4.0 ANTENNA DESCRIPTION

CHAPTER SUMMARY

Refer to this chapter for the following:

- Installation precautions and setup.
- Product Descriptions.
- Electrical Parameters.
- Mechanical Dimensions.
- Thermal considerations.
- GPS Antenna Module mounting.

DETAILED TABLE OF CONTENTS

About the Oncore Antenna

The antenna module is housed in a custom styled, molded encasement that provides a rugged, durable protective cover, ready for exposure to the elements.

All of the antenna module's electrical circuitry and components are contained within the sealed antenna assembly. The major components include a low profile, microstrip patch antenna, a ceramic RF filter (i.e., preselector), and a signal preamplifier. The antenna module is designed and tuned to efficiently collect the Ll band signals transmitted from GPS satellites at a nominal frequency of 1575.42 MHz. Once collected, the signals are amplified and relayed to the Oncore receiver. Signal preamplification within the antenna module is made possible by external power supplied by the Oncore receiver.

Various antenna module mounting options and assembly instructions are detailed in this chapter.

ANTENNA PLACEMENT

When mounting the antenna module, it is important to remember that GPS positioning performance will be most optimal when

the antenna patch plane is level with the local geographic horizon, and

the antenna has full view of the sky ensuring direct line-of-sight to all visible satellites over head.

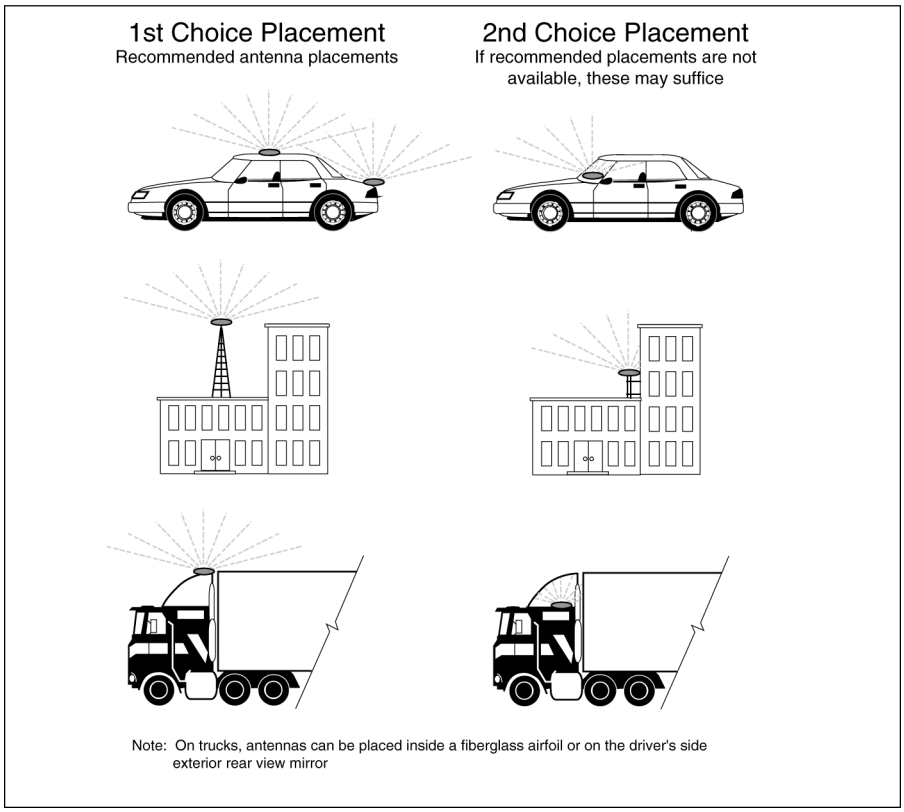


Figure 4.1: Proper Antenna Placement

ANTENNA SYSTEM RF PARAMETERS CONSIDERATION

Active Antenna & GT Oncore Receiver System

Both the gain and the noise of the overall system affect the performance of the A/D converter in a GPS receiver. The illustration below illustrates typical values for the Oncore family of GPS receivers when used with the Motorola antenna and standard RG-58/RG-174 type cable. The thresholds and ranges listed should be considered with a tolerance of 2 to 3 dB.

System Constraints:

1) The gain in decibels is cumulative through all stages (i.e. G = G1+ G2 + G3 ..). The optimal gain of the antenna, cabling and any in-line amplifiers and splitters for the standard GT Oncore (model R3) is > 10 but < 26 dB. See the table below for other Oncore receiver models. The Oncore receiver may operate outside of the optimal gain range but performance will degrade. Therefore, Motorola does not recommend operating outside of the optimal gain range as indicated above and in the table below. For the system illustrated below, the external gain is approximately 22 dB in front of the receiver.

2) System noise (F) is not to exceed 4 dB. The cascaded system noise figure formula is

$$f = f1 + \frac{f2 - 1}{g1} + \frac{f3 - 1}{g1.g2}..., \quad (= 1.9 \text{ dB for the system below})$$

where $f1$ is the noise figure for stage one and $g1$ is the gain for stage one. Note that all of these values are absolute. Recall the formula for converting absolute values to decibels:

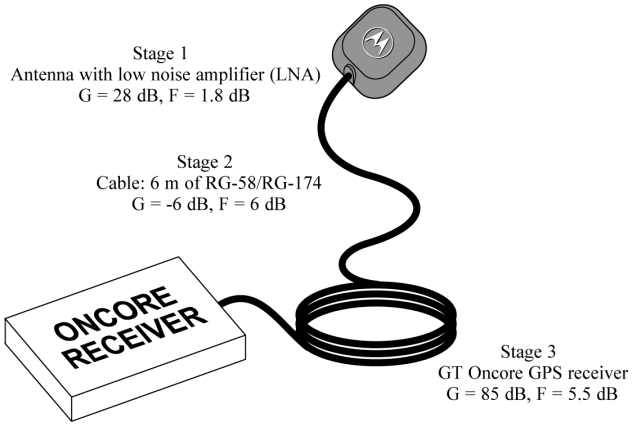


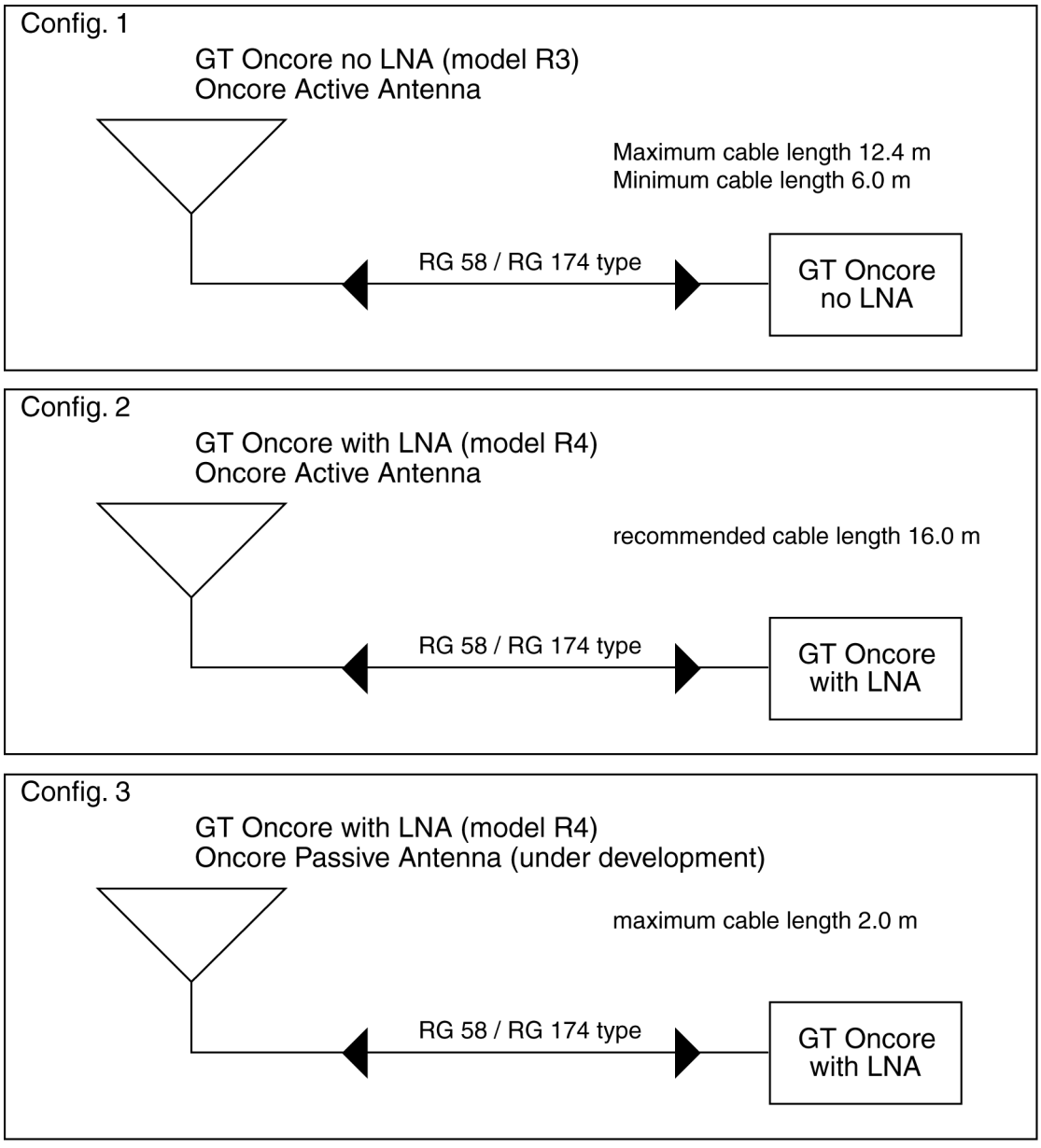
Figure 4.2

Table 4.1

		External Gain Range in dB[1]			RCVR Gain[2]	RCVR NF[2]
Platform	Model	Minimum	Optimum	Maximum		
M12+						
GT/UT	R1	10	22	35	85	5.5
GT+	R3	10	22	26	85	5.5
UT+	R5	10	22	33	100	5.5
VP	B3	10	18	26	68	7.5

Notes:
1. All values indicated in this section are referenced over operating temperature
2. RCVR Gain and NF values are for receiver only and do not include antenna LNA or cable loss. The values indicated are referenced to ambient temperature

RF Cable Length for AVL Applications



Note: All values on this page represent antenna performance at 25°C

Figure 4.3

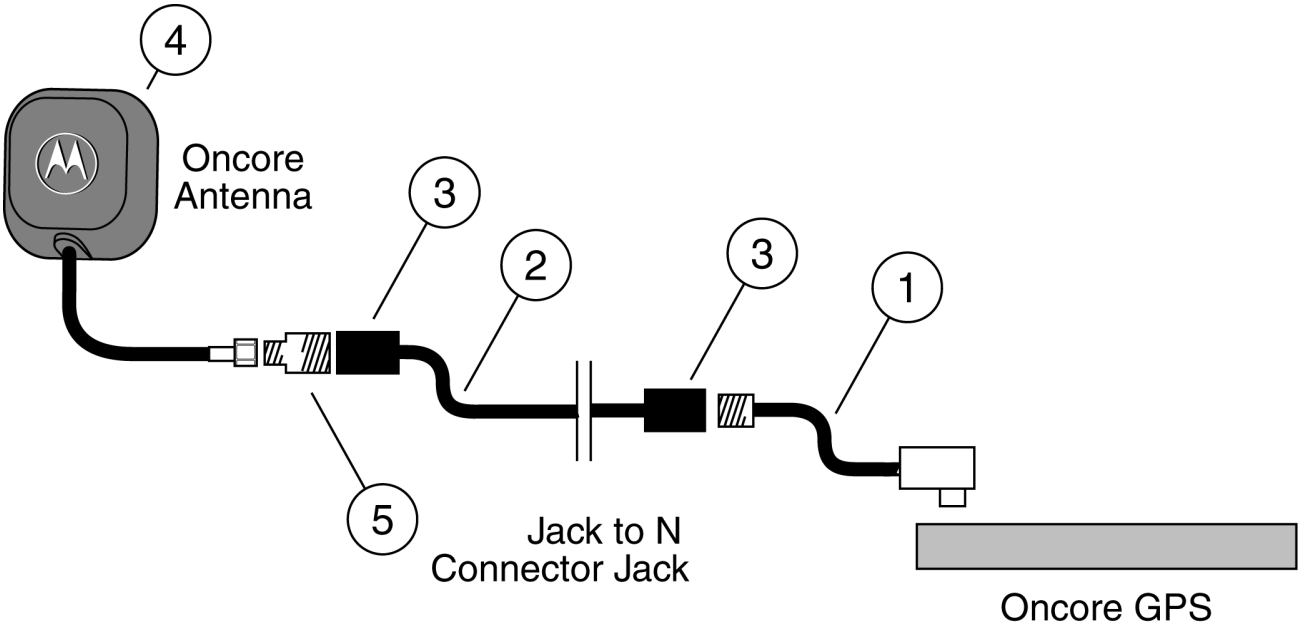


Figure 4.4

Table 4.2

Item	Description	Part No.	Supplier	Tel No.
1	PCX-to-RG-400 RF Cable, 1 foot	128BE27001	Phoenix	630-595-2300
2	Heliax Low Loss RF Cable, 4dB/100 Feet	LDF4-50A	Phoenix	630-595-2300
3	N Terminations	L44AW	Phoenix	630-595-2300
4	Active GPs Antenna 203mm Cable with Sma Connector	GCNAC1232A	Motorola	Contact Your Local Motorola GPS Distributor
5	SM Jack to N Connector Jack	2050110000G/C	Phoenix	630-595-2300

Oncore GPS System Example

The graphic below illustrates an automotive application using the Motorola GT Oncore receiver mounted in the trunk and a GPS antenna mounted in the front dash area. Assumptions were made as to the connector (four Hirose GT 5 connections) and cable type (-6 meters of RG-174 type of cable) and the approximate associated losses (Conservative losses: 1 dB per meter for the cable and 0.5 dB per connector connection) at 1575 MHz. The GT Oncore (model R3) was designed to operate within an external gain range measured at the front of the receiver of greater than 10 but less than 26 dB. The gain at the front of the GT Oncore based on the information and assumptions above is well within the external gain range of the receiver. The calculated gain is approximately 20 dB (see system gain table below). Changing any of the above assumptions or system components illustrated below will necessitate the recalculation of the system gain.

Table 4.3: System Gain

System Component	Gain (dB)
Antenna	-28
Connectors (4 ea.)	-2
Cable	-6
Gain at front end of receiver	20

Note: All values are at 25°C

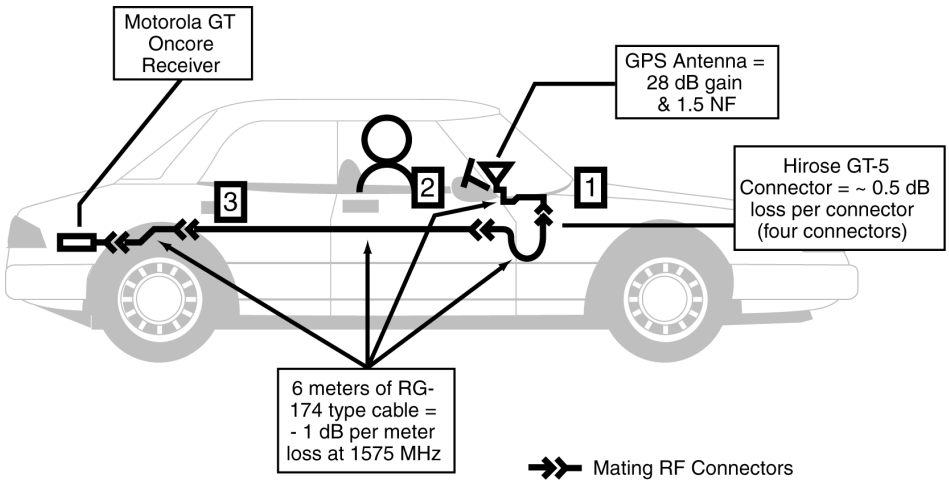


Figure 4.5

ONCORE™ ACTIVE HAWK ANTENNA

Figure 4.6: Hawk Antenna

ANTENNA DESCRIPTION

The Oncore active HAWK antenna is designed to operate with Motorola's successful family of Oncore GPS receivers, as well as many GPS receivers from other manufacturers. The 3 Vdc version of the HAWK GPS Antenna is designed to operate with Motorola's M12 Oncore receivers. The HAWK antenna is a general purpose GPS active antenna designed to meet the stringent environmental and performance needs of the automotive market place.

The antenna design reflects Motorola's high standard for performance when operating in foliage/urban canyon environments and in the presence of electromagnetic interference. The small footprint, low profile package and the shielded LNA (low noise amplifier) offers significantly enhanced performance while operating in a variety of GPS environments. Furthermore, magnetic and blind hole direct mounting options make the antenna suitable for a number of different installation configurations.

Active HAWK Antenna Specifications

Table 4.4 Active Hawk Antenna Technical Characteristics

GENERAL CHARACTERISTICS	Antenna Description	Passive dielectric patch antenna Top and bottom radome plastic housing assembly Active low noise amplifier/filter –PWB assembly RF cable with connector assembly
	Operating Frequency	L1 (1575.42 MHz, +/- 1.02 MHz)
PERFORMANCE CHARACTERISTICS	Input Impedances	50 Ohm
	VSWR	1.5 (typical) @ 1575.42 MHz (2.5 max)
	Bandwidth	10 to 45 MHz (± 3dB points)
	Polarization	Right hand circular
	Azimuth Coverage	360°
	Elevation Coverage	0° to 90°
	Gain Characteristics of Antenna Element	+2.0 dBic minimum at zenith -10 dBic minimum at 0° elevation
	Filtering	-30dB @ 1675 MHz (typical) -30dB @ 1475 MHz (typical)
	LNA Gain	3 Vdc version 24dB (typical, including dB cable loss)
	Noise Figure	<1.8dB (typical), 2.2dB (max)
	Dynamics	Vibration: 7.7 G's (Military Standard 810E) Shock: 100 G's (Military Standard 810E)
ELECTRICAL CHARACTERISTICS	Power Requirements	3 V ± 0.2 Vdc for GC3LPxxxxx models
	Power Consumption 3 Vdc version	16mA (typical), 20mA (max)
PHYSICAL CHARACTERISTICS	Dimensions	38 x 34 x 13.2 mm ± 0.5 mm
	Weight	< 89 grams (including 5m cable and connector)
	Mount	Magnetic and Blind holes (2) Taplite screw size of 2.6 x 5 mm (I mm thick base plate)
	Plastic color 3 Vdc version	Black
	Cable Connectors	BNC (straight) – Special order SMA (straight) – Special order MMCX (right angle) – Standard for 3 Vdc antenna
	Antenna to Receiver Interconnection	Single shield RG-316 type coaxial cable 5 meters (25 ft.) long (See connectors above)
ENVIRONMENTAL CHARACTERISTICS	Operating Temperature	-40°C to +100°C
	Storage Temperature	40°C to +100°C
	Thermal Testing	Cycled 600 hours at –40°C and +100°C
	UV Radiation	Sunshine Carbon Arc System – JIS D0205
	Salt Spray Test	320 hours, Spray 5% NaCl solvent at +35°C.
	Immersion Test	60 minutes at 1 meter
MISCELLANEOUS	Optional Features	Special order models: Substrate (no plastic) version with cable and connector
NOTE	All values above are referenced to 25°C unless indicated otherwise	

Antenna Gain Pattern

The sensitivity of an antenna as a function of elevation angle is represented by the gain pattern. Some directions are much more appropriate for signal reception than others, so the gain characteristics of an antenna play a significant role in the antenna's overall performance.

A cross-sectional view of the antenna gain pattern along a fixed azimuth (in a vertical cut) is displayed in the following figure. The gain pattern clearly indicates that the antenna is designed for full, upper hemispherical coverage, with the gain diminishing at low elevations. This cross-section is representative of any vertical cross section over a 0 to 360 degree azimuth range and thus, the 3 dimensional gain pattern is a symmetric spheroidal surface. It is important to note that this gain pattern varies in elevation angle, but not in horizontal azimuth. This design is well-suited for many GPS applications, accommodating full sky coverage above the local horizon and minimizing ground reflected multipath effects.

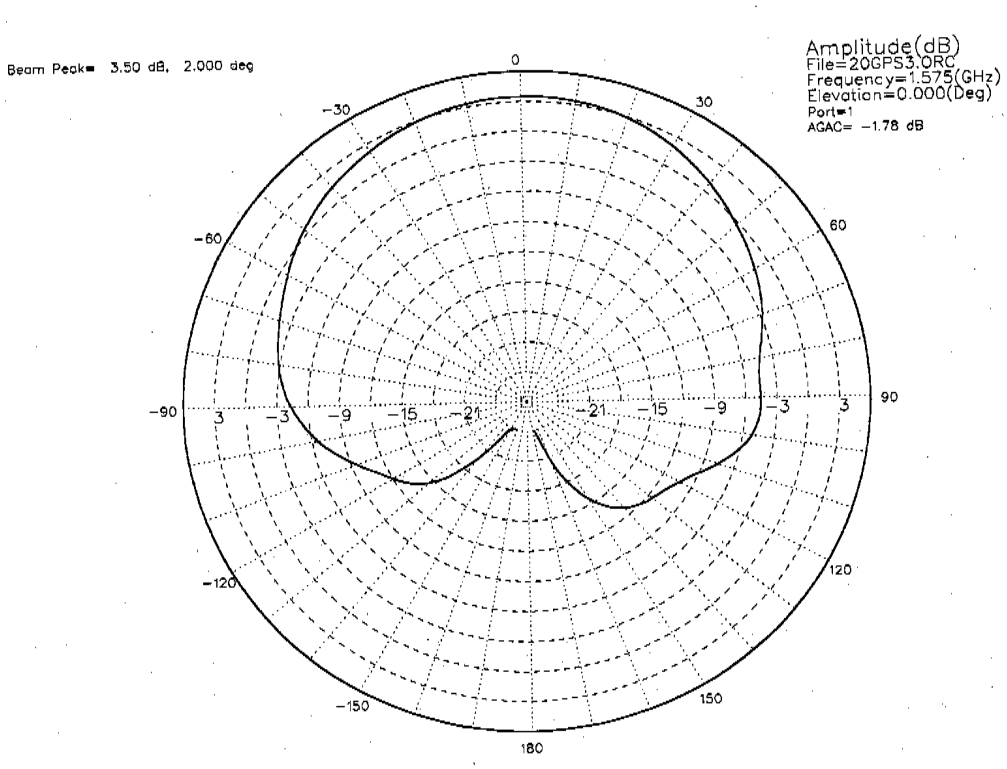


Figure 4.7: Typical Oncore Active HAWK Antenna Gain Pattern

Mechanical Dimensions

All dimensions are in mm. for reference purposes only.

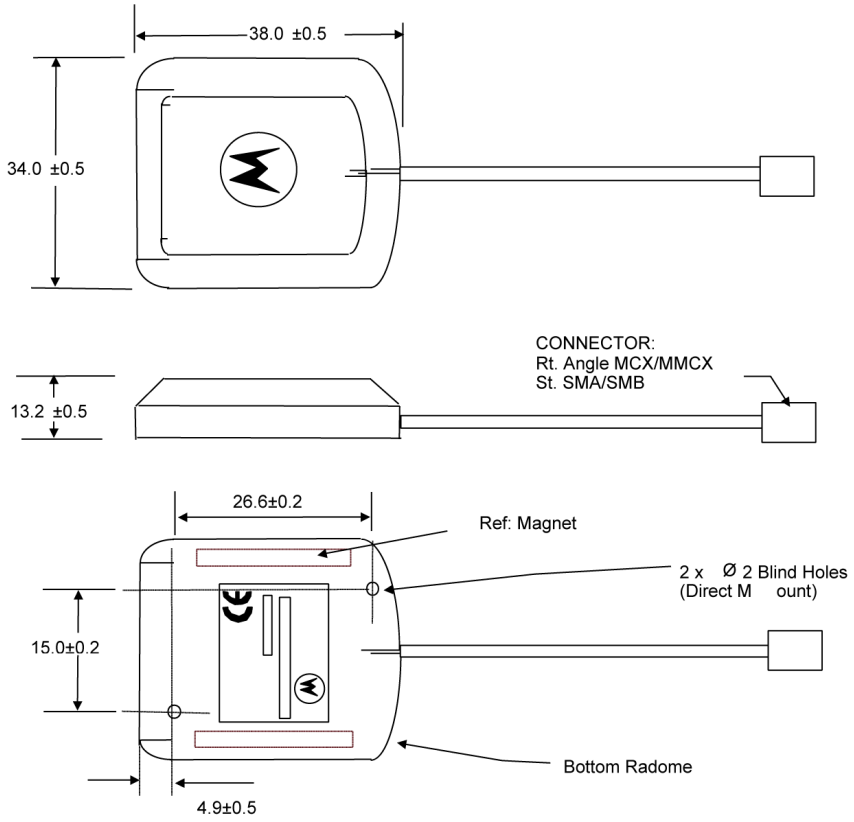


Figure 4.8: Magnet/Direct Mount Configuration

Mechanical Dimensions (Continued)

All dimensions are in mm. for reference purposes only.

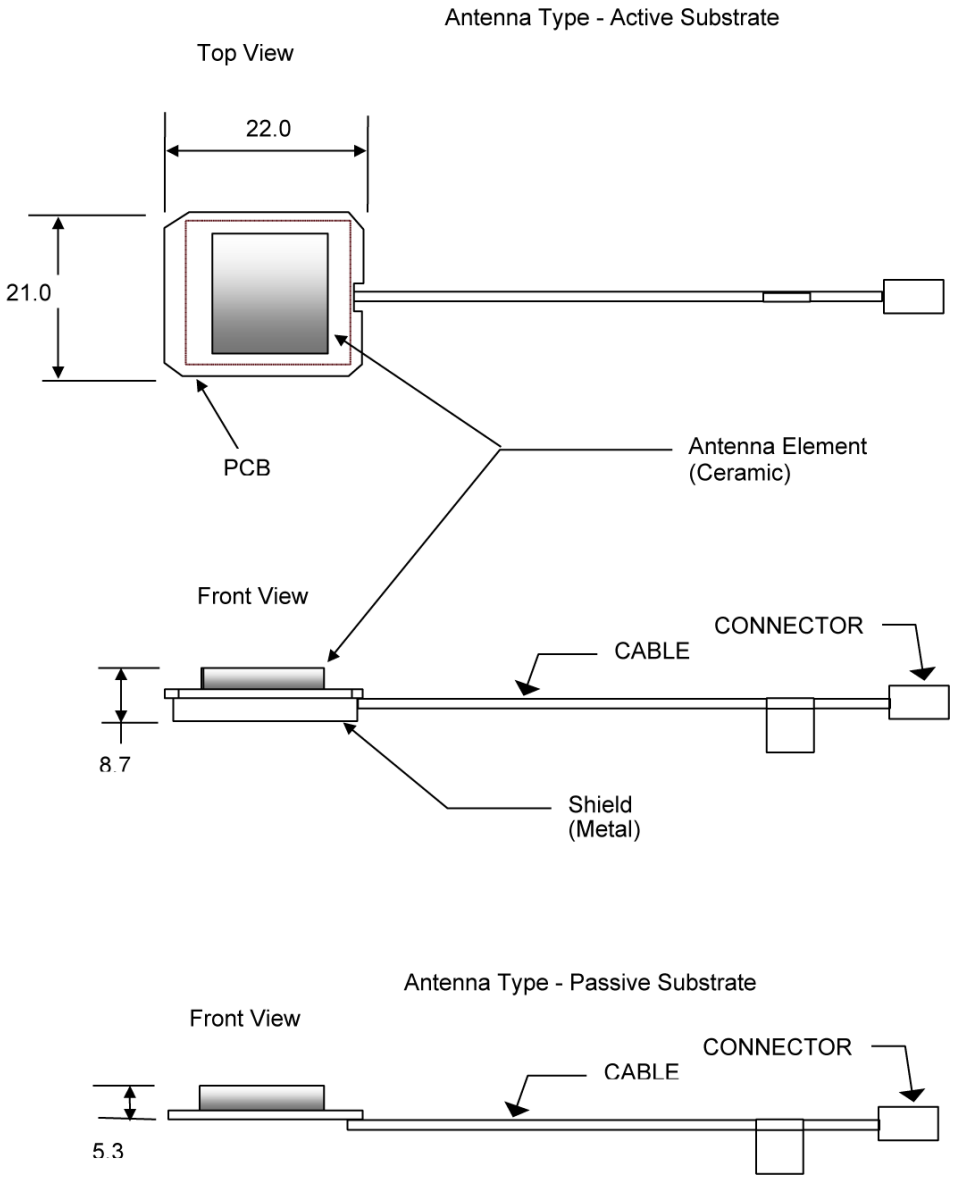


Figure 4.9: Active/ Passive Substrate Configuration

Mechanical Dimensions (Continued)

Notes:

1. For the magnet type GPS antenna - the full force of the GPS antenna, that is, straight upward vertical pull force is 1.5 kgf (minimum). Typically it is 1.8 kgf. This is a permanent/rare earth (Neodymium) type of magnet.

2. 2. Direct mount mounting plate is attached to antenna base using commercial grade 3M VHB: 4914 acrylic foam tape. VHB: 4914 foam joining is double coated acrylic foam with acrylic pressure sensitive adhesive on both sides. It provides static shear, peel adhesion and resistance to solvents, UV light and elevated temperature. Combined with the screw as a secondary method for securing the mounting plate (bracket) to the antenna base, VHB: 4914 tape passed all the qualification tests.

3. The minimum pull force that the cable/radome interface will withstand is 6 kg.

Recommended Mounting Hardware

The recommended screws are 6-32 (English) or M3x0.6 (metric) for securing the mounting bracket onto the attached surface or plate. The suggested hole size is from 3.05 to 3.10 mm in diameter or as user feels appropriate.

Motorola Part Numbers

Table below shows the various mounting styles and types of connectors that are offered, also the Motorola model numbers and outline drawings are included in the table for reference.

Table 4.5

Motorola Part No./Type of Antenna	Motorola Model No.	Operating Voltage	Mounting Style	Length of Cable (mm)	Connecto r Style
01R43913L01 Active – 3Vdc	GC3LP272CA	3.0	Magnet/ Direct	5000 ± 70	BNC St.
01R43913L02 Active – 3Vdc	GC3LP275CA	3.0	Magnet/ Direct	5000 ± 70	Rt. angle SMB
02R43913L03 Active – 3Vdc	GC3LP273CA	3.0	Magnet/ Direct	5000 ± 70	St. SMA
01R43913L04 Active – 3Vdc	GC3LP279CA	3.0	Magnet/ Direct	5000 ± 70	MMCX Rt. angle
01R43913L05 Active – 3Vdc	GC3SU2790A	3.0	Magnet/ Direct	5000 ± 70	MMCX Rt. angle
01R43913L06 Active – 3Vdc	GC3LP223CA	3.0	Magnet/ Direct	203 ± 70	St. SMA

Table 4.6

Motorola Part No./Type of Antenna	Motorola Model No.	Operating Voltage	Mounting Style	Length of Cable (mm)	Connecto r Style
01R43913L20 Active – 5Vdc	GCNLP272CA	5.0	Magnet/ Direct	5000 ± 70	BNC St.
01R43913L21 Active – 5Vdc	GCNLP271CA	5.0	Magnet/ Direct	5000 ± 70	Rt. angle OSX/MCX
02R43913L22 Active – 5Vdc	GCNLP275CA	5.0	Magnet/ Direct	5000 ± 70	Rt. angle SMB
01R43913L23 Active – 5Vdc	GCNLP273CA	5.0	Magnet/ Direct	5000 ± 70	St. SMA
01R43913L24 Active – 5Vdc	GCNSU2750A	5.0	None	5000 ± 70	Rt. angle SMB
01R43913L25 Active – 5Vdc	GCNLP223CA	5.0	Magnet/ Direct	203 ± 10	St. SMA

Table 4.7

Motorola Part No./Type of Antenna	Motorola Model No.	Operating Voltage	Mounting Style	Length of Cable (mm)	Connecto r Style
01R43913L40 Passive– 5Vdc	GCNPA2390A	N/A	None	80 ± 10	MMCX Rt. angle

RF Connectors/Cables Information

This page covers the construction and electrical characteristics of the Shikoku [1.5DS-QEHV] coaxial cable which is a part of the GPS antenna assembly. This is very similar to the 50 ohm RG316 cable type. Figure shows the simplified views of this cable. The following table shows the key characteristics of this type of coaxial cable.

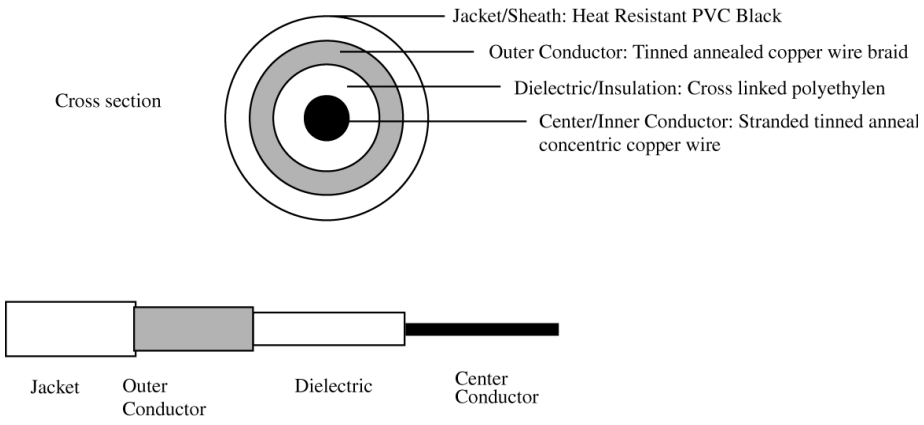


Figure 4.10

Cable Structure & Performance

Table 4.8 Characteristics of coaxial cable

Items:		Dimension	Specification
Center Conductor	Material		Tinned Annealed Copper Wire
	Diameter	mm	0.54 (7 strands of 0.18 mm)
Dielectric/Insulation	Material	-	Cross linked polyethylene
	Thickness	mm	0.53
	Outside Diameter	-	1.6
Outer Conductor	Material	-	Tinned annealed copper wire braid
	Outside Diameter	mm	2.1 (16x5 strands of 0.10)
Jacket Sheath	Material	-	Heat resistance black PVC
	Thickness	mm	0.5
	Finished of Diameter	mm	3.1 +/- 0.20
Approximate weight of cable		kg/km	15
Maximum inner conductor resistance (20°C)		ohm/km	120
Test voltage		V/min	1000
Minimum insulation resistance		Mohm-km	1000
Impedance		ohm	50 +/- 2
Minimum bend radius		mm	31
Operation Temperature Range		ºC	-40 to +105
Standard Attenuation		dB/m	0.91 at 900 MHz
		dB/m	1.26 at 1500 MHz
		dB/m	1.32 at 1600 MHz
		dB/m	1.50 at 1900 MHz
		dB/m	1.54 at 2000 MHz

Antenna Cable RF Connectors

The following RF Connectors are used to terminate cables of various Antenna models.

Table 4.9

Antenna Model No.	Antenna Cable Connector Type	Manufacturer	Manufacturer Part No.
GC3LP272CA	BNC St.	Amphenol	
GC3LP275CA	Rt. angle SMB	Amphenol	SMB-LP-1.5DQEHV
GC3LP273CA	St. SMA	Amphenol	SMA-SP-1.5DQEHV
GC3LP279CA	MMCX Rt. angle	Amphenol	MMCX-LP-1.5DV-CR
GC3SU2790A	MMCX Rt. angle	Amphenol	MMCX-LP-1.5DV-CR
GC3LP223CA	St. SMA	Amphenol	SMA-SP-1.5DQEHV

Table 4.10

Antenna Model No.	Antenna Cable Connector Type	Manufacturer	Manufacturer Part No.
GCNLP272CA	BNC St.	Amphenol	
GCNLP271CA	Rt. angle OSX/MCX	Amphenol	SMB-LP-1.5DQEHV
GCNLP275CA	Rt. angle SMB	Amphenol	SMA-SP-1.5DQEHV
GCNLP273CA	St. SMA	Amphenol	MMCX-LP-1.5DV-CR
GCNSU2750A	Rt. angle SMB	Amphenol	MMCX-LP-1.5DV-CR
GCNLP223CA	St. SMA	Amphenol	SMA-SP-1.5DQEHV

Table 4.11

Antenna Model No.	Antenna Cable Connector Type	Manufacturer	Manufacturer Part No.
GCNPA2390A	MMCX Rt. angle	Amphenol	

Environmental Tests

Provided below is an outline of the product durability and environmental specifications on the active GPS antenna assembly. Both magnet and mounting plate (bracket) style GPS antennas were qualified using the following test outline.

Durability Validation Tests

Type of Test	Test Description
Thermal cycling	Heat Cycle Test: Temp.: -40 to +100 ºC Power: on/off cycling
Thermal Shock	Thermal Shock Test: Temp.: -40 to +100ºC
Humidity	Heat/Humidity cycle Test: Cycling temp. -10 to 60ºC at 65 to 95% R.H. Moisture Resistance Test: Constant temp. at 60 ºC, 90% R.H.
High Temp. Tests	High Temp. Storage Test: at +100ºC . High Temp. Operating Test: Constant at +100 ºC
Low Temp. Tests	Low Temp. Storage Test: at -40 ºC. Low Temp. Operating Test: Constant at -40 ºC.
Vibration Test	Random Vibration Test: Ref. spec. no.: MIL STD 810E, Method 514.4. 7.7 G's RMS,1 hr per axis, all three axis.
Mech. Shock Test	Mechanical Shock Test: Ref. spec. no.: MIL STD 810E, Method 516.4, Procedure I modified. 30 G's/18 ms for min. 100 G's/10 ms for min.
Drop Test	Drop Test: Ref. spec. no.:MIL STD 810E, Method 516.4, Procedure IV modified. 1 meter drop onto concrete surface.
Shipping Drop Test	Shipping Drop Test
ESD Test	ESD Test: Test from 5 KV to 15 kV

Environmental Validation Tests

Type of Test	Test Description
Salt Spray	Salt Atmosphere Test: Spray 5% NaCL solvent (at 35 ºC).
Ultraviolet Radiation	Sunshine carbon arc system: This is a standard JIS D 0202 spec.
Chemical Compatability	Oil Resistant Test:
Immersion Test	Water Penetration Test: Module at 45°C immersed in 18°C water to a depth of 1 meter for one hour

Oncore Antenna Vibration Test Performance

Mechanical Vibration:

MIL SPEC 810E, Method 514.4: (Random Shock, 1 hour per axis)

Mechanical Shock:

Survival: 30G peak; 18ms duration - 300 pulses

100G peak, 10 ms duration - 10 pulses

ONCORE™ TIMING2000 ANTENNA

Figure 4.11: Timing2000 Antenna

ANTENNA DESCRIPTION

The Oncore Timing2000 antenna is intended for use in GPS Timing Applications and is designed for use with the Motorola's Oncore receivers as well as many GPS receivers from other manufacturers. GPS signals are received by the antenna, amplified within the antenna assembly, and then relayed via cable to the Oncore receiver module for processing. The conical Radome housing, Ultra Violet (UV) resistant material and a tubular mounting nut specially designed for ease of weatherproofing, assures superior performance while operating in the world's challenging weather environments.

Timing2000 Antenna Specifications

Table 4.12 Timing2000 Antenna Technical Characteristics

GENERAL CHARACTERISTICS	Antenna Description	Active microstrip patch antenna Molded UV- resistant plastic conical radome Aluminum die cast bottom housing Electrically shielded low noise amplifier assembly
	Operating Frequency	L1 (1575.42 MHz, +/- 2 MHz)
PERFORMANCE CHARACTERISTICS	Input Impedances	50 Ohm
	VSWR	1.5 (typical) @ 1575.42 MHz
	Bandwidth	25 MHz (typical) +/- 3dB points) Filtering is 40dB not4dB at +/- 50MHz
	Polarization	Right hand circular
	Azimuth Coverage	360°
	Elevation Coverage	0° to 90°
	Gain Characteristics of Antenna Element	+2.0 dBic minimum at zenith -10 dBic minimum at 0° elevation
	Filtering	4dB minimum @ +/- 50 MHz
	LNA Gain	25dB (typical)
	Noise Figure	< 1.5dB (typical)
	Dynamics	Vibration: SAE J1455
ELECTRICAL CHARACTERISTICS	Power Requirements	5 +/- 0.25 Vdc
	Power Consumption	26 mA @ 5 Vdc (typical)
PHYSICAL CHARACTERISTICS	Dimensions	102.0 diameter x 82.0 height (mm)
	Weight	312 grams
	Mount	Center mount (M28 nut)
	Connector	N-Connector (jack style)
ENVIRONMENTAL CHARACTERISTICS	Operating Temperature	-40°C to +85°C
	Storage Temperature	-40°C to +85°C
	Humidity	85% noncondensing +30°C to +60°C
	UV Radiation	JIS D0202 (Sunshine Carbon Arc System)
	Salt Spray Test	Spray 5% NaCl solvent at +35°C
	Immersion Test	1 meter (with connector sealed)
	Transient Voltage Test	+/- 12 kV
MISCELLANEOUS	Optional Features	Post Mount Bracket (MNT62312B1)
NOTE	All performance measurements are typical and referenced to 25°C unless indicated otherwise	

Antenna Gain Pattern

The sensitivity of an antenna as a function of elevation angle is represented by the gain pattern. Some directions are much more appropriate for signal reception than others, so the gain characteristics of an antenna play a significant role in the antenna's overall performance.

A cross-sectional view of the antenna gain pattern along a fixed azimuth (in a vertical cut) is displayed in the following figure. The gain pattern clearly indicates that the antenna is designed for full, upper hemispherical coverage, with the gain diminishing at low elevations. This cross-section is representative of any vertical cross section over a 0 to 360 degree azimuth range and thus, the 3 dimensional gain pattern is a symmetric spheroidal surface. It is important to note that this gain pattern varies in elevation angle, but not in horizontal azimuth. This design is well-suited for many GPS applications, accommodating full sky coverage above the local horizon and minimizing ground reflected multipath effects.

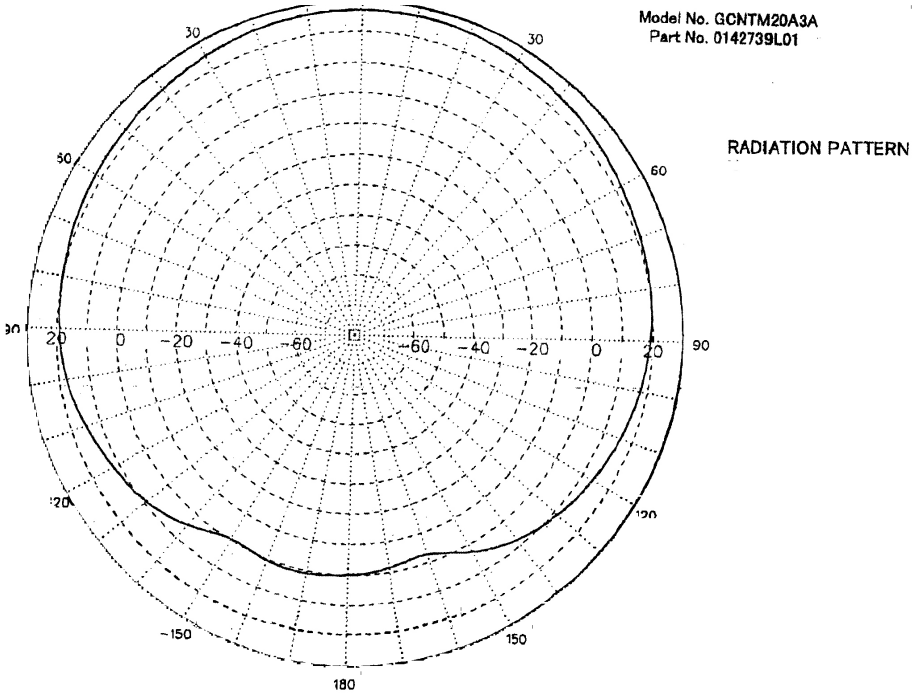


Figure 4.12: Typical Antenna Gain Pattern for ANT GCNTM20A3x

Mechanical Dimensions and Specifications

All dimensions are in mm. for reference purposes only.

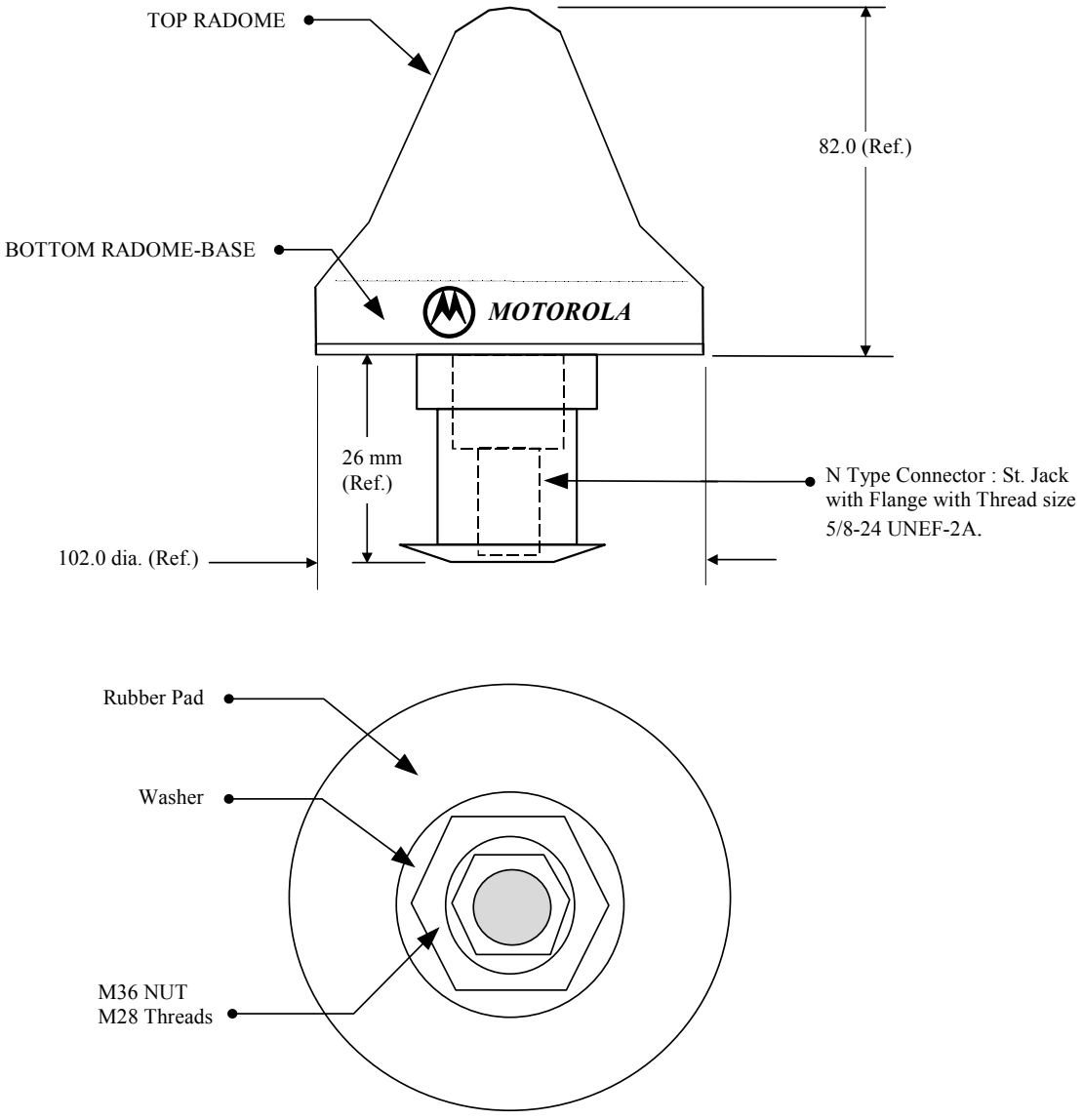


Figure 4.13: Timing2000 Antenna Specifications

Installation Precautions

The following precautions should be taken into consideration to avoid the introduction of hazards when installing the Timing2000 GPS Antenna.

- Mounting bracket must be grounded in accordance with the National Electric Code Section 810-21.
- Avoid contact with power lines; serious injury could result.
- Avoid making the antenna the highest point on the roof.
- Locate the antenna such that there is a 360° view of the sky.
- Do NOT place any obstructions over or around the antenna.
- For optimal performance, do NOT place the antenna inside a building.
- To prevent ESD damage to the antenna, do NOT touch the center pin on the antenna connector.
- Use only a 50 ohm transmission line when connecting to the antenna.
- Do NOT apply more than 5 VDC to the center pin of the Timing2000 antenna.
- Use one GPS receiver for one GPS Antenna.

M12 Timing Antenna Mounting

The Timing2000 is installed with a center-mounting scheme. It uses an industry standard N-connector that is incorporated with the Motorola post mount bracket.

The minimum torque to assemble the antenna and custom hex nut on the post mount bracket is 70 kgf-cm (61 in-lb); do not exceed 100 kgf-cm (86.8 inch-lbf). It is recommended that an adjustable wrench with an opening of 1½ inches be used for this assembly. For optimal performance, ensure that the base of the antenna is positioned as close as possible to the top of the mounting pole. Select a mounting location with a clear view of the sky (360°) and use extreme caution when mounting near high voltage power lines

Figure shows the exploded view of the custom hex nut onto the GPS Timing2000 Antenna using a bracket.

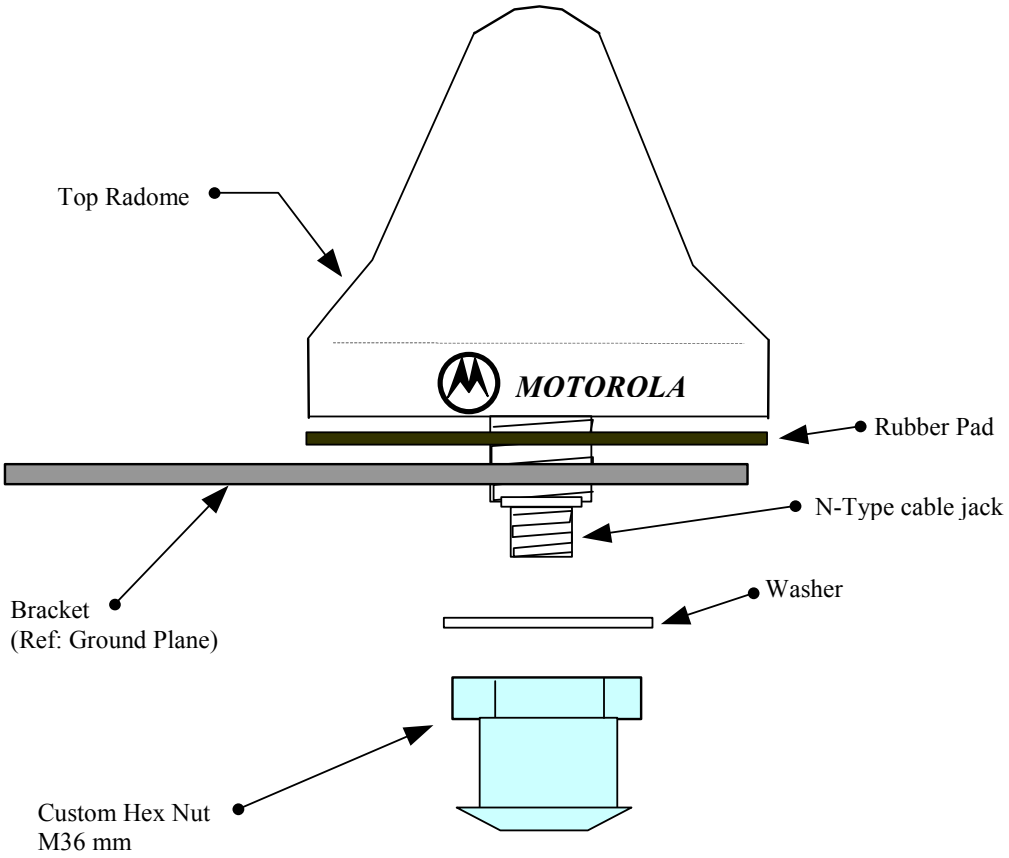


Figure 4.14: Antenna Assembly with bracket

M12 Timing Antenna Mounting (Continued)

It is recommended that the following mounting bracket (Motorola model #: MNT62312B1), designed specifically for the Timing2000 antenna, be used when installing the antenna. It can be used to install the Timing2000 antenna to a 1inch nominal size pipe. Mounting instructions for installing to a ¾ inch pipe are included. The four units included in the mounting assembly are the U bolt, post mount bracket, lock washer and hex nut as illustrated in the figure.

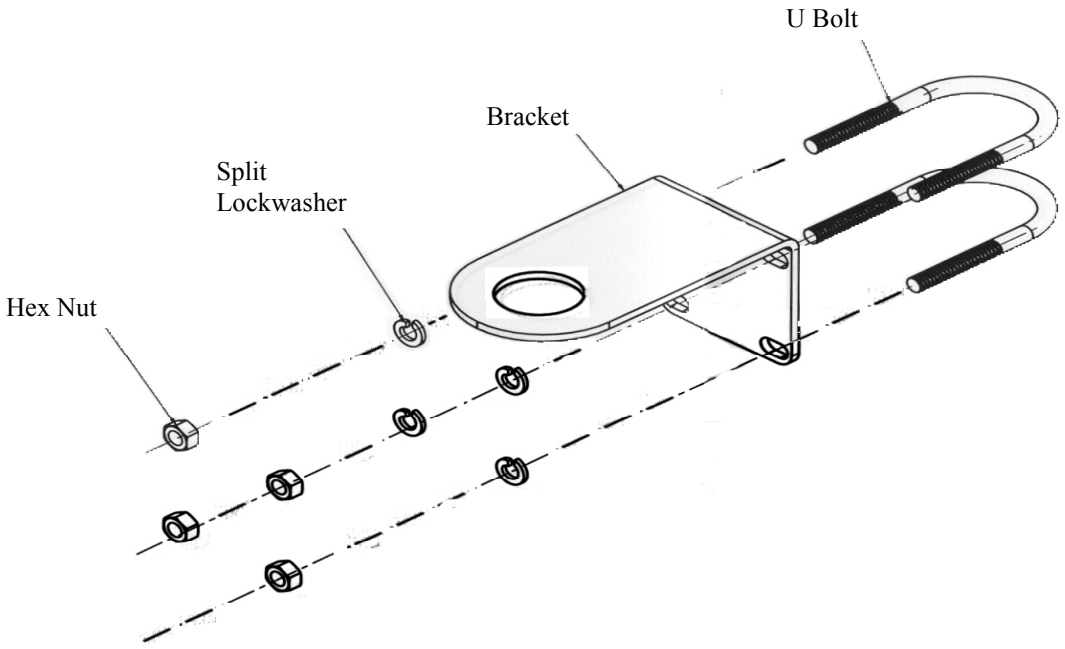


Figure 4.15: Exploded View of Motorola Mounting Bracket (MNT62312B1)

M12 Timing Antenna Mounting (Continued)

Antenna Mount to a 1 Inch Nominal Pipe

Figure below details the installation of the Timing2000 antenna assembly to a 1 inch nominal pipe with the Motorola mounting bracket (MNT62312B1). The recommended maximum torque for this installation is 25 inch-lbf.

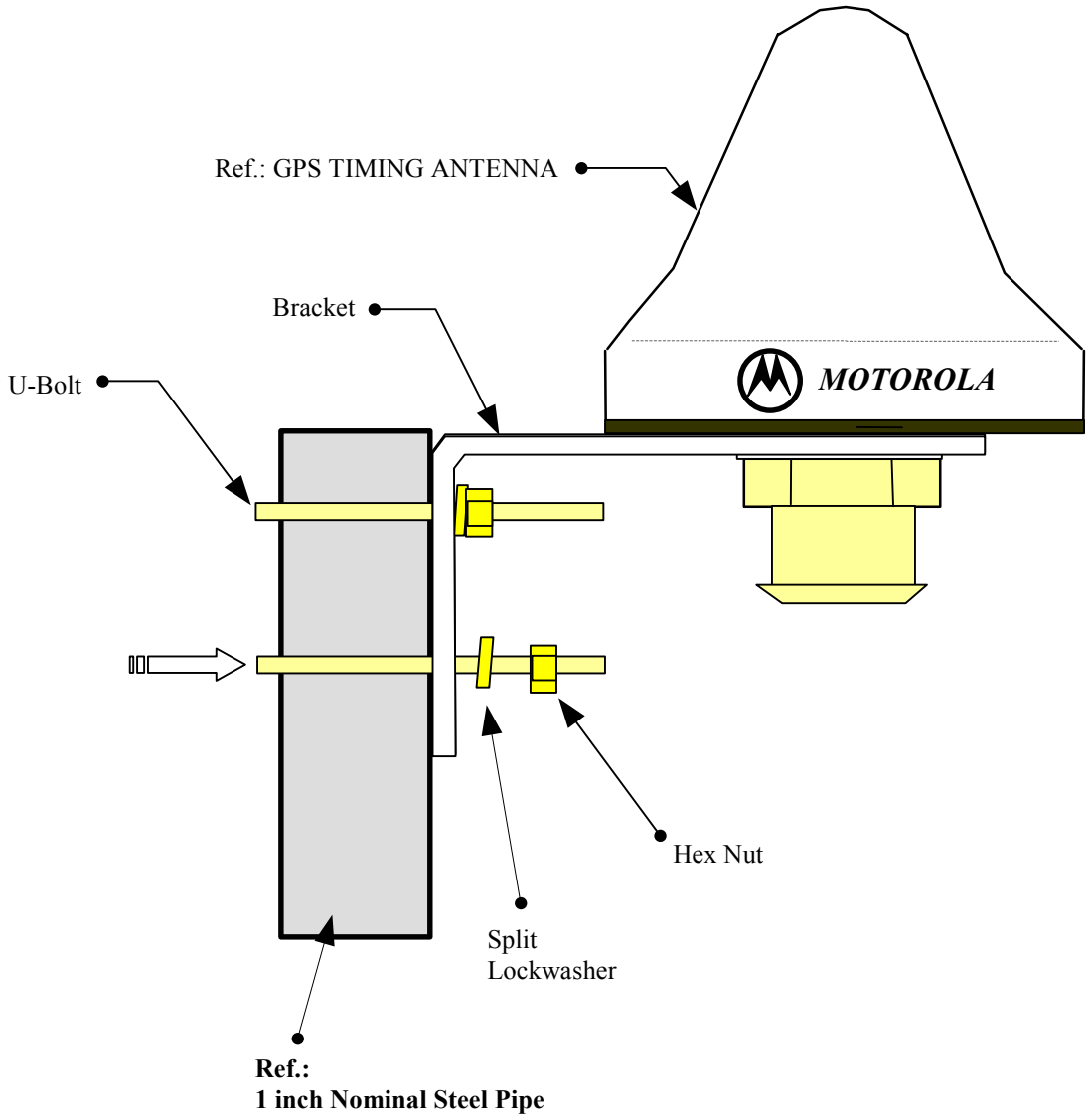


Figure 4.16: Timing2000 antenna installation to a 1 inch nominal pipe

M12 Timing Antenna Mounting (Continued)

Antenna Mount to a 3/4 Inch Nominal Pipe

The MNT62312B1 bracket kit is designed to mount to a 1 inch nominal pipe. However, four round, unthreaded ½ inch long nylon spacers (actual outside diameter 0.742 in. and inside diameter ¼ in.) can be used to install the Timing2000 antenna to a ¾ inch nominal pipe. The fours spacers are not supplied with the bracket kit but they can be purchased through local hardware stores. It is highly recommended that the spacers be of nylon (plastic) material. The recommended maximum torque for this installation is 20 in-lbf.

Figure below shows an exploded view of how the spacers are assembled together with the hardware package.

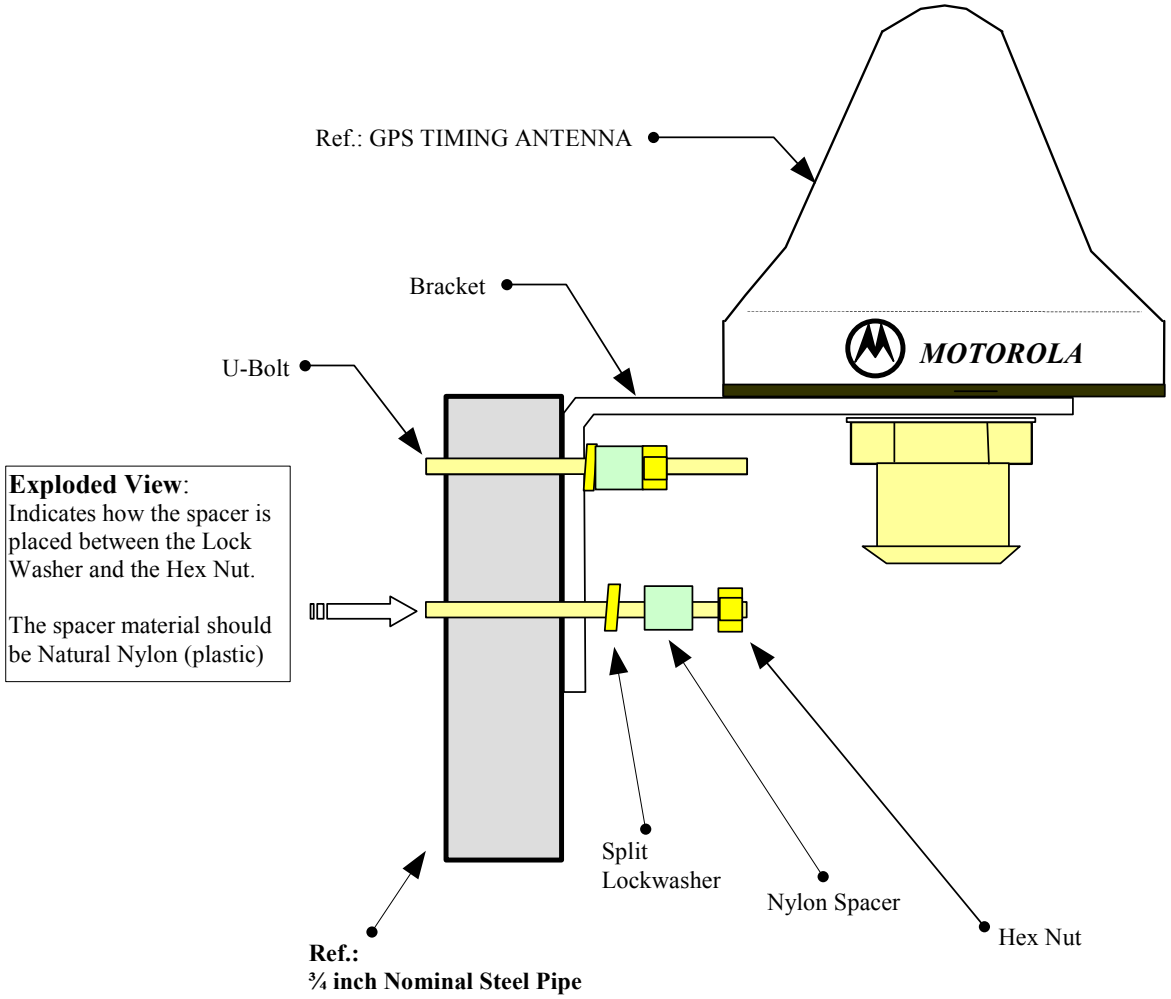


Figure 4.17: Timing2000 antenna installation to a 3/4 inch nominal pipe

M12 Timing Antenna Mounting (Continued)

Timing 2000 Antenna and Extreme Weather and Environmental Conditions

To provide additional protection against extreme weather and environmental conditions, a plastic pipe tubing is recommended. This tubing should be secured to the mounting nut of the antenna assembly and should extend to the mating N-type cable plug. A product similar to Armstong's Armaflex Pipe Insulation Tubing products is recommended. More information on this product can be found at www.armaflex.com. Figure below shows a pictorial overview of this recommendation.

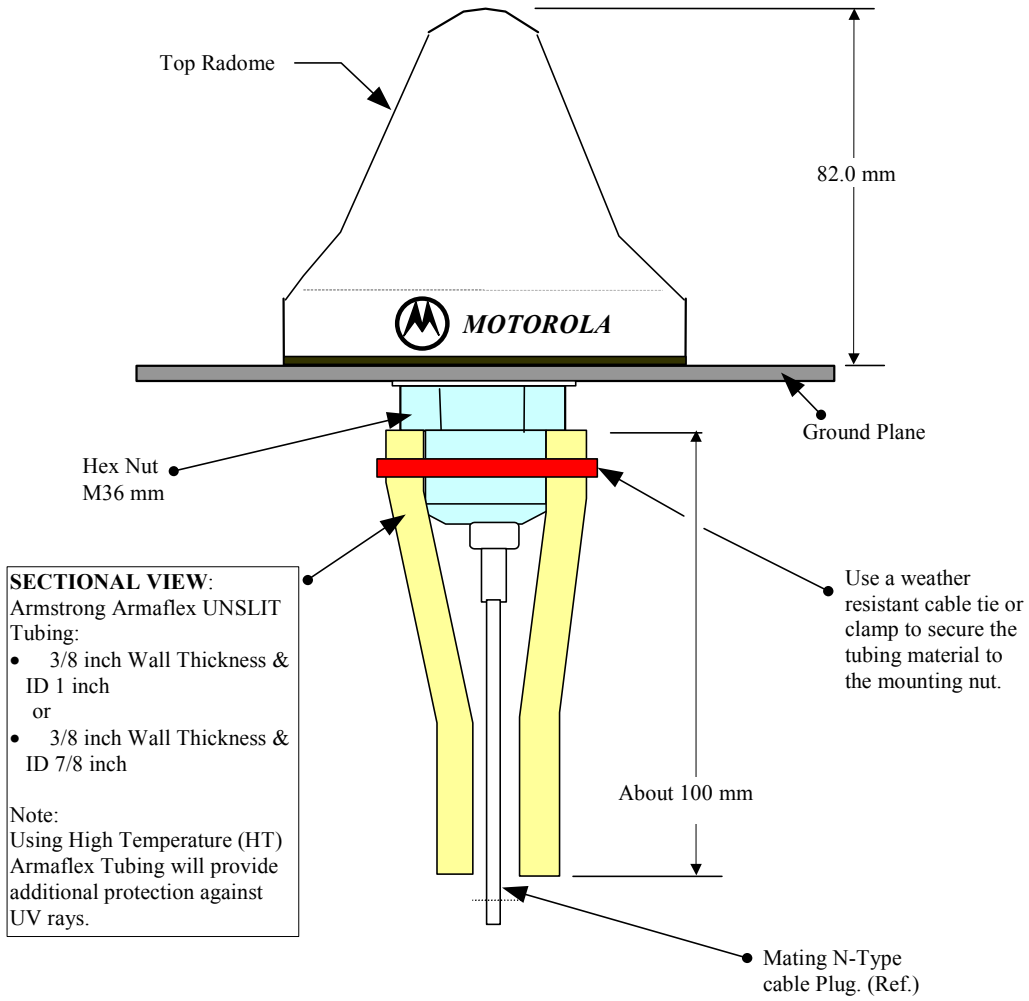


Figure 4.18: Timing2000 antenna with extra environmental protection

Cable and Connector Requirements

The antenna module consumes five-volt power diplexed from the interconnecting coaxial cable. It relays received GPS signals and receives power (5Vdc) from the receiver module via a single cable.

A 50 ohm coaxial cable is recommended for proper connection of the antenna module to the receiver module. Note that for the Motorola receivers, the cable loss along the cable should not exceed 16 dB at a frequency of 1575.42 MHz (GPS – L1). For RG-58 cables, the maximum cable length is restricted to 16m to satisfy this 16 dB requirement.

The Timing2000 antenna uses an industry standard N connector. Weatherproof mating N-connectors are required to ensure a water resistant seal. Some suggested cable connector vendors are:

- AMP
- Andrew
- Huber + Suhner

Environmental Tests

Provided below is an outline of the product durability and environmental specifications on the Timing2000 antenna assembly to which it was qualified.

Durability Validation Tests

Type of Test	Test Description
Thermal cycling	Cycle Test: 600 hours Temp.: -40 to +85 ºC
Thermal Shock	Cycle Test: 200 hours Temp.: -40 to +85ºC
Humidity	Cycle Test: 240 hours Cycling temp. -30 to +60ºC at 85% R.H.
High Temp. Tests Low Temp. Tests	High Temp. Storage Test: +85ºC . Low Temp. Storage Test: -40 ºC.
Vibration Test	Ref. spec. no.: MIL STD 810E, Method 516.4, procedure IV modified.
Drop Test	Ref. spec. no.:MIL STD 810E, Method 516.4, procedure IV modified. 1 meter drop onto concrete surface.
Shipping Drop Test	1 meter drop onto concrete surface one corner three edges all six faces
ESD Test	Test from 5 KV to 15 kV
Leakage Test	Immersion Test: Module (not powered) stabalized at 45 ºC is immersed in 18 ºC water for 20 minutes (depth 1 meter)
Salt Spray	Spray 5% NaCl solvent (at 35 ºC)
Chemical Compatability	Liquid household laundry detergent: (diluted with water 50/50) Liquid automobile wax Automobile vinyl top cleaner Kerosene Isopropyl Alcohol
Ultraviolet Radiation	Sunshine carbon arc system (JIS D 0202)
Voltage Transient Test	Max Voltage: ± 12 kV Max Capacitance: 1000pF 3 transient discharges applied in each polarity; to antenna top radome, bottom housing, and RF connector

ONCORE™ ACTIVE GPS ANTENNA

Figure 4.19: Antenna shown with 6m of cable and BNC connector

ANTENNA DESCRIPTION

The Oncore active GPS antenna is designed to operate with Motorola's successful family of Oncore GPS receivers, as well as many GPS receivers from other manufacturers. The antenna design reflects Motorola's high standard for performance when operating in foliage/urban canyon environments and in the presence of electromagnetic interference, while drawing only 20 milliamps at 5 Vdc, diplexed from the interconnecting coaxial cable.

The small footprint, low profile package and the shielded LNA (low noise amplifier) offers significantly enhanced performance while operating in a variety of GPS environments. Furthermore, magnetic and direct mount options make the antenna suitable for a number of different installation configurations. Moreover, the OEM or system integrator can count on signal gain and noise figure performance over an ambient operating temperature range which leads the industry.

Active GPS Antenna Specifications

Table 4.13 Active GPS Antenna Technical Characteristics

General Characteristics	Antenna Description	Low profile active microstrip patch antenna Molded plastic radome Electrically shielded LNA PWB assembly
	Operating Frequency	L1 (1575.42 MHz, +/- 1.0233 MHz)
Performance Characteristics	Input Impedances	50 Ohm
	VSWR	1.5 (typical) @ 1575.42 MHz
	Bandwidth	45 MHz @ 3 dB points (typical)
	Polarization	Right hand circular
	Azimuth Coverage	360 degrees
	Elevation Coverage	0degrees to 90 degrees
	Gain Characteristics of Antenna Element	-25dBic minimum at zenith (typical) -10 dBic minimum at 0 degrees elevation (typical)
	Filtering	-25 dB @ 1670 MHz (typical) -25 dB @ 1480 MHz (typical)
	LNA Gain	24 dB (typical, including 6 dB cable loss)
	Noise Figure	1.8 dB (typical)
	Burnout protection	Protected from damage by RF signals, when the power received by the antenna is no greater than +17 dBm absolute maximum
	Dynamics	Vibration: 7.7G per Military Standard 810E Method 514.4 Shock: 100G (18 ms sawtooth) Military Standard 810E Method 516.4
Electrical Characteristics	Power Requirements	5 ± 0.25 V; 50 mVp-p ripple (maximum)
	Power Consumption	20 mA @ 5 Vdc (typical)
Physical Characteristics	Dimensions	49.6 L x 43.0 W x 18.0 H mm 33.3 L x 29.8 W x 8.8 H mm (Substrate w/shield)
	Weight	< 40 grams (housed assembly, less cable)
	Cable Connectors	90 degree OSX/MCX (subminiature push on) BNC Call for other connector types (SMB, GT5…)
	Antenna to Receiver Interconnection	Single RG-174U type coaxial cable 6 meters (20 ft.) long (10 dB maximum loss) at 1575.42 MHz) Single RG-174U type coaxial cable 203 mm (8 in.) long
Environmental Characteristics	Operating Temperature Storage Temperature	-40ºC to +100ºC -40ºC to +100ºC
	Humidity	95% non-condensing +30ºC to +60ºC
	UV Radiation	1200 hrs. @ +63ºC w/rain @ 12 min./hr.
	Salt Spray Test	Spray 5% NACl solvent at +35ºC for 320 hrs.
Miscellaneous	Optional Features	Mounting options: -Magnetic mount Direct mount Substrate: patch antenna and shielded LNA on PWB with 6 meters of RG-316U type coaxial cable with 90 degree OSX/MCX connector

Antenna Gain Pattern

The sensitivity of an antenna as a function of elevation angle is represented by the gain pattern. Some directions are much more appropriate for signal reception than others, so the gain characteristics of an antenna play a significant role in the antenna's overall performance.

A cross-sectional view of the antenna gain pattern along a fixed azimuth (in a vertical cut) is displayed in the following figure. The gain pattern clearly indicates that the antenna is designed for full, upper hemispherical coverage, with the gain diminishing at low elevations. This cross-section is representative of any vertical cross-section over a 0 to 360 degree azimuth range and thus, the 3 dimensional gain pattern is a symmetric spheroidal surface. It is important to note that this gain pattern varies in elevation angle, but not in horizontal azimuth. This design is well-suited for many GPS applications, accommodating full sky coverage above the local horizon and minimizing ground reflected multipath effects.

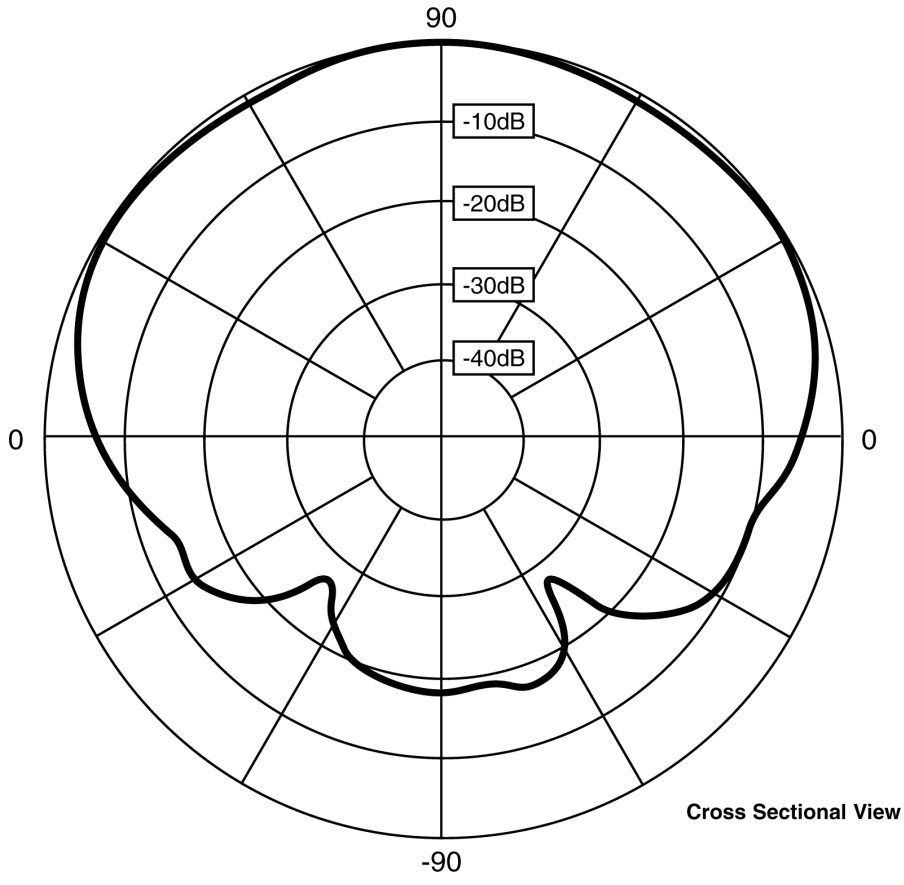


Figure 4.20: Typical Oncore Active GPS Antenna Gain Pattern

Mechanical Dimensions

All dimensions are in mm. for reference purposes only.

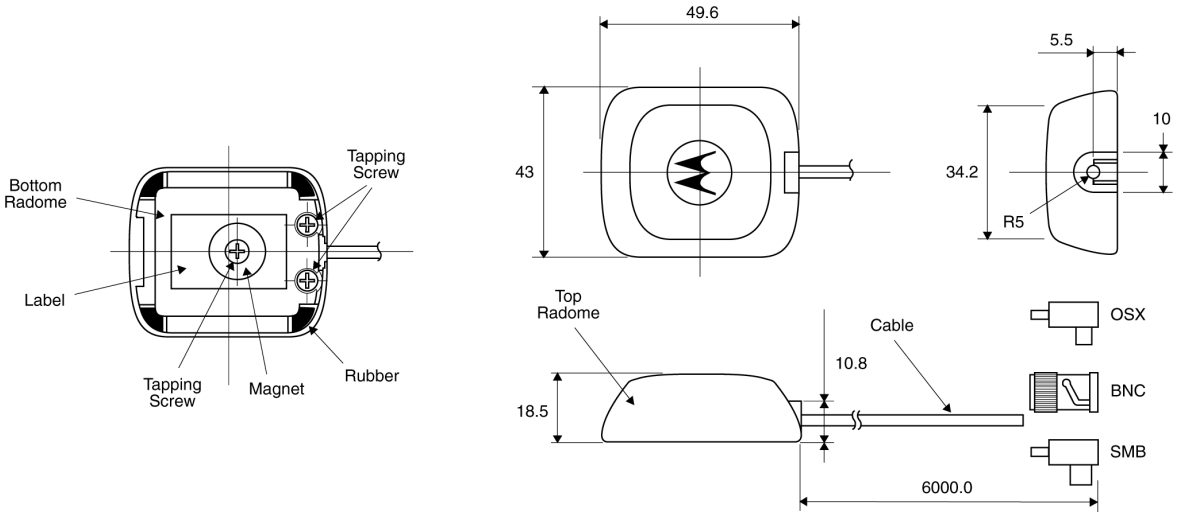


Figure 4.21: Magnetic Mount Configuration

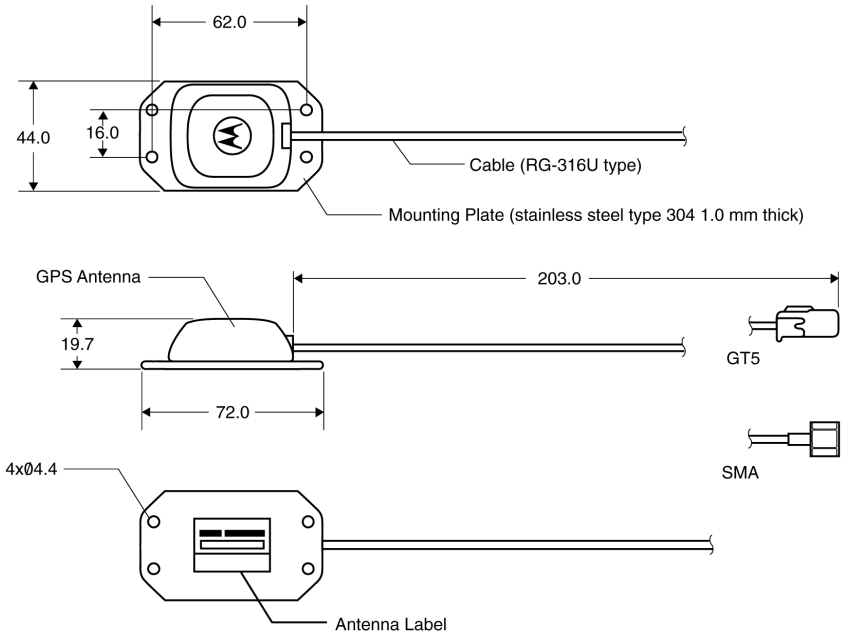


Figure 4.21: Direct Mount Configuration

Mechanical Dimensions (Continued)

Notes:

4. For the magnet type GPS antenna - the full force of the GPS antenna, that is, straight upward vertical pull force is 1.5 kgf (minimum). Typically it is 1.8 kgf. This is a permanent/rare earth (Neodymium) type of magnet.

5. 2. Direct mount mounting plate is attached to antenna base using commercial grade 3M VHB: 4914 acrylic foam tape. VHB: 4914 foam joining is double coated acrylic foam with acrylic pressure sensitive adhesive on both sides. It provides static shear, peel adhesion and resistance to solvents, UV light and elevated temperature. Combined with the screw as a secondary method for securing the mounting plate (bracket) to the antenna base, VHB: 4914 tape passed all the qualification tests (see Appendix B).

6. The minimum pull force that the cable/radome interface will withstand is 6 kg.

Recommended Mounting Hardware

The recommended screws are 6-32 (English) or M3x0.6 (metric) for securing the mounting bracket onto the attached surface or plate. The suggested hole size is from 3.05 to 3.10 mm in diameter or as user feels appropriate.

Motorola Part Numbers

Table 4.5 shows the various mounting styles and types of connectors that are offered, also the Motorola model numbers and outline drawings are included in the table for reference.

Table 4.14

Motorola Model No.	Mounting Style	Length of Cable (mm)	Connector Style
GCNAC1242X*	Mounting Plate (Bracket)	203 ±5	Hirose GT5
GCNAC1232X	Mounting Plate (Bracket)	203 ±5	Straight SMA plug
GCNAC1121X	Magnet	6000 ±70	BNC plug
GCNAC1111X	Magnet	6000 ±70	Right angle OSX/MCX plug
GCNSU1110X* Substrate	N/A	6000 ±70	Right angle OSX/MCX plug

*Special Order

Note: For Motorola model number GCNSU1110X, the GPS antenna will not have the top and bottom radome including the two screws and the rubber gasket. The label will be on the metal shield of the substrate assembly which will be the same size as the regular labels.

RF Connectors/Cables Information

This page covers the construction and electrical characteristics of the Sumitomo [H1.5D-SEXL] coaxial cable which is a part of the GPS antenna assembly. This is very similar to the 50 ohm RG174 cable type. Figure 4.10 shows the simplified views of this cable. Table 4.6 shows the key characteristics of this type of coaxial cable.

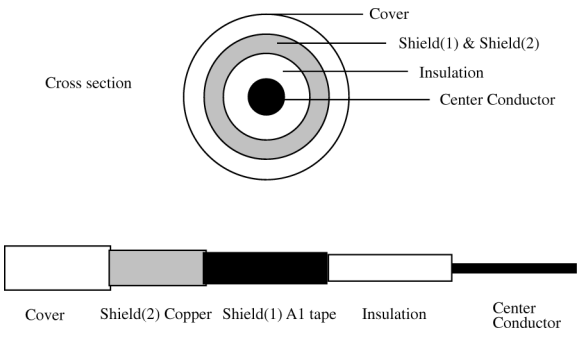


Figure 4.23

Cable Structure & Performance

Table 4.15 Characteristics of coaxial cable

Items:		Dimension	Specification
Center Conductor	Material		Tinned Annealed Copper Wire
	Diameter	mm	0.54 (7 strands of 0.18 mm)
Insulation	Material	-	Irradiated Polyethylene
	Thickness	mm	0.54
	Outside Diameter	-	1.62
Shield (1)	Material	-	Both side aluminium coated polyster tape
	Outside Diameter	mm	1.7
Shield (2)	Material	-	Tin coated copper wire braid
	Diameter of wire	mm	0.1
	Ends/Carriers	-	5/16
Cover	Material	-	Heat resistance black PVC
	Thickness	mm	0.39
	Outside Diameter	mm	3.0 +/- 0.20
Conductance		M/km	Less than 105
Non-Conductance		M/km	More than 1100
Capacitance		pF/m	110 typ.) at 1 kHz
Impedance		ohm	50 +/- 2
Operation Temperature Range		ºC	-40 to +105
Storable Temperature Range		ºC	-40 to +105
Attenuation		dB/m	Typical 0.73 at 900 MHz
		dB/m	Maximum 0.84 at 900 MHz
		dB/m	Typical 0.94 at 1500 MHz
		dB/m	1.08 at 1500 MHz
		dB/m	Typical.1.21 at 1900 MHz
		dB/m	Maximum 1.21 at 1900 MHz

Antenna Cable RF Connectors

The following RF Connectors are used to terminate cables of various Antenna models.

Table 4.16 RF Connectors

Antenna Model No.	Antenna Cable Connector Type	Manufacturer	Manufacturer's Part No.
GCNAC1232X*	SMA	PHOENIX / PELCO	20-0200-0670P
GCNAC1242X	GT-5	HIROSE	559-0078-2 559-0108-1
GCNAC1121X	BNC	M/A-Com	3201-7388-10/ 3231-7399-10
GCNAC1111X	OSX	PHOENIX PELCO	13-2800-0670

Contact the following Companies for information on mating connectors:

Phoenix/Pelco	(800) 323-9562 or (630) 595-2300
M/A Com	(800) 366-2266 or (847) 776-0700
Hirose	(805) 522-7958
LoDan Electronics	(847) 398-4995

Environmental Tests

Provided below is an outline of the product durability and environmental specifications on the active GPS antenna assembly. Both magnet and mounting plate (bracket) style GPS antennas were qualified using the following test outline.

Durability Validation Tests

Type of Test	Test Description
Thermal cycling	Heat Cycle Test: Temp.: -40 to +100 ºC Power: 5V DC on/off cycling
Thermal Shock	Thermal Shock Test: Temp.: -40 to +100ºC
Humidity	Heat/Humidity cycle Test: Cycling temp. -10 to 60ºC at 65 to 95% R.H. Moisture Resistance Test: Constant temp. at 60 ºC, 90% R.H.
High Temp. Tests	High Temp. Storage Test: at +100ºC . High Temp. Operating Test: Constant 5V DC at +100 ºC
Low Temp. Tests	Low Temp. Storage Test: at -40 ºC. Low Temp. Operating Test: Constant 5V DC at 40 ºC.
Vibration Test	Random Vibration Test: Ref. spec. no.: MIL STD 810E, Method 514.4. 7.7 G's RMS,1 hr per axis, all three axis.
Mech. Shock Test	Mechanical Shock Test: Ref. spec. no.: MIL STD 810E, Method 516.4, Procedure I modified. 30 G's/18 ms for min. 100 G's/10 ms for min.
Drop Test	Drop Test: Ref. spec. no.:MIL STD 810E, Method 516.4, Procedure IV modified. 1 meter drop onto concrete surface.
Shipping Drop Test	Shipping Drop Test
ESD Test	ESD Test: Test from 5 KV to 15 kV

Environmental Validation Tests

Type of Test	Test Description
Salt Spray	Salt Atmosphere Test: Spray 5% NaCL solvent (at 35 ºC).
Ultraviolet Radiation	Weather Resistance Test: This is a standard JISD spec. Temp. of panel 63 ºC
Chemical Compatability	Oil Resistant Test:
Rain Test	Water Proofing Test: at 80 ºC, spray water at 600 mm/hour for one hour

Oncore Antenna Vibration Test Performance

Mechanical Vibration:

MIL SPEC 810E, Method 514.4: (Random Shock, 1 hour per axis)

Mechanical Shock:

Survival: 30G peak; 18ms duration - 500 pulses

100G peak, 10 ms duration - 10 pulses