Mage Networks Inc.

MagiNet™ Data Pipeline

Description of Data Pipeline and Data Sheet of Data Pipeline Nodes

A MagiNet™ Data Pipeline is a novel way of providing high bandwidth service over long distances and large areas. Data Pipelines use the available frequency spectrum very efficiently. They marry the advantages of mesh networks with the data rate of point-to-point networks. They eliminate the need for towers as a Data Pipeline can be deployed at a height of 2-5 meters without compromising line of sight and still reach every customer in that area.

BACKGROUND

MagiNet™ is a network solution that expands the traditional point to point and point to multipoint networks to an every-point to every-point network. MagiNet™ is composed of a unique combination of technologies which enable it to outperform traditional networks in every measure of the quality of a telecommunication network:

1. **Capacity:** The amount of data available for the users.
2. **Coverage:** The ability of the signal to reach the customer.
3. **Range:** The distance that can be spanned by the network.
4. **Deployability:** The ease of deploying a given network and the skill level required.
5. **Usability:** The network's self-configuring, self-healing and requires minimal training.

MagiNet™ uses the MagiLink™ technology to combine the simplicity, coverage and range of mesh networks with the capacity of infrastructure networks. MagiLink™ is the most robust and scalable mesh technology available. MagiLink™ is not just a wireless technology but also a routing technology. Meshing and routing is done across both wireless and wired interfaces. MagiLink™ is firmware that is embedded (flashed) onto existing wireless and wired units to transform them into MagiNodes™ and MagiRouters™. That feature enables a unique multi-hop meshing Data Pipeline.

DATA PIPELINE

A Data Pipeline carries data over long distances while eliminating the reduction in data rate caused by the multiple hops. Data Pipeline nodes consist of two MagiNodes™ with directional antennas connected back-to-back using their Ethernet ports. Each unit operates at a different frequency channel f1 and channel f2. The Data Pipeline consists of alternating sections with the different frequencies as shown in Figure 1. This allows the data to flow continuously from one Node to the next as every Data Pipeline Node in the "pipeline" transmits and receives simultaneously.

Mage Networks recently introduced the MagiRouter™. Data Pipelines can be constructed with standard devices by using them combined with MagiRouters™. The MagiRouters™ provide the routing capabilities of MagiLink™ to any wireless devices.They are used for breakouts of multiple data pipelines, and to also convert any wireless device into relays for Data Pipelines. While many models of MagiRouters™ are anticipated at this time the only model available is the MNR-EP-R6.

There is no theoretical limit to how many Data Pipeline nodes can be included in a single Data Pipeline. Any MagiNode™ can be connected to any other MagiNode™ in this manner without requiring any configuration of gateways, net masks or even using the same IP subnets. The routes are discovered automatically by the firmware.

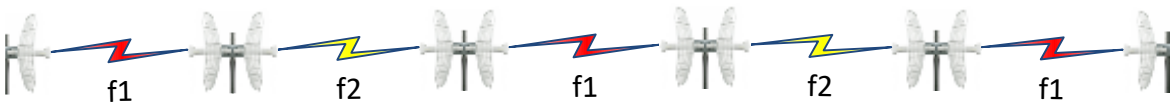


Figure 1 Data Pipeline showing the operation at alternating frequencies on every hop. The MagiNodes are connected back-to-back using their Ethernet ports.

Data Pipelines eliminate the need for large towers. MagiNodes™ are mounted on telephone poles, lamp poles, fence posts, roofs, side of buildings, etc. Data Pipeline units would be placed in locations within 5 kms of each other. Because of that flexible deployment MagiNet™ can overcome large distances, physical obstacles (hills, mountains, ridges, and buildings) and follow the path of least resistance by going around woods and trees (or even under them!).

Data Pipeline units are lightweight and easy to mount. There are primarily 3 models of wireless Data Pipeline MagiNodes allowing for versatility in deployment and use. All units work seamlessly together regardless of which type they are. The three types of units are:

1- MND5-G27 (Figure 2): Operates in the 5GHz ISM band. It has a 27 dBi Antenna, is the workhorse of the system. Used for the longest hops.
2- MND5-M (Figure 3): has a built in 13 dBi Antenna. It is less expensive and can be used for shorter hops when needed. Has MIMO and therefore is capable of 50 Mbps over hops of up to 3 km.
3- MN-WW60-G-AD (Figure 4). Building block of 1 Gbps Data Pipeline. Used for distances of 700m in conjunction with MagiRouters™ to provide backbone to MagiNet™.

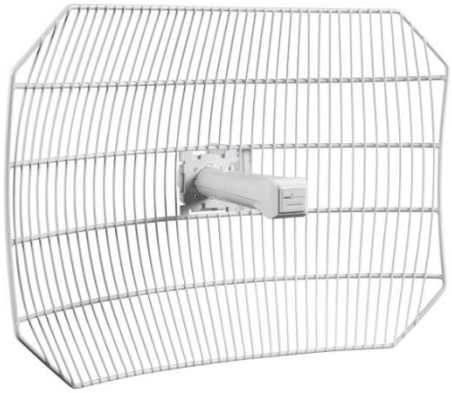


Figure 2 MND5-G27 MagiNode™

The 2.4 GHz versions of the above 5GHz devices can be made available on request.

The deployment and installation of Data Pipeline units is a lot simpler than the construction of a large tower. It is even simpler than deploying roof top units at customer sites when the locations are far from the towers as far as aligning the antennas. By using high gain antennas and yet restricting the distance between units to 4-5 kms (or as needed in case of obstacles), the throughput of the Data Pipeline doesn't decrease with distance

Additionally, the Data Pipeline can be deployed in a scalable manner as shown in Figure 5. Initially, with few customers in an area, a lower data rate Data Pipeline can be deployed. As the number of customers increase, the demand for throughput will increase. The data rate of the Pipeline can be increased relatively simply. Thus, the capital costs of deployment are better matched to the actual revenue stream than in traditional networks.

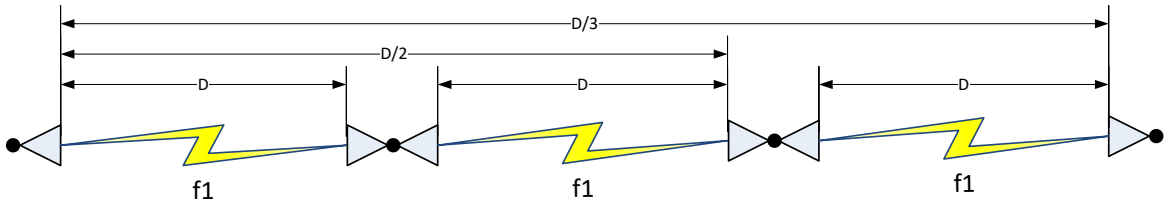
Figure 3 MND5-M MagiNode™

It should also be noted that a MagiNet™ Data Pipeline does not have to be in a single line, it can be deployed in a tree structure, with a main trunk with multiple branches and multiple sub-branches to reach all the customers. It can also be deployed in a hub and spoke structure. More than two MagiNodes™ can be connected to each other by using a regular Ethernet switch. Or even standard devices can be combined by using MagiRouters™.

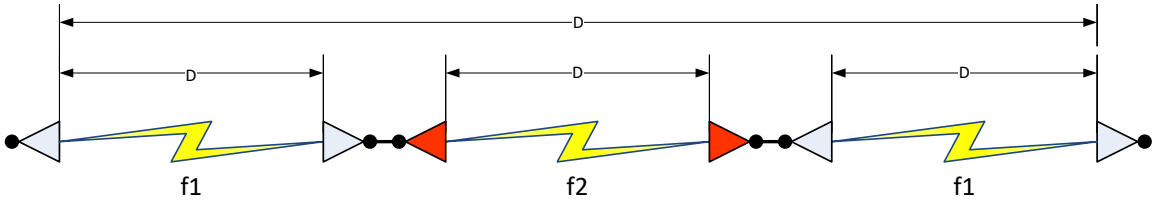
Figure 4 MN-WW60-G-AD MagiNode™

Finally, using the MagiNet™ Data Pipeline doesn't replace the existing systems and solutions that have been previously used. It can be seamlessly combined with the other approaches to provide a powerful tool kit which allows the service provider to overcome all obstacles and provide high quality service to its customers.

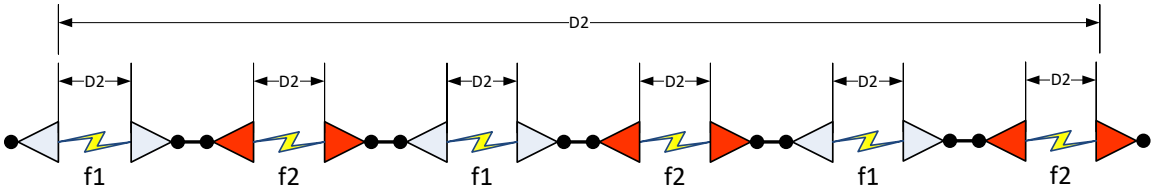
A) Multi-Hop Backhaul: Each hop has data rate = D and operates at frequency f1. Overall data rate is D/3



B) Data Pipeline: Each node in the Backhaul has a new node attached to it via the Ethernet port and the second antenna is removed to convert it to a Data Pipeline.
Each hop has data rate = D, the hops alternate in frequency between f1 and f2. Overall data rate is D.



C) Higher Throughput Data Pipeline: Additional Data Pipeline Nodes are added between the existing ones. The frequency of operation is adjusted accordingly. Now, each hop has data rate = D2, the hops alternate in frequency between f1 and f2. Overall data rate is D2. Because of the distance reduction D2 > D.



C) Parallel Data Pipelines: A second Data Pipeline Nodes is deployed in parallel with the first one. The overall capacity has increased to 2xD2.

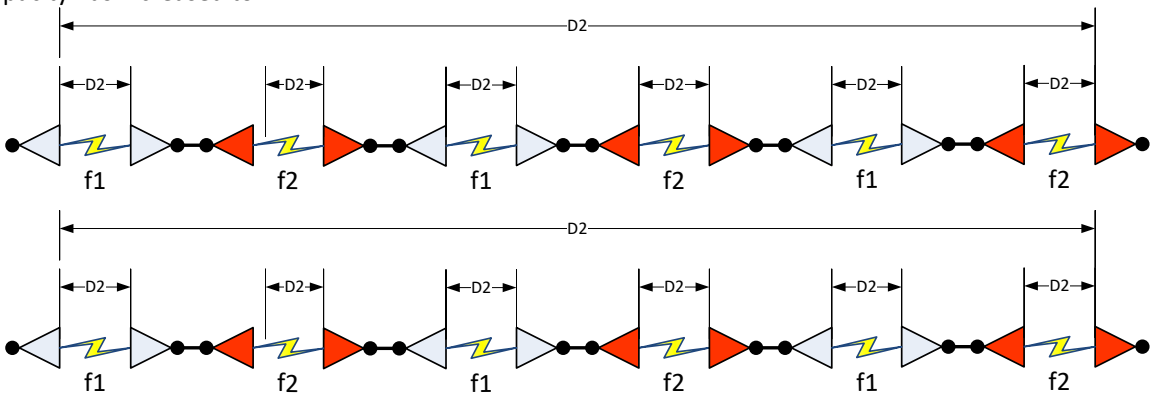


Figure 5 Four stages of Data Pipeline deployment showing how the performance can be increased with increased demand.

EXAMPLES OF DATA PIPELINE APPLICATIONS

Remote Internet Access, Nanton Alberta, 2017

The Mage Networks team deployed and operated a data pipeline in Nanton, Alberta to demonstrate how the network can be used to provide Internet access to remote locations. Access to the Internet was provided by Dayna Dickens and the network was used to connect the ranch of Mark and Kelly Fox 10 km outside town. Using a MagiPoint™ the team was able to use WiFi at all times during the deployment of the network. At the ranch we provided WiFi coverage for the ranch itself, but also up a hill behind the buildings. A video of that deployment can be seen at www.mage-networks.com/technology/.

Data Pipeline Field Test, Lochend Rd., Calgary Alberta, 2017

In this test, two engineers in a Honda CRV, deployed a 20 km long Data Pipeline as a test. The deployment and the tests were completed in a matter of hours. The measured data rate over that distance was 25 Mbps due to the longer hops we used. Note that Data Pipeline data rate is strongly dependent on the distance between hops. To achieve 50 Mbps the hops have to be up to 3 km.

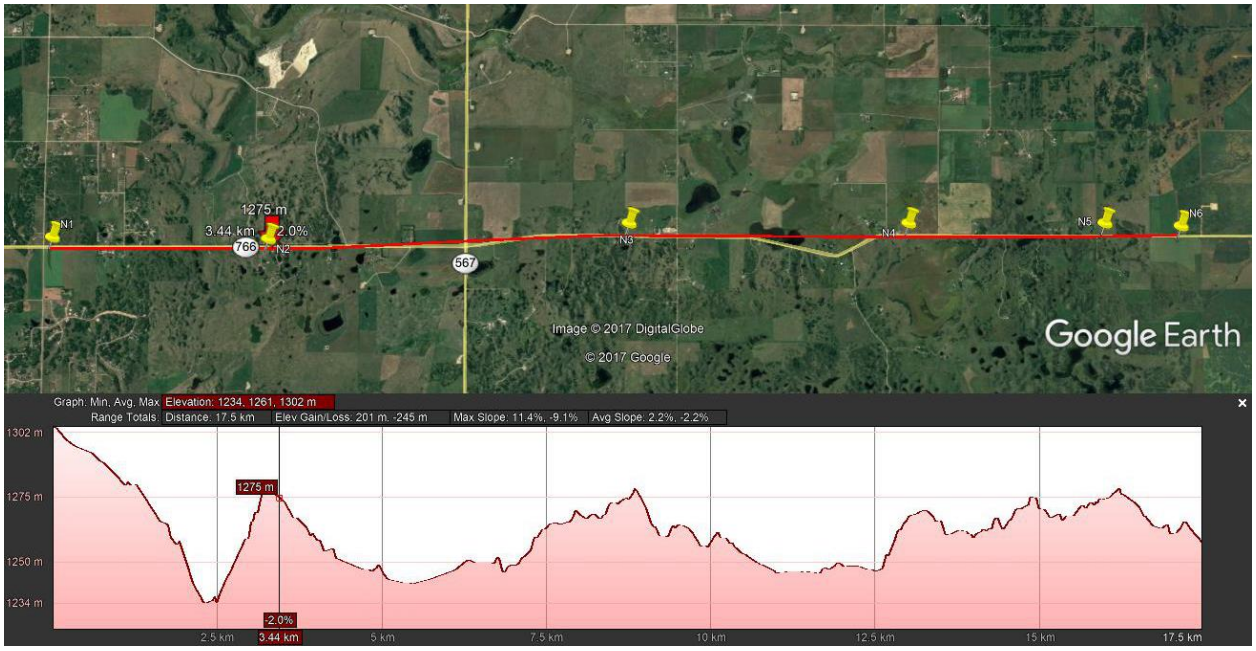


Figure 6 the location of the Data Pipeline units along Lochend Rd near Calgary, AB. The units were on 2m tripods. Nodes were placed whenever there was an obstruction due to terrain. The distance was limited to 5 km to maintain the high data rate.

Education Network in Peepeekisis Cree Nation, Saskatchewan, 2020

The network is operational. It was built in 6 weeks demonstrating how fast these networks can be deployed. The network connects about 70 students to the school for remote learning. The reserve is very widely dispersed as the network is 20 km by 10 km wide. The network also demonstrates the scalability of Mage's solution as it incorporates 25 hops in one branch. We believe this is a world record for number of hops in a multi-hop network.

The network was built using local First Nation labor trained and supervised by Mage Networks' team. The deployment was complicated by the large distances and the number of trees (far more than shown on Google Earth).

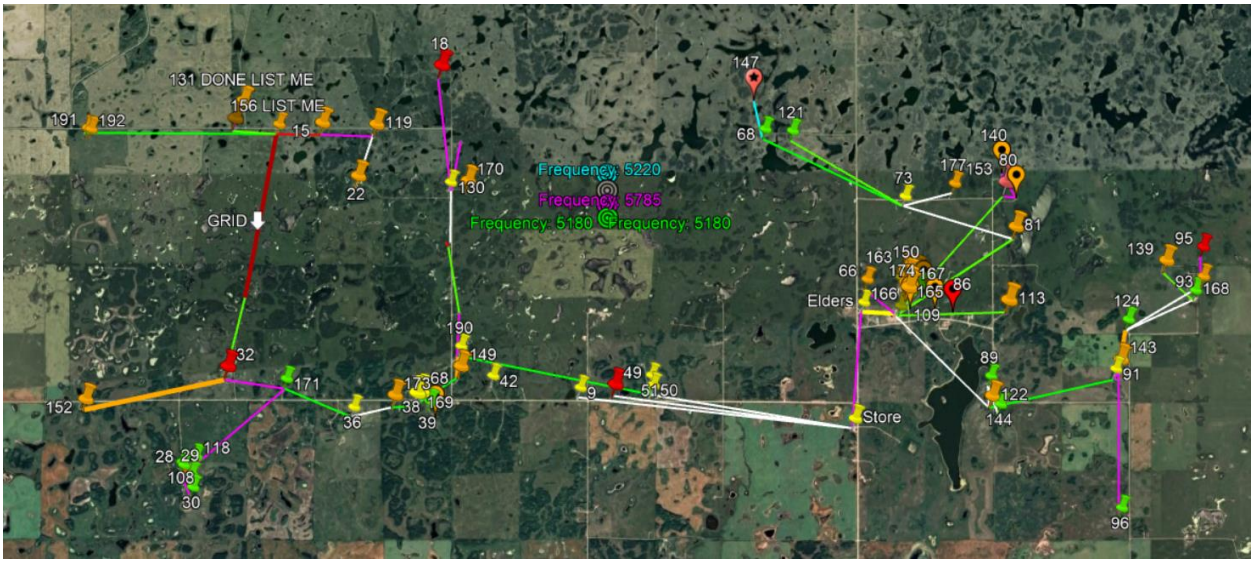


Figure 7 Peepeekisis Cree Nation Educational network. The network was built in a period of 6 weeks, then further expanded over the summer of 2020.

Education Network in Standing Buffalo, Saskatchewan, 2020

As a result of the success of the Peepeekisis network Standing Buffalo Dakota First Nation requested a similar network, also connecting about 70 students to the school for remote and online learning. This network was also built during the summer in parallel with the Peepeekisis network expansion phase. Again locals were trained and supervised by Mage. This network made far more use of the 60 GHz Data Pipelines which were more suited to the terrain and distances.

Figure 8 Standing Buffalo Education Network. Yellow lines indicate the 60 GHz, 1 Gbps Data Pipelines

MAGE NETWORKS

MagiNet™ Data Pipeline Specification Sheets

MND5-M Data Pipeline MagiNode™ M5

MND5-G27 Data Pipeline MagiNode™ 27dBi Grid

MN-WW60-G-AD 60 GHz Point-to-Point Pair

MND5-G27: 5GHz Data Pipeline MagiNode™ with a 27 dBi Grid Antenna. It is used for the 3-4 km hops.

MN-WW60-G-AD Building block of 1 Gbps Data Pipeline. Used for distances of 700m in conjunction with MagiLink™ Routers to provide backbone to MagiNet™.

MND5-M: 5GHz Data Pipeline MagiNode™ with a built in 13 dBi Antenna. It is used for 2-3 km hops. It uses MIMO for very high data rates.

MN-WW60-G-AD 60GHz, 1 Gbps Point-to-Point Pair:

Details	
Product code	**RBLHGG-60adkit**
Architecture	**ARM 32bit**
CPU	**IPQ-4019**
CPU core count	**4**
CPU nominal frequency	**716.8 MHz**
Dimensions	**Ø 391 x 222 mm**
Weight	**1003 gram**
License level	**3**
Operating System	**RouterOS**
Size of RAM	**256 MB**
Storage size	**16 MB**
Storage type	**FLASH**
Tested ambient temperature	**-40°C to 55°C**

Powering

Details	
PoE in	802.3af/at
PoE in input Voltage	12-57 V
Number of DC inputs	1 (PoE-IN)
Max power consumption	5 W

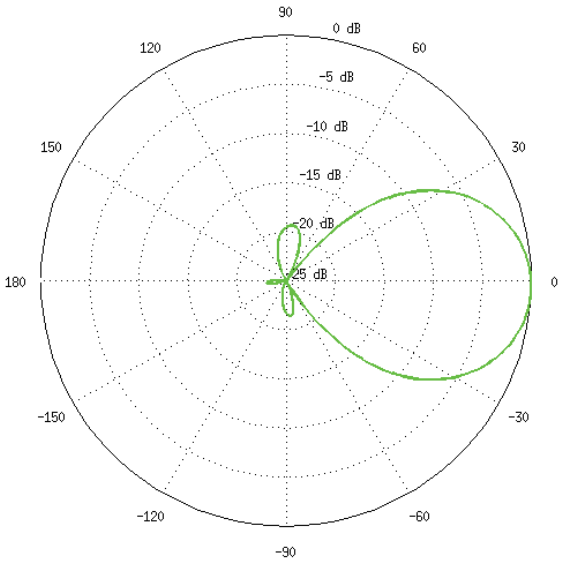
Ethernet

Details	
10/100/1000 Ethernet ports	1

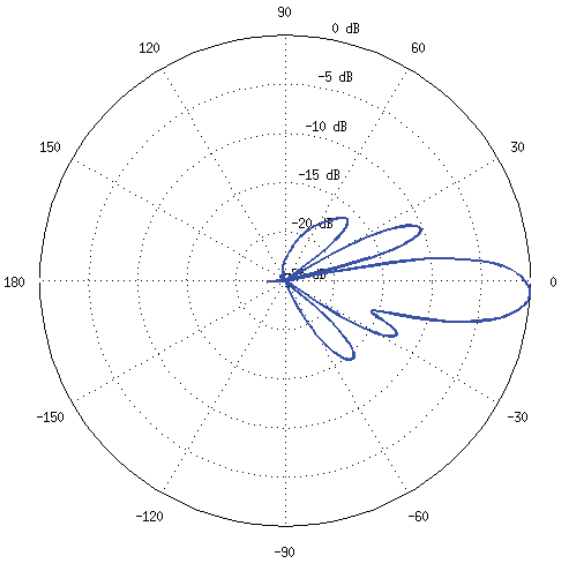
MND5-M Data Pipeline MagiNode™ M5

	MND5-M		
Dimensions	294 x 31 x 80 mm (11.57 x 1.22 x 3.15")		
Weight	400 g (14.11 oz)		
Power Supply (PoE)	24V, 0.5A		
Max. Power Consumption	8W		
Power Method	Passive PoE (Pairs 4, 5+; 7, 8 Return)		
Operating Frequency	Worldwide	USA	USA DFS
	5170-5875 MHz	5725-5850 MHz	5250-5850 MHz
Gain	14.6-16.1 dBi		
Networking Interface (2)	10/100 Ethernet Ports		
Processor Specs	Atheros MIPS 74Kc, 560 MHz		
Memory	64 MB DDR2, 8 MB Flash		
Frequency	5 GHz		
Cross-pol Isolation	22 dB Minimum		
Max. VSWR	1.6:1		
Beamwidth	43° (H-pol) / 41° (V-pol) / 15° (Elevation)		
Polarization	Dual Linear		
Enclosure	Outdoor UV Stabilized Plastic		
Mounting	Pole-Mount (Kit Included)		
Operating Temperature	-30 to 75° C (-22 to 167° F)		
Operating Humidity	5 to 95% Noncondensing		
Wireless Approvals	FCC Part 15.247, IC RS210, CE		
RoHS Compliance	Yes		
Shock & Vibration	ETSI300-019-1.4		

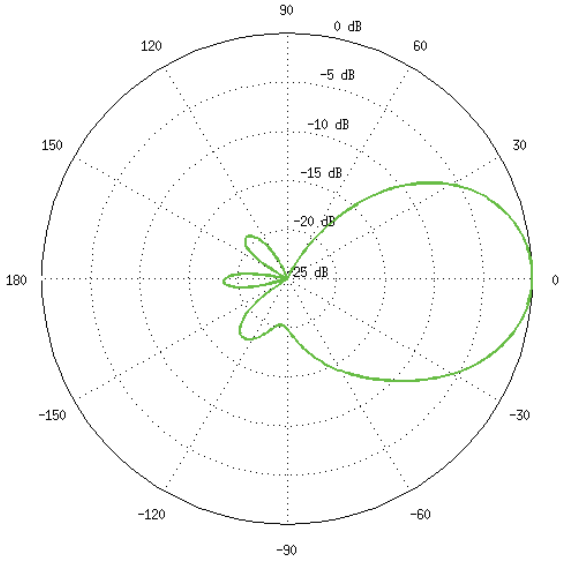
5 GHz TX Power Specifications			**5 GHz RX Power Specifications**		
MCS	**Avg. TX**	**Tolerance**	**MCS**	**Sensitivity**	**Tolerance**
MCS0	27 dBm	± 2 dB	**MCS0**	-96 dBm	± 2 dB
MCS1	27 dBm	± 2 dB	**MCS1**	-95 dBm	± 2 dB
MCS2	27 dBm	± 2 dB	**MCS2**	-92 dBm	± 2 dB
MCS3	27 dBm	± 2 dB	**MCS3**	-90 dBm	± 2 dB
MCS4	26 dBm	± 2 dB	**MCS4**	-86 dBm	± 2 dB
MCS5	24 dBm	± 2 dB	**MCS5**	-83 dBm	± 2 dB
MCS6	22 dBm	± 2 dB	**MCS6**	-77 dBm	± 2 dB
MCS7	21 dBm	± 2 dB	**MCS7**	-74 dBm	± 2 dB
MCS8	27 dBm	± 2 dB	**MCS8**	-95 dBm	± 2 dB
MCS9	27 dBm	± 2 dB	**MCS9**	-93 dBm	± 2 dB
MCS10	27 dBm	± 2 dB	**MCS10**	-90 dBm	± 2 dB
MCS11	27 dBm	± 2 dB	**MCS11**	-87 dBm	± 2 dB
MCS12	26 dBm	± 2 dB	**MCS12**	-84 dBm	± 2 dB
MCS13	24 dBm	± 2 dB	**MCS13**	-79 dBm	± 2 dB
MCS14	22 dBm	± 2 dB	**MCS14**	-78 dBm	± 2 dB
MCS15	21 dBm	± 2 dB	**MCS15**	-75 dBm	± 2 dB



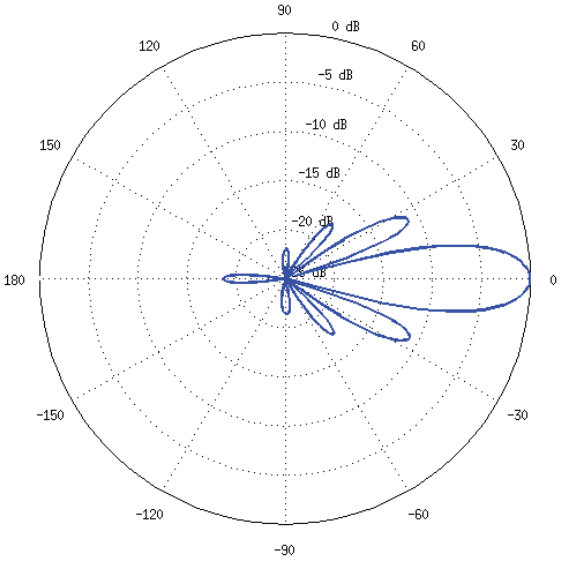
Vertical Azimuth



Vertical Elevation



Horizontal Azimuth

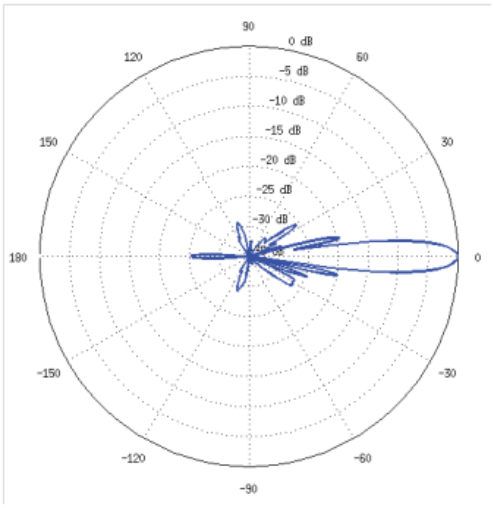


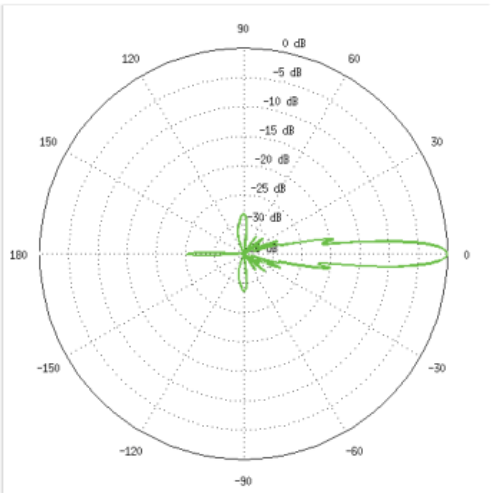
Horizontal Elevation

MND5-G27 Data Pipeline MagiNode™ 27dBi Grid

MND5-G27	
Processor Specs	Atheros MIPS 74Kc, 560 MHz
Memory Information	64 MB DDR2, 8 MB Flash
Networking Interface	(1) 10/100 Ethernet Port
Wireless Approvals	FCC Part 15.247, IC RS210, CE
RoHS Compliance	Yes
Enclosure Characteristics	Outdoor UV Stabilized Plastic
Mounting Kit	Pole Mounting Kit (Included)
Max. Power Consumption	3W
Power Supply	24V, 0.5A PoE Adapter (Included)
Power Method	Passive Power over Ethernet (Pairs 4, 5+; 7, 8 Return)
Operating Temperature	-30 to 75° C (-22 to 167° F)
Operating Humidity	5 to 95% Condensing
Shock and Vibration	ETSI300-019-1.4
ETSI Specification	EN 302 326 DN2
Dimensions (Mount Included)	620 x 460 x 360 mm (24.41 x 18.11 x 14.17")
Weight (Mount Included)	2585 g (5.699 lb)
Wind Survivability	200 km/h (125 mph)
Wind Loading	34.7 N @ 200 km/h (7.8 lbf @ 125 mph)
Operating Frequency	Worldwide: 5170 – 5875 MHz USA: 5725 – 5850 MHz
Max. VSWR	1.5:1
Gain	27 dBi

5 GHz TX Power Specifications			5 GHz RX Power Specifications		
MCS	**Avg. TX**	**Tolerance**	**MCS**	**Sensitivity**	**Tolerance**
MCS0	25 dBm	± 2 dB	**MCS0**	-97 dBm	± 2 dB
MCS1	25 dBm	± 2 dB	**MCS1**	-96 dBm	± 2 dB
MCS2	25 dBm	± 2 dB	**MCS2**	-93 dBm	± 2 dB
MCS3	24 dBm	± 2 dB	**MCS3**	-91 dBm	± 2 dB
MCS4	23 dBm	± 2 dB	**MCS4**	-87 dBm	± 2 dB
MCS5	22 dBm	± 2 dB	**MCS5**	-84 dBm	± 2 dB
MCS6	21 dBm	± 2 dB	**MCS6**	-78 dBm	± 2 dB
MCS7	19 dBm	± 2 dB	**MCS7**	-75 dBm	± 2 dB


90
120
60
150
30
180
0
-150
-30
-120
-60
-90
0 dB
-5 dB
-10 dB
-15 dB
-20 dB
-25 dB
-30 dB


90
120
60
150
30
180
0
-150
-30
-120
-60
-90
0 dB
-5 dB
-10 dB
-15 dB
-20 dB
-25 dB
-30 dB