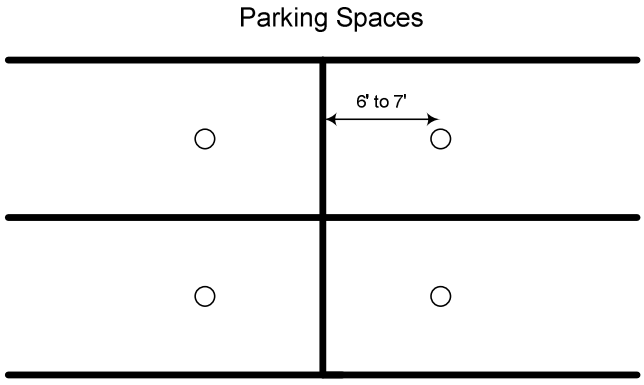
Novalab MAD Sensor Manual

The Novalab Magnetic Anomaly Detector (MAD) consists of a three axis magnetic sensor, processor, and an FCC approved radio with antenna. Its magnetometer function is intended to detect changes in the local magnetic field which could be caused by a nearby ferrous object moving w.r.t. the sensor.

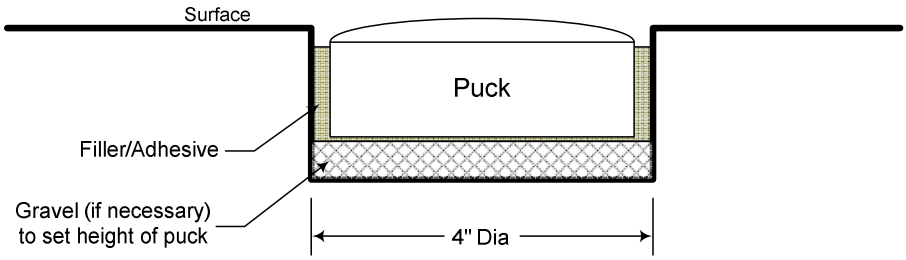
While the device could be used to detect a variety of objects, we will use the detection of a parked automobile as an example of its operation.

Installation

The sensor should be positioned in a parking space such that it has minimal interference from neighboring spaces. This necessitates placing in on the parking centerline and about 6' to 7' from the front of the parking – see figure:



It is important to totally immobilize devices, as any rotation will cause magnetic offsets from the provisioned state. This could happen, for example, if a vehicle's wheel is turning while on the Puck. To that end, whatever filler is used (silicone, etc.) should be applied at the bottom of the Puck well, as well as along its sides, to provide maximum adhesion area. This is shown in the following figure:



It is theoretically possible to totally burry, and thus cover the Pucks. This has not been tested as yet, and should be attempted in order to ascertain its performance in this configuration. It is also possible to mount the devices above grade. This configuration would provide greatest ease of deployment, and best sensitivity and range. However, the preliminary resting done at NovaLab indicates that it may be difficult to achieve the adequate adhesion to the surface that would guarantee long installation life. NovaLab plans to produce different housing dome that would be more suitable for this application.

Gateway Positioning

The testing has showed that whenever possible, the gateway(s) should be positioned in such a way so that the direct line is as much as possible looking along the length of the vehicles, and not widthwise. The reason for this is the range in presence of interference. Wider the spacing between the vehicles will allow more of the signal will get thru to the gateway, so looking at the pucks “lengthwise” will include the parking lanes. In our testing the difference between the lengthwise and widthwise oriented range is as much as 4 – 6 times.

It will rarely be possible to totally achieve this in every installation. It should be remembered however, that a 45 degree path is far better than a widthwise (90 degree) path. In any case, a combination of two gateways per a parking lot, positioned for optimum path as well as distance will guarantee adequate coverage. One should remember that the key to distance is the gap between the cars in the direction of the gateway.

Clearly, every installation is different, and common sense will have to be used during the planning stages. If so required, NovaLab will be happy to provide any assistance needed.

Algorithm

At its simplest, the MAD sensor incorporates an algorithm to resolve the three magnetic sensor readings into a single number. The algorithm used is:

ABS(X – Xcal) + ABS(Y – Ycal) + ABS(Z – Zcal)

ABS is the absolute value
X, Y, Z are the magnetic readings at the time of measurement
Xcal, Ycal, Zcal are readings taken and stored in flash during the zeroing process

The resultant value is then compared to pre-defined (and changeable) threshold values for determination of arrival and departure.

The sensor has been tested over wide temperature range, and has been found to be very impervious to temperature effects. This is due to a fact that the sensor is re-calibrated prior to every measurement (every one second).

Parameters

The following parameters are set in the MAD sensor and can be changed using a configuration radio and PC software.

Arrival Threshold – This is the threshold over which the sensor flags a possible arrival. It looks for the magnetic value to be stable (Arrival Deviation) for a period of time (Arrival Time). In addition to stability, all the readings taken during the "Arrival Period" must be higher than the Arrival Threshold.

Departure Threshold – This is the threshold under which the sensor flags a possible departure. It looks for the magnetic value to be under this threshold for a period of time (Departure Time).

Gray Zone Threshold – This is a value above the departure threshold that represents a zone (from the DT to the GZT) which will generate a departure if the decrease in the reading is over the Departure Step amount.

Arrival Time – This is the number of readings (or number of seconds while taking 1 reading per second) the value of the magnetic sensor needs to be over the Arrival Threshold in order to generate an arrival.

Departure Time – This is the number of readings (1 reading per second) the value of the magnetic sensor needs to be under the Departure Threshold in order to generate a departure.

Departure Step – This is the minimum size of the step from the arrival state into the gray zone in order for the reading to be considered for a departure.

Arrival Deviation – This is the maximum signal variance during the Arrival Time in order for the system to flag an arrival. The sensor is looking for a stopped car.

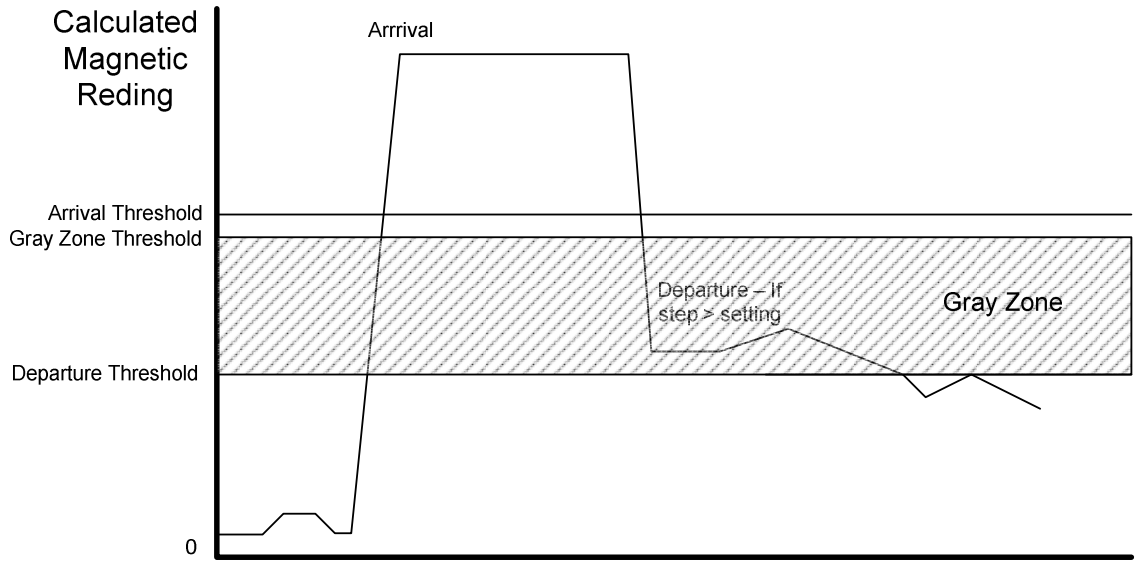
Check In Period – This is the amount of time between forced check in messages.

Default Parameter Values

The MAD sensors come configured with default parameter settings that Novalab has determined to be a good starting point. Further testing may indicate a change in these parameters and Novalab can update the default settings at that point. All settings can be changed in the lab or after installation.

Parameter	Default Setting
Arrival Threshold	220
Departure Threshold	170
Gray Zone Threshold	220
Arrival Time	15 sec
Departure Time	4 sec
Departure Step	80
Arrival Deviation	80
Check-In Period	3510 sec (~1 hr)

The following figure shows a graphical representation of an arrival and departure:



Additionally, there are many other settings, such as the MAD device address etc. that can be changed using the provisioning tool.

Testing Suggestions

While Novalab has fully tested the MAD sensor for functional operation, further "real world" testing is required to determine the level of successful capture and fine tuning of parameters.

Issues for testing are as follows:

- Ability to detect parked (over the sensor) vehicles accurately
- Ability to reject neighboring vehicles
- Range of radio
- Parking Garage (indoor) installation
- Totally buried sensor installation

Suggestions for Testing:

Our suggestion is to configure the Marietta lot with two gateways. The first would be near the "high volume" area and the second would be further (~75 yards) away.

Place two pucks per space (one at 6' and one at 8' from the front of the space. Roswell has 12 pucks so we can do 6 spaces in the high volume area. Reduce the check-in time to 5 minutes (Check-In period = 292), so we see more mag sensor data (this will however reduce the battery life to about 6 months or so).

Place a person for 1 day to watch the spaces and record every parking event that occurs there, an in the neighboring spaces. In that way the data can be reconciled.

Review the data for accuracy and capture percentages and review parameter adjustments. Also, the data from the two gateways can be compared to get a range assessment.

Changes or modifications not expressly approved by NovaLab, LLC *could void the user's authority to operate the equipment.*

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. *This device may not cause harmful interference*
2. *This device must accept any interference received, including interference that may cause undesired operation.*

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

-- Reorient or relocate the receiving antenna.
-- Increase the separation between the equipment and receiver.
-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- *Consult the dealer or an experienced radio/TV technician for help."*

To comply with FCC and Industry Canada RF radiation exposure limits for general population, this device must be installed to provide a separation distance of at least 20cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.