Antenna and Coaxial Cable Installation

AB-V-MA-00601_RevA5
25 September 2024

Contents

1 Introduction

1.1 General information

Technical personnel should refer to this document when installing a Veripos positioning system on any offshore vessel.

This guidance document provides information about the signals received, common installation problems and the correct approaches to installing L-band, GNSS, MF and GAJT® antennas and working with coaxial cabling to maximise the positioning system performance of Veripos receivers.

1.2 Veripos Support

Veripos Support is a service provided as the first point of contact for all Veripos technical support and fault reports. It is available 24 hours a day, 365 days per year. Full contact details are available in the Contact information section

For support cases, contact support.veripos@hexagon.com or raise a ticket at https://help.veripos.com. Either method will immediately notify Veripos Support, who will then assist.

Veripos Support will provide initial help and may, if necessary, escalate tickets to regional on-call engineers to provide more in-depth technical support.

To aid support, upon first contact, please provide the following:

- Details of the issue or question
- Vessel name
- Company name
- Telephone number
- Unit user code
- Veripos hardware type
- Veripos software type
- Operating area
- Is this issue holding up operations?
- Any other relevant information

1.3 Terms and abbreviations

ARP	Antenna reference point
BDE	Below deck equipment
BeiDou	Chinese GNSS satellite constellation
BER	Bit error rate
bps	Bits per second
CRPA	Controlled reception pattern antenna
dB	Decibel
DGNSS	Differential GNSS
DGPS	Differential GPS
DOP	Dilution of precision
DP	Dynamic positioning
ft	Feet
Galileo	European GNSS satellite constellation
GAJT	GPS anti-jamming technology
GLONASS	Global navigation satellite system (Russian)
GNSS	Global navigation satellite system
GPS	Global positioning system
GUI	Graphical user interface
HDOP	Horizontal dilution of precision
HELIAX FSJ2-50	A type of coaxial cable
IALA	International Association of Lighthouse Authorities
IEC	International Electrotechnical Commission
in.	Inch
kg	Kilogram
kW	Kilowatt
LDF4-50	A type of coaxial cable
lb	Pound
m	Meter
MF	Medium frequency
MHz	Megahertz
mm	Millimeter
N-m	Newton meter
nS	Nanosecond
N-Type	A type of RF connector
pF	Picofarad
PDOP	Positional dilution of precision
SNR	Signal-to-noise ratio

TDR	Time domain reflectometer
TNC	Threaded Neill-Concelman (type of RF connector)
VDC	Volts direct current
Vrms	Volts root mean square
VSAT	Very small aperture terminal

1.4 Installation standards

All equipment installations should conform to the following parts of IEC 61108 - Maritime navigation and radio communication equipment and systems - Global Navigation Satellite Systems (GNSS):

- **Part 1 - Global Positioning System (GPS) Receiver equipment**
  Performance standards, methods of testing and required test results.
- **Part 2 - GLObal NAvigation Satellite System (GLONASS)**
  Receiver equipment - Performance standards, methods of testing and required test results.
- **Part 3 - Galileo - Receiver equipment**
  Performance standards, methods of testing and required test results.
- **Part 4 - Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment**
  Performance standards, methods of testing and required test results.
- **Part 5 - Beidou- Receiver equipment**
  Performance standards, methods of testing and required test results.
- **Part 6 - Navigation with Indian constellation (NavIC)/ Indian regional navigation satellite system (IRNSS)**
  Performance standards, methods of testing and required test results.
- **Part 7 - Satellite based augmentation system (SBAS) L1 - Receiver equipment**
  Performance standards, methods of testing and required test results.

CAUTION

The IEC61108 Standard should be referred to when installing GNSS systems onto offshore vessels with particular reference to the recommendations on distances between power sources and antennas.

The 61108 standard can be purchased from the IEC webstore:
http://webstore.iec.ch

1.5 Safety

1.5.1 Policies and procedures

The following information is for reference only and should not take precedence over your own company HSE policies or vessel HSE procedures, which should always be strictly adhered to.

1.5.2 Working at height

In addition to having received working at height training, you should be familiar with site safety equipment and its correct use.

If you feel that you need more training for the job at hand, contact your supervisor immediately. Never attempt working at height if you are not comfortable or insufficiently trained.

Your safety and that of those around you should always be your number one priority.

If possible, avoid working at height. If working at height is unavoidable, plan the operation to mitigate risks to personnel and equipment.

An effective rescue plan should always be in place.

2 GNSS signals

GNSS satellites are grouped into constellations, with each constellation being operated by different nations or organizations. Prominent examples include the American GPS, Russian GLONASS, European Galileo, and Chinese BeiDou systems. The accuracy and reliability of positioning data improve when GNSS receivers utilize signals from multiple constellations simultaneously.

2.1 GNSS satellites

2.1.1 GPS constellation

Attribute	Details
Configuration	Approximately 31 operational satellites, six orbital planes inclined at 55°
Sats / Orbital plane	Designed to have ≥ 4 sats, may vary due to maintenance or replacements.
Orbit altitude	20,200 km / 12,552 miles
Orbital period	11h:58m:02s
GPS L1 Frequency	1575.42 MHz
GPS L2 Frequency	1227.60 MHz
GPS L5 Frequency	1176.45 MHz

2.1.2 GLONASS constellation

Attribute	Details
Configuration	23 operational satellites, three orbital planes inclined at 64.8°
Sats / Orbital plane	Designed to have ≥ 8 sats, may vary due to maintenance or replacements.
Orbit altitude	19,100 km / 11,868 miles
Orbital period	11h:15m:48s
GLONASS L1 Frequency	1598.0625 MHz - 1609.3125 MHz
GLONASS L2 Frequency	1242.9375 MHz - 1248.6250 MHz
GLONASS L3 Frequency	1202.0250 MHz

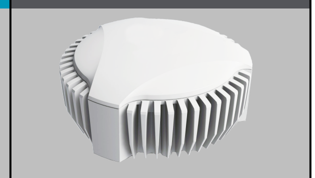
2.1.3 Galileo constellation

Attribute	Details
Configuration	24 satellites, three orbital planes inclined at 56°
Sats / Orbital plane	Designed to have ≥ 8 sats, may vary due to maintenance or replacements.
Orbit altitude	23,222 km / 14,429 miles
Orbital period	14h:04m:45s
Galileo E1 Frequency	1575.42 MHz
Galileo E5b Frequency	1207.14 MHz
Galileo E6 Frequency	1278.75 MHz

2.1.4 BeiDou constellation

Attribute	Details
Configuration	27 MEO, 2 inclined-geosynchronous, 7 geostationary satellites
MEO Sats / Orbital plane	Designed to have ≥ 9 sats, may vary due to maintenance or replacements.
MEO Orbit altitude	21,500 km / 13,359 miles
MEO Orbital period	12h:40m:16s
BeiDou B1C Frequency	1575.42 MHz
BeiDou B2a Frequency	1191.79 MHz
BeiDou B3 Frequency	1268.52 MHz

2.2 Veripos GNSS antennas

	V560	GAJT-710MS
		
GNSS capabilities:	Triple Frequency GPS, GLONASS, BeiDou & Galileo	L1 / L2 GPS
Additional capabilities:	L-band & MF beacon	--

3 L-band signals

3.1 L-band satellites

Five geostationary Inmarsat satellites positioned in geostationary orbit 35,786 km (22,236 miles) above the equator broadcast Veripos correction signals at high power levels compatible with L-band antennas. The broadcasting frequency for each satellite is as follows:

Satellite	Frequency (MHz)	Data Rate (bps)
143.5E	1545.835	1200
IOR	1545.865	1200
AORW	1545.825	1200
AORW	1545.955	1200
98W	1545.865	1200

Each satellite provides a footprint of beam coverage for a specific region of Earth:

Beam Name	Coverage
98W	North America, Gulf of Mexico, South America
AORW	North America, Gulf of Mexico, South America, North Sea, West Africa
25E	North Sea, Mediterranean Sea, Africa, Persian Gulf, Caspian Sea
IOR	Asia, Australasia, Indian Ocean, East Africa, Persian Gulf, Caspian Sea, East Mediterranean
143.5	Asia, Australasia, Indian Ocean

Veripos L-band coverage extends between latitudes of approximately -78° to +78° and longitudes of -78° to +78°, relative to the satellite's fixed location over the equator. As a vessel approaches the footprint's boundary in terms of latitude or longitude, the satellite's elevation decreases, eventually reaching just a few degrees at the footprint's edge. This geostationary arrangement ensures continuous and reliable signal availability for accurate positioning corrections. A global map with a beam overlay is available for reference in the Appendix.

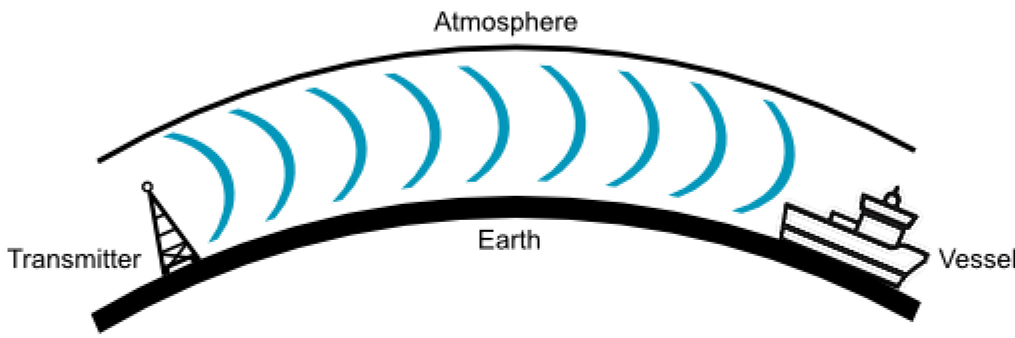
3.2 Veripos L-band antennas

	V560	V86
		
Additional capabilities:	Triple Frequency GPS, GLONASS, BeiDou & Galileo & MF beacon	MF beacon

4 MF signals

4.1 MF transmission

Medium-frequency (MF) signals are broadcast from terrestrial-based transmitters, delivering data primarily via "ground" or "surface" wave propagation. Unlike the signals received by GNSS or L-band antennas from satellites in orbit, MF signals offer a terrestrial alternative. They rely on the unique ability of ground waves to travel long distances by hugging the Earth's surface while providing consistent connectivity that is less affected by atmospheric conditions compared to higher-frequency signals.



MF correction signals received as supplementary data alongside Veripos signals transmitted by Inmarsat satellites offer an additional source of correction data for position calculation. By complementing satellite-based systems, MF signals provide another layer of reliability for Veripos customers. This diversity in signal propagation strategies helps ensure uninterrupted positioning and enhances safety when satellite signals are unavailable or limited.

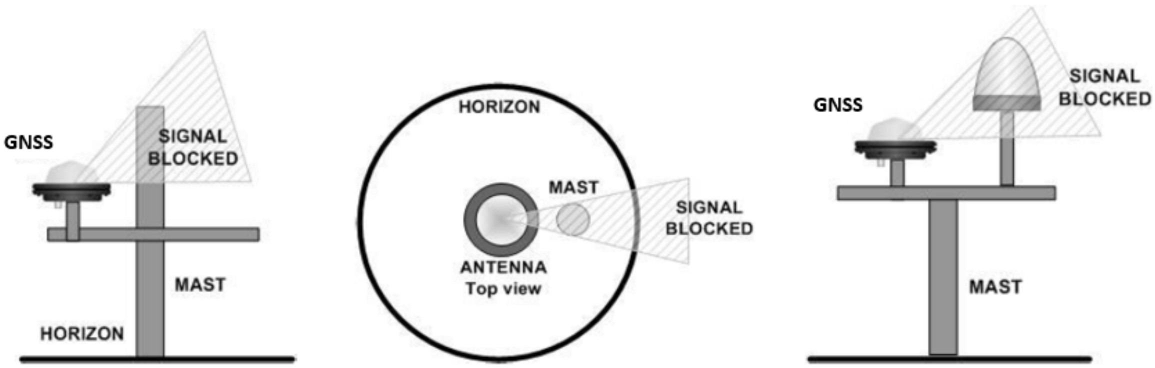
4.2 Veripos MF antennas

	V560	V86
		
Additional capabilities:	Triple Frequency GPS, GLONASS, BeiDou & Galileo & L-band	L-band

5 Common installation problems

5.1 Signal masking

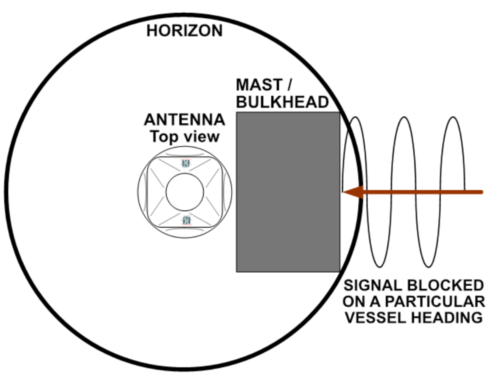
Mounting antennas in locations where the vessel structure or another antenna restricts the antenna's sky view can result in blocked signals on some headings, known as masking. Metal objects completely block the line of sight for satellite signals

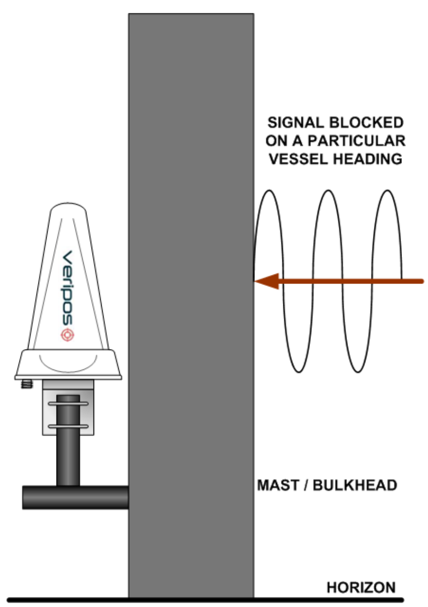


GNSS signal masking can reduce satellite availability, causing severe positional instability and, in extreme cases, terminating position computation. Masking by smaller objects, such as antennas or poles, especially when the vessel is in motion, can momentarily block GNSS signals on certain headings, causing interruptions to the received signal and adversely affecting range measurements. This reduction in the number of available GNSS satellites due to masking limits those usable for position calculation, resulting in increased DOP values, which indicate a drop in positioning performance and reflect less stable calculated positions.

L-band antennas may rely on a single source to receive the Veripos signal. Depending on the work location, a transmitting satellite can be as high as 90° elevation, as low as a few degrees of elevation, or anywhere in between. An unobstructed line of sight is crucial for optimal performance, as signal blockage can severely degrade or interrupt positioning.

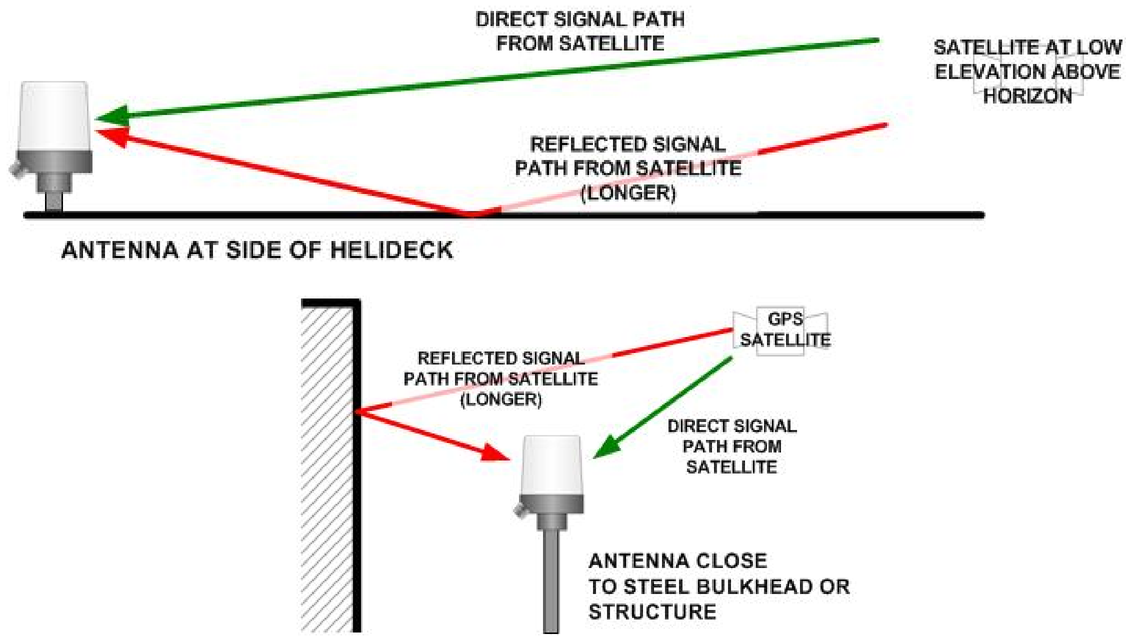
MF antennas supplement Veripos data by using ground wave propagation. However, they are especially prone to signal masking if installed near metal objects such as bulkheads or masts. This interference can block signals on certain headings, reducing positioning accuracy and precision.





5.2 Signal multipath

Multipath signal reception occurs when a GNSS signal is received directly from the satellite and indirectly through reflections off solid surfaces on the vessel, such as bulkheads or the helideck.



The reflected signal's path is longer than the direct path, effectively increasing the computed distance from the satellite. This discrepancy can cause range errors and instability in the position calculation. Multipath effects include constructive and destructive interference, as well as phase shifting when the reflected signal is out of phase with the direct signal. Both the code and carrier phase measurements of the received GNSS signals are adversely affected.

Similar to the GNSS antenna, the L-band antenna receives signals from various sources within its range. Multipath interference affects the L-band signal similarly, causing constructive and destructive interference. This interference contributes to a 'noisy' environment that increases the Bit Error Rate (BER) of the received signal, effectively reducing performance. In extreme cases, momentary signal synchronization loss can occur, leading to signal dropout and a loss of correction data

Since MF radio transmissions operate at lower frequencies than GNSS and Veripos signals, their wavelength is significantly larger. As a result, the MF antenna is much less susceptible to multipath interference.

5.3 Interference from transmitting vessel devices

5.3.1 Common sources of interference

Every modern offshore vessel has a multitude of communication devices that transmit radio waves. Some examples are listed below:

- Radar - a common source of interference
- Radar Inmarsat-C - a problematic source of interference and a repeat offender
- VSAT (Very-small-aperture terminal)
- Inmarsat FleetBroadband
- Iridium satellite communications
- Video telemetry systems (1.394 GHz)
- Data telemetry systems (900 MHz)
- WiFi (IEEE 802.11 standard) systems (2.4 GHz)
- LRIT (Long range identification and tracking)
- General navigation receivers
- GMDSS (Global Maritime Distress and Safety System) equipment
- Communications domes using GNSS receivers for orientation
- Automatic Identification Systems (AIS)
- GPS heading sensors
- Plotter systems or ECDIS (Electronic chart display and information system) with integrated GNSS
- Survey & seismic receivers, heading sensors, and Tailbuoy Tracking

5.3.2 GNSS signal disruption

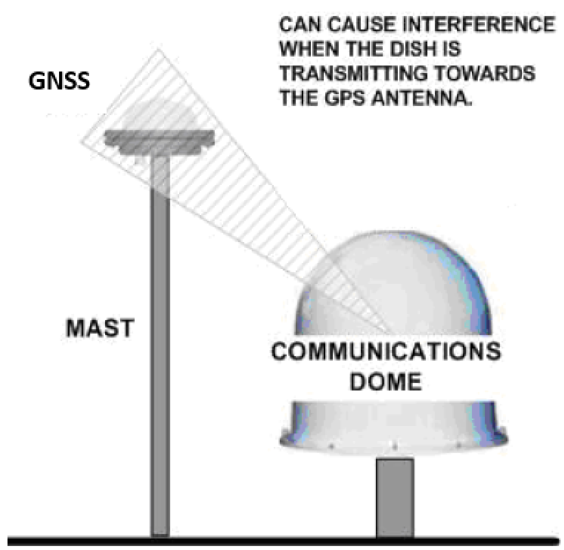
GNSS signals are relatively weak at ground level, making them susceptible to interference from other sources of electromagnetic radiation. Such interference can desensitize the GNSS receiver, complicating signal acquisition and tracking. Interference may occur when a GNSS antenna is mounted too close to a transmitting antenna or is directly in the path of radio transmissions.

The Sat-C system is known to interfere with GNSS signal reception due to:

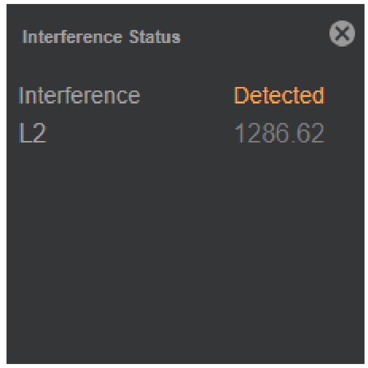
- High transmit power present at the antenna
- The antenna's omnidirectional design, which transmits in all directions
- A transmit frequency close to that of GNSS

Identifying all transmitting devices on the vessel and installing the GNSS antenna in the optimal location is essential to minimize interference. Ideally, the antenna should be positioned lower than the Sat-C antenna and at least 2.5 meters away from it.

After installation, test the effect of each transmitting system by powering up each device and monitoring the impact on the positioning system.



Quantum, a Veripos software application, provides GNSS signal-to-noise ratio (SNR) and interference detection displays to help identify interference sources. If a transmitting device causes signal loss, users should adjust the positioning system accordingly.



Veripos Quantum Software - Interference Status tile with an L2 interference example

Improperly terminated coaxial cables can also cause interference. Even receive-only GNSS systems with faulty coaxial cables may re-radiate interference within a 100-meter radius of the vessel. Proper installation and testing of all coaxial cables are crucial.

5.3.3 L-band signal disruption

The L-band antenna receives Veripos signals in the same frequency band as GNSS signals, making it similarly prone to interference from nearby transmitting equipment. Veripos IMUs and the Quantum visualization tool can display L-band signal status information, aiding in interference detection.

Transmissions from the vessel's Inmarsat dome can disrupt the L-band antenna if the transmission broadcasts toward it in close proximity. With an Inmarsat transmission frequency close enough to that of the Veripos signal, the high transmission power can overwhelm the antenna's pre-amplifier, rendering the system unusable.

Proper positioning and testing of the L-band antenna are crucial. To minimize interference and ensure optimal system performance, vessels should install the L-band antenna in a location that minimizes interference and identify all transmitting devices. Similar to the GNSS antenna, the L-band antenna's positioning should be tested by powering up each transmitting system and observing its impact on the positioning system.

5.3.4 MF signal disruption

The MF antenna receives signals via ground-wave radio transmissions from terrestrial transmitters. Proper spacing and separation from other antennas, especially those that transmit, are required to avoid interference.

6 Antenna installation guidance

6.1 Antenna spacing requirements

As identified in Common installation problems, maintaining appropriate spacing between antennas is crucial to avoiding interference issues.

6.1.1 Proximity from other receiving antennas

A faulty GNSS antenna can re-radiate signals, affecting other GNSS systems if placed too closely together. Additionally, installing these antennas too close to other receiving antennas can cause signal masking.

Vessels should install GNSS and L-band antennas at least 1 meter (3 feet) apart to prevent interference.

6.1.2 Proximity from transmitting antennas

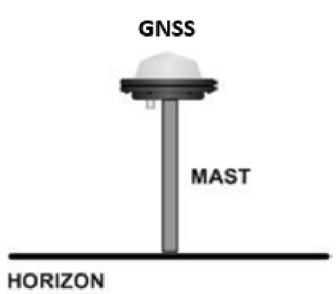
Transmitting antennas on the vessel should be identified because installing GNSS or L-band antennas too close to a transmitting device can cause partial or total signal loss.

The recommended minimum distance from a transmitting device is 2.5 meters (8 feet).

Some transmitting devices require more separation, so it's best to consult the manufacturer's installation guidelines for accurate information.

6.2 GNSS antenna installation

GNSS satellite constellations constantly move across the sky in various directions, spanning from horizon to horizon. Therefore, the GNSS antenna should be mounted in a location with a clear 360° view of the sky down to the horizon in all directions. This is best achieved by installing the antenna at the top of the mast.



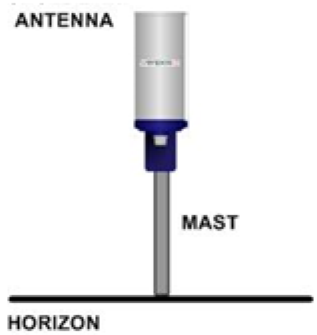
When selecting the mounting location, it is essential to avoid common installation issues that could degrade system performance.

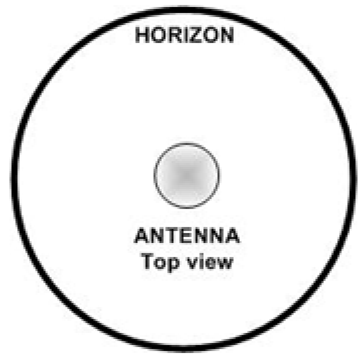
The placement of the GNSS antenna is crucial for the positioning system to function optimally. Mounting it in a poor location or environment could severely compromise system performance.

Constraints sometimes force the installer to choose a less-than-ideal location, necessitating compromises. In such cases, it is imperative to inform the vessel operator of the potential consequences this could have on the positioning system.

6.3 L-band antenna installation

As with the GNSS antenna, install the L-band antenna to ensure a clear view of the sky, typically at the top of the mast.





Each geostationary satellite that transmits Veripos signals broadcasts from a specific longitude directly above the equator, so the satellite's elevation is up to 90° when situated directly below it. Beam coverage extends from approximately -78° to +78° latitude and longitude relative to the satellite's fixed location. As a vessel in transit approaches an L-band beam footprint boundary, the satellite elevation decreases to only a few degrees, near the footprint's absolute limit. This should be carefully considered during L-band antenna installation, especially if the vessel is restricted to the use of only one L-band beam and will operate at higher latitudes where the satellite will appear at a low elevation.

Where available, **Auto Beam is recommended for managing Veripos L-band beam choices**.In this mode, the Veripos receiver tracks up to three beams simultaneously, based on available L-band satellites and the elevation and data received from each satellite. and data received from each L-band satellite used within the calculation. Using Auto Beam can mitigate the impact of a single beam failure or masking. Additionally, when using Auto Beam and transiting different geographic regions, the receiver selects available L-band beams automatically.

Constraints sometimes force the installer to choose a less-than-ideal location, necessitating compromises. In such cases, it is imperative to inform the vessel operator of the potential consequences this could have on the positioning system.

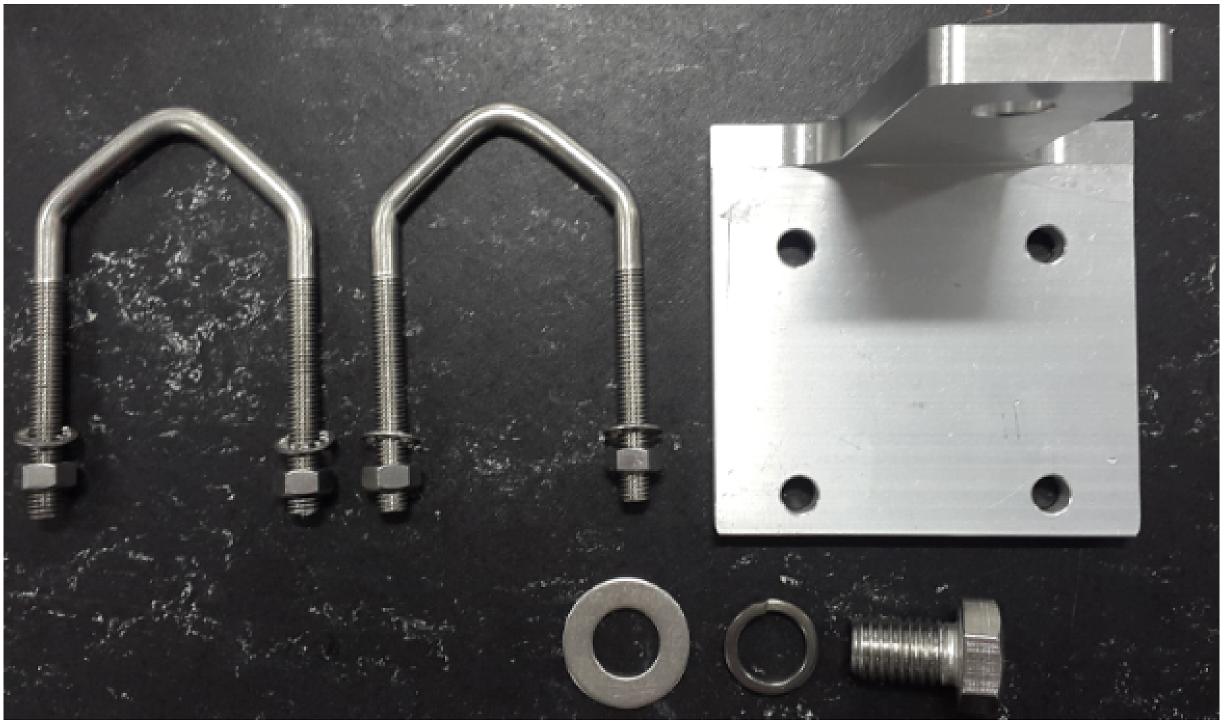
6.4 MF antenna installation

Due to the higher wavelength of signal transmission, the MF antenna is less susceptible to signal masking by smaller obstacles and multipath interference. However, installers should still avoid significant obstacles.

The ground wave signals received by the MF antenna are best received when the antenna is mounted high on the mast with a clear 360-degree view of the horizon.

6.5 Antenna mounting brackets and fixings

The mounting brackets and fixings supplied will vary depending on the antenna type. In all cases, **installers must use all provided washers**.



The example mounting kit above shows various supplied washers, that installers **must use**:

4 x M8 internal tooth washers
Critical to prevent the U-bolts from becoming loose over time.

1 x 5/8” plain washer
Critical to prevent excess load on the antenna base, which can potentially damage the antenna casing.

1 x 5/8” split washer
Critical to prevent the antenna from becoming loose from the mount over time.

7 Antenna installation examples

7.1 Bad antenna installation examples

7.1.1 Bad example 1

Issue:
The mounting of the GNSS antennas on the mast top places them in close proximity to everything else.

Effect:
Multipath and signal masking.

7.1.2 Bad example 2

Issue:
An installation that results in antennas that reside in the direct transmission path of the VSAT dome.

Effect:
Interference

7.1.3 Bad example 3

Issue:
A GNSS antenna is installed beneath the Sat-B dome and in the direct path of the radar transmissions.

Effect:
Signal masking and interference.

7.1.4 Bad example 4

Issue:
The clustered antenna installation places the L-band antennas in tight proximity.

Effect:
Signal masking on certain headings at higher latitudes.

7.1.5 Bad example 5

Issue:
Antennas reside at the main deck level underneath the derrick base structure.

Effect:
Signal masking and multipath.

7.2 Good antenna installation examples

7.2.1 Good example 1

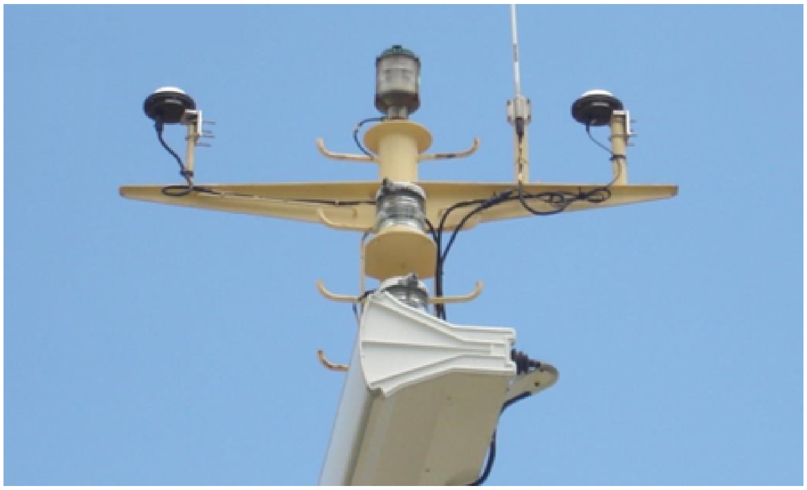
Description:
Well-spaced antennas with uniform heights that are well clear of other sources of transmission.

7.2.2 Good example 2

Description:
Antennas with appropriate spacing at the same height with only minor signal masking from anemometers.

7.2.3 Good example 3

Description:
The top of the mast location results in only minor signal masking from mast light at low elevations.



8 Coaxial cable installation

8.1 Maximum recommended cable lengths

It is necessary to attenuate the various GNSS and differential signals at different rates depending on the signal type and the quality of the coaxial cable.

The following table shows the maximum recommended cable length for signal types for three types of coaxial cable. It is best practice to use low loss cable, before resorting to inline amplifiers.

	L1 GNSS Only	L1/L2 GNSS	L-band	MF / HF
LMR-400	70 m / 229 ft	52 m / 170 ft	120 m / 393 ft	200 m / 656 ft
LDF4-50	130 m / 426 ft	110 m / 360 ft	210 m / 688 ft	350 m / 1148 ft
LMR600	110 m / 360 ft	90 m / 295 ft	180 m / 590 ft	300 m / 984 ft

Many requests for assistance with vessel installations often stem from practices used during the handling, termination, or installation of cables and their connections. To minimize issues, Veripos recommend to **ONLY use high-quality cables from trusted sources** such as:

- www.amphenolrf.com
- www.timesmicrowave.com
- www.andrew.com

8.2 Cable specifications

	LMR-400	LMR-600	LMR-240*	LDF4-50 HELIAX	FSJ2-50 HELIAX
Diameter:	0.375" / 9.53mm	0.5" / 12.7mm	0.240" / 6.10mm	0.5" / 12.7mm	0.375" / 9.53mm
Impedance:	50Ω	50Ω	50Ω	50Ω	50Ω
Attenuation dB/100ft @ 1500MHz:	5.1	3.3	9.9	2.8	5.08
Attenuation dB/100m @ 1500MHz:	16.8	10.9	32.4	9.18	16.7
Velocity of Propagation:	85%	87%	84%	88%	83%
Minimum Bend Radius (Installation):	1.5" / 38.1mm	1.5" / 38.1mm	5.0" / 127mm	5.0" / 127mm	1.0" / 25.4mm
Minimum Bend Radius (Repeated):	4.0" / 101.6mm	6.0" / 152.4mm	2.5" / 63.5mm		

** Limit the use of LMR240 to short tails or custom mast top installations. Avoid use for the entire cable run due to the higher attenuation of these small-diameter cables.*

> **WARNING**
> Conduct all work safely, following the appropriate safety systems relevant to the site where the work is taking place.

8.3 Preparation

Survey the route of the antenna cabling to ensure:

1. The total length of the cable run does not exceed the supplied cable length for this installation. Contact your supplier or Veripos if this is the case.
2. The cable does not cross or run parallel with any **single phase or three phase mains cable** (110 VAC, 220 VAC or 440 VAC) or any **high-power RF cables** leading to transmitting devices such as Inmarsat and VSAT domes.
3. The cable **avoids the proximity to fluorescent lighting and wiring**.
4. The cable is not placed under tension. A **support wire** is used where the cable run has to cross a free space and does not rely solely on cable ties for support.
5. Sufficient space is available in the selected cable entry through the bulkhead, for the connectors to pass through without damage. If the connector cannot pass through the cable entry it may be necessary to cut the connector off and re-terminate once the cable has been passed through.
6. The cable is **not pinched**.
7. The route is **free from all burrs or sharp edges** that could cut the cable jacket over time and lead to water ingress.
8. All **connectors and couplers are completely sealed** from the environment with overlapping layers of self-amalgamating tape and finished with layers of electrical tape or Scotchkote.
9. **Stress loops** are fitted to prevent excess force on the connectors, in particular on the antenna connectors.
10. The **minimum bend radius** for the cable is not exceeded.

Typical cable installation in a bridge mast area

8.4 Cable routing

In most cases, the installation of coaxial cables is much easier when gravity helps. However, starting the run from the top of the mast can be difficult and will often lead to entanglement, especially if the cable is coiled. Therefore, it is better to start the installation from the bottom of the mast, beginning with the run-up to the antenna sites. Installation should begin with either a coax length that is known to be slightly longer than the intended run or a spool of cable.

Preparation

- Mark both ends of each cable with electrical tape for identification.
- Unwind the entire cable onto the deck to remove twists and kinks.

Installation

Starting from the bottom:

- Use a pull rope to guide the cable up the mast cable tray/route.
- Secure the cable near the antenna with a cable tie, leaving a coil of spare cable for future adjustments.
- Cable tie the cable every meter (3 ft) on the way down the mast.

Routing:

- Avoid sharp edges, pinching, or kinking the cable.
- Ensure the cable passes through any penetrations without damaging the outer jacket.
- Strictly adhere to the minimum cable bending radius.

Final steps:

- Leave enough slack at the equipment location before securing the cable with plastic cable ties, starting from the base of the mast.
- Do not over-tighten ties to avoid damaging the cable jacket.
- Coil or cut and re-terminate any slack. Custom-cut cables are ideal for permanent installations.

Terminating

- For a length of coax, terminate the antenna end with the appropriate coaxial connector before pulling it up the mast.
- For a spool of cable, terminate the demodulator end first, then secure and remove slack while working back up to the mast.

Measurement and cutting

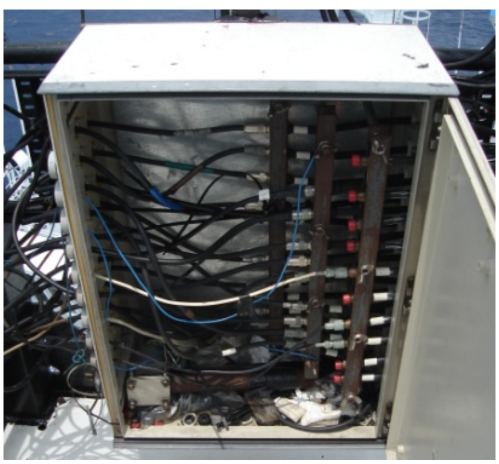
- Measure the mast cable tray with a rope or tape measure to avoid estimation errors.
- Cut the cable to the exact length needed, terminate it, and add a spare coil at the antenna site.

> **CAUTION**
> Always make sure that connections are sealed with self-amalgamating tape to protect the connections from the environment.

NOTE
Not all cable faults are visible. Before use, test and inspect pre-existing vessel coaxial cables on the vessel with an insulation tester. Additionally, thoroughly inspect connectors for corrosion, water ingress or incorrect installation.

If in doubt, always install a new cable!

If preinstalled coaxial cables exist, connect antennas and demodulators to the appropriate cables through the cable junction box.



8.5 Cable tails

When the main cable run is completed, the last link to the antenna should be with a thinner LMR240 cable tail. There are several reasons for this:

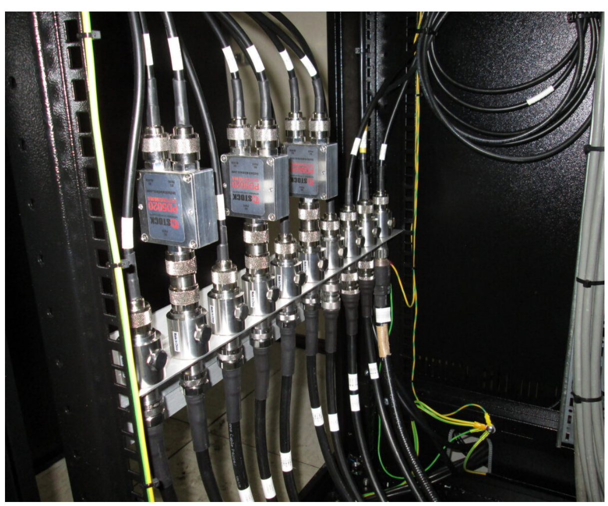
- The tail is a replaceable part. If it is damaged or water ingress, replacement is easy without the involvement of the more expensive main cable.
- Using a thinner cable tail reduces stress on the antenna connector, which is particularly important as a heavy main cable, especially one terminated with a small TNC connector, can add significant stress to the antenna. With vessel motion and vibration, this stress can lead to the connector shearing off the antenna or even cause the main cable to fail due to a short circuit.
- Creating a drip loop can prevent rainwater from running down towards the main cable connection.

Drip loops and spare coils

The join between the main cable and the cable tail should be well sealed with self-amalgamating tape, starting below the connector heat shrink on the cable sheath at both sides of the join. This step is crucial to ensure a secure and reliable connection.

The below deck equipment rack should make use of the same LMR240 tails:

- The LMR240 tails place less stress on the demodulator connectors and are easier to dress in.
- If lighting arrestors or splitters are required, this makes for a much easier installation.



Lightening arrestors and splitters fitted to a bracket with LMR240 tails dressed in to the rack

If there is a junction box at each end of a permanent cable run, the final run may use a custom-length LMR240 cable. Make sure that the entry into the junction box has the correct size cable grommet and that, after installation, the grommets are tightened to provide a watertight seal. The use of self-amalgamating tape to seal the connections inside the junction box can provide extra protection.

8.6 Cable termination

NOTE
The illustrations in this section apply to the exact make and model of the connector and cable referenced. It is important to note that slightly different models or their equivalents might have variations in connector components. For precise termination instructions, please consult the manufacturer's guidelines.

8.6.1 LMR400 – Times Microwave EZ-400-NF-X N-Type female connector

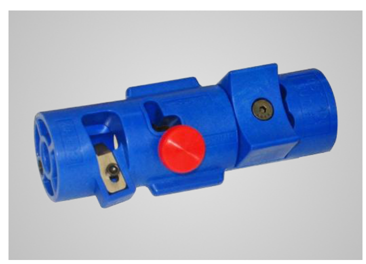
The Times Microwave **EZ-400-NF-X** connector comes with the following parts:

From left to right: weather seal, crimp sleeve & body assembly

To properly terminate LMR400 cable with the EZ-400-NF-X connector, Veripos recommend use of:

Times Microwave cable cutting tool
P/N CCT-03

Times Microwave LMR400 cable prep tool
P/N CST-400



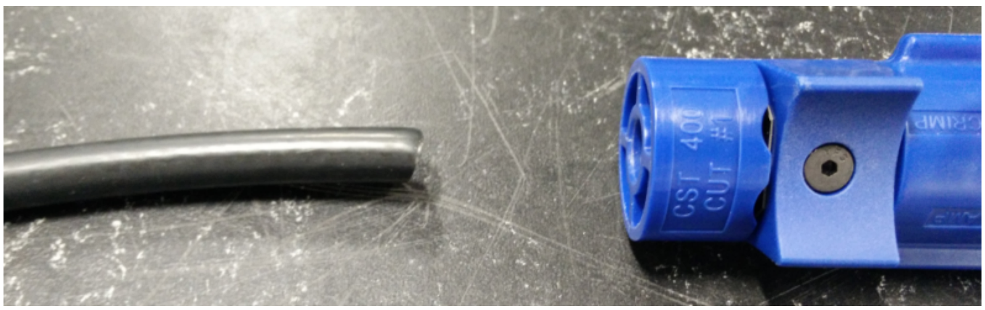
Times Microwave cable cutting tool
P/N DBT-U

Times Microwave LMR400 cable prep tool
CT-400/300

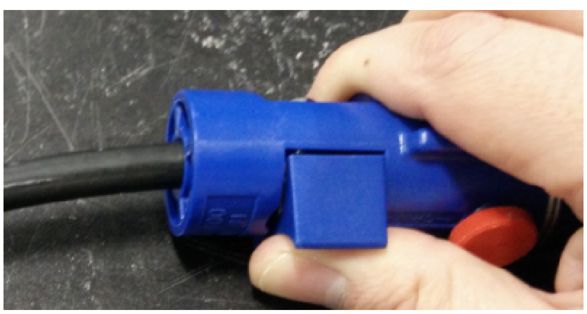
8.6.1.1 Procedure

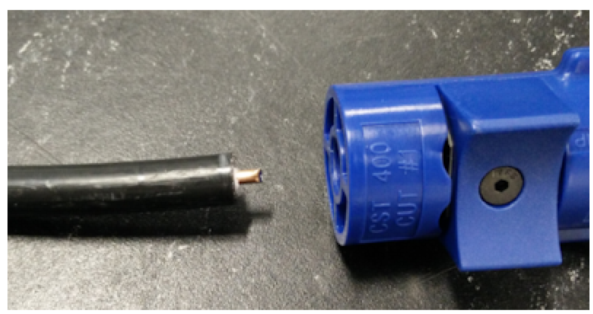
Step 1 – Slide adhesive-lined heat shrink and crimp collar onto the cable. Cut the cable square.

Step 2 – Use side 1 of the cable preparation tool to expose the centre conductor by inserting the cable into the tool and rotating it clockwise until resistance ceases.



While rotating, push down on the cutter to activate the cutting blade:





If the cable preparation tool is not available, carefully trim the cable to the following dimensions:

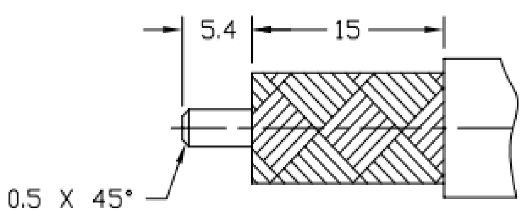
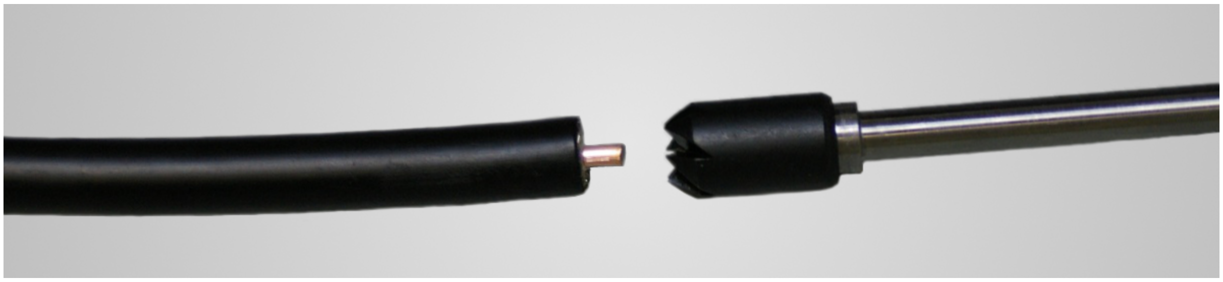
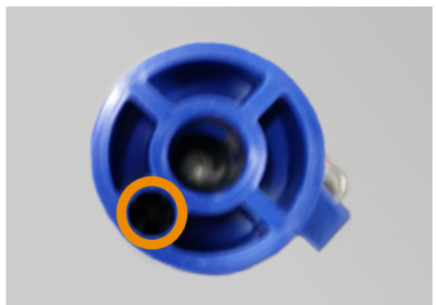


Diagram courtesy of Times Microwave

Step 3 – Remove any residual plastic from the centre conductor before deburring with a deburring tool or a fine metal file.



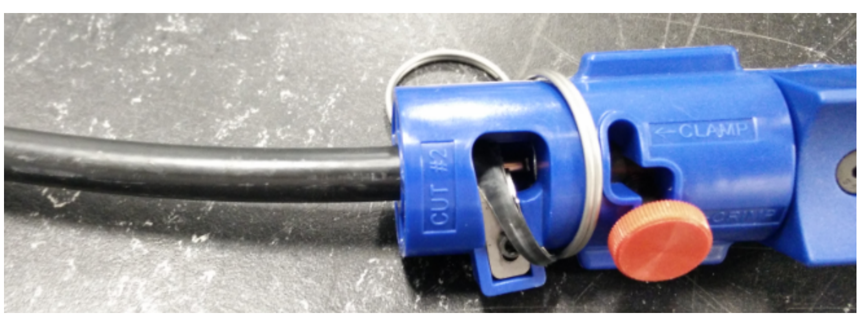
Use of the CST-400 tool for this task is possible, as it has a deburring attachment on the side 2 end:

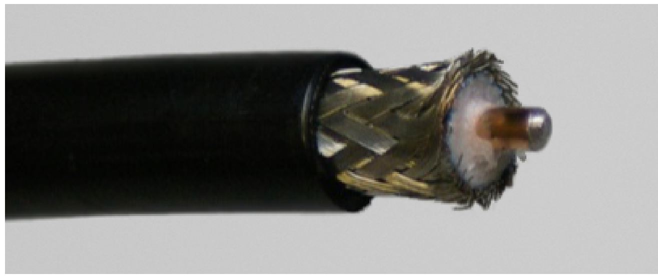


Deburring attachment on CST-400

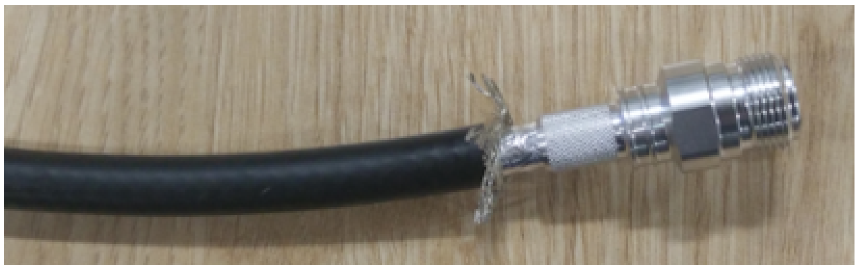
Step 4 – Set the CST-400 to Crimp if necessary by loosening the red thumb screw, sliding to Crimp, and then re-tightening.

Trim the cable jacket using side 2 of the cable prep tool. Insert the cable and rotate the tool clockwise until no resistance can be felt.





Step 5 – Flare the braid and check to make sure no aluminium foil is touching the centre core. Insert the cable into the connector body making sure that the braid remains outside.



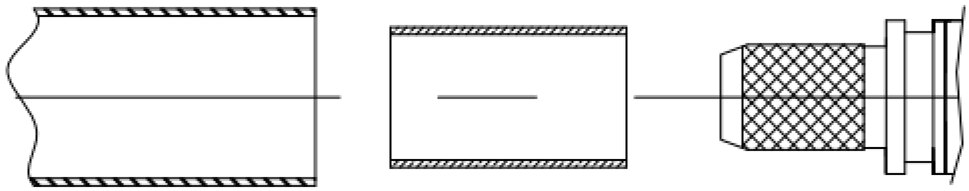
Step 6 – Slide the crimp collar over the braid.

Step 7 – Use the crimp tool to crimp the collar onto the connector, making sure it's as tight to the rear of the connector body as possible.

Step 8 – Slide the adhesive-lined heat shrink onto the connector back, applying heat from a heat gun.

8.6.2 LMR240 – Times Microwave EZ-240-TM-X TNC male connector

The Times Microwave EZ-240-TM-X connector comes with the following parts:

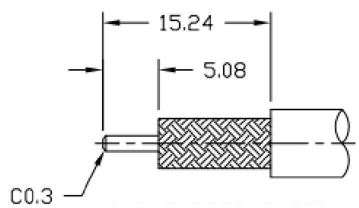


From left to right: weather seal, crimp sleeve & body assembly. Diagrams courtesy of Times Microwave

Use of the following tools will ensure proper termination of an LMR240 cable with the **EZ-240-TM-X**:

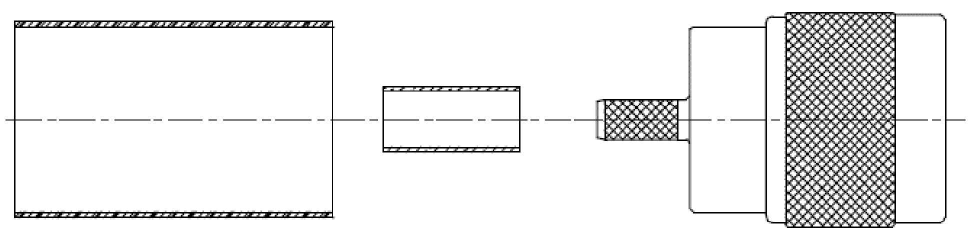
1. Times Microwave Cable Preparation tool CST-240
2. Crimp tool with 0.255" / 6.48mm hex die
3. Heat gun

The termination procedure for the **EZ-400-NF-X** connector can be followed, substituting the relevant parts where appropriate.



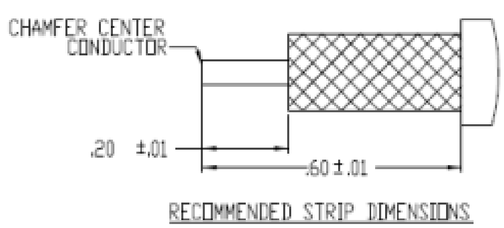
8.6.3 LMR240 – Times Microwave EZ-240-NMH-X N-Type male connector

The Times Microwave **EZ-240-NMH-X** connector comes with the following parts:



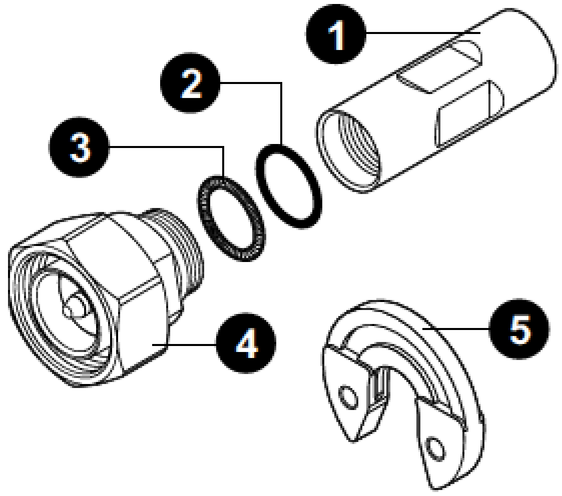
From left to right: shrink sleeve, crimp sleeve & body sub-assembly. Diagrams courtesy of Times Microwave

Follow the termination procedure for the **EZ-400-NF-X**, substituting the relevant parts where appropriate:



8.6.4 LDF4-50 Heliax – Commscope L4TNM-PSA N-Type male connector

The CommScope L4TNM-PSA connector comes with the following parts:



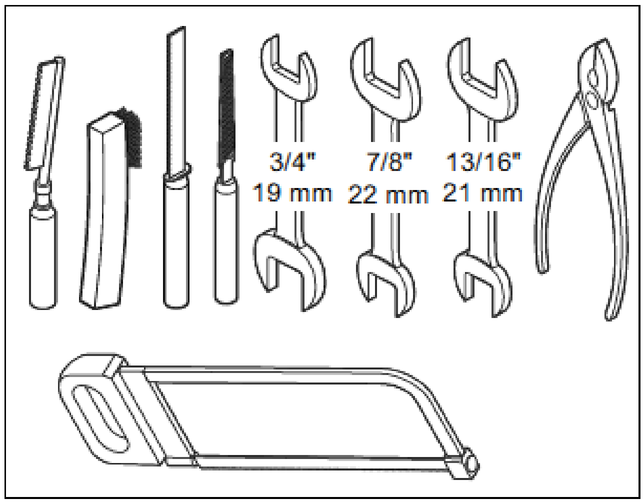
Diagrams courtesy of commscope.com

The below instructions apply to both the male (L4TNM-PSA) and the female (L4TNF-PSA) connectors.

The instructions detailed below assume that the cable preparation tools are not available and that manual preparation is required.

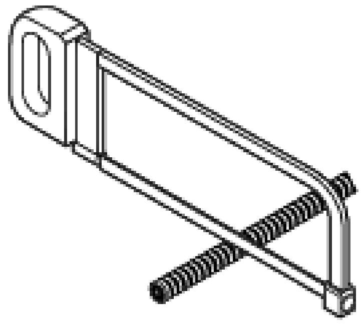
Use of the following tools will ensure proper termination of an LDF4-50 cable with the **L4TN-PSA** connector:

1. Cable prep tool - PN: MCPT-L4 (Optional)
2. Cable prep tool – PN: CPT-12U (Optional)
3. Flare tool – PN: 224363 (Optional)
4. Hacksaw
5. Ruler
6. 19mm Wrench
7. 21mm Wrench
8. 22mm Wrench
9. Small metal file
10. Small brush for debris removal
11. Knife
12. Pliers



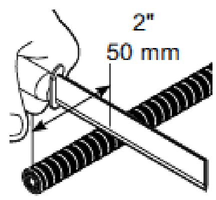
If required, substitute the cable preparation tool with a suitable knife or other appropriate cutting blade; however, the cable preparation tool is recommended whenever possible from both a safety and quality standpoint.

Step 1 – Using a hacksaw, cut the end of the LDF-450 cable at 90° to leave a clean edge:

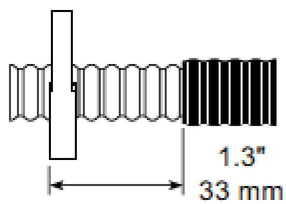


Do not use cable cutters, as this will squeeze the cable and cause it to become oval.

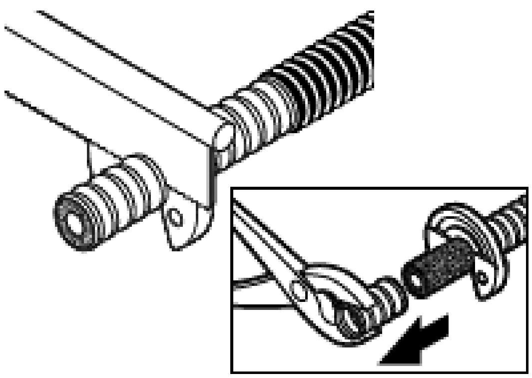
Step 2 – Measure 50mm from the end of the cable and remove the outer cable jacket using an appropriate cutting blade:



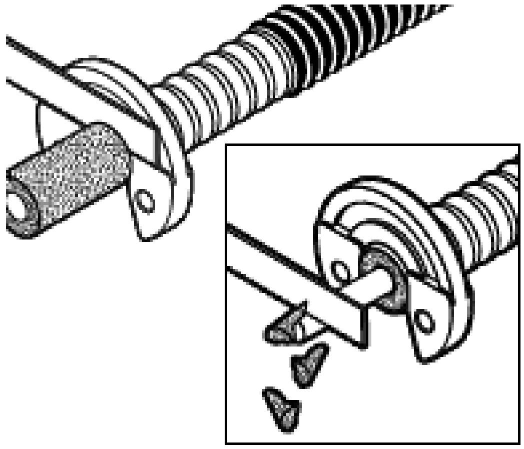
Step 3 – Position the saw guide (supplied with connector) as shown:



Step 4 – With the saw guide still in place, cut the outer conductor and remove the outer conductor using pliers:

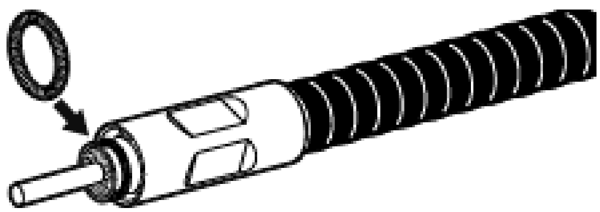


Step 5 – Remove the foam and adhesive, leaving the centre conductor exposed:

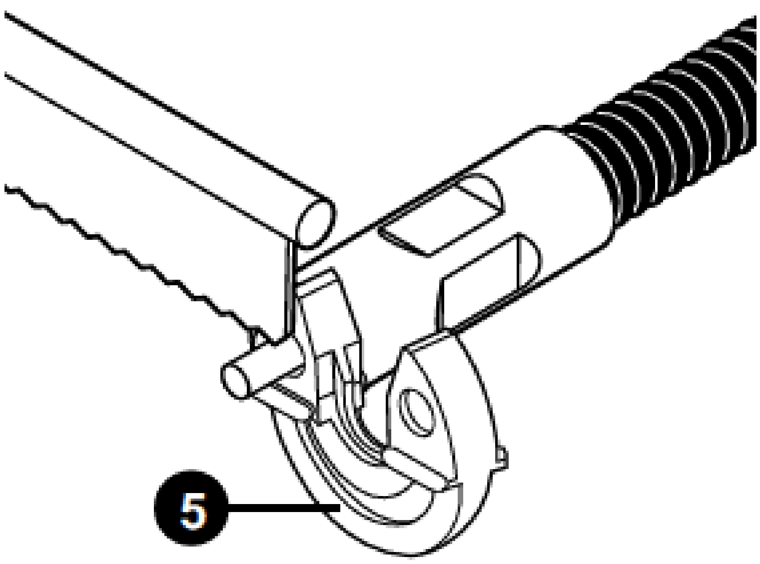


Step 6 – Placethe O-ring in the position shown below:

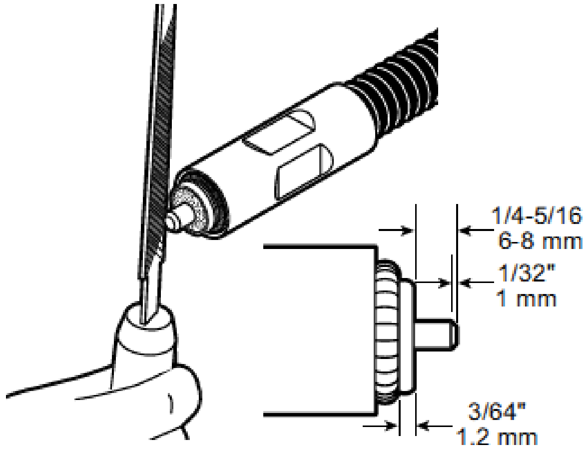
Step 7 – Fit the connector body by applying gentle pressure and rotating. Install the spring ring on the first corrugation:



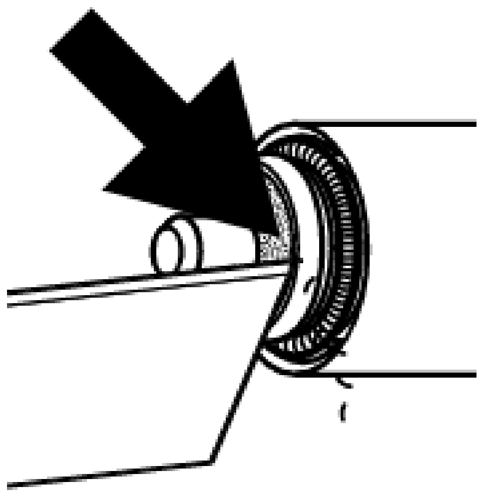
Step 8 – Fit the provided saw guide as shown and cut the centre conductor to length:



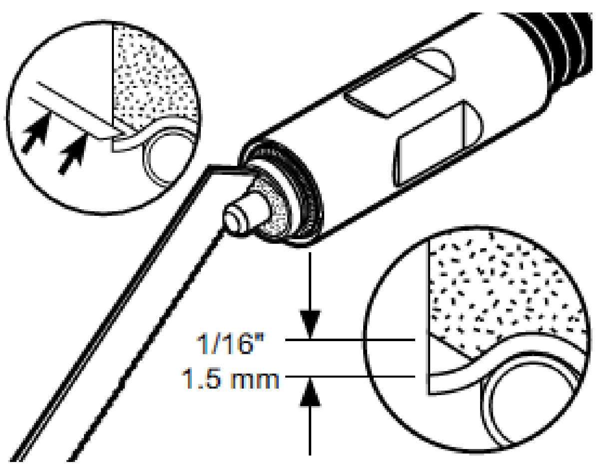
Step 9 – Taper the end of the centre conductor using a small file or a deburring tool (if available):



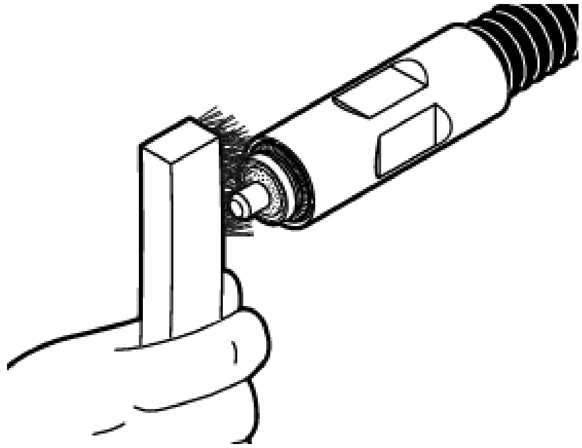
Step 10 – Deburr the inside edge of the outer conductor:



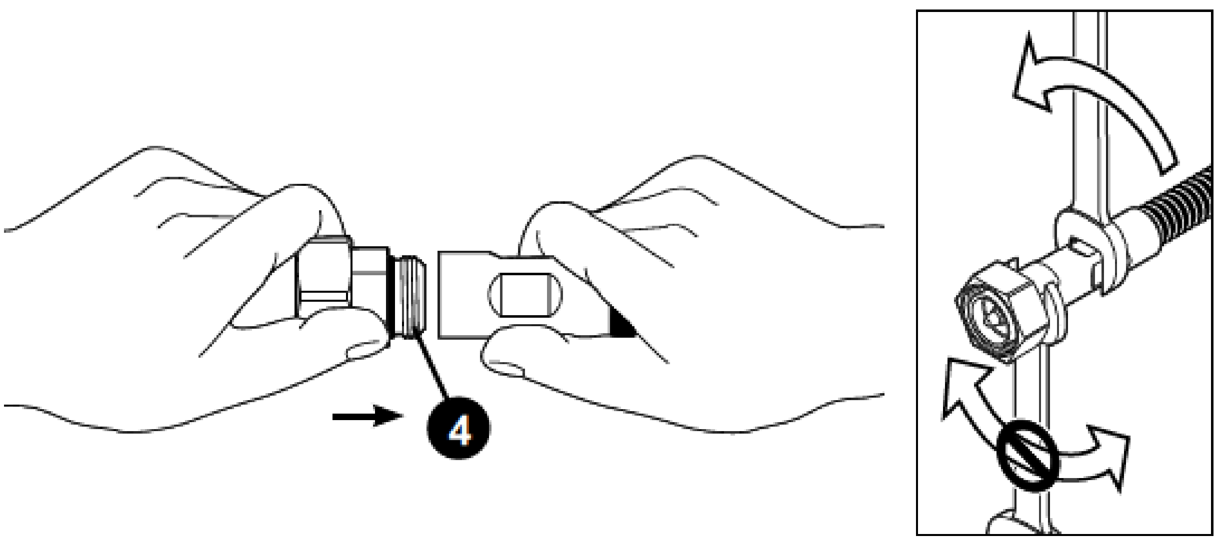
Step 11 – Compress the foam as shown to create a gap between the foam and the outer conductor:



Step 12 – Remove any debris using a small wire brush:



Step 13 – Fit the N-Type connector and tighten using wrenches. Do not rotate the wrench at the front of the connector, only the wrench located towards the back of the connector should be rotated as illustrated below:



9 Appendix

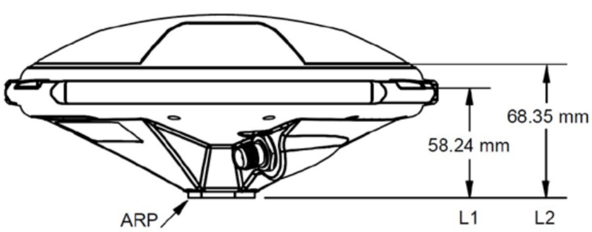
9.1 Summary specification of antennas

9.1.1 Veripos V560 combined GNSS & L-band antenna

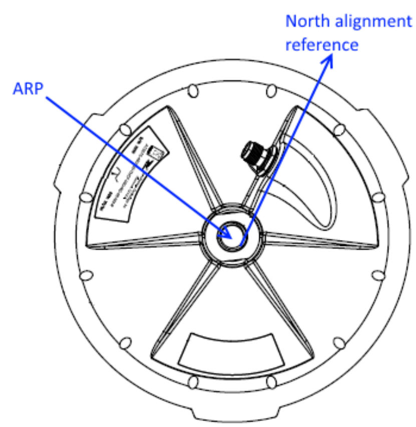
L-band/GPS/GLONASS: 1525-1610 MHz
GPS L2/GLONASS L2: 1160-1252 MHz
(complete with a narrow band filter for interference rejection)
LNA Gain: 45db
DC Voltage input: 3.0 to 15.0V
RF Input Connector: TNC female (note cable RF connector – TNC male)
Material: Weather Proof Polymer Plastic
Mount: 5/8” Tripod Tread Connector
Temperature Range: -55 to +85°C
Certification: IEC 60945
Diameter: 7.5" / 19.05cm
Height: 3.17” / 8.05cm
Weight: 1.6lbs / 0.73kg

9.1.2 V560 phase centre offsets

The diagram on the left shows the antenna reference position (ARP) vertical offset from the GNSS L1 and L2 frequencies phase centres, and the diagram on the right shows ARP at the antenna base and the antenna North alignment reference:



V560 phase centre values above ARP



V560 ARP & North alignment reference

The table below details the North, East and Up phase centre values for GNSS L1 and L2 frequencies:

	Relative to Antenna Reference Point (ARP)		
GNSS Frequency	**North (mm)**	**East (mm)**	**Up (mm)**
L1	-0.34	-0.53	58.24
L2	0.11	-0.76	68.35

9.1.3 Veripos GAJT-710MS antenna

The GAJT-710MS Controlled Reception Pattern Antennas (CRPA) combines an antenna array and null forming electronics into a hardened enclosure that is suitable for installation on a wide range of applications. The GAJT-710MS uses a seven-element antenna array to receive GPS signals in the L1 and L2 bands only.

GAJT mitigates interference by creating nulls in the antenna gain pattern in the direction of jammers, providing significant anti-jam protection even in dynamic multi-jammer scenarios.

Controlled Reception Pattern Antenna (CRPA):	• Bandwidth ±11 MHz (centered on GPS L1 and GPS L2) • RF output 50 Ω TNC • Simultaneous L1 and L2
Interference Rejection:	• Interference suppression 40 dB (typical) • Number of simultaneous nulling directions 6
Dimensions:	290 x 290 x 120 mm
Weight:	7.5 kg
Power consumption:	25 W
Input voltage:	+10 to +28 VDC

9.2 Summary specification of cabling

With the system Veripos typically provide pre-terminated cables and tails for use with both L-band and GNSS antennas (see the *Delivery note*). Veripos recommend use of Times Microwave coaxial LMR cable for installation of all antennas.

9.2.1 Times LMR-400 coaxial cable

9.2.1.1 Electrical specifications

Performance property	Units	US	(metric)
Attenuation @1.5GHz:			
30.77m (100ft.)	5.1dB		
100m	16.8dB		
Velocity of propagation	%	85	
Dielectric constant	N/A	1.38	
Time delay	nS/ft (nS/m)	1.20	(3.92)
Impedance		50	

Performance property	Units	US	(metric)
Capacitance	pF/ft (pF/m)	23.9	(78.4)
Inductance	uH/ft (uH/m)	0.060	(0.20)
Shielding effectiveness	dB	>90	
DC resistance Inner conductor Outer conductor	 /1000 ft (/km) /1000 ft (/km)	 1.39 1.65	 (4.6) (5.4)
Voltage withstand	VDC	2500	
Jacket spark	Vrms	8000	
Peak power	kW	16	

9.2.1.2 Mechanical specifications

Performance property	Units	US	(metric)
Bend radius, installation	in. (mm)	1.00	(25.4)
Bend radius repeated	in. (mm)	4.0	(101.6)
Bending moment	ft-lb (N-m)	0.5	(0.68)
Weight	lb/ft (kg/m)	0.068	(0.10)
Tensile strength	lb (kg)	160	(72.6)
Flat plate crush	lb/in. (kg/mm)	40	(0.71)

9.2.1.3 Environmental specifications

Performance property	°F	°C
Installation temperature range	-40 to +185	-40 to +85
Storage temperature range	-94 to +185	-70 to +85
Operating temperature range	-40 to +1851	-40 to +85

9.2.2 Times LMR-240 coaxial cable

9.2.2.1 Electrical specifications

Performance property	Units	US	(metric)
Attenuation @1.5GHz:			
30.77m (100ft.)	9.9dB		
100m	32.4dB		
Velocity of propagation	%	84	
Dielectric constant	N/A	1.42	
Time delay	nS/ft (nS/m)	1.21	(3.97)
Impedance		50	
Capacitance	pF/ft (pF/m)	24.2	(79.4)
Inductance	uH/ft (uH/m)	0.060	(0.20)
Shielding effectiveness	dB	>90	
DC resistance Inner conductor Outer conductor	 /1000 ft (/km) /1000 ft (/km)	 3.2 3.89	 (10.5) (12.8)
Voltage withstand	VDC	1500	
Jacket spark	Vrms	5000	
Peak power	kW	5.6	

9.2.2.2 Mechanical specifications

Performance property	Units	US	(metric)
Bend radius, installation	in. (mm)	0.75	(19.1)
Bend radius repeated	in. (mm)	2.5	(63.5)
Bending moment	ft-lb (N-m)	0.25	(0.34)
Weight	lb/ft (kg/m)	0.034	(0.05)
Tensile strength	lb (kg)	80	(36.3)
Flat plate crush	lb/in. (kg/mm)	20	(0.36)

9.2.2.3 Environmental specifications

Performance property	°F	°C
Installation temperature range	-40 to +185	-40 to +85
Storage temperature range	-94 to +185	-70 to +85
Operating temperature range	-40 to +185	-40 to +85

9.3 L-band coverage map