

Technical Note:

## Outdoor GNSS Antenna Installation Considerations

Many Orolia timing and synchronization products utilize an embedded GNSS (Global Navigation Satellite Systems) receiver as a primary reference. Typical installations utilize an outdoor active GNSS antenna to collect and transmit GNSS satellite radio signals to the receiver via an RF cable. This technical note describes the main considerations for a successful outdoor GNSS antenna installation for a timing application:

- Locating the antenna
- Connecting to the antenna
- Using ancillary products
- Evaluating signal attenuation to validate cable length
- Using signals in addition to GPS L1

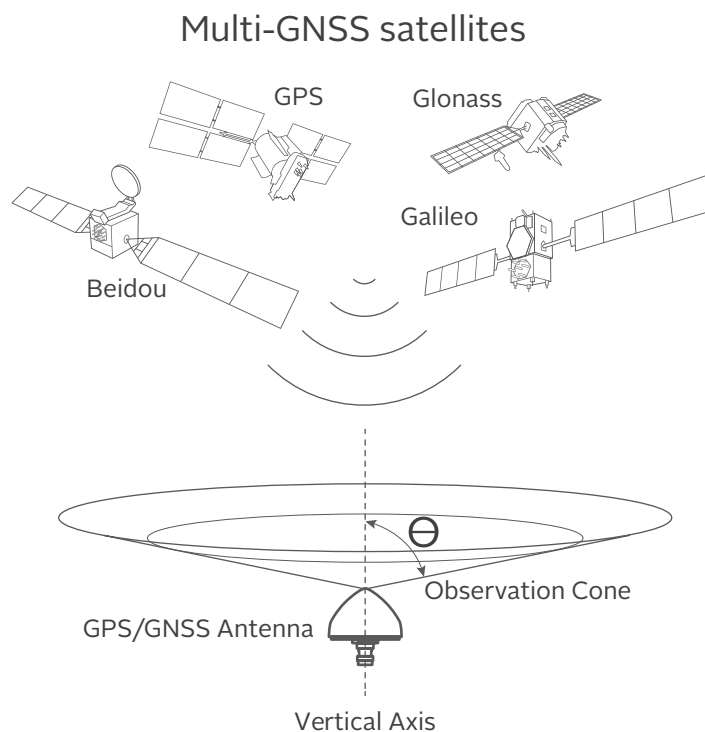
### Locating the GNSS Antenna

The GNSS antenna must have a direct view of GNSS satellites with an unobstructed line of sight to the sky. Rooftops that are clear of other structures or geographic features overhead, with views to the horizon, generally make good installation locations. Such a clear view allows the antenna to track the maximum number of satellites throughout the day. Installations with obstructed views may experience reduced reception quality and may not be able to simultaneously track the maximum number of satellites. An observation angle of  $70^\circ$  from the vertical axis ( $20^\circ$  above the horizon) usually offers good performance. Contact Orolia if your antenna location's view of the sky is restricted for mitigating approaches.

When installing your GNSS antenna, select a site at which the antenna will not become buried in drifting or accumulated snow. It should not be covered by foliage or placed in a position where it could become obstructed in this way. Whenever possible, avoid placing the GNSS antenna in close proximity to broadcast antennas or high power transmitters.

### Connecting to the Antenna

A coaxial cable transmits GNSS signals from the antenna to timing receiver. It also conducts 5 volts from the receiver to power the antenna and other elements of the antenna system if necessary. The choice of cable is on the basis of attenuation characteristics, weathering ability, temperature rating, and UV resistance. Type N female connectors are used on the antenna and any other element in the antenna cable system, therefore male connectors terminate cables. While Type N female connectors are used on many receivers, smaller form factor products can require the use of alternative connectors. Therefore a different connector may need to terminate the cable to the receiver or an adapter can be used. The application of weather proofing sealant or tape is a good idea for all outdoor connections.



Do not allow the antenna cable to be placed in standing water, as water may permeate through the coax jacket over time. On flat roof installations, the cable may be suspended by cable hangers or placed in sealed conduit. GNSS antenna cable can be installed through a conduit either by itself or with other cables. The conduit dimensions must be large enough to accommodate the “N” type connectors, which have a diameter of about 0.8 inches (20 mm), and the GNSS cable itself, which has a diameter of about 0.4 inches (10 mm) for LMR400 equivalent. Using a conduit that is too small or whose bend radius is too tight will prove difficult during installation (and may actually damage the cable). The maximum bend radius of the antenna cable can be as little as 1 inch (25 mm) and as large as 4 inch (100 mm) depending on the type of cable.

### Using Ancillary Products

Several items are available to improve the functionality and reliability of a GNSS antenna system. You can leverage the installation of a single GNSS antenna across several GNSS devices by the use of an RF splitter. A surge suppressor is strongly recommended to protect indoor equipment against lightning damage. Install a surge protector and properly connect it to earth ground at the point where the antenna cable enters the building. It is best to calculate cable distances from the antenna to the surge suppressor and surge suppressor to receiver so two connectorized cables can be ordered at the proper length. This saves time and eliminates the risks of splicing cable and installing connectors in the field.

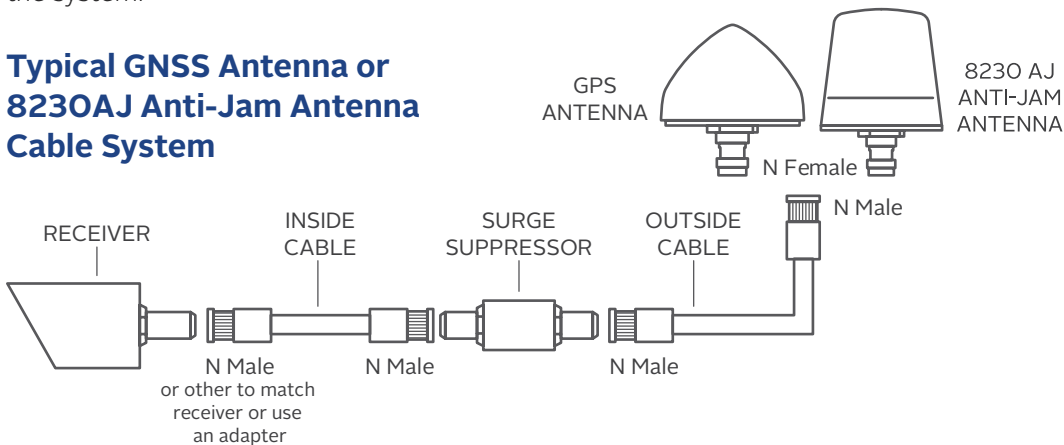
For installations that require a long cable run, an inline amplifier can be used to ensure signal levels at the receiver. The amplifier should be placed at a point where the antenna gain has been reduced to 10 db. It should also be placed a minimum of 5 ft (1.5 m) from the surge suppressor to protect it from lightning damage.

All ancillary items used in the GNSS antenna cable system are required to pass 5 volts from the receiver to the antenna (nominally 27 ma). This power can be used for other items in the system.

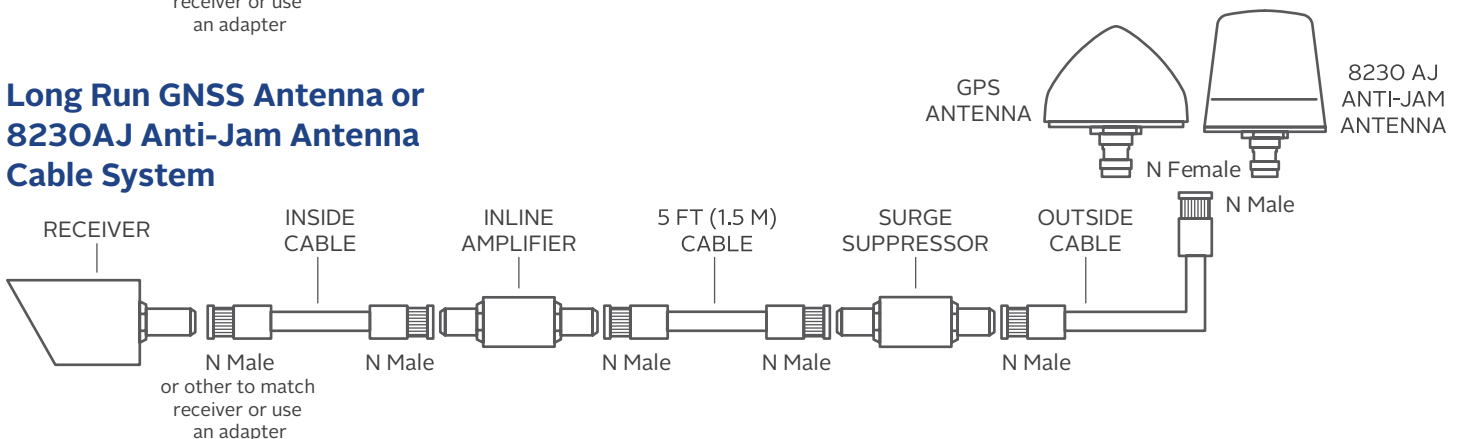


Examples of inline amplifier and surge suppressor

### Typical GNSS Antenna or 8230AJ Anti-Jam Antenna Cable System



### Long Run GNSS Antenna or 8230AJ Anti-Jam Antenna Cable System



## Evaluating Signal Attenuation to Validate Cable Length

The question of maximum cable length is dependent on the sum of the gain (and losses) of all the items in the GNSS antenna system and the tolerance for minimum gain required for reliable operation of the receiver. A good way to evaluate these considerations is the following equation:

$$\text{Antenna Gain} - \text{Cable Loss} - 1 \text{ db/Surge Suppressor} - 0.5 \text{ db/Connector} + 20 \text{ db/Inline Amplifier} \geq \text{Minimum Receiver Gain}$$

Gain of antennas commonly used by Spectracom timing systems:

Model	Gain	Signal Support
8230AJ	40 dB	Multi-GNSS
8230	35 dB	Multi-GNSS
ANT-35	33 dB	GPS L1
8225S	30 dB	GPS L1, L2
8225	30 dB	GPS L1

Coax loss is proportional to length. Typical attenuations of Spectracom supplied cable at the GNSS L1 frequency 1575 MHz are:

Model	Type	Attenuation per 100 ft	Attenuation per 10 meters
CA01-0NON-xxxx	LMR400	5.5 db	1.7 db
KX4NN-xx	RG213	10.0 db	3.5 db
KX15NN-xx	RG58	27.6 db	9.2 db

15 db is a typical value for minimum receiver gain. This value is slightly dependent on the receiver and the quality of the antenna location (clear view of the sky, free from interference, etc.). At the same time, a receiver could become saturated if there is not some attenuation of the signal from the antenna. Again, depending on the receiver, the max gain at the receiver will be in the range of 26 to 33 db.

## GNSS Signals, Beyond GNSS L1

GNSS antenna systems may need to accommodate a variety of signals as required by the receiver capability. For instance authorized users of SAASM receivers utilize signals at different frequencies (L1 and L2). While there had been limited alternatives in commercial applications, the proliferation of Global Navigation Satellite Systems (GNSS) now offer the benefit of redundancy by receiving signals from different systems and at different frequencies.

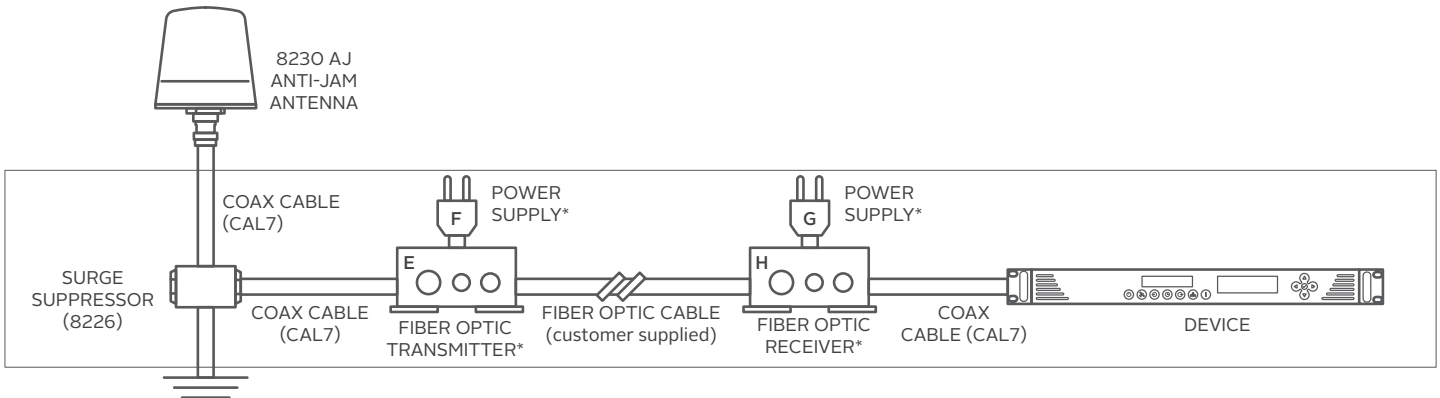
A common application today is to combine:

- GPS L1 (1575.42 MHz),
- Galileo E1 (1575.42 MHz),
- GLONASS L1 (1602.0 MHz),
- BeiDou B1 (1561.1 MHz),
- QZSS L1 (1575.42 MHz),
- optional SAASM: GPS L1 & L2 (1227.6 MHz).

Spectracom-provided antenna systems support combinations of L1 and L2 or GNSS/GLONASS L1. Other antenna systems should be checked for compatibility with the required range of GNSS signals.

### Fiber converter kits

- Fiber transmitter and receiver extends distance to 5,000 ft (1500 m)
- ST type connectors, 50/125 micron simplex multimode fiber

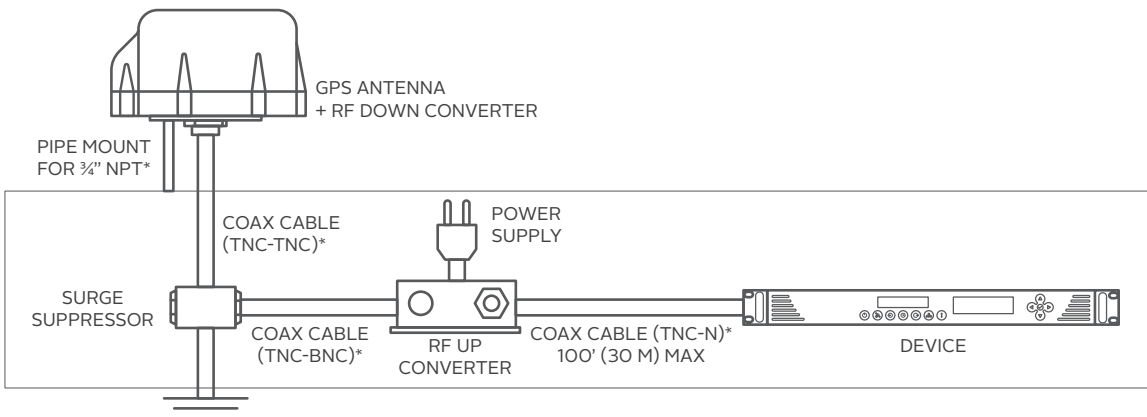


#### \* Kit includes

- Fiber optic transmitter (E) with power supply (F)
- Fiber optic receiver (H) with power supply (G)
- Type N to TNC adapter for transmitter and BNC-N adapter for receiver

### RF converter kits

- GPS antenna and cable system kit extends distance to 1,500 ft (450 m)



#### \* Sourcing

- Kit does not include coax cables, recommendation: RG-58 for items C & E; LMR400 equiv (Spectracom CA01-ONON-3xxx) for coax cable (TNC-N) 100' (30 m) max
- Kit does not include antenna pipe mount
- Kit includes surge suppressor terminated with TNC connectors and TNC-BNC and TNC-N adapters