Leica AR20

Visionary 3D GNSS Antenna
Matchless multipath suppression

Visionary 3D GNSS Choke Ring Antenna

The Leica AR20 is a new innovative design antenna that brings new levels of performance for reference station and monitoring applications. The AR20 contains a new 3D design choke ring for improved tracking performance, excellent phase centre symmetry and unmatched multipath supression across all GNSS frequency bands.

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Leica Geosystems

Leica AR20

Future-proof GNSS infrastructure

New innovative design choke ring antenna
The AR20 is a newly designed 3D GNSS choke ring antenna with variable choke rings for superior tracking performance. The precision design also allows for very low and stable phase centre offsets and very smooth symmetry of the phase centre variations versus azimuth and elevation.

More robust for longer durability
The newly designed AR20 choke rings are treated with a newer and more robust double treatment for longer lasting durability in all environments. An optional radome cover is also available for added protection.

Additional power surge protection
The innovative integrated multi-stage power surge arrestor for the AR20 enhances protection against power surges in the electrical system, typically caused by lightning or any other source of high voltage.

Superior multipath performance
The AR20 has excellent Axial Ratio at low elevations which results in superior multipath rejection across all GNSS frequency bands including L5, due to the new 3D (made) design. Traditional 2D choke ring designs are typically optimised for a single frequency band, while the AR20 has been optimised for superior multipath performance across all GNSS frequency bands.

Technical Specification	
Design	Planar structure with 3D choke ring ground plane
Signals tracked	GPS: L1, L2 (including L2C), L5 GLONASS: L1, L2, L3, L5 Galileo: E1, E5a, E5b, E5alt (AltBOC), E6 BeiDou: B1, B2, B3 QZSS: L1, L1C, L2C, L5, L1-SAIF, L6 NavIC: L5 L-Band (incl. SBAS, TERRASTAR and CDGPS)
Phase centre	Accuracy: Typically less than 1 mm Repeatability: Within 1 mm
Dimensions (H x W)	163 mm x 320 mm
Weight	5.9 kg
Supply voltage range	3.3 – 12 VDC
Connector	N-Type (female)
Mounting	Standard 5/8" whitworth thread
Nominal impedance	50 ohms
Current	100 mA maximum
Gain (typically)	29 dB or 40 dB optional
Noise figure	Less than 2.0 dB

Technical Specification	
Axial ratio	Less than 1.2 at zenith
Lightning Protection	Integrated 3 stages surge protector to comply with at least one surge waveform (IEC 61000-4-5 class 4 voltage level)
Temperature range	ISO9022 and Mil. STD 810G Operating: -55° C to +85° C Storage: -55° C to +85° C
Environmental protection	Humidity: up to 100% Rain, dust, sand, wind: IP67 – Protection against blowing rain and dust. Waterproof to temporary submersion into water (1 m depth)
RoHS compliant	Yes
Vibration	ISO9022-36-05: 10 to 55 Hz; ± 0.15 mm; 5 cycles
Drop	Withstands 1.0 m drop onto hard surfaces
Antenna cables	Are available in lengths of 3.2/2.8/10/30/50/70 metres. Longer cables available on request
Radome	Available as option

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Leica AR25
White Paper

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Biography

Lennon Bedford graduated from the University of Otago in 2003 with a Bachelor of Surveying (Hons). He is currently an Application Engineer for GNSS Networks and Reference Stations for Leica Geosystems based in Heerbrugg, Switzerland.

Neil Brown holds a PhD in satellite geodesy from the University of Melbourne and has been involved with GNSS research since 2000. He is currently Senior Product Manager for GNSS Networks and Reference Stations for Leica Geosystems, based in Heerbrugg, Switzerland.

Justin Walford holds an M.Sc.E in Survey Engineering from the University of New Brunswick, and has been involved in GNSS applications and research since 1990. He is currently Product Manager for GNSS Networks and Reference Station Hardware for Leica Geosystems, based in Heerbrugg, Switzerland.

Abstract

This paper introduces the AR25, a new multi constellation Global Navigation Satellite System (GNSS) choke ring antenna for precise geodetic applications. This revolutionary new '3D' choke ring design allows better low elevation satellite tracking while maintaining the renowned performance characteristics of the traditional choke ring antenna such as smooth amplitude and phase pattern, effective multipath rejections and phase centre stability. The AR25 contains a new ultra wideband Dorne-Margolin element to allow for superior reception of all existing and planned GNSS signals, providing users with improved positioning precision and reliability.

Introduction

The well known Jet Propulsion Laboratory (JPL) designed choke ring antenna with a Dorne-Margolin vertical dipole has been widely accepted within the reference station community. Many choke rings from various manufacturers have been based on this design and used within the IGS and other reference station networks. However, antenna theory has evolved since this antenna was made allowing for innovative choke ring designs that provide better all-round performance. Reference station operators demand the highest performance antennas to allow the most accurate determination of site positions and velocities and high quality Real Time Kinematic (RTK) corrections. The antenna is arguably the most important part of any reference station infrastructure as it defines the measurement reference point. In order to achieve the best performance there are many aspects to the antenna that must be considered, including:

- Low elevation tracking
- Phase centre stability
- Multipath mitigation
- Out of band rejection
- Front to back ratio
- Gain pattern

Reference station operators are generally reluctant to change antennas because they are so important for the site position and accuracy. However, there are many new signals that are now available or planned as part of modernized GPS, modernized GLONASS, Galileo, Compass, QZSS and other satellite navigation or augmentation systems. These space segment improvements include signals transmitted on additional frequencies to the GPS L1 and L2 and GLONASS L1 and L2 that are commonly in use today. Antenna changes will be required to provide "all in view" tracking. Most notable are GPS L5, Galileo E1, E2, E5a, E5b, E6 and Compass B1, B2, B3. Hence it is also important, aside from the factors listed above, that an antenna supports these new signals to avoid the need to change the antenna again in a few years time.

From an antenna design point of view however, widening an antenna to track this range of frequencies creates many challenges to optimize the above characteristics for each frequency. The Galileo E6 and Compass B3 frequencies are the most difficult because of their proximity to frequencies used by air traffic control.

In this paper, the performance of the new wideband AR25 choke ring is compared to the AT504GG, an existing high-end choke ring antenna based on the original design from JPL. The AR25 uses an innovative 3D choke ring design in which the rings are at different heights and contain slots to allow dissipation of unwanted Radio Frequency (RF) energy. This new design helps to improve gain at the horizon while maintaining stable phase centre and pattern symmetry for amplitude, phase and group delay. This allows for better reception and tracking of low elevation satellites, improved multipath mitigation and out of band rejection.

In order to compare the antennas, various real world and laboratory tests were conducted to evaluate key performance criteria for each antenna. Anechoic chambers tests were used to assess the general antenna design and expected performance for the future signals. Empirical tests using the current GPS and GLONASS constellations were used to relate the theoretical characteristics to real world performance.

New Signals

Future proofing the AR25 for the planned GNSS frequencies detailed in Table 1 brings many benefits to reference station and network users. A nominal modernized GPS, modernized GLONASS and Galileo constellation will comprise 78 satellites. This level of coverage will bring new levels of:

- Satellite availability (allowing improved positioning in difficult environments such as urban canyons)
- Geometry (i.e. low GDOP, PDOP etc.)
- Productivity (reduced time to fix)
- Reliability (improved ambiguity resolution, especially in difficult environments)
- Redundancy (better ability of the system to detect problems)
- Precision (more precise signals, better modeling)

Increased satellite availability leads to improved geometry and redundancy of observations. This in turn improves reliability and precision of position, important in a host of applications utilizing GNSS signals. The benefits of combined GNSS technologies for RTK applications are examined in detail by Takac and Walford (2006).

The new AR25 3D choke ring design has been optimized for maximum compatibility with the antenna element, for the highest tracking performance.

Table 1: Existing and proposed GNSS signals (MHz)

System	L1/E1/E2/B1	L2/B2	L5/E5	E6/B3
GPS	1575.42	1227.6	1176.45	
GLONASS	1598.063 - 1605.375 *	1242.938 - 1248.625 *		
Galileo	1575.42		1176.45, 1207.14, 1191.795	1278.75
Compass	1561.098, 1575.42, 1589.742	1207.14	1176.45	1268.52
SBAS	1575.42			
OmniSTAR and CDGPS	1525 - 1560			

k = -7,6

New Innovative 3D Choke Ring Design

A typical choke ring antenna consists of several concentric ring structures that surround the central antenna element (Figure 1). The choke rings, which are usually slightly more than one quarter of a GPS L2 wavelength deep, are designed to eliminate reflected signals and prevent the propagation of surface waves near the antenna (Kunysz, 2001).

Figure 1: The AT504GG – A traditional '2D' choke ring antenna

The choke ring antenna has become the industry 'standard' for high end permanent reference stations due to its proven phase center stability, smooth amplitude and phase pattern and low susceptibility to multipath. The choke ring antenna is used as a benchmark for antenna qualification as an IGS station (IGS, 2007).

A significant weakness of the traditional choke ring antenna is its poor reception and tracking of satellites near the horizon. Signals from low elevation satellites are very important for many applications of GNSS because they help to de-correlate station height and troposphere parameters. One of the main design features of the 3D design of the AR25 choke ring antenna (Figure 2) is the improved low elevation tracking.

Figure 2: New "3D" Leica AR25 wideband choke ring antenna

The rings of the AR25's ground plane are arranged with each ring sitting lower than the previous ring so that the choke ring forms a conical shape. The steps between the rings are configured in such a way that their length on the longer side is approximately equal to a quarter wavelength of the lowest frequency used, in this case L5-L2, and the shorter side is approximately a quarter wavelength of the highest frequency used, in this case L1-G1 (Figure 3). The net effect of this configuration is a high impedance surface, which attenuates any surface currents excited by the antenna, and eliminates distortion of the amplitude and phase pattern. The 3D design improves low elevation antenna gain while maintaining the renowned characteristics of the original choke ring antenna such as stable phase center, pattern symmetry for amplitude, phase and group delay.

Figure 3: Cross-section of AR25 showing the groove depths

Additionally the AR25 uses a new ultra wideband Dorne-Margolin element. The new element is specially constructed and tested to ensure consistent performance across all bands.

Choke ring antennas are the preferred choice for reference station installations partly because of their durable construction. The AR25's robust construction ensures that the antenna will pass the test of time in the harshest of environments. An optional weather proof radome is also available.

Testing

The Anechoic chamber tests were conducted at the David Florida Labs of Canadian Space Agency located in Ottawa (Kanata) to determine the radiation pattern and phase center offset and variation in benign conditions (free of multipath). Data was collected at 23 GNSS discrete frequencies from 1175.3MHz to 1610 MHz. Spatially, data was sampled at 3 deg. intervals in both azimuth and elevation planes. The wideband antenna was tested using a carrier wave RF frequency.

The AR25 3D choke ring with its new Dorne-Margolin element was compared with an existing high-end 2D choke ring antenna with a standard Dorne-Margolin element. During the test the Low Noise Amplifier (LNA) circuits were bypassed to determine the net gain of the antenna element.

In order to assess the performance of the antenna outside of an anechoic chamber, testing was carried out in a 'real world' environment by Leica Geosystems in Switzerland. The antennas tested were production models including the filter and LNA.

Antenna Gain

The level of antenna gain is an important indicator of the antenna's tracking ability. High gain values over the elevation range translate into more complete data and a higher signal to noise ratio.

While the bandwidth of the AR25 has been significantly widened and the low elevation performance

optimized, it is clear from Table 2 that the peak antenna gain at the zenith has not been compromised.

Table 2: Comparison of the antenna peak gain of the AR25 and AT504GG measured at the zenith (90°El) for the three frequency bands

	AR25	AT504GG
High-Band Frequencies (L1,C1,C2,G1,E1,E2)	+4.9dBic	+5.5dBic
Mid-Band Frequencies (L2,G2,E6,C6)	+7.0dBic	+7.7dBic
Low-Band Frequencies (L5,E5a, E5b)	+5.3dBic	+5.9dBic

Table 3 shows that the peak gain on the horizon is better for the AR25 than for the AT504GG across all frequency bands, especially the high-band where significant improvement is seen. This indicates that the AR25 has superior low elevation tracking ability.

Table 3: Comparison of the antenna peak gain of the AR25 and AT504GG measured on the horizon (0°El) for the three frequency bands

	AR25	AT504GG
High-Band Frequencies (L1,C1,C2,G1,E1,E2)	-4.3dBic	-11.1dBic
Mid-Band Frequencies (L2,G2,E6,C6)	-7.3dBic	-9.8dBic
Low-Band Frequencies (L5,E5a, E5b)	-9.0dBic	-10.2Bic

Front-Back Ratio

The front-back ratio indicates an antenna's directivity and resistance to multipath (Hekmat et al., 2005). The higher the ratio of gain from the front (90° elevation) compared to the back (-90° elevation), the better the antenna's theoretical ability to reject reflected signals. The front-back ratio is influenced by a combination of the antenna's backside shielding and sensitivity to Left Hand Circular Polarized (LHCP) signals.

Table 4 shows the back-front ratios for the antennas for each of the 3 frequency bands. While the ratios are lower than those for the AT504GG, the values are still very good and exceed the values from a non-choke ring antenna. Some trade off is to be expected due to the significantly improved low elevation tracking.

Table 4: Comparison of the front back ratio for the AR25 and AT504GG tested at +/-90° elevation

	AR25	AT504GG
High-Band Frequencies (L1,C1,C2,G1,E1,E2)	28.9dB	36.4dB
Mid-Band Frequencies (L2,G2,E6,C6)	35.5dB	35.8dB
Low-Band Frequencies (L5,E5a, E5b)	24.9dB	35.6dB

Antenna Radiation Patterns

The radiation pattern for an ideal antenna would show consistently high gain from the zenith down to the horizon and would then roll off rapidly for elevations below the horizon. A consistent radiation pattern across all frequencies translates to similar phase center offset and tracking ability. The greater the difference between the Right Hand Circular Polarized (RHCP) and Left Hand Circular Polarized (LHCP) antenna gain, the greater the antenna's resistance to reflected signals. The high frequency band antenna radiation patterns for the AR25 and the AT504GG are shown in Figures 4 and 5. The antenna gain values have been normalized to enable direct comparison of the patterns. The peak antenna gain is 0dBic in each case.

Figures 4 and 5 show that while the antenna gain of the AT504GG falls away sharply as the high band signals elevation decreases, the AR25 maintains superior antenna gain over a greater elevation range. This translates into superior tracking ability of high band signals. The peak gain of the AR25 is +5dBic at the zenith and -5dBic on the horizon, enabling the antenna to track satellites at all elevation angles. It is also clear that, while the difference between the RHCP and LHCP signals is more or less the same for both antennas for the low elevations, the separation between the oppositely polarized signals is much greater for the AR25 for the high elevations, in comparison to the AT504GG. This indicates that, not only has the AR25 retained the renowned multipath mitigation characteristics of the AT504GG at low elevations, but has even improved the resistance reflected signals at high elevations for the high band frequencies.

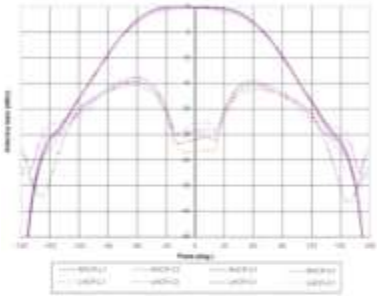

Figure 4: High-band antenna radiation pattern for AR25

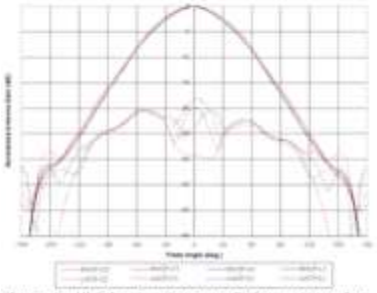

Figure 5: High-band antenna radiation pattern for AT504GG

Low Elevation Tracking

The anechoic chamber test results for the AR25 showed significant improvements in peak antenna gain on the horizon in comparison to the AT504GG. In theory, this improvement in antenna gain should result in superior low elevation satellite tracking. In order to confirm this theory, 'real world' testing was carried out. Data was recorded down to zero degrees elevation for both the AT504GG and AR25 antennas at 1Hz over a 24 hour period.

Figure 6 clearly reveals the AR25's exceptional reception of signals from low elevation satellites. For example, at 4° elevation the AR25 receives 99.14% of the expected GPS L1 observations, while the AT504GG receives just 3.95%. The AR25 displays a clear superiority in tracking ability from the horizon up to 10° elevation making it a powerful tool for a wide range of applications such as such as atmospheric modeling.

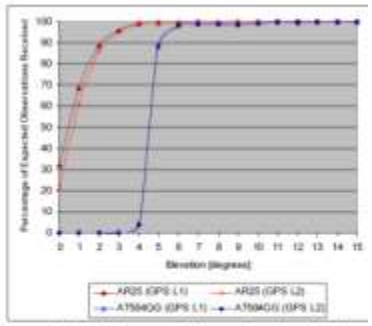

Figure 6: Completeness of observations by elevation for the AR25 and the AT504GG

Carrier Phase Multipath Mitigation

The antenna radiation patterns and front-back ratios calculated using observations performed in the anechoic chamber give us some indication of the antennas ability to mitigate multipath. However, testing the antenna in a 'real world' environment with low elevation obstructions and nearby reflective surfaces can show different characteristics.

GPS and GLONASS data was recorded for both the AT504GG and AR25 antennas every 10 seconds over a 24 hour period. The reference antenna was set up 3m away from the subject antenna. This short baseline length means that, following double difference processing, the remaining error will show the residual measurement noise. Each epoch of data was processed independently resulting in 8640 position solutions. Figure 7 shows the horizontal coordinate scatter plots for the two antennas while Figure 8 shows the height times series. Table 5 shows the standard deviations of the both antenna's.

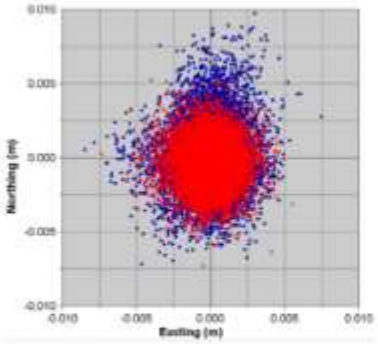

Figure 7: Horizontal coordinate variation for AR25 (red) and AT504GG (blue)

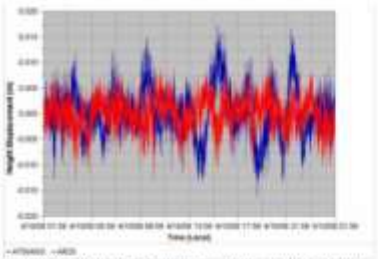

Figure 8: Height displacement over time for AR25 (red) and AT504GG (blue)

The horizontal scatter for the AR25 is noticeably less variable (Figure 7), and vertical variations are also significantly smaller (Figure 8), than for the AT504GG. This superiority is confirmed by the smaller standard deviations (STDV) in Table 5.

Table 5: Dispersion of the calculated coordinates

	STDV (E)	STDV (N)	STDV (H)
AR25	1.1mm	1.3mm	2.5mm
AT504GG	1.3mm	1.8mm	3.8mm

Phase Center Variation

In an ideal GNSS antenna, the observation point would correspond exactly with the physical center of the antenna housing. In practice the observation point, or electrical phase center, moves around in three dimensions with the changing azimuth and elevation of the satellite signal. The difference between the electrical phase center and the physical center of the antenna can be removed through Phase Center Offsets (PCO) and Phase Center Variations (PCV) calculated through antenna calibration. These corrections are only effective if the predicted phase center movement is repeatable for all antennas of the same model.

The horizontal phase center offsets (HPCO) for the GPS L1 and L2 frequencies were calculated for 20 production model AR25 antennas in order to asses the repeatability. Table 6 shows the mean HPCO values for the L1 and L2 frequencies along with the respective standard deviations.

Table 6: Horizontal Phase Center Offsets of a sample of 20 production model AR25 antennas

	L1 E	L1 N	L2E	L2N
Mean	0.6	1.0	0.0	0.2
Std. Dev.	0.6	0.4	0.6	0.5

The average HPCO's are all 1mm or less (Table 6). However, since the constant offset is removed via the antenna calibration, the most important factor for insuring repeatable measurements is the unit to unit variation. The sub-millimeter standard deviations show that repeatability of the phase center is very good.

Conclusion

This paper presents the new AR25 3D wideband choke ring antenna from Leica Geosystems. With emerging satellites systems on the horizon, a new high performance antenna is needed to encompass all GNSS signals. The AR25 has sufficient bandwidth to receive all existing and currently planned GNSS signals, while maintaining the highest performance standards. A detailed comparison with the renowned AT504GG choke ring antenna has shown that the revolutionary new 3D choke ring design, combined with a new ultra wideband Dorne-Margolin element and high performance LNA, has revealed impressive performance improvements, especially with respect to low elevation tracking. The reception of the proposed new signals along with additional low elevation satellites will bring new levels of positional accuracy to reference networks, and benefits the end users of the data. The AR25 has been designed and built for durability and will stand the test of time, even in the harshest of environments.

References

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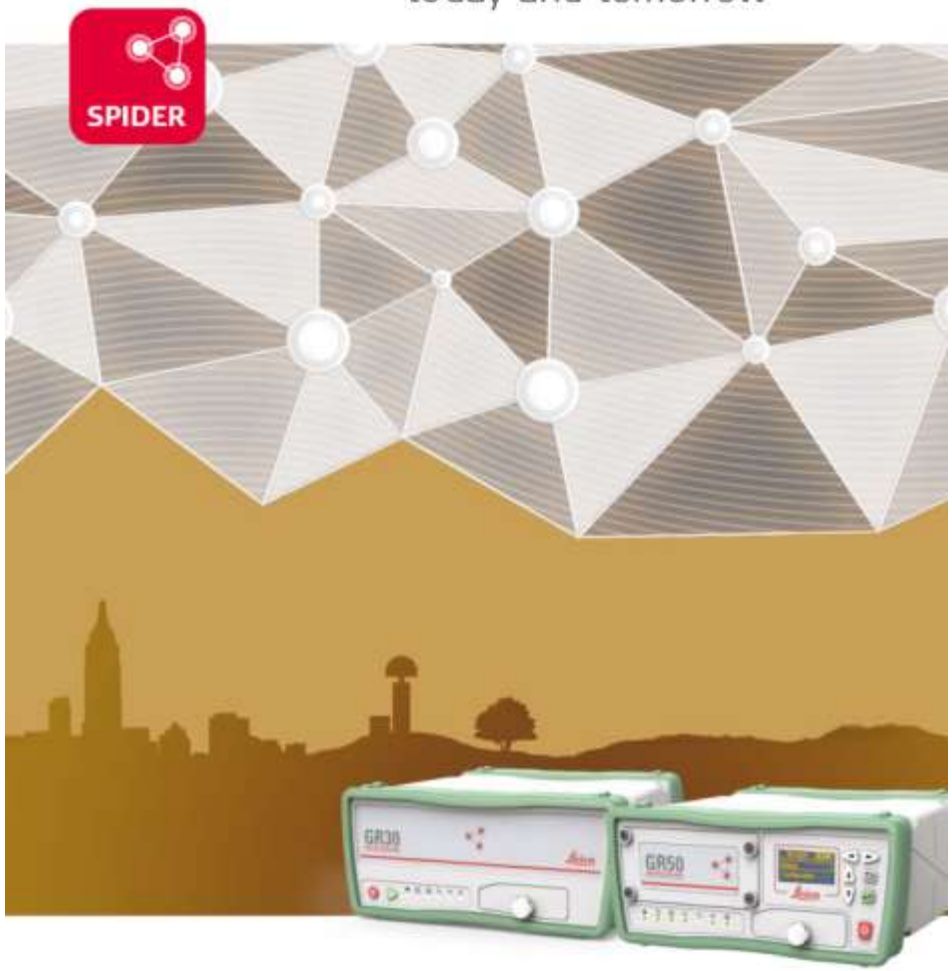
Leica GR30 & GR50
Versatile solutions for today and tomorrow



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Leica Geosystems

Leica GR30 and GR50 – Continuously evolving

The Leica Geosystems' innovative and industry-leading technology for GNSS reference stations and networks continues to evolve, meeting rapidly changing GNSS technology demands. Exceeding GNSS signal needs today and tomorrow by supplying 555 channels, plus providing industry-leading frequency spectrum analysis and interference mitigation makes Leica GR30 and GR50 reference servers the ultimate future-proof investments.

Part of the Leica Geosystems' GNSS solution, Leica GR30 and GR50 provide cutting-edge technology for outstanding performance. Regardless of the application, all new or existing GNSS permanent and semi-permanent network installations can be assured of receiving and delivering highly accurate and reliable data 24/7 for many years to come.

Flexible and adaptable, these reference servers offer multiple solutions for multiple needs. Leica GR30 and GR50 meet the highest demands for reliability and work in the toughest environments. Professionals put them to work on any type of GNSS applications, from campaign and permanent single base stations to RTK networks, from structural monitoring to offshore positioning, or from atmospheric research to seismic studies.

LEICA SPIDER

The Leica Spider family of products provide all you need for smart solutions, from single base stations to comprehensive infrastructure RTK networks and services.

The Leica reference server is a future proof investment, ensuring consistent high quality data for many years to come.

SmartTrack+
Up to 555 GNSS channels

Designed for top performance and with the future in mind, the GR30 and GR50 features the ultimate GNSS technology. 555 channels enable simultaneous tracking of all visible satellite signals of the current and planned global and regional navigation satellite system constellations. Upgradable software allows to add support for future signals as they become available. SmartTrack+ resilient signal tracking and interference mitigation technology ensures reliable GNSS multi-frequency operation even in challenging environments.

Smart Server Solution

Just like a data centre server, GR30 and GR50 are designed for reliable operation. With highly redundant communication, power supply and streaming and smart-logging capabilities the GR-series offer more than just a standard reference station receiver. Maximum benefit with minimum interaction is achieved through a comprehensive and easy-to-use web interface, event notification via email, SNMP support, automated firmware updates and plug-and-play connectivity.

Modular RefWorx Software

The unique onboard RefWorx firmware offers a comprehensive intuitive web interface, providing novice as well as highly experienced professionals complete and easy control. Context sensitive assistance paired with Leica Active Assist facilitate efficient support when needed. Feature-rich with optional onboard tools, such as Leica VADASE and Site Monitor, the RefWorx solutions support a wide range of applications for the diverse GNSS reference station and monitoring needs.

FLEXIBLE INSTALLATIONS

SMART DATA STORAGE

SMART COMMUNICATION

SMART POWER SOLUTIONS

MODULAR REFWORX SOFTWARE

SMART FOR HIGH SECURITY

Viewer/manager/administrator user levels and web interface restrictions together with HTTPs and SSL encryption prevent unauthorised access to the receiver. Integrated firewall and IP address filtering provide additional layers of security.

FLEXIBLE INSTALLATION

- Purpose built casing with rubber bumpers
- Wall or rack mount kit simplify fixed installation
- Easily attaches to a tripod for campaign setup
- Connectors are rugged and well spaced for easy handling

SMART DATA STORAGE AND CLEAN UP

- Removable SD card up to 32 GB
- FTP server and automated FTP push
- GR50 with external USB hard drive powered directly from the server
- Up to 12 logging sessions using MDB, RINEX and Hatanaka, including zip compression
- Data rates up to 50 Hz
- Smart prioritised clean up ensures preserving important data

SMART COMMUNICATION

- Connect the GR server to a network via the ethernet cable
- Add a slot-in device such as radio or GSM module to ensure server powered communication that is IP67 compliant
- For the GR50 additionally decide for a WLAN or Bluetooth® model
- Up to 20 parallel data streams
- Up to 50 Hz streaming rates
- Multiple connections
- Wide range of RTK and raw data formats

SYSTEM BACKUP AND RESTORE

- Easy distribution of the GR server configuration onto other GRs
- Protects against accidental changes

SMART POWER

Low power consumption for extended operation time in demanding environments.

GR30: Fully automated power management for up to two external power sources.

GR50: Intelligent Power Management of four configurable power sources.

- Two external inputs
- Power over Ethernet (PoE)
- Removable and rechargeable internal battery
- Internal charger ensures the battery provides up to 24 hours of power and data backup

FULL NTRIP CASTER

- Unlimited number of mount points
- Server and client connections via one single port
- Receive correction data in client mode for calculating an RTK fixed position and monitoring the antenna position while continuing to work as a GNSS reference server

ACTIVE ASSIST

Redefining customer support to guarantee your satisfaction

Active Assist is an online support service. Through a secure web service you can request a trained support technician to access the receiver and diagnose issues and perform trouble-shooting. Active Assist works even if the receiver is behind a firewall, ensuring quick and comprehensive support.

Revolutionising the world of measurement and survey for nearly 200 years, Leica Geosystems creates complete solutions for professionals across the planet. Known for premium products and innovative solution development, professionals in a diverse mix of industries, such as surveying and engineering, safety and security, building and construction, and power and plant, trust Leica Geosystems to capture, analyse and present smart geospatial data. With the highest-quality instruments, sophisticated software, and trusted services, Leica Geosystems delivers value every day to those shaping the future of our world.

Leica Geosystems is part of Hexagon (Nasdaq Stockholm: HEXA B; hexagon.com), a leading global provider of information technologies that drive quality and productivity improvements across geospatial and industrial enterprise applications.

Swiss Technology by Leica Geosystems

Leica GNSS Spider
Leica SpiderWeb
Leica SpiderQC

Leica AR20
Leica AR25
Leica AR10

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Leica VADASE

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Leica GR30 & GR50

Versatile solutions for today and tomorrow

GNSS Performance

Prepared for the constantly changing requirements of GNSS technology, the GR30 and GR50 reference servers are optimised with multi-frequency, 555 channel capabilities. All GNSS installations are certain of receiving and delivering highly accurate and reliable data – today and tomorrow. Rugged and reliable, the GR-series comes with innovative SmartTrack+ technology, ensuring superior quality data even under the harshest conditions.

Smart and Reliable

From RTK, static networks or single base stations to structural monitoring, atmospheric and seismic studies or offshore positioning; all GNSS applications will find a highly reliable solution in the GR-series reference server. Reliable with highly redundant communication, low power consumption and data logging. Smart because RefWorx software offers the highest versatility.

ACC»

Customer care is only a click away

Through Active Customer Care (ACC), a global network of experienced professionals is ready to expertly guide you through any challenge. Eliminate delays with superior technical service, finish jobs faster and avoid costly site revisits with excellent consultancy support. Control your costs with a tailored Customer Care Package, giving you peace of mind you're covered anywhere, anytime.

Leica GR30 & GR50

GNSS TECHNOLOGY				
Leica SmartTrack+		Very low noise GNSS carrier phase measurements (< 0.5 mm rms). Signal acquisition < 30 s[1]. Industry-leading Pulse Aperture Correlator (PAC) multipath mitigation technology. Advanced radio frequency power spectrum analysis and interference mitigation on all GNSS bands.		
GNSS Signals[2]		GPS (L1, L2P(Y), L2C, L5); GLONASS (L1, L2P, L2C, L3)[3]; Galileo (E1, E5a, E5b, AltBOC, E6)[4]; BeiDou (B1, B2, B3)[5]; QZSS (L1, L2C, L5); NavIC L5; SBAS (WAAS, EGNOS, GAGAN, MSAS)		
Number of channels		555 universal tracking channels		
MEASUREMENT PERFORMANCE AND ACCURACY[6]				
Code differential		Hz: 0.25 m + 1 ppm / V: 0.5 m + 1 ppm		
Site Monitor	RTK Positioning modes:	Reference station (smoothed)	Monitoring (instantaneous)	Network RTK (instantaneous)
	Single baseline (< 10 km):	Hz: 6 mm + 1 ppm V: 10 mm +1 ppm	Hz: 8 mm + 1 ppm V: 15 mm + 1 ppm	Hz: 8 mm + 1 ppm V: 15 mm + 1 ppm
	VRS, FKP, iMAX, MAC (RTCM SC 104):	Hz: 6 mm + 0.5 ppm V: 10 mm + 0.5 ppm	Hz: 8 mm + 0.5 ppm V: 15 mm + 0.5ppm	Hz: 8 mm + 0.5 ppm V: 15 mm + 0.5 ppm
	Time for initialisation (typical):	10s	10s	4s
VADASE	Velocity and displacement engine:	Velocity accuracy: Hz: 0.003 m/s, V: 0.005 m/s. Typical velocity derived displacement sensitivity: Hz: 1 cm/s, V: 2 cm/s		
PORTS AND CONNECTORS, COMMUNICATIONS				
Ruggedized RJ45 Ethernet / Power over Eth. Serial RS232 / Slot-in / WLAN or Bluetooth® USB client (PC or tablet) / USB host (ext. disk) External oscillator / Event input / PPS Out Dual Power Input		1 / - 1 / 1 / - 1 / - 1 / - / - 1		1 / Yes 2 / 1 / 1 1 / 1 1 / 1 / 1 1
Internal removable battery and built-in charger		-		GEB242 (up to 24h backup)
Slot-in communication interface		Exchangeable radio/GSM/GPRS/UMTS devices supported. Automatic gateway routing provides backup of internet access for continuity of communications.		
ELECTRICAL, PHYSICAL AND ENVIRONMENTAL				
Power supply		Nominal 24 V DC, range 10.5 – 28 V DC. Two external power inputs.		
Power consumption		3.5 W typical, 24 V at 145 mA		3.1 W typical, 24 V at 130 mA
Dimension / weight (with rubber bumpers)		20 x 200 x 94 mm / 1.67kg		20 x 200 x 94 mm / 2.01 kg
Temperature		Operating: -40 to 65 °C, Storage: -40 to 80 °C		
Humidity		Up to 100%		
Vibration		Withstands strong vibration during operation. Compliance with ISO9022-36-08 and MIL-STD-810G - 514.6-Cat.24		
Drop		Withstands 1 m drop onto hard surfaces.		
Proof against water, sand and dust		IP67 (IEC 60529) and MIL-STD-810G - 512.5-I Dust tight, protected against water jets. Waterproof up to 1 m temporary submersion.		
GENERAL				
User interface		Web interface for full receiver control and status information.		
		On / Off and 1x function button 6x LED for power, memory, logging, RT out, RT in, position		On / Off and 6x button keypad. Display. 7x LED for power, memory, logging, RT out, RT in, position, Bluetooth®
Data logging		Removable SD card up to 32 GB. 12 parallel logging sessions. Data rates up to 50 Hz. RINEX 2.11/3.xx, Hatanaka and Leica MDB formats including zip compression.		
Data streaming		Up to 20 parallel data streams with multiple connections. Data rates up to 50 Hz. Supports Leica, Leica 4G, QMR, QMR+, RTCM v2.3/3.2/2.3/3.3, BINEX, NMEA 0183 V 2.20 and proprietary formats via TCP/IP, Ntrip, serial, USB and Bluetooth®		
RefWorx Web and FTP Services		Full control and configuration of the receiver over a web browser. Internet connection sharing (ICS) using the GR50 as a internet gateway for connected devices. Ntrip server (source), client and caster functionality with unlimited mount points. Secure access using HTTPS, SSL certificates, access management and port blocking. FTP server and FTP client (push), Email notification, SNMP support.		

[1] Hot start (typical). Cold start < 60 s (typical).
[2] The tracking capability for a specific satellite system is based on publicly available information. For cases where public information is subject to change or not yet available Leica Geosystems cannot guarantee full compatibility.
[3] Hardware ready for: GLONASS L3, L5 (CDMA) and Galileo E6 will be provided through future firmware upgrade.
[4] Designed for BeiDou Phase 2, Phase 3 compatibility. B2 will be provided through future firmware upgrade.
[5] Measurement precision, accuracy in position and height, reliability and time for initialisation are dependent upon various factors including the number of satellites tracked, the observation time, the ephemeris accuracy, the ionosphere conditions, multipath and resolved ambiguities. Figures quoted are RMS (root mean square) and assume normal to favourable conditions.

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- when it has to be **right**

Leica Geosystems

Leica GNSS Reference Antennas
White Paper

- when it has to be right

Leica Geosystems

State of The Art , Leading Edge Geodetic Antennas from Leica Geosystems

Justin Walford, *Leica Geosystems*

BIOGRAPHY

Justin Walford holds an M.Sc.E in Survey Engineering from the University of New Brunswick, and has been involved in GNSS applications and research since 1990. He is currently Senior Product Manager for GNSS Networks and Reference Station Hardware for Leica Geosystems, based in Heerbrugg, Switzerland.

ABSTRACT

This paper introduces the range of state of the art wideband reference antennas from Leica Geosystems with emphasis on the new the Leica AR20 and AR10 antennas.

Leica Geosystems offers three unique and cutting edge geodetic antennas all with leading edge performance within their categories and each with their own individual strengths.

The Leica AR25 choke ring antenna with its revolutionary 3D choke ring design is a high quality; high performance antenna designed for all geodetic applications, including Network RTK and is especially suited for scientific applications requiring extended low elevation tracking. The design of the AR25 3D antenna is well documented in the separate Leica AR25 White Paper, and therefore is not covered here; see Bedford et al (2009). Comparative performance analysis w.r.t. to the AR20 and AR10 is covered within this paper.

Figure 1: Leica AR25 Choke Ring Antenna

The recent Leica AR20 choke ring antenna is a new visionary design taking the strengths of the AR25 3D design in a new; more cost effective way. The AR20 contains a new 3D (inside) choke ring design that brings leading edge multipath performance across all GNSS frequency bands and improved phase centre stability.

Figure 2: Leica AR20 Choke Ring Antenna

The AR10 is a high end performance Geodetic Antenna for a wide range of permanent or semi permanent Reference Station and Monitoring applications that require near choke ring antenna data quality without the size and weight of the traditional choke ring. The AR10 has a unique robust UV resistant integrated conical radome.

Figure 3: Leica AR10 Integrated Antenna

FUTURE PROOF

The need for future proof geodetic antennas is very clear as the cost of replacing antennas can be a burden for owners and disruptive to end users that use the data. Changing an antenna can also result in a small change of

Leica AR25

Multi-Constellation GNSS Antenna
Revolutionary Design, Built to Last

SPIDER

Will your infrastructure stand the test of time?

The Egyptians showed great ingenuity and innovation to build the pyramids with such precision and strength that they still stand today. The revolutionary multi-constellation AR25 choke ring antenna sets new standards in low elevation tracking and multipath reduction by using an innovative 3D design that is built to last, even in the harshest of environments.

Leica AR25
Stay ahead – be prepared

With emerging satellite systems closely on the horizon, in the form of the European Galileo System and the Chinese Beidou System, a new high performance antenna is needed to encompass all Global Navigation Satellite Systems, and further support the Leica Geosystems "future proof" philosophy.

The new AR25 has been designed for all existing and currently planned signals of the GPS, GLONASS, Galileo, BeiDou, QZSS and NavIC systems.

The way ahead

The Leica AR25 brings choke ring design to a new level to enhance the key benefits of the choke ring antenna. Moving away from the traditional 2D choke ring design, the innovative 3D choke ring sets a new standard, whilst building on the strong traditions of the previous design. The AR25 uses a new ultra-wideband Dorne-Margolin element. The Dorne-Margolin antenna element design has become the industry standard for high accuracy and performance. Antenna gain has been optimised to allow use with most manufacturers geodetic receivers.

New standard

Choke ring antennas are known for their superior multi-path rejection compared to other types of geodetic antennas. The Leica AR25 maintains superior levels of multipath rejection and tracking expected from a choke ring antenna, whilst setting new standards in low elevation tracking compared to traditional 2D choke ring design.

Enhances in atmospheric studies and network RTK modelling demand high performance antennas that can track satellites as soon as they are visible, down to the horizon and even below. Designed for a variety of applications, including reference stations, monitoring, seismic studies, scientific and atmospheric studies, the AR25 is a robust high performance antenna, built to stand the test of time.

GNSS future proof

Technical Specification	
Leica AR25	
Design	Dorne-Margolin antenna element with 3D choke ring ground plane
Signals tracked	GPS: L1, L2 (including L2C), L5 GLONASS: L1, L2, L3, L5 Galileo: E1, E5a, E5b, E5ab (AltBOC), E6 BeiDou: B1, B2, B3 QZSS: L1, L1C, L2C, L5, L1-SAIF, L6 NavIC: L5 L-Band (incl. SBAS, OmniSTAR, Veripos and CDGPS)
Dimensions	380 mm x 200 mm
Weight	8.1 kg, radome 1.1 kg
Connector	N-Type with TNC adapter supplied
Supply Voltage	3.3 - 12 VDC
Nominal Impedance	50 ohms
Gain	typically 40 dB
Noise Figure	< 1.2 dB max
Temperature, operating	-55°C to +85°C
Temperature, storage	-55°C to +90°C
Environmental Protection	Humidity: up to 100% Rain, dust, sand, wind: IP67 – Protection against blowing rain and dust. Waterproof to temporary submersion into water (1m)
Accessories	Weatherproof radome available
Antenna Cables	Are available in lengths of 1.2/2.8/10/30/50/70 metres. Longer cables available on request

Leica Geosystems AG
Heerbrugg, Switzerland

www.leica-geosystems.com