Antenna Application Note for AarLogic GPS 3 family

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1 Antenna types

1.1 Passive Antennas

Ceramic antenna patch. Gain <= 3dBi. Long cold start time (TTFF). No energy for antenna LNA needed. Between antenna and receiver must be SAW to filter non GPS-signals if the application also uses cellular communication (GSM, etc.). The the usage of low insertion loss SAW between antenna patch and GPS module is recommended.

Obviously there is no energy respectively power supply for the antenna needed, because there is no amplifier.

1.2 I-Stage Active Antennas

Ceramic patch antenna with up to 3dBi gain, LNA (low noice amplifier) with up to 18dBi Gain, SAW filter included. Design normally only used for internal antennas. These antennas need a power supply. The typically voltage range is 2.7-5V. As higher the voltage as higher the gain but also the noise figure (affects SNR).

Exemplary products:

- ANT-NXG31113 (internal antenna)

1.3 II-Stage Active Antennas

Ceramic patch antenna with up to 3dBi gain, 2 LNA, SAW filter included. Design used for internal as well as external antennas used.

Antenna gain up to 28 dBi. When used in external antennas, the system gain applies considering loss of SAW, cable & connectors. For example: System gain of external GPS antennas by Round Solutions <= 24dBi

Exemplary products:

- ANT-NXG354 (internal antenna)
- ANT-NXM652 (external antenna, magnetic mount)
- ANT-GNR600 (Cellular&GPS external antenna for roof mount)

2 Applications

2.1 Lowest power consumption

Typical application: small personal trackers with very long battery running time.

AarLogic GPS 3M + passive SAW filter + Passive GPS antenna on PCB. Theoretical maximum gain of th antenna patch: 5dBi. Maximum gain in real world: 3.5dBi. Realistic gain: <3dBi. It applies the rule: As smaller the antenna as smaller its gain.

Please take care of the position and alignment of the passive GPS antennas in your device, because this strongly affects the gain. Optimal alignment: 90 degrees view to satellite (satellite direct above antenna).

The antenna will be placed onto the PCB connected to the GPS receiver by a 50Ω-micro-stripe-line. Most important is a sufficient ground plane for the antenna.

There are no external Passive GPS antennas. Due loss of the cable/connector system the signal level for the GPS module would not be sufficient.

2.2 Low power consumption

Typical application: Handhold device, battery driven

Exemplary configurations:

- AarLogic GPS 3M + I-stage-LNA (ANT-NXG3113)
- AarLogic GPS 3T (Integrated Antenna)

2.3 Designs with external antennas

Typical application: Vehicle tracking

The AarLogic GPS 3M comes an integrated LNA providing a system gain of 18 dBi. Therefore the usage of external antennas can become a problem if their system gain exceeds 24dBi. If the antenna gain is exceeds 32dBi the receiver of GPS chipset can be saturated which leads to higher energy consumption and worse performance.

Nearly every external antennas is used with a cable length of at least 2.5m and at least one additional connector. This reduces the system gain because of the

- RF loss of the cable,
- The linear loss of supply voltage,
- Loss due the connectors
- Loss due optional adapter cables

For a typical configuration of an external GPS antenna (for example like ANT-NXM652) with 2.5m of RG174 using a supply voltage of 2.85V (default for AarLogic GPS 3M) the maximum system gain is 24dBi.

When using other GPS receivers and external antennas be careful that your antenna gain does not saturate your GPS receiver resulting in bad performance or even destroyed receiver.

2.4 Trucks & Buses

In most cases using external GPS antennas on large vehicles like trucks, buses or in marine applications long cables (5m-10m) to the receiver are needed. In this case the usage of the integrated power supply of the GPS receiver feeding the LNA in the antenna is not recommended because of the expected loss due

the long cable. For such cable lengths the supply voltage of the GPS itself is not sufficient.

In such cases a switched external power supply for the active GPS-antenna is recommended to achieve optimal GPS performance. Then the optimal supply voltage for the active GPS antennas can be used.

3 Antenna selection criteria

3.1 Maximum gain

The system gain of (active) GPS antennas used with the AarLogic GPS 3M module must not exceed 24dBi.

3.2 Antenna selection table

	AarLogic GPS 3M	AarLogic GPS 3T	Telit GPS (GM862-GPS, GE863-GPS)	Trimble Lassen IQ
Passive GPS antenna	**Yes** (additional SAW recommended)	No additional antenna needed: GPS antenna already integrated	**No**	**No**
I-Stage GPS antenna	**Yes**		**No**	**No**
II-Stage internal GPS antenna	**No**		**Yes**	**Yes**
II-Stage external GPS antenna (cable length >2.5m)	**Yes**		**Yes**	**Yes**
II-Stage external GPS antenna (cable length >10m)	**Yes** (additional voltage supply for antenna recommended)		**Yes** (not recommended due performance)	**Yes** (not recommended due performance)

3.3 Antenna tuning AarLogic GPS 3T

To achieve optimal antenna performance the small antenna patch of the AarLogic GPS 3T can be customized for the used enclosure material and thickness. To achieve best results in the tuning process the final design (electrical & enclosure) is needed. Please find further explanations in chapter 4.

4 Remarks on antenna tuning in general

The center frequency of GPS signals is 1575.42 MHz. Normally every antenna is tuned by its manufacturer to its nominal center frequency on a 7 x 7 cm ground plane without plastic cover. If ground plane size decreases the gain and reflection suppression will be reduced. The second effect is the shifted center frequency towards lower frequencies. And the antenna becomes more sensitive to objects in close distance.

Changing the ground plane size of a 25 x 25 mm antenna from 70 x 70 mm to 40 x 40 mm can reduce its center frequency by 10 to 15 MHz. In addition the center frequency is generally lowered about 5 MHz if a plastic enclosure will be used (as in most applications). Therefore in most cases antennas should provide a higher nominal center frequency (depending on the enclosure and ground plane size).