

# GPS-88 & GPS-89



## GPS-Controlled Frequency Standards

- Traceable internal calibration system approved by SP (Swedish National Testing and Research Institute)
- No calibration cost – ever
- Remote monitoring via Ethernet interface
- Cesium stability – at Rubidium price
- No doubt about accuracy, display of frequency offset
- Standard frequencies for telecom, calibration and test systems



Deliver precision frequency and time reference with these GPS-controlled frequency standards. The Pendulum GPS-88 and GPS-89 are fully traceable and extremely accurate frequency standards, with applications in telecommunications, calibration laboratories, automated test systems and design departments.

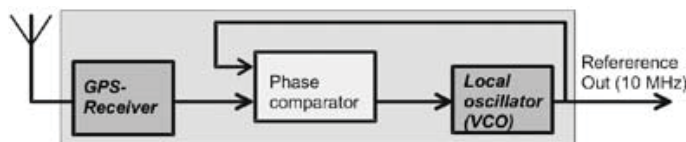
### Cesium Controlled Frequency via GPS satellites

The GPS-controlled frequency standards, Pendulum GPS-88 and GPS-89, deliver a precision frequency and time reference, everywhere in the world. They receive their long-term frequency stability from built-in atomic clocks in the GPS-satellites.

The GPS-88 and GPS-89 are designed to provide also a very high short-term frequency stability via high-quality local oscillators. They are cost-efficient, traceable and extremely accurate frequency standards. The models GPS-88/GPS-89 are very suitable as frequency standards in the telecommunication and electronics industry. They fit in the calibration laboratory, as a frequency reference in test systems and as a local reference in the design department.

### Traceable Frequency Standard

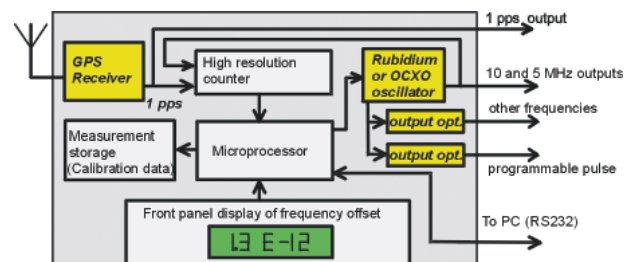
Off-air frequency standards have existed for several years with the same internal architecture, see figure 1.



**Figure 1:** A typical “black box” GPS-receiver (antenna in - reference out). Internal oscillator offset and adjustments are invisible to the user.

The typical unit is a “black box” for the user, with an antenna input and a frequency output. The control process (disciplining) of the local oscillator is totally hidden for the user. How can the user monitor or even trust the frequency output from the “black box”? The traditional way is to use another frequency reference (e.g. a

rubidium standard), a phase comparator and a PC for logging the deviation between the “black box” and the other frequency reference. We have now made the comparison and control process visible and documented (a requirement for traceability is a “comparison process on a continuing basis that produces documented measurement results”).



**Figure 2:** The model GPS-88 and GPS-89 have built-in continuous comparison between the GPS-receiver and the internal oscillator. The frequency offset is displayed and stored and a traceable calibration protocol can be produced at any time.

We have used our leadership in high resolution counting technology and built-in an advanced phase measurement kernel. The received GPS-signal is continuously measured against the local oscillator and the phase/frequency deviation is stored in a non-volatile storage and can at any time be transferred to a PC for printout of a calibration report. The unbroken calibration history chain – day by day – is maintained in the non-volatile memory for several years, see figure 2. Based on calibration data, the current

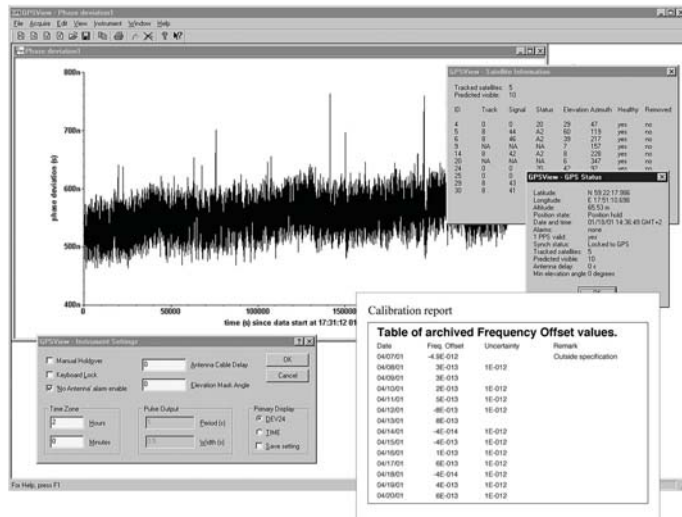


24 h mean frequency offset, is continuously displayed on the front panel. Furthermore, also the short-term stability of the frequency reference is continuously calibrated and can be documented, when the unit is connected to a PC.

We have put a lot of efforts into ensuring that the user will have an unbroken traceability chain, from the first day of operation and for the years to come. The user should connect the frequency standard to the enclosed PC program GPSView™ at least once every second year to download the 24 h frequency offset data and print out a calibration report.

To include also the short-term phase variation (hour by hour), download of instrument data should be made, and a run of the control and monitoring program GPSView™, once per month, see figure 3. Days with insufficient GPS-contact, e.g. due to transportation, storage, service or whatever are clearly marked, in the calibration report generated by GPSView™.

The GPS-88 and GPS-89 are really true traceable and documenting GPS-controlled frequency standards!



**Figure 3:** GPSView™ can print a traceable calibration report at any time, show frequency offset, display GPS-satellite status and much more.

## Two Models and Optional Configurations

We offer two models to choose from:

- The very high stability GPS-89 with its built-in Rubidium atomic clock as the local oscillator.
- The budget model GPS-88 with its high stability local oven controlled crystal oscillator.

Both models come as standard with one 5MHz and five 10 MHz sine wave outputs, plus a 1pps (one pulse-per-second) output.

There are five frequency output options to choose from:

- **Option 70:** which allows for five more 10 MHz outputs to be mounted, ideal for e.g. test systems when multiple instruments should be supplied from the same frequency standard.
- **Option 71:** which gives four sine wave outputs of resp. 10 MHz, 5MHz and 0.1 MHz, plus a 0.1 MHz square wave output.

- **Option 72:** which gives five extra 2,048 MHz outputs (E1) for use in telecom applications.
- **Option 73:** which gives five extra 13 or 26 MHz outputs intended for GSM base station applications.
- **Option 75:** which allows the user to define his/her own pulse frequency output. Both instruments can communicate with a local PC via the RS232-port (standard) or with a remote PC via the Ethernet-port (optional).

## Two Operating Modes

Most users would prefer an automatic adjustment (known as disciplining) of their frequency standard, to fully eliminate long-term frequency changes (aging). This disciplined mode is also the default mode in the models GPS-88 and GPS-89. As long as there is a valid satellite signal, the internal local oscillator is monitored and adjusted for drift. Disciplining the local oscillator makes life easy for the average user, and ensures that the mean 24 h frequency offset is always virtually zero.

The manual Hold-over mode removes the automatic adjustment, thereby improving the short-term stability for GPS-88 (The GPS-89 is always very stable, independent of mode). This mode is intended for critical applications that demand superior medium-term stability, especially jitter and wander measurements in digital telecommunication networks. The unique manual Hold-over mode makes it possible to temporarily switch over from disciplined to Hold-over mode during the actual measurement, thereby achieving a superior frequency accuracy at the start of the measurement and a superior stability through the measurement. Also in the manual Hold-over mode, the local oscillator is calibrated with full traceability and the frequency offset is displayed and stored.

## Remote Monitoring of Your Frequency Standard

You can remotely read the status of your frequency standard, get phase- or frequency deviation data, print calibration reports and much more. Use the optional Ethernet communication interface to access your frequency standard via Internet or any Ethernet LAN (10Base-T).

## Made for Portability

When using manual Hold-over mode, the GPS-88/GPS-89 acts like a perfectly calibrated stand-alone OCXO or Rubidium Frequency Standard. This means that one common draw-back of a typical GPS-receiver – the lack of portability – is eliminated. Other GPS-receivers may need hours to lock, after a change of location, whereas models GPS-88/GPS-89 are up and running after just 10 minutes.

## GPSView™

The GPS-88 and GPS-89 comes as standard with the PC-SW GPSView™. This SW allows you to print calibration reports, view short-term phase variations and long-term frequency variations and to view GPS-satellite status. See figure 3.

## SP-Report

The test report from the Swedish National Testing and Research Institute (SP) verifies the outstanding stability and traceability of the GPS-89. The SP-report can be downloaded at [www.spectracomcorp.com](http://www.spectracomcorp.com)

## Operating modes

### Disciplined Mode

The frequency deviation between the local oscillator and the received GPS-signal is used to continuously adjust the oscillator. The resulting 24 h mean freq. offset is displayed continuously on the front panel, and stored together with adjustment data in non-volatile memory every 24 h.

### Hold-Over Mode

The internal timebase oscillator is not adjusted. This mode is normally automatically entered when there is no useable received GPS-signal. This mode can also be activated via the Manual Hold-over key. If there is a valid received GPS signal, the actual frequency offset is calculated and displayed plus stored in non-volatile memory every 24 h.

## GPS-89 (GPS-Rb)

### Frequency Stability - Locked To GPS

**Frequency offset (24 h mean):**  
 $<1 \times 10^{-12}$  (at temperature 20°C to 26°C)

### Short term (Allan dev.):

$<1 \times 10^{-12}$  ( $\tau = 1000$  s)  
 $<3 \times 10^{-12}$  ( $\tau = 100$  s)  
 $<1 \times 10^{-11}$  ( $\tau = 10$  s)  
 $<3 \times 10^{-11}$  ( $\tau = 1$  s)

**Warm up (+25°C):** 20 mins to lock

### Frequency Stability - Hold-Over

**Aging/24 h:**  $<2 \times 10^{-12}$  (typ.)

**Aging/month:**  $<5 \times 10^{-11}$

**Temp. (0°C to 50°C):**  $<3 \times 10^{-10}$

**Temp. (20°C to 26°C):**  $<2 \times 10^{-11}$  (typ.)

### Short term (Allan dev.):

$<3 \times 10^{-12}$  ( $\tau = 100$  s)  
 $<1 \times 10^{-11}$  ( $\tau = 10$  s)  
 $<3 \times 10^{-11}$  ( $\tau = 1$  s)

**Warm up (+25°C):** 10 minutes to  $4 \times 10^{-10}$

### Phase Noise

Offset	Phase noise
1 Hz	-80 dBc/Hz (typ.)
10 Hz	-90 dBc/Hz (typ.)
100 Hz	-130 dBc/Hz (typ.)
1 kHz	-140 dBc/Hz (typ.)
10 kHz	-140 dBc/Hz (typ.)
100 kHz	-145 dBc/Hz (typ.)

## GPS-88 (GPS-OCXO)

### Frequency Stability - Locked to GPS

**Frequency offset (24 h mean):**  
 $<2 \times 10^{-12}$  (at temperature 20°C to 26°C)

### Short term (Allan dev.):

$<5 \times 10^{-11}$  ( $\tau = 1000$  s)  
 $<3 \times 10^{-11}$  ( $\tau = 100$  s)  
 $<5 \times 10^{-12}$  ( $\tau = 10$  s)  
 $<5 \times 10^{-12}$  ( $\tau = 1$  s)

**Warm up (+25°C):** 20 mins to lock

### Frequency Stability - Hold-Over

**Aging/24 h:**  $<3 \times 10^{-10}$

**Aging/month:**  $<3 \times 10^{-9}$

**Temp. (0°C to 50°C):**  $<2.5 \times 10^{-9}$

**Temp. (20°C to 26°C):**  $<4 \times 10^{-10}$  (typ.)

### Short term (Allan dev.):

$<5 \times 10^{-12}$  ( $\tau = 100$  s)  
 $<5 \times 10^{-12}$  ( $\tau = 10$  s)  
 $<5 \times 10^{-12}$  ( $\tau = 1$  s)

**Warm up (+25°C):** 10 minutes to  $5 \times 10^{-9}$

### Phase Noise

Offset	Phase noise
1 Hz	-100 dBc/Hz (typ.)
10 Hz	-120 dBc/Hz (typ.)
100 Hz	-130 dBc/Hz (typ.)
1 kHz	-135 dBc/Hz (typ.)
10 kHz	-135 dBc/Hz (typ.)
100 kHz	-135 dBc/Hz (typ.)

## Common

### Standard Reference Outputs

#### (Connector type BNC)

**10 MHz:** Sine wave,  $>0.6$  Vrms in 50  $\Omega$

**5 MHz:** Sine wave,  $>0.6$  Vrms in 50  $\Omega$

**Freq. Stability:** See frequency stability specs for GPS-88 resp. GPS-89 for GPS-locked respectively hold-over modes

**1 pps:** Approx. 0V...5V in open output  
 Approx. 0V...2.0 V in 50  $\Omega$  load

**Duty cycle (GPS-locked):** Approx. 20%

**Jitter (GPS-locked):** 60 ns rms relative to UTC or GPS (opposition hold, SA on)

#### Option 70 outputs:

See specification for 10 MHz above

#### Option 71 outputs:

**Sine wave outputs:** 10, 5, 1 and 0.1 MHz;  
 $>1$  Vrms in 50  $\Omega$

**Pulse output:** 0.1 MHz;  $>3$  Vp-p in 50  $\Omega$   
 0V.LO  $<0.8$  V 3V  $<$  HI.5V

**Freq. stability:** See frequency stability specs for GPS-88 resp. GPS-89 for GPS-locked resp. hold-over modes

#### Option 72, 73/13 or 73/26 outputs:

**Frequency:** 2.048 MHz square wave (opt. 72)  
 13 MHz (option 73/13)  
 26 MHz (option 73/26)

#### Output level:

-1.2 V to +1.2 V  $\pm 10\%$  in 75  $\Omega$  (G.703:10)

**Freq. Stability:** See frequency stability specs for GPS-88 resp. GPS-89 for GPS-locked resp. hold-over modes

**Jitter:**  $<0.01$  UI

**Option 75 output:** The frequency is adjustable via the included PC-program

**Pulse output:** Approx. 0V...5V in open output  
 Approx. 0V...2.0 V in 50  $\Omega$  load

**Selectable period:** N $\times$ 100 ns (2  $<$  N  $<$  228)

Range: 200 ns to . 27 s (. 0.04 Hz to 5MHz)

**Selectable pulse width:** N $\times$ 100 ns

Range: (1  $<$  N  $<$  228-1) 100 ns to . 27 s

#### Factory default setting:

Frequency: 1Hz (Period = 1s)

Duty cycle: 50% (Pulse width = 0.5 s)

**Jitter:**  $<500$  ps (rms)

**Freq. Stability:** See freq. stability specs for GPS-88 resp. GPS-89

## Internal Data Storage

### 24 h-freq. offset:

2 years data, Non-volatile memory

### Adjustment data:

2 years data, Non-volatile memory

### Phase data:

40 days data, Volatile memory controls

## Controls

**Manual hold-over:** Inhibits automatic GPS-adjustment and forces. Hold-over operation. Also toggles between freq. offset and time-of-day display

## LED Indicators

**Locked to GPS:** ON Disciplined mode

OFF Hold-over mode

**Alarm:** ON Alarm condition. Explaining text in 7-segment display area

OFF Normal operation

### Manual hold-over:

ON Manual Hold-over mode

OFF Automatic choice of disciplined or

Hold-over mode depending on "Locked to GPS"

status

## Display Indicators

**7-segment area:** 24 h mean freq. offset (if

valid data exist for the past 24 h);

Time of day (if GPS-contact gives valid time);

"GPS-88"/"GPS-89" (otherwise);

Alarm text (plus Alarm LED)

**REMOTE segment:** Local Lock-out (from PC)

**Analog bar graph:** Satellite signal strength

## GPS-Receiver

**Antenna connector:** Type N

**Channels:** 12, parallel tracking

**Carrier, code:** L1, C/A

### Antenna (option 01)

**Type:** active L1

**Operating temp.:** -40°C to +70°C

**Height:** 81 mm (3.2")

**Weight:** 230 g (8oz.)

**Gain:**  $>30$  dB

**Connector:** TNC

### Antenna Cable (Option 02/20, Option 02/50, and Option 02/130)

**Type:** RG213

#### Length:

20 m (02/20), 50 m (02/50), 130 m (02/130)

**Connectors:** N-type and TNC (male)

#### Cable delay:

101 ns (02/20), 251 ns (02/50)

#### Attenuation:

Approx. 8dB at 1.6 GHz (02/20)

Approx. 20 dB at 1.6 GHz (02/50)

## PC-Connection

**Interface:** RS232, DTE

**Connector:** 9-pin male DB9, Rx on pin2,

Tx on pin 3, GND on pin 5

**Baud rate:** 9600 bps

**Data structure:** 8 data bits 1 stop bit, no parity

### Option 76 Ethernet

**Communication port:** Connector: RJ45

Protocol: 10Base-T

Buffer RAM: 1kbit

**Configuration port:** Connector: Dsub9, RS232

**Fan**

Temperature controlled

**Environmental****Temperature:**

0°C to +50°C (operating)  
-40°C to +70°C (storage)

**Safety:** Compliant to CE: EN 61010-1 +A1 (1992) +A2 (1995), Cat II, Pollution degree 2

**EMI:** Compliant to CE: EN 61326-1(1997)

**Power consumption**

**Line voltage:** 100 to 240 V ( $\pm 10\%$ )

**Line frequency:** 47 to 63 Hz

**Power GPS-88:**

<75 W at warm-up

<35 W continuous operation

**Power GPS-89:**

<25 W at warm-up

<12 W continuous operation

**Attenuation:**

Approx. 8dB at 1.6 GHz (02/20)

Approx. 20 dB at 1.6 GHz (02/50)

**Mechanical Data****WxHxD:**

315x86x395 mm (12.4x3.4x15.6 in)

**Weight:**

*GPS-89:* Net 4.4 kg (9.7 lb);

Shipping 7.4 kg (16.3 lb)

*GPS-88:* Net 3.9 kg (8.6 lb);

Shipping 6.9 kg (15.2 lb)

**GPSView™ SW**

GPSView™ is a Windows 2000/XP/Vista-program that communicates with GPS-88/GPS-89.

It provides a traceable calibration document based on the 24 h frequency offset values, internally stored in the non-volatile memory of the Frequency Standards. It is only needed to connect a PC to the GPS-88/GPS-89, and run GPSView™, once every second year, to obtain an unbroken traceability chain since first use. For performance analysis over a shorter period (40 days), also short-term phase variation data can be obtained over the latest 40 day period.

From GPSView™, the user can select time-of-day or frequency-offset display, control the operating mode (disciplined or Hold-over), and lock the front panel to prevent unintended change via the "manual Hold-over" key. The user can also set the optional pulse output frequency and duty cycle.

GPSView™ can also retrieve and display GPS-receiver status info. Calibration data can be printed in graph format to produce a calibration report, and can also be stored in a file format suitable for direct import in MS-Excel for further analysis.

**Ordering Information****Basic Model****GPS-88:**

GPS-controlled OCXO Frequency Standard.

5x 10 MHz and 1x 5MHz outputs

**GPS-89:**

GPS-controlled Rubidium Frequency Standard.

5x 10 MHz and 1x 5MHz outputs

**Included with instrument:**

Operators manual

Calibration certificate

GPSView SW

**Options**

*Option 70:* 5 extra 10 MHz outputs

*Option 71:* Multiple reference outputs  
0.1/1/5/10 MHz

*Option 72:* 5 extra 2.048 MHz outputs

*Option 73/13:* 5 extra 13 MHz outputs

*Option 73/26:* 5 extra 26 MHz outputs

*Option 75:* 1 extra pulse output 0.5 Hz...5MHz

*Option 76:* Ethernet connection

**Optional Accessories**

*Option 22:* 19" rack mount kit

*Option 27:* Carrying Case

*Option 27H:* Heavy-Duty Transport Case

*Option 01:* GPS antenna

*Option 01/50:* GPS Antenna Mounting Kit

*Option 02:* Antenna cable, 20 m

*Option 02/50:* Antenna cable, 50 m

*Option 02/130:* Antenna cable, 130 m