



# PolaRx5 GNSS Reference Receivers

Low-power

Best-in-class measurement

Advanced interference mitigation

"We use the PolRx5 for enhancing the EarthScope Plate Boundary Observatory, the international standard for geodetic networks."

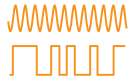
*M. Meghan Miller, Ph.D., President, UNAVCO, Inc. 01/02/2016*



Photo credit: UNAVCO, Inc.

# Why Septentrio?

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## High-quality measurements

The PolaRx5 family of reference receivers track all visible signals generating ultra low-noise measurements. According to independent competitive tests, the PolaRx5 provided the fewest cycle slips while offering the highest number of observations per slip.



## Feature rich

Quick and easy setup thanks to on-board web server. 40 parallel data records. LOCK+ guarantees robust tracking of rapid signal dynamics during scintillation events or earthquakes. Advanced Interference Mitigation (AIM+) tackles interference using proprietary filtering and keeps you working in difficult radio environments.



## Smart archiving and network monitoring

The PolaRx5 series includes a smart telemetry system for efficient use of data bandwidth. The system checks file fragments at the remote data location so that only missing parts are transferred. This reduces both the time and cost associated with data transfer over a satellite link.



## Proven performance

Septentrio receivers have a well-earned reputation in scientific monitoring and time and frequency transfer. They are used by some of the most prestigious institutions around the world in high profile projects so you don't have to take our word for it.

# PolaRx: your GNSS reference

## PolaRx5

Best-in-class for GNSS measurement quality



## PolaRx5e

Rugged receiver with battery



## PolaRx5S

For space weather and scintillation



## PolaRx5TR

For time and frequency transfer



### Hardware

IP rating	IP65	IP68	IP65	IP65
Internal battery	No	Yes	No	No
Internal clock	TCXO	TCXO	OCXO	TCXO
REF IN	Yes	Yes	No	Yes
PPS IN	No	No	No	Yes
External clock synchronisation	Frequency only	Frequency only	No	Frequency and time
REF OUT	Yes	Yes	Yes	Yes
PPS OUT	Yes	Yes	Yes	Yes

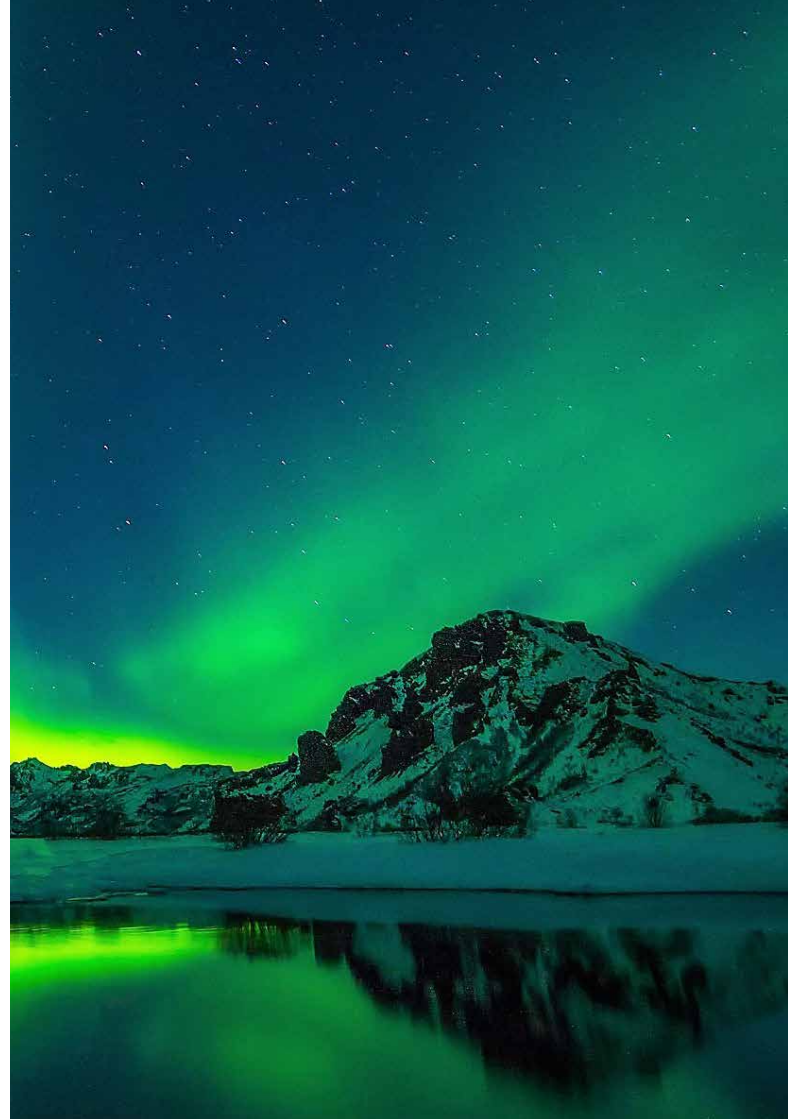
### Software

PPP for Seismic	Yes	Yes	No	No
CGGTTS	No	No	No	Yes
ISMR	No	No	Yes	No
IQCorr Output	No	No	Yes	No

# High-spec as standard

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- ▶ Tracking all GNSS L-band frequencies with high-precision, low-noise measurements on GPS, GLONASS, Galileo, BeiDou, NavIC, QZSS and SBAS
- ▶ Low and scalable power consumption
- ▶ 40 parallel data records (RINEX, BINEX, NMEA, MSM and SBF) with event driven protection against data deletion when disk is full
- ▶ A unique storage integrity functionality to improve data archiving
- ▶ Best-in-class interference monitoring and mitigation
- ▶ Quick and easy setup and configuration via the Web UI, with full control of receiver settings and outputs



# CORS reference stations and earth monitoring

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Septentrio's origins are deeply rooted in the scientific community having founded as an offshoot of IMEC. Septentrio has worked with the European Space Agency (ESA) since the beginning of the Galileo Space Program; the first ever GNSS receiver able to receive live Galileo signals was built by our team of dedicated engineers. The PolaRx5 and PolaRx5e are the most advanced CORS receivers on the market today.

## Low-noise and fewer cycle slips

According to independent tests\*, PolaRx5 delivers:

- ▶ Highest measurement availability
- ▶ Lowest number of cycle slips
- ▶ High signal to noise
- ▶ Best-in-class measurement quality

## Seismic applications

Correction data transmitted by satellite allows cm-precision PPP positioning to record both:

- ▶ Real-time high-frequency earthquake vibrations
- ▶ Quasi-stationary tectonic and ice sheet movements

### Measurements

Carrier Phase measurement precision 1-1.3 mm  
Measurement update rate 100 Hz

### Output formats

RINEX  
BINEX  
RTCM/ MSM

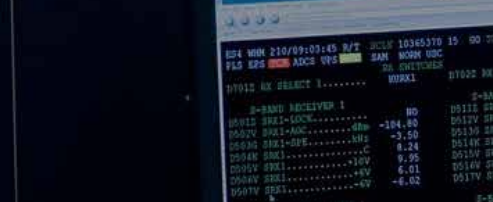
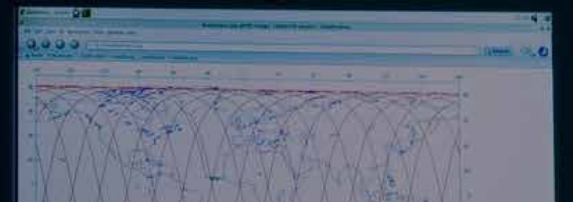
### Data management and monitoring

40 parallel data logging records  
Smart data archiving  
FTP server/push, SFTP  
Web UI  
COSMOS network monitor

\*Evaluation GNSS receiver report UNAVCO, 2015



# PolaRx5 for CORS and network operations



# Time and frequency transfer

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Dedicated to time and frequency transfer applications, the PolARx5TR is optimised for quality of code and carrier phase measurements. The PolARx5TR is fully compliant with recommendation CCTF 4 and 5 (2015) of the Consultative Committee for Time and Frequency.

## Key Features

- ▶ Ultra-precise time synchronisation for time transfer applications
- ▶ PPS IN internal delay auto-calibration
- ▶ CCGTTS V2E compliant
- ▶ Tracks all visible signals (GPS, GLONASS, Galileo, BeiDou, NavIC)
- ▶ High-precision, low-noise measurements
- ▶ Unique interference monitoring and mitigation
- ▶ Powerful Web UI and logging tools
- ▶ on-board CCGTTS

## Measurement precision

Code-carrier bias	0 by design
Inter-frequency code bias	< 10 ns
Inter-system code bias in common carrier	< 2 ns
Code measurements	< 0.5 ns
Phase measurements	< 5 ps
PPS in delay calibration precision	20 ps

## Time accuracy

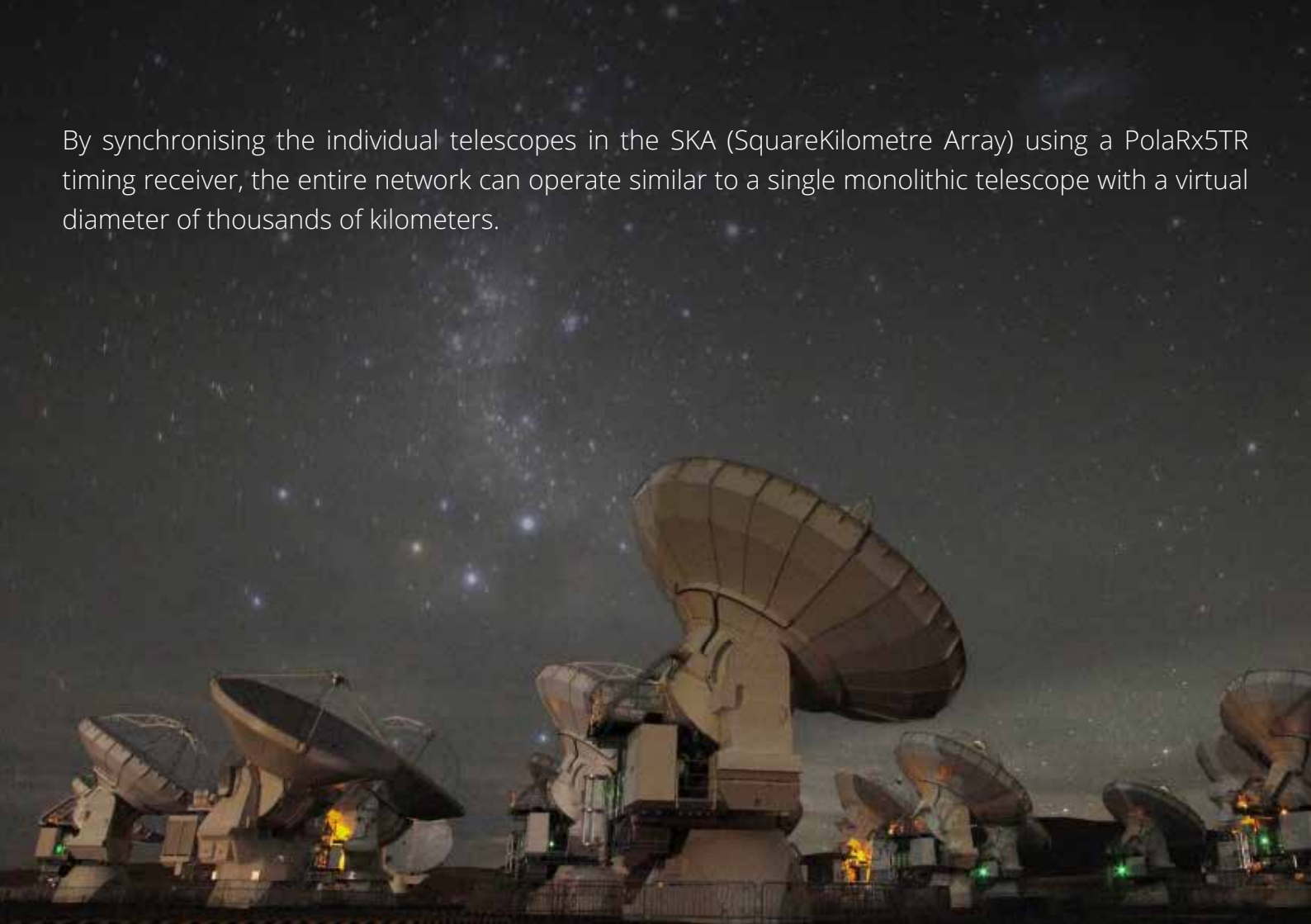
1 PPS out	5 ns
1 PPS out rise time	< 2 ns
Event	20 ns

## External input

10 Mz reference input
1 PPS-IN



By synchronising the individual telescopes in the SKA (SquareKilometre Array) using a PolaRx5TR timing receiver, the entire network can operate similar to a single monolithic telescope with a virtual diameter of thousands of kilometers.



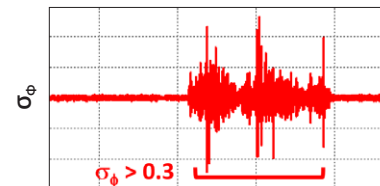
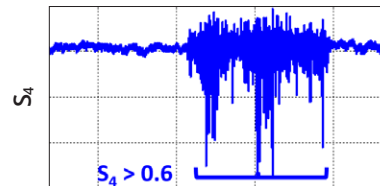
# Scintillation

The PolARx5S is the world's leading ionospheric GNSS receiver providing I&Q correlations, phase, code and carrier-to-noise at up to 100 Hz for all GNSS L-band frequencies.

The PolARx5S outputs an extensive set of GNSS measurements and iono-indices, including I&Q correlation, phase and intensity, up to 100 Hz. Featuring an ultra-low noise oscillator, it enables precise phase scintillation monitoring with a phase noise standard deviation (Phi60) as low as 0.03 rad.

Fluctuations in the electron density of the ionosphere can distort the phase and amplitude of GNSS signal producing fluctuations known as scintillations.

Ionospheric scintillations are typically characterised by two indices:  $S_4$  and  $\sigma_\phi$ .



Hours

## Measurement precision

Phase noise bandwidth	1 - 50 Hz (configurable)
Phi60 noise floor	0.03 rad

## Iono-indices

- $S_4$
- Phi01, Phi03, Phi10, Phi30, Phi60
- Code-Carrier divergence (CCD)
- Scintillation Intensity (SI)
- Phase spectrum slope and strength at 1 Hz (p&T)

## TEC

- Corrected for satellite biases
- Calibration tool for receiver+antenna biases
- User-selectable signal combination
- No need for CA-P calibration table

## Update

Code, phase, intensity, correlations	100 Hz
Iono indices and TEC	60 s

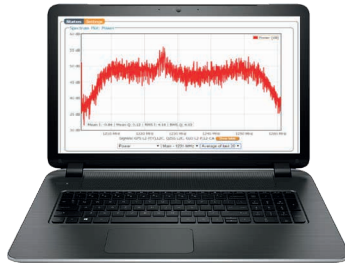
Elevated solar activity has repercussions for the Earth's ionosphere which in turn affects GNSS signals.



# Jamming and spoofing

## Advanced Interference Mitigation (AIM+)

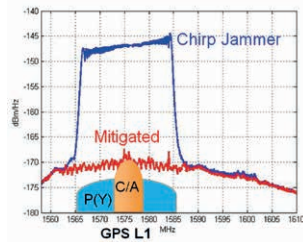
AIM+ offers built-in protection against intentional and unintentional jamming using a sophisticated system of sampling and mitigation mechanisms. The AIM+ system can suppress the widest variety of interferers from simple, continuous narrow-band signals to the more complex, wideband and pulsed transmissions.



Integrated spectrum analyzer in the Web UI

## AIM+ in action

The GPS L1 signal contaminated with a chirp-jammer signal both before (blue) and after (red) activation of the Advanced Interference Mitigation (AIM+).



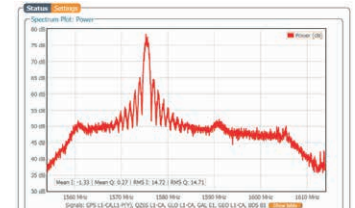
For more detailed info on our GNSS+ technologies, please visit [septentrio.com/technology](https://septentrio.com/technology)

## Spoof resistant

Unlike jamming that simply blocks GNSS signals, spoofers aim to replicate the GNSS signal to take over the receiver. Septentrio receivers have an array of built-in features that detect, flag and mitigate spoofing.

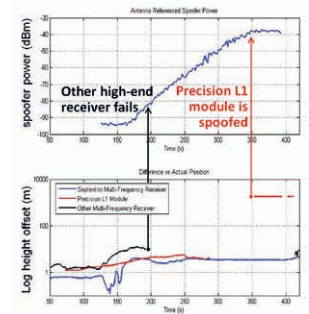
## Visualise

The spoofed GPS signal from a HackRF SDR in the spectrum plot.



## Mitigate

Septentrio receivers are able to switch to alternative dual-frequency combinations when spoofing is detected on one frequency.



# COSMOS Web monitoring software for GNSS receivers

Cosmos allows for the visualisation of health and status information and the functional management of GNSS receivers. You can filter receivers by online status, quality indicators, uptime, set-up email alerts, user profiles and access level control.

## See at a glance in a map or in a list view

- ▶ Signal quality
- ▶ Uptime
- ▶ Temperature
- ▶ Voltage
- ▶ Marker information

The screenshot displays the COSMOS web monitoring software interface. The top navigation bar includes the 'septentrio' logo, 'Dashboard', and 'About' links. The main dashboard features four summary cards: 'Total receivers' (27), 'Online receivers' (25), 'Offline receivers' (2), and 'New receivers' (0). Below these cards is a search bar for markers. A table lists receiver data with columns for STATUS, MARKER, UPTIME, OVERALL QI, T, and V. A 'FILTERED RECEIVERS' panel on the right shows filter options for STATUS (Online, Offline, New), OVERALL QI (0-10), UPTIME (DAYS) (0-81), and TEMPERATURE (°C) (-40-80). A detailed profile for 'Ax4\_KWW' is shown, including its status (Online), uptime (1h 21m 40m), receiver type (AstelRx4), firmware version (0.0.0nonstandard), position (N 50° 50' 55.06", E 4° 43' 55.64"), altitude (129.907 m), PVT mode (SBAS aided PVT), RX STATUS (No error), and various signal quality indicators (Overall QI, Main Signals, Main RF Power, CPU, Auxiliary).

STATUS	MARKER	UPTIME	OVERALL QI	T	V	
Online	SEPT	71:14:10m	10/10	-48°C	12V	VISIT PAGE
Online	SEPT	53:11:15m	10/10	-42°C	12V	VISIT PAGE
Online	SEPT	50:17:23m	10/10	45°C	12V	VISIT PAGE
Online	SEPT	47:08:09m	10/10	51°C	12V	VISIT PAGE

AX4_KWW	Online
UPTIME	1h 21m 40m
RECEIVER	AstelRx4
FW VERSION	0.0.0nonstandard
POSITION	N 50° 50' 55.06" E 4° 43' 55.64"
	129.907 m
PVT	SBAS aided PVT
RX STATUS	No error
QI OVERALL	10/10
MAIN SIGNALS	10/10
MAIN RF POWER	10/10
CPU	10/10
AUXILIARY	10/10
T	52°C
V	N/A

# Recommended antennas



## VeraPhase 6000

- ▶ Lowest phase center variation (PCV) of any antenna ( $\pm 1$  mm)
- ▶ Lowest axial ratio across all frequencies through all elevations (< 2dB at horizon)
- ▶ Highest gain across all GNSS frequencies for any comparable antenna

	VeraPhase 6000	PolaNt Choke Ring
<b>Current</b>	45 mA	65 mA
<b>Weight</b>	0.82 kg	5 kg
<b>Size</b>	$\varnothing = 16.7$ cm; h=17.5 cm	$\varnothing = 38$ cm; h = 40 cm



## PolaNt Choke Ring B3/E6

- ▶ Higher phase center stability
- ▶ Powerful out-of-band interference filtering
- ▶ Superior multipath rejection

### Supported frequencies

L-Band  
GPS L1, L2, L5  
GLONASS L1, L2, L3  
Galileo E1, E5ab, E6  
BeiDou B1, B2, B3  
NavIC L5  
SBASS L1,L5  
QZSS L1, L2, L5, L6

# About Septentrio



On land, at sea and in the air, Septentrio continues to set the industry benchmark for GNSS positioning solutions. By combining easy-to-use technology with robust hardware, users in the marine, mining, surveying and many more industries trust Septentrio's AsteRx, PolaRx and Altus product lines for centimetre-level RTK position accuracy in the most challenging environments.



UAV



Mapping



Scientific



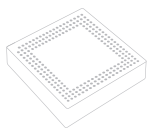
Automation



**Accurate**

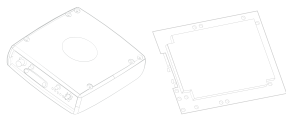
**Robust**

**Reliable**



**mosaic**

GNSS receiver  
module



**AsteRx**

OEM & integrated  
GNSS receivers



**Altus**

Surveying & GIS  
equipment



**Antennas**

High quality GNSS  
antennas



**Software**

GNSS software  
solutions

**EMEA (HQ)**

Greenhill Campus  
Interleuvenlaan 15i  
3001 Leuven, Belgium  
+32 16 30 08 00

**Americas**

Suite 200  
23848 Hawthorne Blvd  
Torrance, CA 90505, USA  
+1 310 541 8139

**Asia-Pacific**

Shanghai, China  
Yokohama, Japan  
Seoul, Korea

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septentrio.com

sales@septentrio.com

