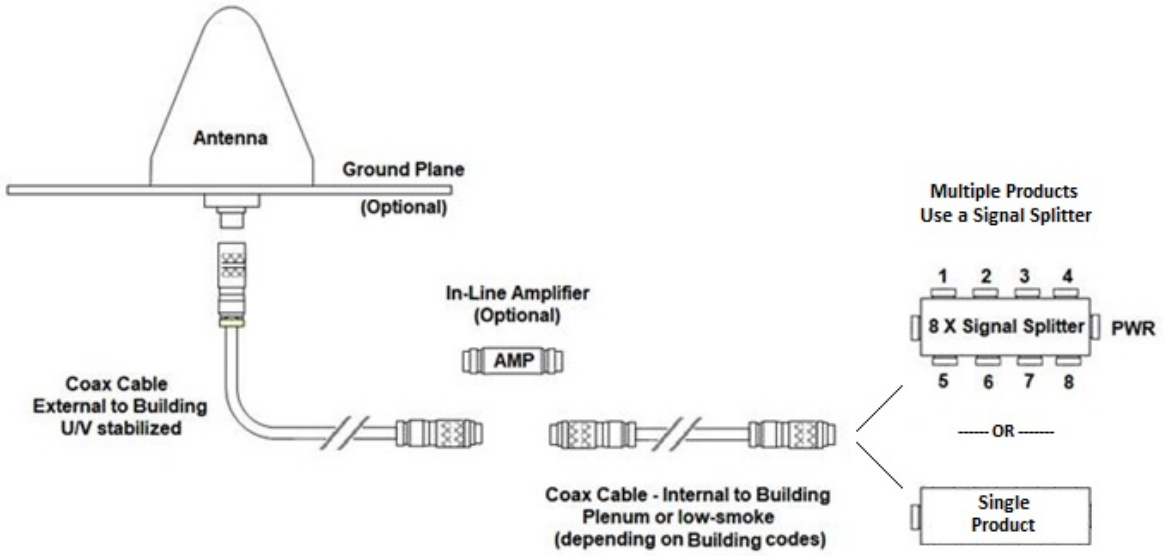
SYNERGY SYSTEMS, LLC
*Time proven products and support®*

6 January 2021

# GPS and Multi-GNSS Antenna Installation Considerations

**Background –** In the USA, GPS and Multi-GNSS antenna installations on commercial buildings are usually required to comply with the National Electrical Code; State, county, and local city fire codes; commercial building codes and local labor laws. There are similar requirements in other countries.

GPS and Multi-GNSS antenna systems must be designed to provide signals within the specified input gain range required for Single or Multiple GNSS receivers or signal re-radiators. The following is an outline of a standard GPS, or Multi-GNSS, antenna system showing an optional Ground Plane for reducing multi-path signals. This design includes an 8-way splitter so up to eight receivers can operate simultaneously (2 way and 4-way splitters are optional). No signal splitter is required for supplying satellite signals to a single receiver.




## There are several Antenna System design decisions to be made depending on application.

### 1. Type of Antenna:

GPS antennas are in common use and remain the preferred choice for GPS only applications. As of 2010, however, many installations started using Multi-Band, Multi-Frequency (MB/MF) GNSS antennas even though receivers were not yet able to use their full, Multi-GNSS capabilities. It is better to spend slightly more for the MBMF antenna(s) now, than to modify an existing system later, usually at a much higher cost. Designing antenna systems for future requirements also allows for system upgrade at a lower future cost.

### 2. Antenna Gain:

GPS and Multi-GNSS Antennas must provide an overall gain sufficient to provide the selected receiver with signal levels within the receiver's input signal gain range – typically between 10 dB and 50 dB. Review the receiver manufacturer's, or re-radiator system requirements, for the receiver selected and design the combination of antenna gain and coax loss to provide a gain to the receiver ideally in the center of its gain range.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**3. Where and how to Locate and mount GPS and Multi-GNSS antennas:**

GPS and GNSS antennas used for Fixed position reference and precision timing applications are commonly mounted on top of a pole, using a pipe-clamp mount, or attached to a pole using a right angle bracket. Where possible, avoid locations where roof mounted air conditioning equipment and large diameter HVAC air ducts are mounted. On an open roof, a Tripod, or an elevated pipe-mount, may be needed to keep the antenna above Metal, and other reflective obstructions, to avoid or reduce multi-path signal reflections. Where these obstructions exist, a Ground Plane can be installed directly underneath the antenna (see Addendum).

In general, it is best not to co-locate GPS\GNSS antennas in close proximity to RF radiators. When an antenna is located too close to a radiating antenna, of whatever power or frequency, there is a very real possibility of the Low Noise Amplifier (LNA) in antennas being overloaded by a transmitting antenna. This condition either degrades or prevents the already weak GPS\GNSS satellite signals from reaching the receiver, or re-radiator unit, inside the structure. In some cases, determining the frequency and power of a transmitting antenna, from either a near or distant source, may be required to insure that an interfering signal, either fundamental or harmonic (such as Radio and TV stations or Airport Radar) will not affect receiver performance. Antennas with a 3 pole, narrow bandwidth filter are required in these situations.

There is also the potential for multiple GPS\GNSS antenna installations to experience antenna to antenna interference. It is possible that a receiver's 1st local oscillator to "leak" out of the antenna and interfere with other GPS\GNSS antennas mounted in very close proximity. To avoid costly installation mistakes, multiple GPS\GNSS antennas can be temporarily mounted close together and the receivers tested for optimum performance prior to establishing fixed mounting locations.

**4. Antenna Signal Splitters:**

The antenna system portrayed above uses either a direct connection to the receiver or, an 8-way splitter for additional receivers. In a multiple receiver installation, a 2-way or 4-way splitter can be installed to save a little on initial cost, but it is a small part of the total system cost especially if additional receivers are to be added in the future. In either case, the splitter should be an active type with high-isolation, better than 40dB, and unity-gain. When deploying this type of antenna system, a splitter with at least two extra signal outputs is recommended to cover future expansion and\or unforeseen requirements.

**5. Antenna system protection:**

Not shown in the graphic below are methods for installing lightning arrestors and surge suppressors. Two suppressors are typically installed; one near the receiving antenna and the other at the point where the coax cable enters a building. Arrestors are available from companies like PolyPhaser, Huber+Suhner, etc.

**6. Coax Cable Considerations:**

A big consideration is establishing the need for passing coax cables through multiple, in-building bulk-heads and\or roof or floor interfaces. If bulk-head connectors are needed to pass through these interfaces, the total loss of the coax connectors employed at those interfaces will have to be calculated so the antenna gain can be properly chosen for the installation. A loss of 1/2 dB per connector is a conservative estimate. Below are some antenna system cabling options. Some of them introduce several dB of connector losses in the coax cabling system. The antenna gain, coax cable size and type are chosen after one of the installation configurations shown below, or an alternate, is chosen.


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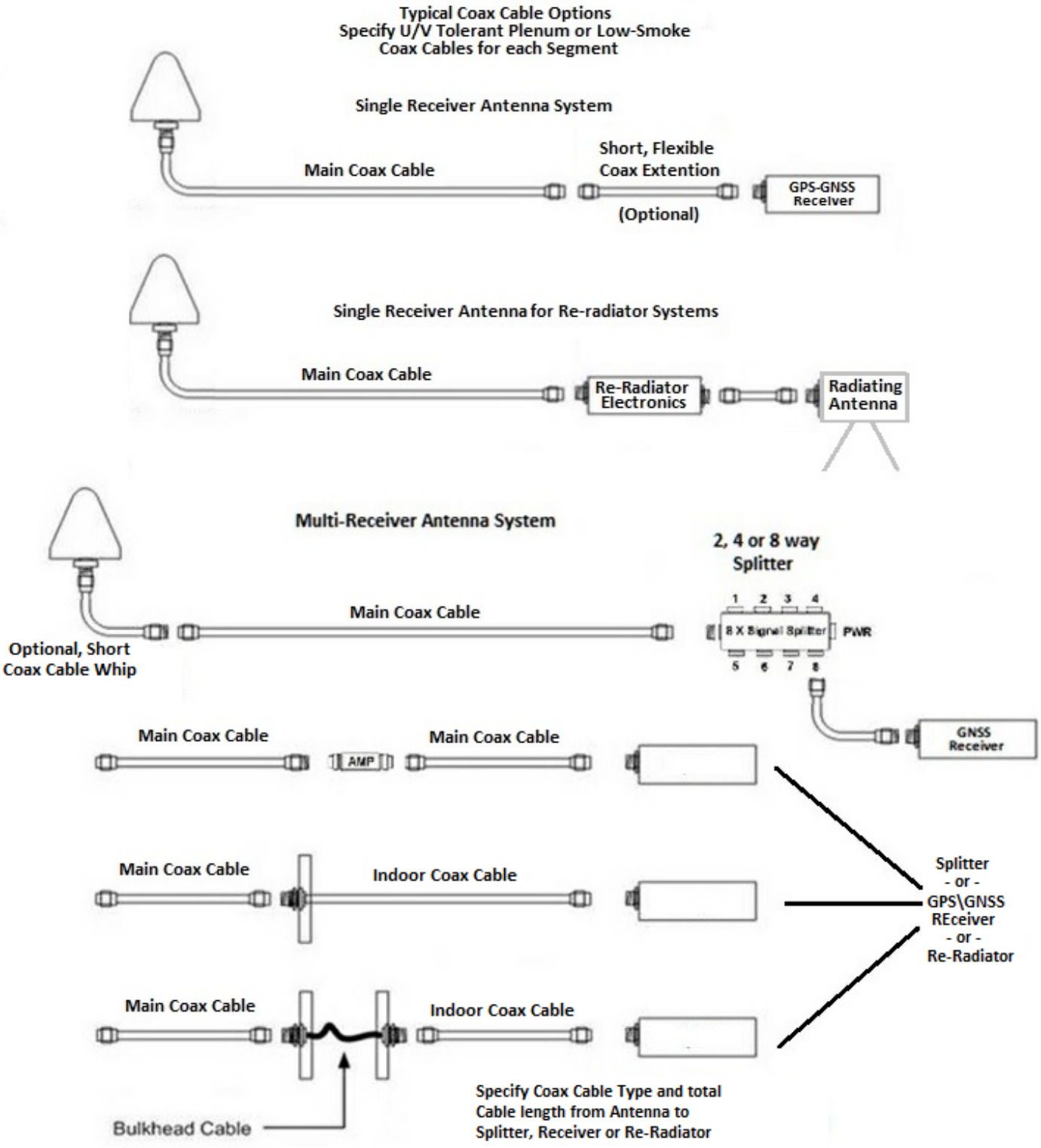



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**7. Signal Splitter for Multiple Receivers:**

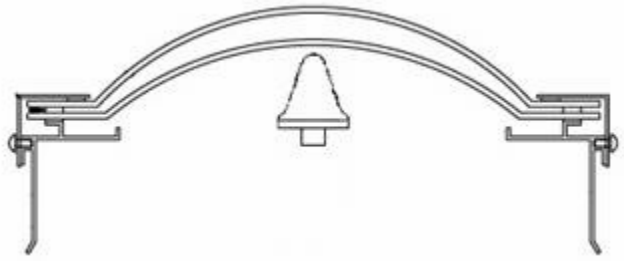
Determine the distance between the (a) antenna and splitter and (b) the splitter to the GPS or Multi-GNSS receiver(s). This will help determine the coax cable loss characteristics required, and thus the diameter, of coax cable to be used.

**8. In-Line Signal Amplifiers:**

While in-line amplifiers may be necessary for some antenna systems using very long (200 ft – 300 ft) coaxial cables, they add cost and contribute to total antenna system noise and power requirements. Specifying a higher gain antenna, and/or a lower loss, larger diameter coax cable, can help provide the required gain in many installations without adding amplifier induced noise or cost. Non-Amplified, coax cable only antenna systems also increase reliability due to fewer active components being used in the overall system.

**9. Inside Building Installations:**

Windowsill locations can provide a temporary location for testing but permanent antenna placement in existing skylights, with appropriate supports to mount antennas, provide much better GPS\GNSS satellite signals. Here is a sketch of a skylight antenna installation at Synergy.



**10. Using GPS\GNSS antennas with signal re-radiators:**

Signal re-radiating systems have become popular for providing GPS\GNSS signals at multiple indoor locations. Signal re-radiating antennas have lobes that spread the re-radiating GPS\GNSS signals unevenly within their coverage area. After the GPS\GNSS antenna is installed, and the re-radiating antenna placed, a hand-help GPS locating device, with a signal strength indicator, can be used to determine optimum signal strength locations where reception is optimal.

**Summary** - It is not unusual to encounter situations during installation that can negatively affect system performance. Those “unknown” situations can be minimized by considering the above during the antenna installation planning process.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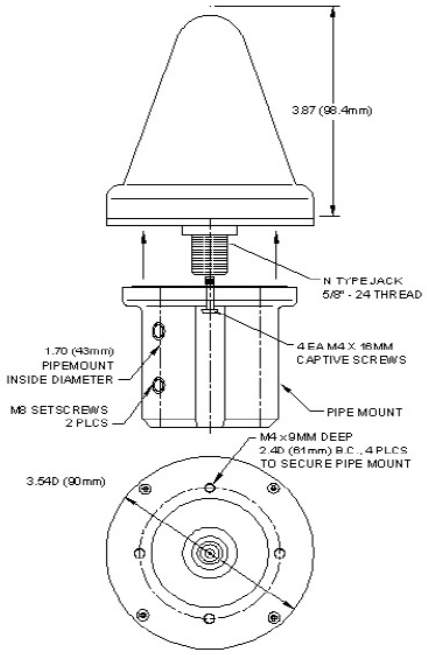
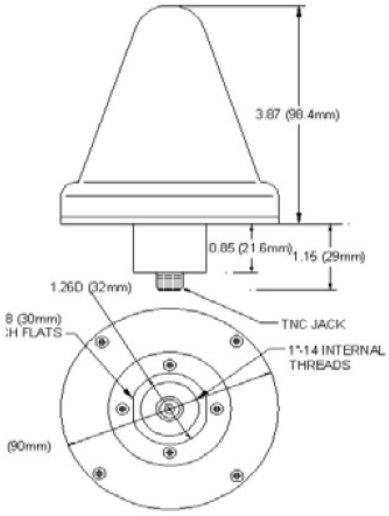
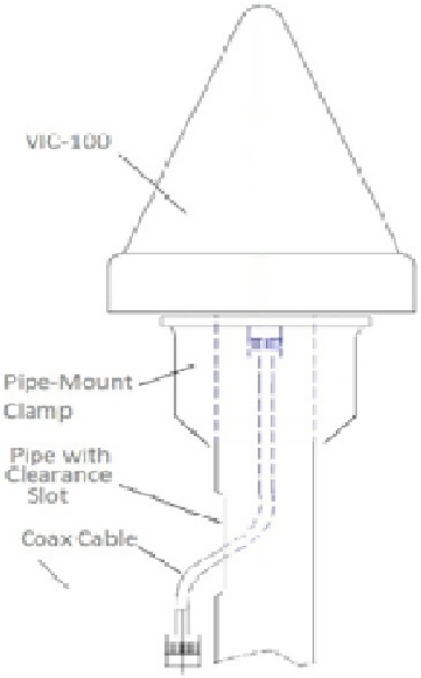
**ADDENDUM**

**Antenna Mounting Considerations – VIC-100 GPS Antenna.**

A. A Standard VIC-100 GPS is outlined below. It is used an example but may apply to many other types of pole mounted antennas.




Ordering Information:

| Part Number: | Description |
|---|---|
| 10001170G | TNC Jack, marine mount (1"-14 thread) |
| 10001171G | N Jack, no mount (spare antenna for 10001192G) |
| 10001221G | TNC Jack, Pipe clamp |
| 10001192G | N Jack, Pipe clamp |
| 10001818G | N Jack, Pipe clamp, Lightning protection |

Specifying the VIC-100 with lightning protection eliminates the need for a separate lightning arrestor on the antenna side of the coax cable.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