User Manual

Specification:	**AXGPS9000-LN_Rev.3**	
Type:	GPS-Disciplined OCXO (GPSDO)	
Frequency:	10.000 MHz	
Author:	HH	
Revision / Date:	2	28.06.2022

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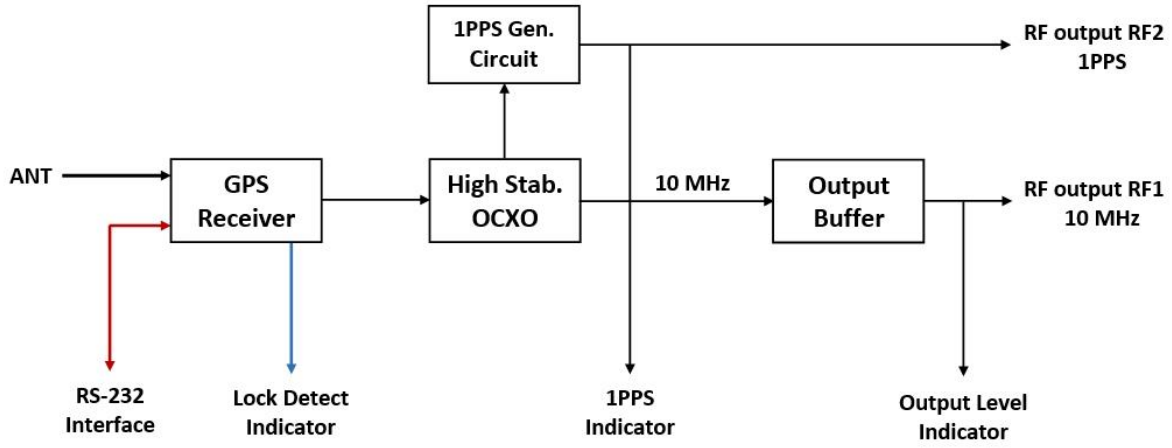
1 Introduction

The AXGPS9000-LN is a very high stability low noise GPS-Disciplined OCXO (GPSDO). The state-of-the-art GNSS receiver and disciplining topology allow for a very high stability in the short- and long-term range. The internal high stability OCXO guarantees excellent holdover performance in unlocked state.

The GPSDO has one 10 MHz output port and one 1PPS pulse output, which exhibits very low jitter. The module can be monitored and controlled via a RS-232 interface, which also allows to read GPS data in conformance with the NMEA-0183 standard.

The GPSDO is designed for a very long life time. The output signals can be distributed using distribution amplifiers of AXTAL's AXDA9000 series, which are perfectly matched to the module. The GPSDO can also be build with integrated distribution amplifiers (please contact AXTAL for details).

The block diagram below shows the basic design topology of the AXGPS9000-LN.



2 Enclosure drawing and connections

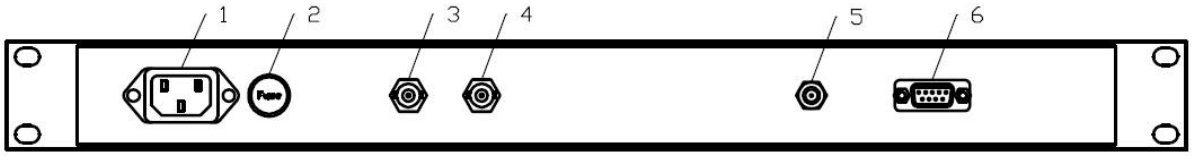


Figure 1: Rear Panel

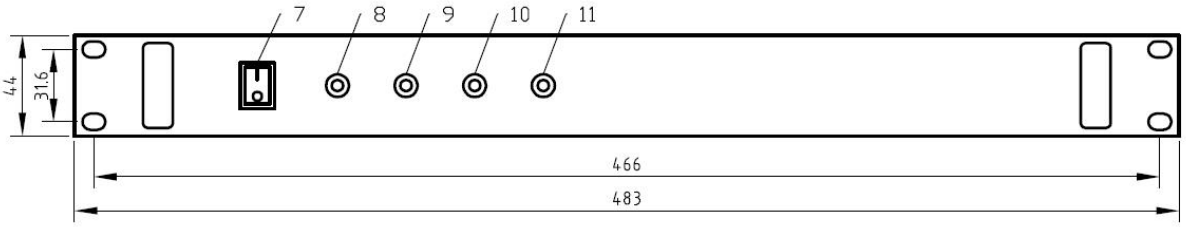


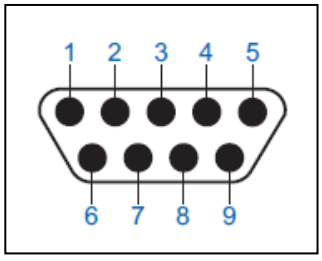
Figure 2: Front Panel

#	Panel	Symbol	Function
1	**Rear**	POWER IN	AC Supply Input (IEC 60320-1 / C14)
2		FUSE	2 A Slow 5x20 mm Fuse
3		RF OUT	RF Output 10 MHz
4		RF OUT	RF Output 1 PPS
5		GPS IN	GPS Input
6		COMM	Communication Interface – See table 2
7	**Front**	POWER SWITCH	Power Switch ON/OFF
8		POWER ON	LED – Power ON Indicator
9		LOCK DETECT	LED – Lock Detect Indicator (GPS)
10		PPS	LED – 1 PPS Indicator
11		OL	LED – Output Level Indicator (ON > +12 dBm)

Table 1: Connections

#	Symbol	Function
1	N.C.	No Connection
2	RX	Receive Data
3	TX	Transmit Data
4	N.C.	No Connection
5	GND	Common GND
6	N.C.	No Connection
7	N.C.	No Connection
8	N.C.	No Connection
9	N.C.	No Connection

Table 2: Sub-D connector pin-connections



Front View D-Sub connector

3 Safety

Do not install or operate the unit without having read this manual and the detail specification.

Verify that the AC input voltage and power capacity are within the specification before connecting the unit. Ensure proper grounding and ESD precautions.

The unit shall be handled by skilled persons only. Do not open the unit to modify or repair the unit by yourself. Any damage or malfunction shall be reported to AXTAL.

Do not replace the fuse, if the unit is powered on!

4 Unpacking & Mounting

4.1 Unpacking

Carefully remove the unit from the shipping box and ensure ESD precautions.

Inspect the unit for any visible damage before mounting or operation. Immediately report any damage to AXTAL and in case of a damaged shipping box also to the forwarder.

Check that the correct model was delivered. The label on the side of each unit shows the detail part number of the unit.

4.2 Cooling

The unit does not require cooling, but ensure that the maximum operating temperature is not exceeded. The unit shall not be submitted to direct airflow and a stable operating temperature is recommended for best performance.

4.3 Mounting

If the unit is placed on a table, then apply the sockets, which were shipped with the unit, to the bottom plate. The unit is preferably mounted in a 19” rack with suitable rack slides. It is allowed to obstruct the air inlets of the housing as it is not required for cooling.

The unit can operate independent of the mounting orientation, but horizontal mounting is recommended. Do not obstruct the front panel to ensure reading the LED indicators.

5 Power-on & Warm-up

5.1 Power line quality

The quality of the AC power supply shall be compatible with the surge and burst testing levels of IEC 61000. This ensures that the unit is not damaged and that the performance is as defined in IEC 61000.

5.2 Power-on

Connect a matching power cable to the AC supply input (#1) and switch on the unit (#7). The LED indicator (#8) at the front panel must be lid, if the unit is properly powered. Check the fuse (#2), if the unit does not power-on even though proper power supply is applied. Please contact AXTAL, if the fuse repeatedly burns. See also Safety precautions above.

5.3 Warm-up

The GPSDO requires sufficient warm-up time for the internal OCXO to stabilize and the GPS receiver to lock to the GPS signal. Assuming a good GPS signal and sufficient satellite coverage (determined by the quality and location of the antenna) the unit should be fully locked within 20~45 minutes. To achieve the full frequency stability as specified, the unit must run continuously for at least 24 hours. Ensure a stable temperature environment.

6 Environmental Specifications & Maximum Ratings

Please refer to the detail specification for environmental conditions, operating range and maximum ratings. Do not exceed any of the stated limits! Otherwise, the unit may be permanently damaged including adjacent units and risk for the user may arise in extreme cases.

The instrument is designed to be installed in a clean room or laboratory environment. Thus, no more pollution than pollution degree 1 shall occur to the equipment. External cleaning may be done with a wet soft cloth, but no water shall enter the unit!

7 Operation

The GPSDO sources one 10 MHz sine wave and one 1PPS pulse output signal within a 50 Ohm impedance environment. Both signals exhibit supreme long-term stability in GPS locked state. Please refer to the datasheet for details and read carefully before operating the amplifier.

7.1 GPS/GNSS operation

Connect a matching antenna to the GPS input (#5), which must be located in a way to allow for good satellite coverage. The details for the GPS input are stated in the datasheet. The standard GPSDO version allows only to use the GPS L1 band, but Galileo and Beidou versions are also available. Please contact AXTAL for more details.

As stated under “Warm-up” the unit requires maximum 45 minutes to stabilize and lock after power on, if it is operated properly and in accordance with the instructions given in the datasheet and this manual. A proper lock is indicated by the LED (#9) on the front panel. If the unit doesn’t lock after 1 hour, please read the status information via RS-232 interface to check the operation details.

To achieve the full frequency stability as specified in the datasheet, the unit must run continuously for at least 24 hours. Best holdover performance is reached after at least 7 days operation.

The unit is sensitive to vibration and it shall only be used under static conditions. Please make sure, that no air flow is applied to the unit and that temperature fluctuations are kept to a minimum. Otherwise, the electrical performance may be degraded significantly.

7.2 Output RF1 – 10 MHz

The output port (#3) delivers a sine wave signal with typical +13~+14 dBm output level at a 50 Ohm load. Only if the port is terminated with 50 Ohm and the signal level is above the minimum limit of +12 dBm is the LED (#11) indicator on the front panel lid.

A proper 50 Ohm termination is required in conjunction with high-quality coaxial cables to ensure best performance. The output port is protected against continuous short-circuit, but this should be prevented in any case. Even though this will not damage the unit, no proper operation and performance can be guaranteed for a permanent short-circuit at the output port.

7.3 Output RF2 – 1PPS

The output port (#4) delivers a square wave signal with typical 4 V_{P-P} output level at a 50 Ohm load, which is DC coupled and TTL compatible. The signal has typically 10% duty cycle and is driven by high-speed buffers, which allow very fast rise and fall times in the low nanosecond range. The 1PPS signal is also continuously indicated by the LED (#10) on the front panel.

7.4 RS-232 Communication Interface

The GPSDO acts as a Data Terminal Equipment (DTE) in terms of the RS-232 specification. Therefore, a null modem cable has to be used to connect to another DTE like a PC. As shown in *Table 2*, only 3 signals are used for a minimal communication standard.

The configuration of the serial port, which must be used with any preferred terminal emulator (e.g. *Hyper-Terminal* or the free *TeraTerm* for Windows, *xterm* for Linux), is as follows:

Speed	57600 bit/s
Data bits	8
Parity	None
Stop bits	1
Flow Control	None

Table 3: Serial port configuration

Once the connection is established and the GPSDO is powered-on, it starts with sending its version information and continues with the system status every second, which is explained below together with all other possible commands.

All commands must be written in uppercase letters.

7.4.1 Stop Output

Command Format: <ETX> resp. *CTRL+C*
Command Function: Stop the output of state information

Click *CTRL+C* to stop the output of the system status or GPS information on the terminal or send the associated ASCII code. <ETX> is 0x03 in terms of ASCII code.

7.4.2 Help Information

Command Format: HELP<CR><LF>
Command Function: Display help information of each command

Input 'HELP' and then press *Enter* to display possible commands as shown in *Fig. 4*

```
->HELP
 SA      -- Satellite Elevation Angle
 TZ      -- Set the time zone
 UD      -- Set User Delay
 ANT     -- Enable antenna status detection
 STA     -- Display System Status
 GPS     -- Display GPS information
 VER     -- Software Version
 HELP    -- Command Help
 Ctrl+C -- Stop Display
```

Figure 3: Help information

7.4.3 Elevation Angle Setting

Command Format: SA<CR><LF>
SA<Space><Argument><CR><LF>
SA<Space><Argument 1><Space><Argument 2><CR><LF>
Command Function: Check and set the elevation angle of satellite searching

The GPS receiver can be set in what elevation range it looks for satellites. The smaller the elevation angle, the easier the satellites can be searched and vice versa. The GPS receiver can change the elevation angle with a built-in intelligent adjustment algorithm in order to improve the timing specification, if enough satellites are received. When the satellites that can be received decrease, the GPS receiver will automatically reduce the elevation angle. It is recommended to set the elevation angle to 25° when a GPS antenna is installed at the rooftop without shelter.

In the case of 'SA' command without arguments, the possible argument range and the current elevation angle will be displayed. For example, the current elevation angle is 25° in *Figure 4*.

```
->SA

+--------------------------------------------------+
|01| SA x  : 0(deg) < x < 50(deg) Automatic         |
|02| SA x F: 0(deg) < x < 50(deg) Fixed             |
|03| SA x N: 0(deg) < x < 50(deg) Not Fixed         |
+--------------------------------------------------+
| Current value: SA = 25                           |
+--------------------------------------------------+

->SA 20 F
Fixed!

Satellite elevation angle: 20 deg.
```

Figure 4: Elevation angle setting

In the case of 'SA' command with one argument, it is used to set the elevation angle. If the angle setting is called with two arguments (the elevation angle and a letter), the user can choose to override the automatic adjustment of the angle and to fix it at the given value.

7.4.4 Time Zone Setting

Command Format:	TZ<CR><LF>
	TZ<Space><Argument><CR><LF>
Command Function:	Check and set the time zone

The received time and date is corrected by the time zone before displaying it in the system status, to take account of the position of the GPS receiver. The time zone setting is expressed using positive or negative offsets from UTC.

In the case of 'TZ' command without arguments, the current time zone will be displayed. For example, the current time zone is UTC+1 in *Figure 5*.

```
->TZ

+--------------------------------------------------+
|01| TZ    : Help information                      |
|02| TZ x  : x is time zone                        |
+--------------------------------------------------+
| Time Zone:  1                                    |
+--------------------------------------------------+

->TZ 2
Set OK!
```

Figure 5: Time zone setting

If the 'TZ' command is called with argument, it is used to set the time zone.

7.4.5 User Delay Setting

Command Format: UD<CR><LF>
UD<Space><Argument><CR><LF>
Command Function: Delay setting

The antenna cable length can be compensated with an user delay setting. This setting will shift the 1PPS signal of the GPS receiver by the given value in nanoseconds. The delay setting is a relative adjustment with accuracy of 12.5 nanoseconds, referred to the previous value.

In the case of 'UD' command without arguments, the current user delay will be displayed. For example, the current user delay is 12.5 ns in *Figure 6*.

```
->UD

+-----------------------------------------------------+
| UD x : -80000000 < x < 80000000                     |
|        Accuracy is 12.5ns                           |
| Example : UD 1    delayed 12.5ns                    |
+-----------------------------------------------------+
| UD = 1         , delayed:        12.5 ns            |
+-----------------------------------------------------+

->UD 1
Set OK!

->UD

+-----------------------------------------------------+
| UD x : -80000000 < x < 80000000                     |
|        Accuracy is 12.5ns                           |
| Example : UD 1    delayed 12.5ns                    |
+-----------------------------------------------------+
| UD = 2         , delayed:        25.0 ns            |
+-----------------------------------------------------+
```

Figure 6: User delay setting

If the 'UD' command is called with argument, the user delay will be shifted in the specified multiples of 12.5 ns. For example, 'UD 1' adds 12.5 nanoseconds to the delay.

7.4.6 Antenna State Detection

Command Format: ANT<CR><LF>
ANT<Space><Argument><CR><LF>
Command Function: Detect the connection state of an antenna

The GPS receiver can detect the connection state of an antenna. Some configurations with power splitters behind the antenna may prevent the detection to work. In this case, simply switch the detection OFF, if the GPSDO works properly.

In the case of 'ANT' command without arguments, the actual condition of the antenna state detection will be displayed as in *Figure 7*.

```
->ANT

+-----------------------------------------------------+
|01| ANT   : Help information                         |
|02| ANT x : x = 1 Enable; x = 0 Disable              |
+-----------------------------------------------------+
| The antenna state detection is DISABLED!            |
+-----------------------------------------------------+

->ANT 1
SET OK!
```

Figure 7: Antenna state detection

When the command argument is '1', the antenna state detection is enabled. When the argument is '0', the antenna state detection is disabled.

7.4.7 System Status Display

Command Format: STA<CR><LF>
Command Function: Display the state of the system

The system status will be output every second, showing further information about the operating mode and main parameters, as shown in *Figure 8*.

```
->STA

Status:0x02; The:       -3; Loop:6179; Ant:02; 3D:1; Sat: 6; ELV:25;
LL:4921.28846,N,00906.47881,E; TM:2018-0723-152822; TS:1532352502;
Status:0x02; The:       -3; Loop:6178; Ant:02; 3D:1; Sat: 6; ELV:25;
LL:4921.28851,N,00906.47875,E; TM:2018-0723-152823; TS:1532352503;
Status:0x02; The:       -4; Loop:6177; Ant:02; 3D:1; Sat: 6; ELV:25;
LL:4921.28855,N,00906.47869,E; TM:2018-0723-152824; TS:1532352504;
```

Figure 8: System status display

Each entry of one status line is separated by a semicolon, with the following meanings:

Status: indicates system state

0x10	power-on state
0x13	self-calibration
0x11	estimated frequency offset
0x00	rapid acquisition state
0x01	acquisition state
0x02	clocking state
0x12	holdover state

The: indicates accuracy between the 1pps signal of the GPS and the 1pps signal of the receiver output in multiples of 12.5 nanoseconds.

Loop: indicates countdown and records the time remaining of current state.

Ant: indicates antenna state

02	Normal connection
04	Disconnection
other	Abnormality

3D: indicates 3D positioning

1	successful positioning
0	unable to position

Sat: indicates the number of satellites that can be searched (0 to 12 in normal case)

ELV: indicates actual elevation angle

LL: indicates the actual position according to NMEA 0183, which is based on WGS84.
The notation is to be interpreted as follows:

XXYY.ZZZZ for latitude and XXXYY.ZZZZ for longitude, appended by E, W, S or N.

The conversion into degrees, minutes and seconds, respectively decimal degrees is achieved by the following equations:

XXYY.ZZZZ ⇒ XX° YY' (0.ZZZZ * 60)"
XXYY.ZZZZ ⇒ XX° + (YY.ZZZZ / 60)°

TM: indicates the actual date and time in the GPS receiver.
The notation is to be interpreted as follows:

YYYY-MMDD-hhmmss

TS: indicates the timestamp based on the former date and time in unix time format. It is defined as an approximation of the number of seconds that have elapsed since 00:00:00 UTC, 1 January 1970 and doesn't take into account leap seconds.

7.4.8 GPS Information Display

Command Format: GPS<CR><LF>
Command Function: Display the information of the GPS receiver

The GPS information will be output every second, showing the original NMEA 0183 messages coming from the GPS chip. It consists of the two messages

GGA (Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver) and

ZDA (Time & Date - UTC, day, month, year and local time zone)

```
µb
D$GPGGA,101110.00,4921.29083,N,00906.46068,E,1,04,1.76,115.3,M,47.6,M,,*56
$GPZDA,101110.00,23,07,2018,00,00*6B
µb
D$GPGGA,101111.00,4921.29008,N,00906.46177,E,1,04,1.76,118.4,M,47.6,M,,*51
$GPZDA,101111.00,23,07,2018,00,00*6A
µb
D$GPGGA,101112.00,4921.28953,N,00906.46260,E,1,04,1.76,120.7,M,47.6,M,,*59
$GPZDA,101112.00,23,07,2018,00,00*69
```

Figure 9: GPS information

For more information of NMEA 0183 check out the available online resources.

7.4.9 Version Information

Command Format: VER<CR><LF>
Command Function: Display version information

This command is used to query the version information of the GPS receiver module.

```
->VER

+-----------------------------------------------------+
|                     Ysync.,Inc                      |
+-----------------------------------------------------+
| NTX-300 GPSDO                                       |
| VER     : V1.2.7                                    |
| DATE    : 09:50:43  Feb 20 2014                     |
| REF     : GPS                                       |
| VOLTAGE : Calibrated                                |
| OCXOSN  : 5255-0008                                 |
| ChipSN  : 19011009-AEAB8082-55280CC9-F50020C4       |
+-----------------------------------------------------+
```

Figure 10: Version information

VER: indicates the version of the firmware.

Date: indicates the date of the firmware.

REF: is followed by the reference source of the GPS.

VOLTAGE: indicates the calibration state.

OCXOSN: indicates the serial number of the local oscillator.

CHIPSN: indicates the serial number of the main chip.