources.

First, the input LNA of the MN3310 does not have a preselect filter and is fairly broad band. If for example a GSM transmitter is located nearby, then the GSM signal could overload the LNA. The output of the LNA is going to be proportional to its input, and if the GSM signal dominates, the GPS signal will be attenuated and sensitivity of the receiver will be reduced. The OEM designer would need to design suitable input filtering to the MN3310 to protect in this case.

A second case occurs in the collocated transmitter. The power amplifier has both a gain and a noise figure. If we take an example of a power amp noise figure of 15dB and 30dB of gain, this would mean that the power amp radiates broadband noise approximately 45dB above thermal noise. This means the power amp alone could present a noise source in the GPS band of -129dBm. While this would easily meet any regulatory emissions requirements, it would render the GPS receiver inoperative. In this case, a suitable filter must be placed on the output of the power amplifier of the collocated transmitter to avoid this case.

6 Layout Considerations

In order to get the optimal performance from the MN3310 GPS receiver module there are a few points that the user should note when designing the layout.

6.1 Solid Ground Plane

It is necessary to provide a solid ground plane below the module. The liberal use of vias to connect the top layer ground plane to the bottom layer and internal layers ground plane is necessary to ensure a sold RF ground. The module uses the same ground for power supply, digital and RF signals. Hence, the user should not attempt to split the ground plane.

6.2 Decoupling capacitors for power supply

A decoupling capacitor should be placed as close as possible to the VCC pin of the MN3310 GPS receiver module. The recommended value is 10uF.

6.3 Position of vias

As a word of caution, it is advisable to not place vias between pads or too near the pads as this creates a possibility of a short circuit during soldering.

7 GPS Antenna Selection

Currently there are several types of GPS antennas available for the user to choose from. Each type of antenna has both advantages and disadvantages which need to be carefully weighed in making a selection. In addition, most antenna types are available in both an active (includes built-in LNA) and passive versions.

When selecting the antenna it is important both to consider the characteristics of the GPS signal itself along with the characteristics of the antenna. The GPS signal is broadcast at 1.57542GHz and is received from all visible GPS satellites. The receiver needs a minimum of four signals to compute a 3D position. Ideally, the antenna should have an unrestricted view of the sky. Certain locations may limit the visibility of the sky, such as being close to a building, etc, so it is important that the product in which the antenna is installed does not further limit satellite visibility.

The GPS signal is also right-hand circularly polarized (RHCP), so best results are achieved under most conditions with a right-hand circularly polarized antenna. Under severe obscuration where multipath signal reflections are present, a linearly polarized antenna may give better results under the assumption that a reflected signal is better than no signal.

Antennas are specified by antenna type, antenna gain, antenna pattern, polarization and axial ratio. Antenna gain is typically considered to be the ratio of the signal level received by the antenna under consideration at zenith as compared to a theoretical isotropic radiator (equal signal level in all directions). The gain is measured in dBi (for a linearly polarized antenna) or dBic (for a circularly polarized antenna). The gain of an antenna will vary depending upon elevation and azimuth of the signal source with respect to the antenna. Graphically plotting this variation shows a visual presentation of the antenna pattern. The axial ratio of an antenna is a measure of the quality of its polarization. An axial ratio of 1 is perfect circular polarization, an infinite axial ratio is perfectly linear polarization.

7.1 Patch Antennas

Patch antennas are typically square or round ceramic elements with metallic plating on both sides (see Figure 1), the top being the metallic antenna element and the bottom being the ground plane.

Figure 1 – Typical patch antenna

If a patch antenna is selected, it is important that it be oriented such that the top surface of the antenna is horizontal with respect to the surface of the earth. Tilting the antenna away from the horizontal will result in an artificial obscuration of potentially visible satellites.

While patch antennas are low cost and can provide good gain, it is important that the patch antenna be used with a proper ground plane. The antenna vendor can provide assistance in this area. In addition, patch antennas are detuned by the presence of any object within its near field, such as a plastic cover. The antenna vendor can tune the antenna to compensate for this detuning.

7.2 Helix Antennas

Helix antennas are usually spirally wound onto a tubular ceramic piece (see Figure 2). For best performance, the helix antenna needs to be vertical with respect to the surface of the earth. Helix antennas do not require a ground plane, but may work better with one.

Figure 2 – Sarantel helix antenna (cover removed)

7.3 Chip Antennas

Chip antennas (Figure 3) are the smallest antennas available for GPS and are quite popular in small handhelds. However, chip antennas are linearly polarized making them more receptive to multipath signals which would degrade the computed position in some cases. Chip antennas also have very specific ground plane requirements. The antenna vendor can provide assistance in this area and can possibly tune the antenna for a specific application.

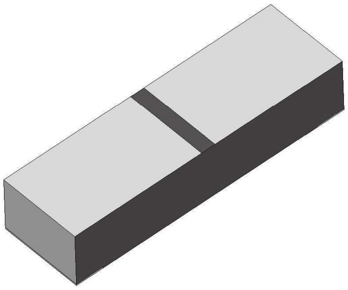

Figure 3 – Chip Antenna

8 Notices

All reference and informational documents (including marketing information, specifications, reference designs, etc.) are provided for information only and are subject to change without notice. Reasonable efforts have been made in the preparation of these documents to assure their accuracy, however Micro Modular Technologies Pte. Ltd. assumes no liability resulting from errors or omissions in these, or any document, or from the use of the information contained herein. Micro Modular Technologies Pte. Ltd. reserves the right to make changes in the product design and specifications as needed and without notification to its users. Please check our website for the most current documentation. All information contained herein is the property of Micro Modular Technologies Pte Ltd. and may not be copied or reproduced, other than for your information, without prior written consent.

9 Contact Information

Corporate Headquarters
Micro Modular Technologies Pte. Ltd.
No. 3, Ubi Avenue 3, #05-01
Crocodile House, Singapore 408857

Tel: (65) 6745 8832
Fax: (65) 6293 0661
Email: sales@micro-modular.com

Americas and Europe
Micro Modular Technologies Americas
14720 Creekside Lane
Longmont, CO 80503, U.S.A.

Tel: (1) 303-482-2842
Fax: (1) 303-339-0398
Email: sales@micro-modular.com

For a list of Regional Sales Representatives,
please see our web page:
www.micro-modular.com

Document no: MN3310_DG_080205