



# Programmable Dual Frequency GPS Receiver for Monitoring Space Weather

## CASES SM-211 GPS Receiver

### SALIENT FEATURES

- Remote re-programmability
- Standalone system
- Full control of receiver behavior, products, and cadences
- Cost Effective
- Superior performance in severe scintillation environment
- Flexible Communication Interfaces
- Availability of precise GPS Total Electron Content & scintillation parameters

### Built From the Ground Up for Space Weather Monitoring

The CASES SM-211 dual-frequency GPS sensor developed by ASTRA represents a revolutionary advance in GPS space-weather monitoring. The SM-211 was designed with the following constraints in mind:

- Fast logging (100 Hz)
- Dual-frequency
- Superior Tracking through scintillation events
- Cost-effective solution enables deployment of arrays of CASES receivers

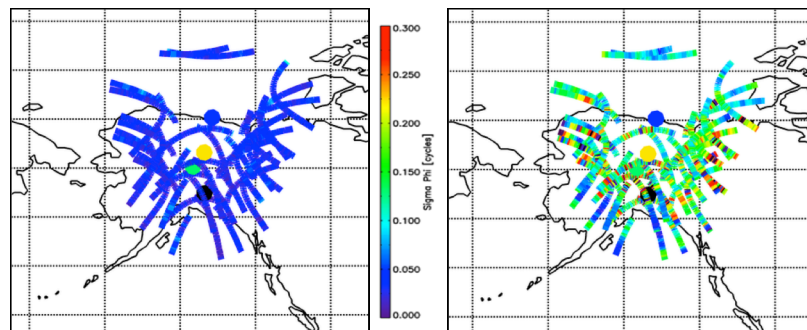


### Unparalleled Tracking Performance in Scintillating Environments

The SM-211 GPS receiver has been developed as a cost-effective space weather instrument for monitoring ionospheric scintillation and total electron content. The receiver implements several proprietary processing techniques that make it well suited for space weather monitoring:

- Data-bit prediction and wipe-off for robust tracking through scintillation,
- A differencing technique for eliminating local clock effects,
- An advanced triggering mechanism for determining the onset of scintillation, and
- Data buffering to permit observation of the prelude to scintillation.

Quiet Conditions (left) & Active (right) using ASTRA's AK Array



Gakona (black), Kaktovik (blue), Poker Flat (teal), Fort Yukon (yellow).  
Scintillation Altitude: 350.00 km, Elevation Mask 20.00 deg

Real-time Phase Scintillations in Alaska: [www.astraspacenet.com/cases-alaska](http://www.astraspacenet.com/cases-alaska)



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## CASES SM-211 GPS Receiver

### PERFORMANCE

#### Channel Configuration

40 Channels

#### Signal Tracking

GPS: L1 and L2C

#### Configurable Data Rate

High Rate at 50 or 100 Hz

Low Rate at 1 Hz or less

Scintillation Parameters at

0.01 Hz

#### Time to First Channel Lock

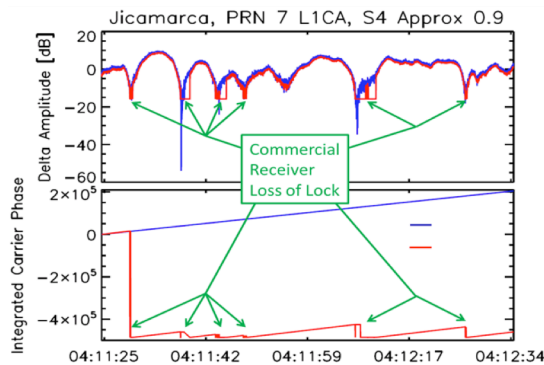
Cold Start ~60s

Hot Start ~15s

### COMM INTERFACES

- One USB Host Port (two on Wifi version)
- One SDHC Port
- One RS-232 Debug Port
- One RJ45 Ethernet Port
- 802.11 b/g Wifi (Wifi version only)

### Comparison of CASES vs. Competitor GPS monitor in a Scintillating Environment



Scintillation events are characterized by deep fades in GPS signals. Signal amplitude and carrier phase data from CASES receiver (blue curve) shows continuous coverage through scintillation events, while data from another commercial GPS receiver (red curve) show loss of lock during these periods of deep signal fades.

### Programmable Parameters

#### Selected Parameters

- Number of tracking channels
- Low rate data cadence
- Scintillation parameters
- High rate data availability & cadence
- Data storage options
- EML chip spacing
- PLL loop order
- PLL bandwidth
- PLL discriminator type
- DLL bandwidth
- FLL bandwidth
- FLL weak bandwidth
- Code generation type
- Navigation smoothing parameters
- SPR threshold for non-scintillating channel
- Window length for scintillation calculations
- Frequency resolution for SPR calculation
- Scintillation threshold for triggering selective availability of high rate data
- Elevation mask for scintillation triggering

### Data Products

Data Type	Per Channel High Rate Data	Per Channel Low Rate Data	Per Channel Scintillation Parameters	Navigation Information
<b>Default Data Rate</b>	<b>100 Hz</b>	<b>1 Second</b>	<b>60 Second</b>	<b>1 Second</b>
<b>Configurable Rate?</b>	<b>Yes, 50 or 100 Hz</b>	<b>Yes, &gt;= 1 Second</b>	<b>Yes</b>	<b>Yes, &gt;= 1 Second</b>
<b>Available Parameters</b>	Integrated Carrier Phase In-Phase Accumulation Quadrature Accumulation GPS Time Receiver Time	<b>Pseudorange-based TEC</b> <b>Phase-based delta TEC</b> Pseudorange Integrated Carrier Phase GPS Time Receiver Time Doppler Frequency PRN (Azim/Elev/Health) C/N0 Data Validity Flag Cycle Slip Flag Signal Acquisition Status	$S_4$ $\sigma_\phi$ $\tau_0$ Scintillation Power Ratio GPS Time Reference Channel Status PRN	Receiver X/Y/Z Position Receiver X/Y/Z GPS Time Receiver Time Velocity Receiver Clock Error Receiver Clock Error Rate Navigation Solution Flag