ELECTRONICS & DEFENSE

LNRClok-1500 & GRClok-1500

Rubidium Clock with Embedded GPS/GNSS

User Manual

Contents

Revisions List

Software Revision (**based on LNRCLOK-1500 standard SW**):			Hardware Revision :
Date	Version	Prompt / ID Comment	
2012-12-10	3.10	SPTLNR-001/00/3.10 2012-12-10 Well adapted to GPS u-Blox LEA-xT	
2014-05-16	3.10	SPTLNR-001/00/3.10 2014-05-16 Command FC possibly don't write in eeprom	
2014-08-04	3.10	SPTLNR-001/00/3.10 2014-08-04 Pin #4, Rb Lock, can be inverted by sw	
2018-02-28	3.10	SPTLNR-001/00/3.10 2018-02-28 Operation Time + command OT added	

1. Introduction

The LNRCLOK is a smart Low Noise Rubidium Clock with an optional embedded GPS/GNSS receiver. The GRCLOCK is a smart Rubidium Clock with embedded GPS/GNSS receiver. The standard version provides following signals:

- Extremely stable 10 MHz sinus
- Optional embedded frequency synthesizer
- 1PPS output.
- Embedded GPS receiver (Optional for LNRCLOCK)

This device can track a PPS Ref signal provided by a stable reference like a GPS receiver. The LNRCLOK & GRCLOCK are designed for navigation, communication and timing instruments requiring extremely stable and precise frequency referenced to the atomic world standard.

This manual contains information about the operation and field maintenance of the LNRCLOK & GRCLOCK (referenced as LNRCLOCK within this common manual)

Chapter 2 contains a general description of the unit. It also presents a basic theory of operation for a technician or engineer who requires a better understanding of the unit's operation.

Chapter 3 gives information on how to install and operate the unit. It is recommended that these chapters be read prior to operate the unit. This chapter describes also the possible serial interface connection for the monitoring and tuning of the internal parameters and the timing signals operations.

2. LNRCLOK System Description

2.1. Principle of Operation and Basic Configuration

The LNRCLOK essentially consists of a voltage-controlled crystal oscillator (VCXO) which is locked to a highly stable atomic transition in the ground state of the Rb87 isotope. While the VCXO is oscillating at a convenient frequency of 60 MHz, the Rb clock frequency is at 6.834…GHz in the microwave range. The link between the two frequencies is done through a phase-stabilized frequency multiplication scheme whereby a synthesized frequency is admixed to enable exact matching.

The Rb atoms are confined in a high temperature vapor cell. The cell is put in a microwave resonator to which the microwave power derived from the VCXO is coupled. The Rb87 atoms in the cell occur with equal probability in the two hyperfine energy levels of the ground state (F=1 and F=2).

In order to detect the clock transition between these two levels, the atoms need to be manipulated in such a way that most of them occur in only one level. This is done by optical pumping via a higher lying state (P). Figure 1 visualizes the atomic energy levels and transitions involved in the optical pumping process.

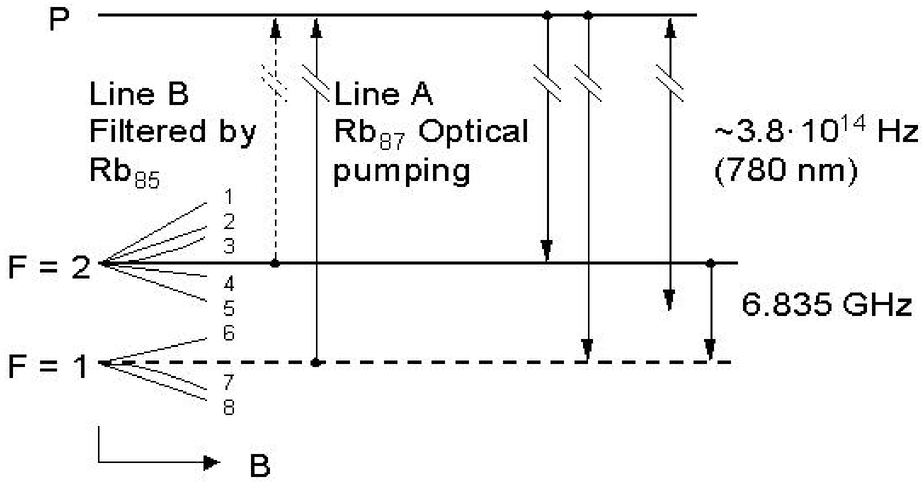


Figure 1: Energy levels and transitions in Rb87 atoms during LNRCLOK operation.

The pump light comes from a Rb resonance lamp which emits the light of Rb87 atoms. This light, which intersects the absorption cell, is filtered in such a way that mainly one optical frequency, which corresponds to a transition out of one of the two ground state levels (line A), enters the principal absorption region.

The pump light excites Rb87 atoms which are in the lower hyperfine level (F=1) to the short-lived excited state P from which they decay to the two ground state levels (F=1,2) with equal probability. Since pumping occurs continuously out of the F=1 level, after some time, almost all atoms are found in the F=2 level and no further absorption occurs.

The transmitted light level is detected by a photodiode after the cell. If now a microwave field resonant with clock transition F=2 to F=1 is coupled to the interaction region, the level F=1 is repopulated and light absorption is enhanced. A sweep of the microwave field over the resonance is detected as a small dip in the transmitted light level after the cell.

This signal is fed into a synchronous detector whose output generates an error signal which corrects the frequency of the VCXO when its multiplied frequency drifts off the atomic resonance maximum.

The absorption cell is filled with metallic vapor which contains Rb85 and Rb87 isotopes and a buffer gas. Filtering of the pump light is achieved in the entrance region of the cell by absorption with Rb85 atoms which have an accidental overlap with one of the Rb87 resonance transitions (line B): integrated filter cell.

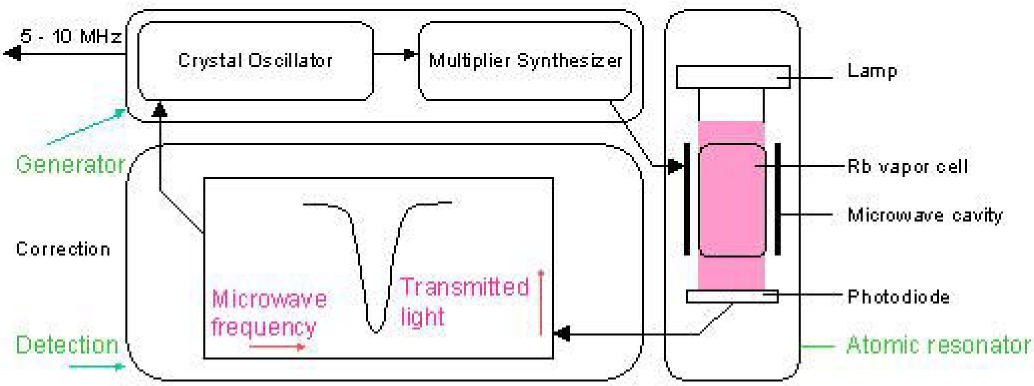


Figure 2: Rubidium atomic clock principal block diagram.

The principal function of the buffer gas is to keep the Rb atoms away from the cell walls and restrict their movements. As a result they are practically "frozen in place" for the interaction time with the microwave field. In this way the Doppler-effect is virtually removed and a narrow line width results.

The cell region is also surrounded by a so-called C-field coil which generates a small axial static magnetic field to resolve the Zeeman sub-transitions of the hyperfine line and select the clock transition, i.e. the one with the least magnetic sensitivity. To further reduce the magnetic sensitivity, the complete device is placed into a magnetic shield.

Figure 2 gives a basic overview of the different function blocks of the Rubidium atomic clock. The LNRCLOK consists of three different packages. The optical elements, which include the Rb absorption cell and microwave cavity, form the atomic resonator, while the electronics package is constituted of the generator and the detection circuitry.

2.2. Physics Package

The main design characteristics of the physics package are its low power consumption, small size and mass, along with minimal environmental sensitivities and mechanical ruggedness.

All parts of the physics package are directly mounted on a PCB. The external shell housing is used as magnetic shield. This allows a miniature design with low power consumption, short warm-up time and minimal environmental sensitivity.

Other design features which contribute to the compact design are:

- Use of the integrated filter technique (IFT)
- Use of a magnetron-type microwave resonator

The integrated filter technique which combines the optical filtering and pumping in one cell contributes also to the reliability since the configuration is simplified and the number of components reduced. The thermal capacitance of the cell assembly is relatively low. As a consequence, the necessary power during warm-up is greatly reduced.

The magnetron resonator is a cylindrical cavity loaded with a concentric capacitive-inductive structure (annular metal electrodes). It allows smaller cavity dimensions and concentrates the microwave field at the right region of the cell.

The Rb lamp is an electrode-less RF-discharge lamp: a heated glass bulb which contains Rb and a starter gas surrounded by an RF-coil.

Although the atomic clock transition frequency is inherently quite stable, there are second order influences which affect the frequency, i.e. temperature (buffer gas), light intensity (light shift = optical Stark effect), magnetic field (2nd order Zeeman effect). As a consequence, the temperatures of lamp and cell, the power of the lamp oscillator and the current in the C-field coil have to be carefully stabilized.

2.3. Electronics Package

2.3.1. Principal Functions of the Electronic Circuits

The clock transition of a Rb resonator is a microwave transition at 6.834 GHz.

The microwave resonance occurs as a dip in the optical signal; i.e. in the Rb lamp light which, after transiting the cell, is detected by a photodiode.

The basic purpose of the electronics package is to synchronize the entering microwave frequency, derived from a quartz crystal oscillator, to this absorption dip. This is achieved by tuning the microwave frequency to maximum optical absorption.

Frequency variations of the microwave signal are transformed into DC current changes at the photo-detector.

The dip, visualized in the photo-current versus microwave frequency curve of the Figure 3, is very small. It is in the order of 1% of the total photo-current which is however approximately 10 times higher compared to other commercial rubidium standards on the market.

Since DC detection of the dip is not feasible, an AC detection method is used for the following reasons:

- The dip amplitude is very small compared to the total photo-current.
- The slope of the derivative of the dip photo-current versus microwave frequency corresponds to roughly 1 nA/Hz. AC detection is the only solution to have a good signal/noise ratio since the photo-detector with associated amplifier are affected by flicker noise.

The AC method involves square wave frequency modulation of the microwave signal at a rate of fm~300 Hz. As shown in Figure 3, the modulated microwave frequency flips between 2 discrete frequency values f1 et f2. The resulting photo- current i(t) appears then also (after the transient)at 2 discrete values i1 and i2 .

The difference between i1 and i2 produces the error signal used for the quartz crystal center frequency adjustment until the mean value of f1 and f2 is exactly equal to the rubidium hyperfine frequency.

The clock microwave frequency of the Rb atoms in the vapor cell has a nominal value of 6834.684 MHz. This frequency is generated from a voltage controlled quartz oscillator (VCXO) that oscillates at 60 MHz.

Multiplication from 60 MHz to 6840 MHz is accomplished in one stage (x114) using a step-recovery diode mounted in the magnetron resonator inside the physics package.

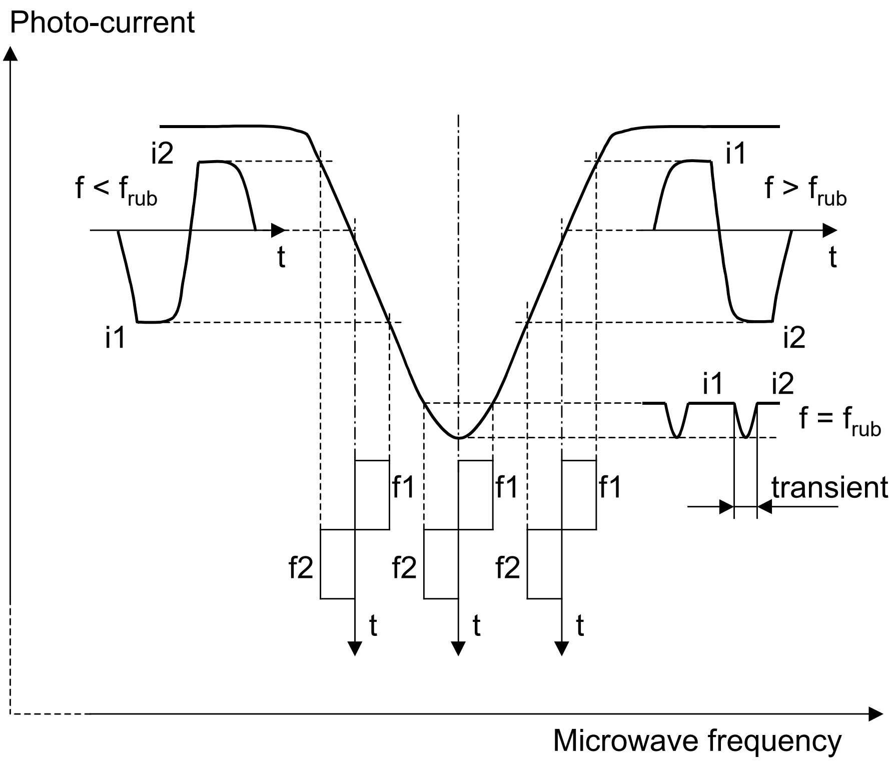


Figure 3 Dip minimum detection.

The 5.316… MHz phase modulation is introduced at the 60 MHz level. The 5.316… MHz spectrum is thus reproduced as a sideband of the 6840 MHz signal multiplied from the 60 MHz VCXO. The difference of the two frequencies corresponds to the Rb clock frequency.

This 5.316… MHz is generated by a DDS (Direct Digital Synthesizer) which is frequency modulated at the rate of fm for dip detection.

The center frequency of the synthesizer is adjustable with step sizes of 0.00512mHz in order to have the capability to adjust the LNRCLOK output frequency (10 MHz) with a resolution of $5.12 \cdot 10^{-}$

[13] per step and, also, to compensate the frequency shift due to the buffer gas pressure inaccuracies in the cell.

The Rb light is generated by a plasma discharge in the Rb lamp. This is sustained by a RF oscillator which drives a coil surrounding the Rb lamp bulb. In addition, the lamp is heated to 140°C and stabilized within 0.2°C over the full operating temperature range. The temperature controlled heating power is generated by a transistor heater. Another part of the heating power is generated by the RF oscillator.

The Rb absorption cell is heated to ~85°C and also stabilized within 0.3°C over the full operating temperature range. The heating by a transistor and the temperature control follows the same pattern as for the lamp heater.

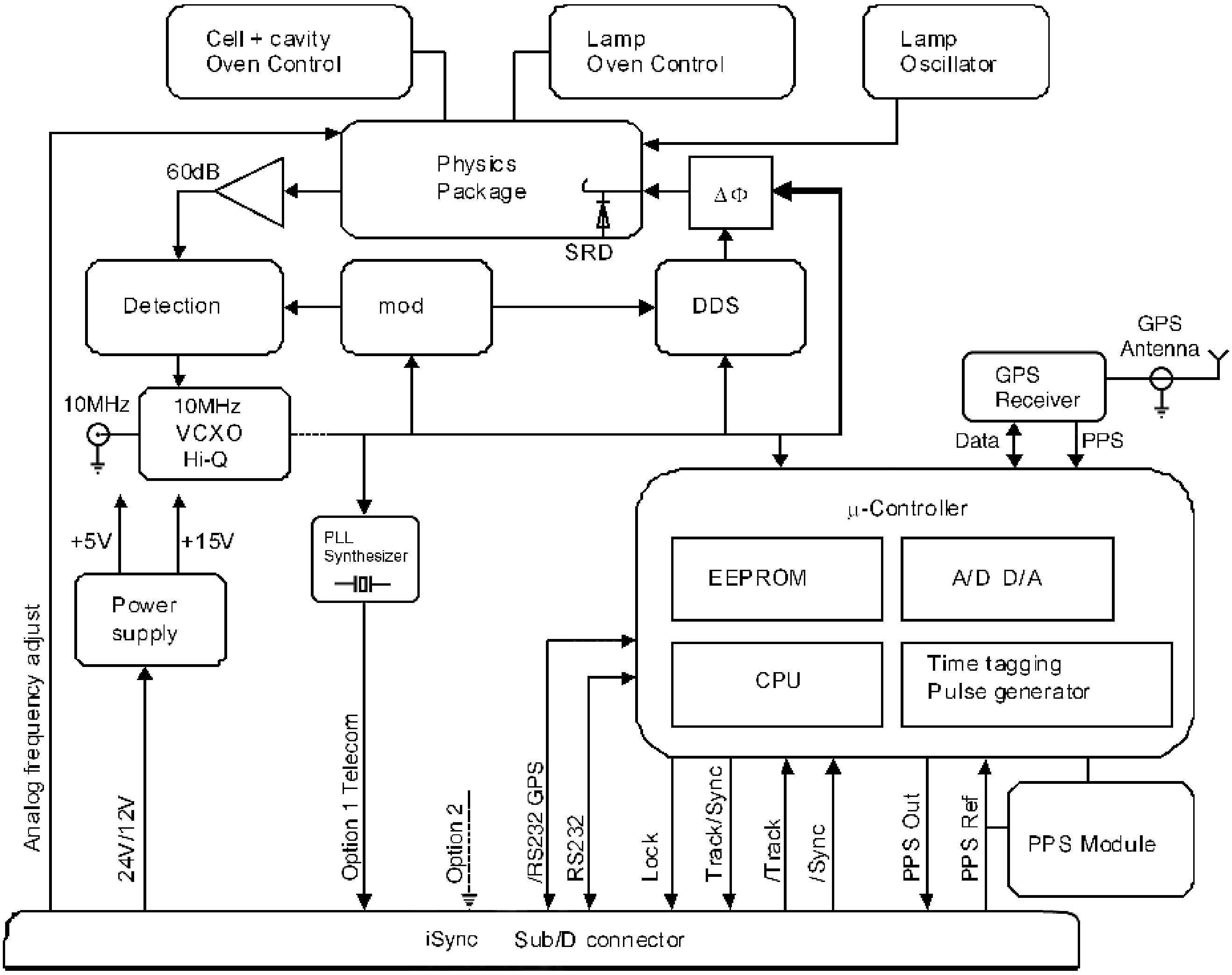


Figure 4: LNRCLOK bloc diagram.

The C-field coil within the physics package generates a magnetic field necessary for Rb spectral lines separation. This magnetic field allows fine tuning of the 10MHz output frequency by shifting the Rb frequency hyperfine transition by the second-order Zeeman effects.

A high stability current generator drives this coil. The current is adjustable by the user.

An analog frequency control input is available to the user for center frequency adjustment by external potentiometer or external digital to analog converter.

A serial interface connection for the monitoring and tuning of the internal parameters and the PPS facilities is provided to the user.

The correct operation of the unit can be checked by a single open collector type output signal called “lock monitor”. This lock monitor information is generated by the micro-controller and is a function of the following parameters:

- Light level intensity
- Rb signal level (detected signal)
- Heaters supply voltages

The different alarm threshold levels corresponding to the different internal LNRCLOK electronics and physics parameters are programmed during the automatic adjustment procedure at the factory.

The PPS functions can be simply controlled by grounding 2 pins. (Track: pin 15, Sync: pin 14.)

When the LNRCLOK is successfully tracking an external PPSREF, a TTL signal goes low.(“Track/Sync”).

The power section of the LNRCLOK consists of two dc-dc converters. One is used for generating the internal 5V needed by the logic circuitry, the other converter is used to generate 15V needed by the analog amplifiers.

The synchronization of the two converters is achieved by the use of a common ramp generator given by an internal 156.25kHz signal derived by direct division of the 60 MHz main VCXO.

A detailed block diagram of the LNRCLOK is given in Figure 4.

2.4. The Timing and Tracking System

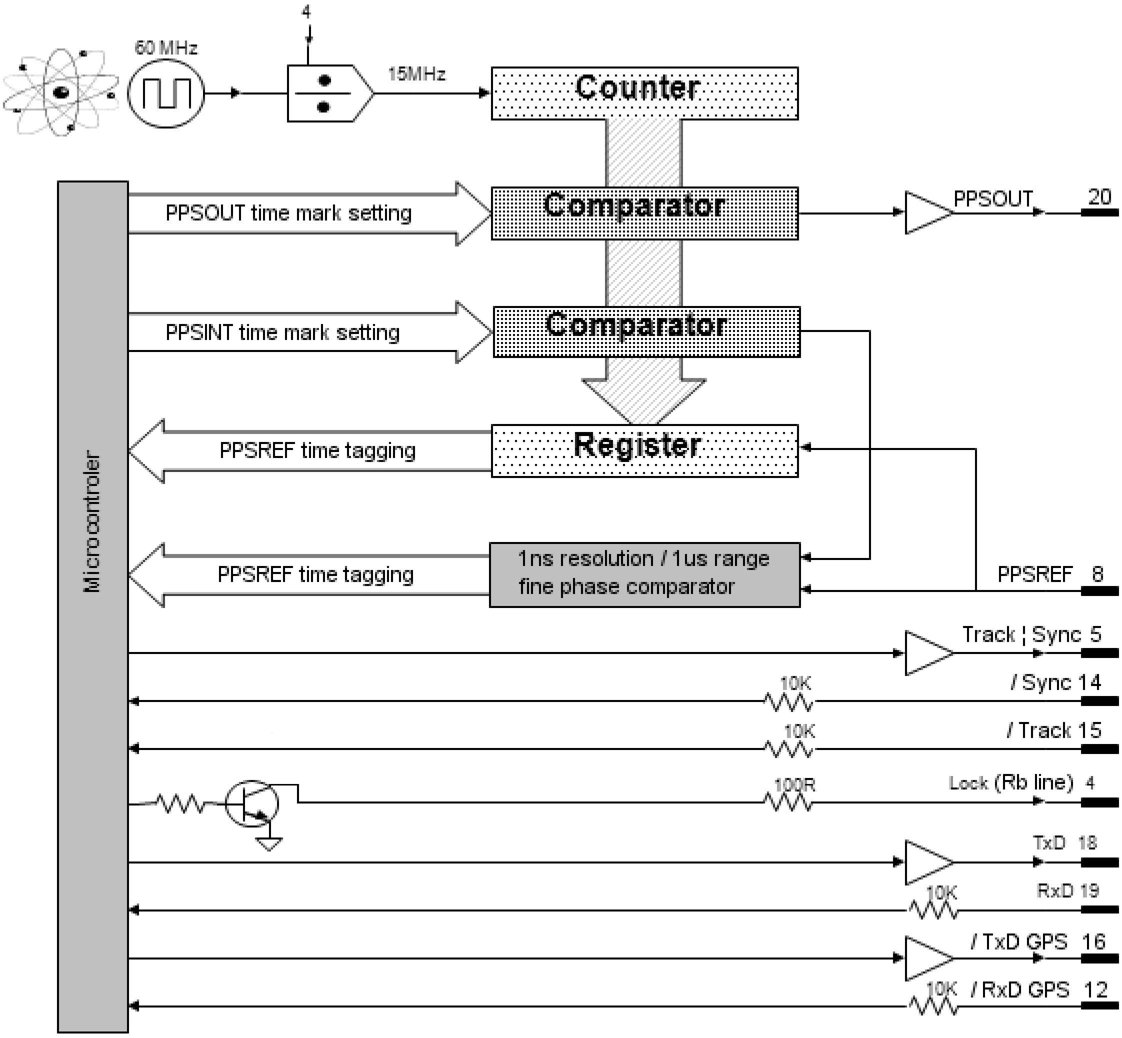


Figure 5: Timing system.

The LNRCLOK model includes extended PPS (Pulse Per Second) facility. The hardware of this facility consists of two modules. The first module is a timer clocked at 15 MHz. This timer tag the PPSREF connected to the LNRCLOK and generates two other PPS. The first one is called PPSINT and is used internally. The second one is called PPSOUT and appears on pin 20 of the connector.

The second module is a fine phase comparator with 1 ns resolution and 1 µs range. This module compares the phase between PPSREF and PPSINT. The phase information is used for the perfect tracking of a low noise PPSREF and for calculating the noise of this PPSREF. The calculation is used to adjust the time constant of the tracking loop. This way, a noisy PPSREF can be directly connected to the LNRCLOK without adjustments by hard or software.

A tracking can be initiated by grounding pin 15 "/Track" and if the tracking is successful, the pin 5 "Track/Sync" will be set in low TTL level. By grounding pin 14 "/Sync", the PPSOUT will be aligned to PPSINT. But all of the tracking and PPS functions can also be controlled via the serial interface port RS232.

2.4.1. The “Track” Mode and the “Sync” Mode

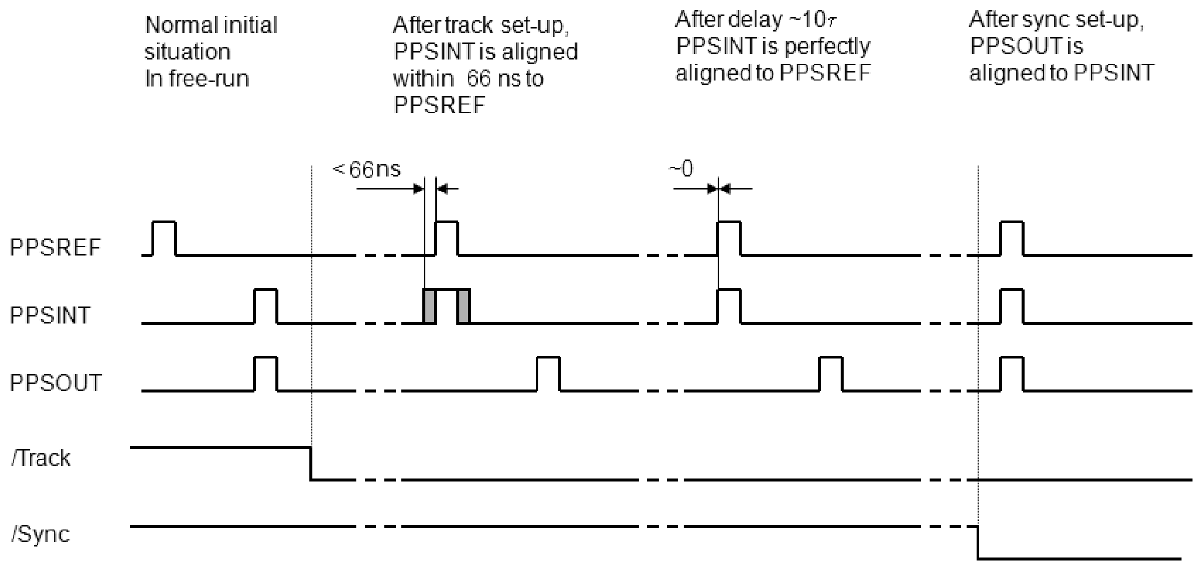


Figure 6: “Track” mode and “Sync” mode.

PPSOUT behave differently, depending if SYNC is active or not.

If SYNC is not active, the position of PPSOUT will never change, it will therefore not make a jump at the beginning of the tracking. It is in fact a frequency tracking.

If SYNC is active, PPSOUT will make a jump to be aligned to PPSINT. This jump will happen just after the beginning of the tracking. PPSREF, PPSINT and PPSOUT are synchronized.

At the beginning, the phase-time difference between PPSINT and PPSREF can be as big as 66 ns. After some time, this difference will become more and more little and finally PPSINT and PPSREF will be aligned.

SYNC can be made active before a tracking, during a tracking, by hardware, grounding the pin 15, "/Sync" or by software, it is quiet flexible.

SYNC can also be made active permanently.

2.4.2. The Frequency Learning

When the LNRCLOK is tracking the PPSREF of a master oscillator, in reality, it align its frequency to the one of the master.

The learning process is simply the memorization of this frequency from time to time to use it after a reset or Power-On.

By default, when the LNRCLOK is continuously and successfully tracking a PPSREF, the average value of the frequency is saved in EEPROM every 24 hours.

With the command FSx<CR>, it is possible to cancel the learning or to make a immediate save.

2.4.3. The Frequency in Use

With the PPSREF facilities, a different frequency can be in use in different situations. Let know first, that the frequency just currently in use is located in a single register, and that this register can always be read by the user. The command to read this register is: FC??????<CR>.

On a LNRCLOK connected through the serial interface to a terminal, it is possible to follow the evolution of the tracking by this way.

The frequency in use in different situations is as follows:

- After a Reset or Power-On, the value is copied from the EEPROM to the RAM and is used.
- When not in tracking, the command FCsddddd or the command Cxxxx, change the value in use and store it in the EEPROM.
- At the beginning of a tracking, the value in use is the one of the EEPROM.
- During a tracking, the value in use changes continuously to align as well as possible the PPSINT to the PPSREF. A holdover frequency is also estimated continuously. By default, the holdover frequency is saved in EEPROM every 24 hours.
- When a tracking is stopped intentionally, the LNRCLOK goes in FREE RUN and the value in EEPROM becomes in use.
- If a tracking is stopped because of a degraded or a missing PPSREF, the LNRCLOK goes in HOLDOVER with the holdover frequency previously estimated..

2.4.4. User Frequency Correction

This correction is only possible in Free Run mode and is made with the command FCsddddd.

The command has 2 effects:

- Memorization of the asked frequency in EEPROM.
- Immediate use of the new frequency.

2.4.5. THE PPS TRACKING LOOP

The LNRCLOK is equipped with a numerical PI regulation loop to track the PPSREF. The time constant of the tracking loop is either set automatically, or forced by the user with the command TCdddddd.

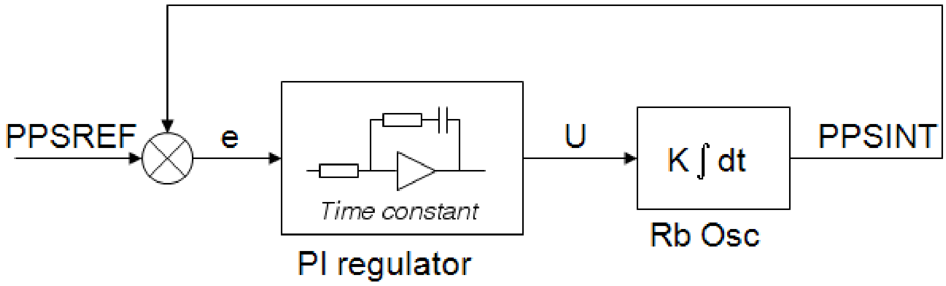


Figure 7: Schematic of the PPSREF regulation loop.

By default the time constant is set automatically. In such situation, the optimum loop time constant is computed from information's like PPSREF noise and temperature fluctuations. If this information is missing, the time constant is slowly forced to 1000 second.

2.4.6. TRACKING LIMITS AND ALARMS

If the frequency between the LNRCLOK and the master to track is too large, after some time, the phase time error between PPSINT and PPSREF become bigger and bigger. To avoid too large values, the device has a limitation system.

There are two limits. If the phase time error becomes bigger than the first limit, an alarm is raised up, but the tracking continues. If the phase time error comes bigger than the second limit, then the tracking stops. The first limit is called (no) alarm window and the second window tracking window. The value of the half (no) alarm window can be changed by the user with the command AWddd. By default its value is ± 4us. The value of the half tracking window can be changed by the user with the command TWddd. By default its value is ± 4us. For more details, see the Chapter "TIMING AND TRACKING COMMANDS".

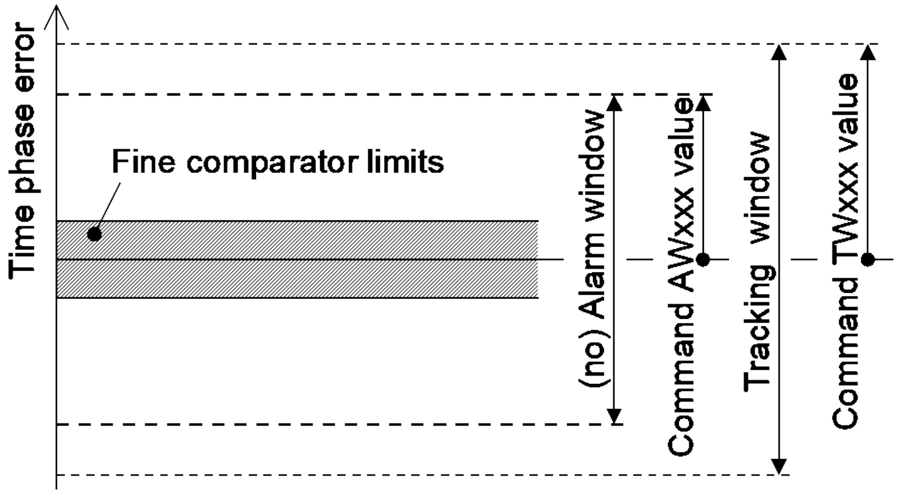


Figure 8: Tracking limits.

2.4.7. FREQUENCY FLUCTUATIONS DURING THE TRACKING

By default, during a tracking, the LNRCLOK is able to tune it's frequency on the nearly full range given by a 16 bit number. In reality from FC-32765 to FC+32765. Or in relative frequency : +/- 1.6e-8.

In case the frequency limit is reached during a tracking, no error will be raised up as long the phase time error is staying in the (no) alarm window.

So high frequency variations are may be not acceptable in some applications. In such case it is possible to lower the limit by software tuning, See MAv.. parameters, Frequency limit.

2.4.8. FINE PHASE COMPARATOR OFFSET

This fine offset adjustment can be used in case of precise phase calibration. The range of the offset is +127/ - 128 steps of the fine phase comparator. As the fine comparator works analogue, a step corresponds to approx. 1 ns. The command to put the offset is COsddd <CR>

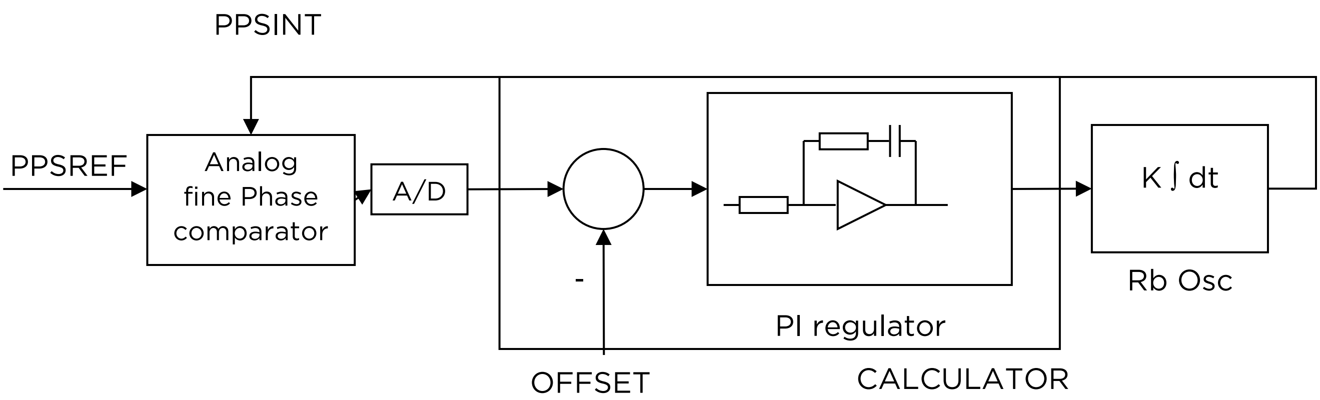


Figure 9: Schematic of the analog fine phase comparator regulation loop.

2.4.9. STARTING THE TRACKING, PRECAUTIONS

In a situation where just a frequency disciplining is asked, like in a laboratory, it is recommended to allow the restart of the tracking by setting MAV parameter 06, bit 2 to 1.

In other situations, like synchronization of a base station to the GPS constellation, it is recommended to not allow the restart of tracking by setting MAV parameter 06, bit 2 to 0. This way GPS receiver anomaly may be cancelled. But this induce stacking in Status=5 problems. To fix up Status=5 problems, it is recommended to restart the tracking.

3. LNRCLOK INSTALLATION AND OPERATION

3.1. INTRODUCTION

This chapter of the manual contains information regarding the installation and operation of the SpT Model LNRCLOK. It is recommended to read this chapter carefully prior to operate the unit.

3.2. Safety

Warning: Use proper ESD precautions

Caution: Ensure that all cables are properly connected

Note: The equipment contains small quantities of rubidium metal hermetically sealed inside the glass lamp and cell assemblies, hence, any dangers arising from ionizing radiation are caused for human health (exemption set in article 3 to Council directive 96/29/Euratom).

Handling the product in a reasonably foreseeable conditions do not cause any risk for human health, exposure to the SVHC (substances of very high concern) would require grinding the component up.

3.3. Environmental Responsibility

- The equipment contains materials, which can be either re-used or recycled.
- Do not deposit the equipment as unsorted municipal waste. Leave it at an authorized local WEEE collection point or return to Safran Trusted 4D to ensure proper disposal.
- To return the appliance:
  - Submit a support ticket at aftersales.clocks@nav-timing.safrangroup.com and request an RMA.
  - We will contact you for more information and/or with shipment process details.

3.4. SHIPPING AND RECEIVING INFORMATION

The LNRCLOK is packaged and shipped in a foam-lined box. The unit is inspected mechanically and electrically prior to shipment. Upon receipt of the unit, a thorough inspection should be made to ensure that no damage has occurred during shipping. If any damage is discovered, please contact aftersales.clocks@nav-timing.safrangroup.com

Should it be necessary to ship the unit back, the original case and packing should be used. If the original case is not available, a suitable container with foam-packing is recommended.

CAUTION Care must be taken for the transportation of the LNRCLOK to ensure that the maximum acceleration due to a choc 50g/ 18ms is not exceeded. LNRCLOK contains crystal resonator.

When LNRCLOK is integrated into an instrument, such instrument shall be packed in a suitable container, similar to containers generally used for the transportation of instruments like scope, video display or computer.

3.5. MOUNTING

The unit should be mounted in preference to a metallic base-plate or thermal dissipater.

The heat transfer characteristics of the mounting surface must be adequate to limit the rise of the unit's base plate to <+60°C. Since the minimum total power consumption for proper Rb operation is around 300mA / 24V, the allowable environmental temperature (Ta_{max}), for this mounting is:

$$Ta_{max} = 60°C - Vs \times Is \times Rk$$

Vs = Supply voltage

Is = Supplied current

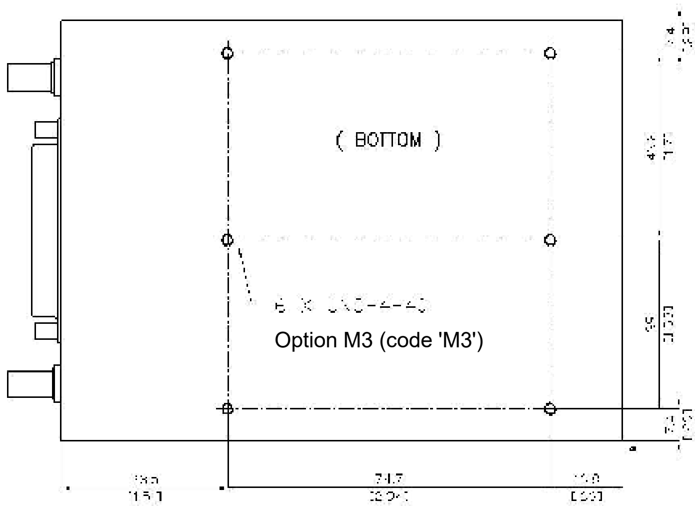
Rk = Heat sink thermal resistance

> **CAUTION** Care must be taken to ensure that the maximum operating temperature is not exceeded. (+60°C as measured at the unit's base plate).

The LNRCLOK is designed for being directly mounted on the host instrument PCB, involving a problem of thermal dissipation. The LNRCLOK mounting depends on the available space, the ambient temperature into the instrument box and the distance of the LNRCLOK case to the nearest instrument heat sink.

The LNRCLOK is a well shielded unit. Nevertheless, some consideration must be given to the operating location of the unit, regardless of its application. To minimize frequency offsets and/or non-harmonic distortion, the unit should not be installed near equipment generating strong magnetic fields such as generators, transformers, etc.

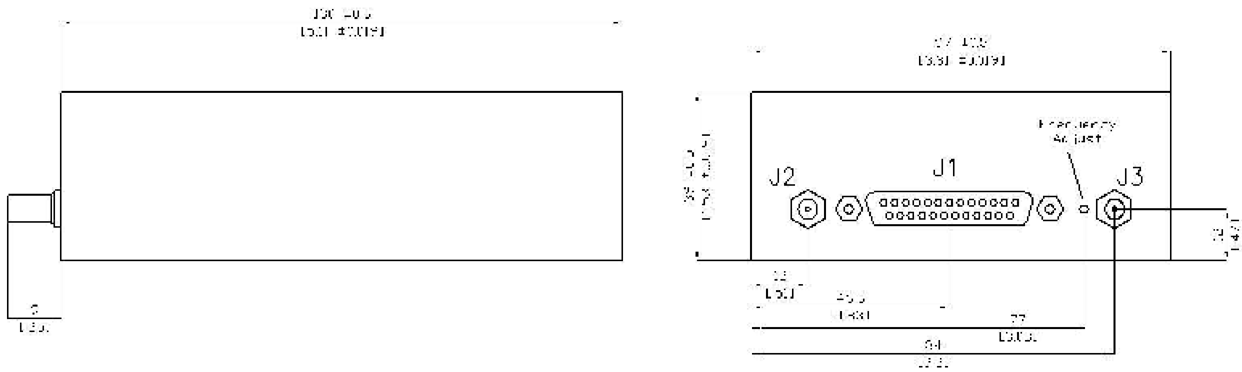
3.5.1. LNRCLOK-1500 PACKAGE.



Maximum length of the fastening screws :
For UNC-4-40 : 0.1968"

For M3 : 5 mm

00 Dimension are in mm



J1 : Sub-D 25 pins / pin connector.

J2 : SMA / socket. 10 MHz output.

J3 : SMA / socket. GPS antenna (optional for LNRCLOK-1500 or GRCLOK-1500)

3.6. PIN FUNCTION LAYOUT for LNRCLOK-1500

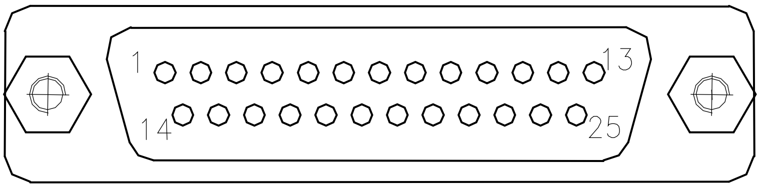


Figure 10: J2 Sub-D pin connector of LNRCLOK-1500.

The complete pin layout is given in following table :

Pin nbr.	LNRCLOK-1500	Dir
1	12V(11.2 to 16) or 24V (20 to 32)	Input
2	12V(11.2 to 16) or 24V (20 to 32)	Input
3	GND	Ret
4	**Rb lock** (open collector) (lock=open)	Output
5	**Track/Synch** Alarm (TTL+1K) (lock=0V)	Output
6	**FA** (analog frequency adjust input)	Input
7	**Vref out** (+5V internal reference)	Output
8	**PPSREF** (reference time pulse)	Input
9	**NC (Factory use or diagnostics)**	Output
10	**GND**	Ret
11	**OPTION** (PLL synthesizer output 0-5V CMOS > 20mA sink/source)	Output
12*	**NC** (/RxD2 GPS, RS232 Receive 5V-0)	Input
13	**NC** (Option 2)	Output
14	**/Sync**(synchronize PPSOUT to PPSREF)	Input
15	**/Track** (PPSREF phase tracking)	Input
16*	**NC** (/TxD2 GPS (RS232 Transmit 5V-0)	In-Out
17	**/Reset** (LNRCLOK micro controller)	Input
18	**TxD1** (RS232 Transmit 0-5V)	Output
19	**RxD1** (RS232 Receive 0-5V)	Input
20	**PPSOUT** (output time pulse from internal clock)	Output
21	**NC** (Time Tagging)	Ret
22	**GND**	Ret
23	**GND**	Ret
24	**NC** (RFOut in other iSync clock)	Output
25	**GND**	Ret

* For LNRClok without integrated GPS, these pins are activated in order to communicate with an external LEA-6T

NORMAL OPERATION

When 24 Vdc (or 12V) is applied to pins 1/2 (+) and 3/10/22/23/25 (-), the unit will immediately begin to generate a 10 MHz signal from the crystal oscillator. Within approximately 10 minutes (standard version) after application of input power, the unit will "lock". Hence the crystal is now stabilized by the atomic resonant frequency.

3.6.1. THE “LOCK” MONITORING

The unit provides a single signal called ‘lock monitor’ (pin 4) which toggles to high level (open collector) when the internal crystal oscillator is locked to the Rb atomic resonance. See Chapter 2.

3.6.2. ANALOG FREQUENCY PULLING

The LNRCLOK is equipped with an analog frequency adjustment circuit which provides center frequency adjustment by applying an external voltage from 0 to 5V on pin 6. LNRCLOK standard frequency pulling range for 0 to 5V is ~$5 \cdot 10^{-9}$. This analog voltage can be generated with an external potentiometer connected to Vref, pin 7 and GND (see pin function layout). When this functionality is not used, pin 6 should let be potential free.

3.6.3. PPS FACILITIES

Immediately after power-on, a PPSOUT signal is provided.

Once the LNRCLOK is “lock”, a tracking to a PPSREF can be initiated by grounding the pin 15 (“/Track”).

When the LNRCLOK is successfully tracking this PPSREF, the pin 5 goes to the low TTL state.

If the pin 15 (/Track) is grounded permanently, the LNRCLOK initiates immediately to track a PPSREF after "lock".

The PPSOUT can be aligned to the PPSREF by grounding the pin 14 ("/Sync").

If the pin 14 (/Sync) is grounded permanently, the LNRCLOK will immediately align PPSOUT to PPSREF after it starts to track a PPSREF.

3.6.4. OTHER PROVIDED SIGNALS

RF = 10MHz on separate SMA connector.

3.6.5. OPTIONAL SIGNALS

Option 1, pin 11, Telecom synthesizer.

3.7. SERIAL COMMUNICATION INTERFACE 1

3.7.1. INTRODUCTION

The LNRCLOK is equipped with a micro-controller which supervises the normal working of the device. All the working parameters are stored in a built-in EEPROM memory.

The built-in serial interface allows an automatic parameter adjustment during the manufacturing.

The serial interface serves also for the monitoring and tuning of the internal parameters and the PPS facilities.

3.7.2. SERIAL INTERFACE CONNECTION

The data transfer from the LNRCLOK can be made by direct connection to a PC or standard terminal.

The data transfer parameters are the following:

bit rate: 9600 bits/s.
parity: none
start bit: 1
data bits: 8
stop bit: 1
output "mark" voltage : 0 V
output "space" voltage : 5 V
input "mark" voltage : 0 to 2.5 V (CMOS)
input "space" voltage : 2.5 to 5 V (CMOS)

WARNING: This voltage in uncommon, but in most cases, the serial PC interface accepts the 0 to 5V level and a direct connection can be made. In case this 0 to 5V standard is not working, please refer to the small adaptation circuit called 'RS 232 adapter circuit' described in annex I..

If you experience problems with the serial interface, have a look into the FAQ section of the www.spectratime.com web site.

3.7.3. SIMPLE 1 CHARACTER COMMANDS

LNRCLOK INTERNAL VOLTAGES MONITORING

The internal parameters monitoring is made via the serial interface and with the use of single command "M" followed by a carriage return character.

M<CR>[<LF>]

The LNRCLOK will respond to this single character command with an eight ASCII / HEX coded string which look like

HH GG FF EE DD CC BB AA <CR><LF>

Where each returned byte is an ASCII coded hexadecimal value, separated by a <Space> character. All parameters are coded at full scale.

HH: Read-back of the user provided frequency adjustment voltage on pin 6 (0 to 5V)
GG: reserved
FF: peak voltage of Rb-signal (0 to 5V)
EE: DC-Voltage of the photocell (5V to 0)
DD: varactor control voltage (0 to 5V)
CC: Rb-lamp heating current (Imax to 0)
BB: Rb-cell heating current (Imax to 0)
AA: reserved

- *DC-Frequency adjustment voltage.*
  HH: o/p frequency adj. voltage (0 to 5V for $00 to $FF)

  This parameter corresponds to the frequency adjustment voltage provided by the user .This information can be used for a read-back of the voltage applied to pin 6 of the LNRCLOK connector.

- *Reserved*
  GG:

- *Rb signal level.*
  FF: Peak voltage of Rb signal level (0 to 5V for $00 to $FF)

  This signal monitors the rectified value of the AC signal produced by the interrogation process of the Rb dip absorption. During warm-up time this signal is approximately 0V and after it stabilizes to a nominal value of 1 to 5V. As long as this signal is too low the internal LNRCLOK control unit sweeps the Xtal frequency in order to find the Rb absorption dip.

- *DC-Voltage of the photocell.*
  EE: DC-Voltage of the photocell (5V to 0 for $FF to $00)

  This signal corresponds to the transmitted Rb light level. This is the light of the Rb lamp which is partly absorbed by the Rb cell. The nominal photocell voltage is in the range 2.0 to 3.5 V but must stay stable after the warm-up time. The photocell voltage is related to the internal reference 5 V voltage. The full scale corresponds to the coded value $00 and the zero (no light) corresponds to the coded value $FF

- *Frequency adjustment voltage.*
  DD: VCXO control voltage (0 to 5V for $00 to $FF)

  This parameter corresponds to the voltage applied to the varicap of the internal VCXO.

In normal operation this voltage is mainly temperature dependent in the range 2 to 3V in order to compensate the frequency versus temperature characteristic of the crystal resonator.

During warm-up the control unit generates a ramp of this parameter from 0.3 to 5V and from 5V to 0.3V until the Rb dip absorption is found.

- *Rb lamp heating limiting current.*
  CC: Rb lamp heating limiting current (Imax to 0 for $00 to $FF)

  This parameter corresponds to heating limiting current applied to the lamp heating resistive element. In normal operation, this current depends on the ambient temperature but should stay between $1A and $E6. During warm-up, this current is set to its maximal value $00 (no current limiting).

- *Rb cell heating limiting current.*
  BB: Rb cell heating limiting current (Imax to 0 for $00 to $FF)

  This parameter corresponds to heating limiting current applied to the cell heating resistive element. In normal operation, this current depends on the ambient temperature but should stay between $1A and $E6. During warm-up, this current is set to its maximal value $00 (no current limiting).

- *Reserved*
  AA:

CENTRE FREQUENCY ADJUSTMENT WITH THE SERIAL INTERFACE

A single character command is available to the user for centre frequency adjustment.

Cxxxx <CR>[<LF>] *: output frequency correction through the synthesizer, by steps of $5.12 \cdot 10^{-13}$, where xxxx is a signed 16 bits, in ASCII / HEX coded.

This value is stored in EEPROM as last frequency correction which is applied after RESET or power-ON operation.

Notes:

* Warning: This command can act into non volatile memory. Numbers of commands sent during the whole unit life time is limited to 100'000 in total (all commands cumulated). See MAv06:4 parameter to cancel to write in eeprom. (Since Version 2014-05-16)

- The argument of this command can vary from 0x8000 to 0x7FFF (-32768 to 32767).
- In track state, the frequency is changed internally by the software for optimum alignment and this command is no more active.
- The basic command FCsddddd does the same.
- Even if MAv06:4 parameter is settled to cancel the writing in eeprom of FC, a writing in eeprom is any way possible if the command FCsddddd is followed by the command FS3

Examples:

C0000<CR> : return to the nominal value (factory setting)

C7FFF<CR> : the current frequency is increased of 16.7 ppb. 10'000'000.000 Hz become 10'000'000.167 Hz.

C8000<CR> : the current frequency is decreased of 16.7 ppb. 10'000'000.000 Hz become 9'999'999.833 Hz.

READING BACK TUNING PARAMETERS IN RAM OR EEPROM

It is possible to read back some internal parameters.

Rxx <CR>[<LF>]: read value at RAM position xx, in ASCII / HEX coded.

Response: YY <CR><LF> Where YY is a byte, in ASCII coded hexadecimal.

Lxx <CR>[<LF>] : load value at EEPROM position xx, in ASCII / HEX coded.

Response: YY <CR><LF> Where YY is a byte, in ASCII coded hexadecimal.

Parameters location can vary, depending on hardware and software version. These 2 commands are maintained for compatibility with former versions.

3.8. BASIC 2 CHARACTERS COMMANDS

Extended commands beginning with 2 characters are implemented in the device for efficient managing, setting, tuning, reading back and surveying. Like the 1 character commands, this commands use the serial port 1.

3.9. Timing & Locking Control Functions shortlist

Command name	Syntax command	Data field (if any)	Response syntax	Response data (if any)
Identification	ID<CR><LF>	-	SPTLNR-aaa/rr/s.ss <CR><LF>	aaa: 001. rr: revision number s.ss: software version
Serial number	SN<CR><LF>	-	xxxxxx<CR><LF>	xxxxxx : 6 digits serial nbr
Status	ST<CR><LF>	-	s<CR><LF>	s:Status s=0 :warming up or no light s=1 :tracking set-up s=2 :track to PPSREF s=3 :synch to PPSREF s=4 :Free Run. Track OFF s=5 :FR. PPSREF unstable s=6 :FR. No PPSREF s=7 : FREEZE s=8 :factory used s=9 :searching Rb line
Beat a message on the serial port once per second. Except BT8, BT9.	BTx<CR><LF>	x=0 : Stop beat x=1 : Effective Time interval PPSOUT vs PPSREF x=2 : Phase comparator x=3 : Both x=1 & x=2 x=4 : Beat Time of day x=5 : Beat status x=6 : Beat <CR><LF> x=7 : Beat Date, Time, Status x=8 : Spec. PPSREF tagging x=9 : Special GPS message x=A : Beat NMEA $PTNTA, x=B : Beat NMEA $PTNTS,B, x=R : Beat NMEA $GPRMC,.. x=Z : Beat NMEA $GPZDA,..		
View PPSRef Sigma	VS<CR><LF>		ddd.d<CR><LF>	ddd.d : Sigma of PPSRef in ns. In tracking, Status 2, 3.
View Time constant	VT<CR><LF>		dddddd<CR><LF>	dddddd : Loop time constant now in use, in second.
Set Tracking PPSINT - PSSREF	TRx<CR><LF>	x=0 : set tracking state : OFF x=1 : set tracking state : ON x=?: interrogation	x<CR><LF>	x:Tracking state x=0 :tracking state OFF x=1 : tracking state ON
Set Synchronisation PPSOUT – PPSINT	SYx<CR><LF>	x=0 : set synch. state : OFF x=1 :set synch. state : ON x=? :interrogation	x<CR><LF>	x:Synchronisation sate x=0 : synch. state OFF x=1 : synch. state ON
Set no Alarm Window	AWddd<CR><LF> *	ddd = Half no Alarm Window in µs. From 1 to 255 AW000 : no checking AW??? : interrogation	ddd<CR><LF>	ddd : half no Alarm Window in µs.
Set Tracking Window (in µs)	TWddd<CR><LF> *	ddd = half Tracking Window in µs. From 001 to 255 TW000 : no checking TW??? : interrogation	ddd<CR><LF>	ddd : half Tracking Window in µs.
Set tracking phase loop time constant	TCdddddd<CR><LF> *	dddddd = Time constant in seconds (000100 to 999999) TC000000 : change to auto. TC?????? : interrogation	dddddd<CR><LF>	dddddd : time constant in seconds
Set frequency save. Average value, when Status = 2, 3	FSx<CR><LF> *	x=0 : save not evr. 24 hours x=1 : save hold. evr. 24 hours x=2 : save hold. now	x<CR><LF>	x=0 : save not evr. 24 hours x=1 : save holdover frequency every 24 hours

		x=3 : save current freq. now x=? : interrogation		
Set fine phase comparator Offset	COsddd<CR><LF> *	s :+/- sign ddd : limited with range + 127 / - 128 CO???? : interrogation	sddd<CR><LF>	s :+/- sign ddd : offset in approx 1 ns steps
Raw phase adjust	RAsddd<CR><LF>	s :+/- sign ddd : limited with range + 127 / - 128	sddd <CR><LF>	s :+/- sign ddd : raw phase just asked in 66 ns steps
Set PPSOUT Pulse Width (rounded to 66ns)	PWddddddddd<CR><LF> *	ddddddddd=pulse width in ns Max :999999933 PW000000000: no pulse PW?????????: interrogation	ddddddddd<CR><LF>	ddddddddd=pulse width in ns
Set PPSOUT delay (rounded to 66ns)	DEddddddddd<CR><LF>	ddddddddd=delay in ns Max : 999999933 DE000000000 : synch. to PPSREF DE????????? : interrogation	ddddddddd<CR><LF>	ddddddddd= delay in ns
Set Pulse Per d second	PPdddeee<CR><LF> *	ddd: 1 pulse every ddd second eee: offset to GPS epoch (sec) PP000000 : no pulse PP?????? : interrogation	dddeee<CR><LF>	ddd: 1 pulse every ddd second eee: offset to GPS epoch in second
Date	DT <CR><LF>		yyyy-mm-dd	yyyy : year mm : month dd : day
Set date	DTyyyy-mm-dd <CR><LF>	yyyy : year mm : month dd : day	yyyy-mm-dd	yyyy : year mm : month dd : day
Time of day	TD<CR><LF>	-	hh:mm:ss<CR><LF>	hh:hours mm:minutes ss:seconds
Set time of day	TDhh:mm:ss<CR><LF>	hh:Hours mm:Minutes ss:seconds	hh:mm:ss<CR><LF>	hh:hours mm:minutes ss:seconds
Set frequency correction	FCsddddd<CR><LF> *	s=+/- signe ddddd = limited within range : +32767/-32768 FC?????? : interrogation	sddddd<CR><LF>	s: +/- signe ddddd : frequency in 5.12 x 10^{-13} step
Set module adjust	MAvxx..<CR><LF> *	v : action verb xx: 00..FF: parameter number v=R : Read from ram v=W : Write to ram v=L : Load from eeprom v=S : Store to eeprom * v=F : Flash value v=B : Behavior at start v=A : Activate msg at start * v=C : Cancel msg at start * v=H : Help v=T : Type of data		
FREEZE frequency	FREEZEx<CR><LF>	x= 1:freeze frequency x= 0:no	x<CR><LF>	x: 1:frequency frozen x: 0:no
Reset micro controller	RESET<CR><LF>			(Identification & welcome message, GPS binary)

Note :

* Warning : These commands are acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).

3.10. Timing & Locking Control Functions extended list

3.10.1. INFORMATION COMMANDS

ID	Identification.
SN	Serial number.
ST	General Status.
BTx	Beat a message (every second) on the serial port.
VS	View PPSRef Sigma.
VT	View Time constant.

ID<CR><LF>	Identification.	
Answer:	SPTLNR-001/rr/s.ss<CR><LF>	
	rr:	revision number
	s.ss:	software version
Factory setting:	-	
EEPROM modification :	No	
Data in :	FLASH	
MAv access :	Yes	
Reset value:	-	

Example

Command	Answer	Comment
ID<CR>	SPTLNR-001/00/3.10<CR><LF>	-

SN<CR><LF>	Serial number.	
Answer:	aaaaaa<CR><LF>	
	aaaaaa:	6 characters serial number
Factory setting:	-	
EEPROM modification :	No	
MAv access:	No	
Reset value:	-	

Example

Command	Answer	Comment
SN<CR>	000098<CR><LF>	-

ST<CR><LF>	General Status.

Answer:	s<CR><LF>	
	s:	Status.
	0: warming up or no light	
	1: tracking set-up	
	2: track to PPSREF	
	3: sync to PPSREF	
	4: Free Run. Track OFF	
	5: PSREF unstable (Holdover)	
	6: No PPSREF (Holdover)	
	7: frequency frozen	
	8: factory used	
	9: searching Rb line	
Factory setting:	-	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	(0)	

Notes

The Status is also transmitted every second with BT5, BT7.

The Status is also included in the NMEA messages $PTNTA, $PTNTS,B.

Example

Command	Answer	Comment
ST<CR>	4<CR><LF>	Status=4, free run.

BTx<CR><LF>	Beat a message (every second) on the serial port.	
	x:	message to beat.
	0:	no beat.
BT1<CR><LF>	Beat effective time interval PPSOUT vs PPSREF.	
Answer:	**dddddddd<CR><LF>**	
	dddddddd:	delay in ns.
BT2<CR><LF>	Beat fine phase comparator value.	
Answer:	**sppp<CR><LF>**	
	sppp:	**s**: +/- **ppp**: value in approx. ns.
BT3<CR><LF>	Beat effective time interval PPSOUT vs PPSREF + fine phase comparator value.	
Answer:	**dddddddd sppp<CR><LF>**	
	dddddddd:	delay in ns.

	sppp:	**s**: +/- **ppp**: value in approx. ns.
BT4<CR><LF>	Beat time of day.	
Answer:	**hh:mm:ss<CR><LF>**	
	hh:mm:ss	**hh**: hour **mm**: minute **ss**: second
BT5<CR><LF>	Beat general status.	
Answer:	**x<CR><LF>**	
	x: general status. See STx command	
BT6<CR><LF>	Beat <CR><LF>.	
Answer:	**<CR><LF>**	
	just <CR><LF>	
BT7<CR><LF>	Beat Date, Time, Status.	
Answer:	**yyyy-mm-dd hh:mm:ss x<CR><LF>**	
	yyyy-mm-dd	**yyyy**: year **mm**: month **dd**: day
	hh:mm:ss	**hh**: hour **mm**: minute **ss**: second
	x: general status. See STx command	
BT8<CR><LF>	Time tagging of PPSREF vs PPSINT as soon as PPSREF is arrived.	
Answer:	**ssssssssss.nnnnnnnnn<CR><LF>**	
	ssssssssss:	Seconds elapsed since 2000-01-01 00:00:00.
	nnnnnnnnn:	Residual in ns. Rounded to LNRCLOK : 66ns.
BT9<CR><LF>	Send GPS receiver message status as soon GPS messages are complete.	
Answer:	**x<CR><LF>**	
	x:	See BT9 Note
BTA<CR><LF>	Beat NMEA message $PTNTA	
BTB<CR><LF>	Beat NMEA message $PTNTS,B	
BTR<CR><LF>	Beat NMEA message $GPRMC	
BTZ<CR><LF>	Beat NMEA message $GPZDA	
Factory setting:	0	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	0	

Notes

- BT8 can work as time tagging for PPSREF.
- BT1 BT3 output ????????? if there is no PPSREF .
- Regarding the phase comparator, no precision or linearity can be expected. This comparator just increases the resolution of the phase used by the tracking algorithm.
- This command is just for debugging. To store a beat behavior in EEPROM, one should use MAv parameters 0B and 0C.

Example

Command	Answer	Comment
BT5<CR>	..3<CR><LF>..3<CR><LF>..	Status=3, sync, in tracking.

VS<CR><LF>	view the Sigma of PPSRef.In tracking Status 2 or 3.
Answer:	**ddd.d<CR><LF>**
	ddd.d: ddd.d: Sigma in ns
Factory setting:	-
EEPROM modification :	No
Data in :	RAM
MAv access :	No
Reset value:	000.0

Note

- Measurement time interval : 1 second.

Example

Command	Answer	Comment
VS<CR>	005.3<CR><LF>	Means Time Variance @1s of 5.3 10^{-9}

VT<CR><LF>	view the time constant of the tracking loop just in use
Answer:	**dddddd<CR><LF>**
	dddddd: dddddd: Time constant in s
Factory setting:	-
EEPROM modification :	No
Data in :	RAM
MAv access :	No
Reset value:	001000 in automatic mode, setled time constant otherwise

Example

Command	Answer	Comment
VT<CR>	001000<CR><LF>	Time constant of 1000 second

3.10.2. TRACKING COMMANDS

TRx	Tracking start and stop.
SYx	PPSOUT synchronization.
AWddd	Set the no alarm window during a tracking.
TWddd	Set the tracking window during a tracking.
TCdddddd	Set tracking loop time constant.
FSx	Set frequency saving.
COsddd	Set phase comparator Offset.
RAsddd	Raw phase adjust.

TRx<CR><LF>	Set tracking state of PPSINT - PPSREF . Interrogation of tracking state.	
TRx<CR><LF>	x:	Tracking state.
	0:	Set tracking state to OFF.
	1:	Set tracking state to ON.
	?:	Interrogation.
Answer:	**x<CR><LF>**	
	x = 0	Tracking state OFF.
	x = 1	Tracking state ON.
TRE<CR><LF>	eeprom tracking state interrogation	
Answer:	**y<CR><LF>**	
	y = 0	eeprom tracking state off
	y = 1	eeprom tracking state on
Factory setting:	0	
EEPROM modification :	No	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	Pin 15 potential Last value stored in EEPROM	

Notes

- When the tracking state is ON, the tracking starts.
- When the device is heating, the tracking start is delayed.
- Every TR1 command induce a new tracking start.
- The tracking state can also be settled to ON by grounding the pin 15. TR0 answering "1" means the pin 15 is grounded.
- The value stored in EEPROM can only be changed with the MAv system.

Example

Command	Answer	Comment
TR1<CR>	1<CR><LF>	Tracking start.

SYx<CR><LF>	Set synchronization state of PPSOUT - PPSINT. Interrogation of sync. state.	
SYx<CR><LF>	x:	Synchronization state.
	0:	Set sync. state to OFF.
	1:	Set sync. state to ON.
	?:	Interrogation.
Answer:	x<CR><LF>	
	x = 0	Sync. state OFF.
	x = 1	Sync. state ON.
SYE<CR><LF>	eeprom sync state interrogation	
Answer:	y<CR><LF>	
	y = 0	eeprom sync. state off
	y = 1	eeprom sync. state on
Factory setting:	0	
EEPROM modification :	No	
Data in :	RAM, EEPROM	
MAv access:	Yes	
Reset value:	Pin 14 potential Last value stored in EEPROM	

Notes

- When the sync. state is ON, a synchronization is done at the end of the tracking setup.
- Every SY1 command induce a new synchronization.
- The commands SY1 and DE000000000 are equivalent in tracking.
- The sync. state can also be setled to ON by grounding the pin 14. SY0 answering "1" means the pin 14 is grounded.
- The value stored in EEPROM can only be changed with the MAv system.

Example

Command	Answer	Comment
`SY1<CR>`	`1<CR><LF>`	Synchronization PPSOUT - PPSINT.

AWddd<CR><LF>*	Set the no alarm window during a tracking. An alarm is raised up if the time interval ppsint vs ppsref become bigger than the ddd value, but the tracking continues as long this time interval is lower than the Tracking Window.	
	ddd:	half no alarm window in µs. From 001 to 255.
	000:	no checking.
	???:	interrogation.
Answer:	ddd<CR><LF>	
	ddd:	half no alarm window in µs. From 001 to 255.
Factory setting:	004	

EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).
Data in :	RAM, EEPROM
MAv access :	Yes
Reset value:	Last value stored in EEPROM.

Notes

- When an alarm is raised up, Status=5 and the pin 5 of the output connector is driven to high.
- A value of 000 means no checking. In such situation, an alarm is raised up in case of a calculation overflow (approx +/-500 µs).

Example

Command	Answer	Comment
`AW???<CR>`	`004<CR><LF>`	-

TWddd<CR><LF>*	Set the tracking window during a tracking. Set the window in which the interval ppsint vs ppsref should stay during a tracking. If not, the tracking is stopped.	
	ddd:	half tracking window in µs. From 001 to 255.
	000:	no checking.
	???:	interrogation.
Answer:	**ddd<CR><LF>**	
	ddd:	half tracking window in µs. From 001 to 255.
Factory setting:	004	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	Last value stored in EEPROM.	

Notes

- When the tracking is stopped, Status=5, and the pin 5 of the output connector is driven to high. The iSync goes in holdover and the frequency in use is an average value of former frequencies.
- A value of 000 means no checking. In such situation, the tracking is stopped in case of a calculation overflow (approx +/-500 µs.

Example

Command	Answer	Comment
`TW???<CR>`	`004<CR><LF>`	-

TCdddddd<CR><LF>*	Set tracking loop time constant.	
	dddddd:	time constant in seconds.
	000000:	change to automatic mode.
	000100:	minimum value, 100 s.
	999999:	maximum value, 999999 s.
	??????:	interrogation.
Answer:	dddddd<CR><LF>	
	dddddd:	time constant in seconds.
Factory setting:	000000	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	Last value stored in EEPROM.	

Notes

- In automatic mode, the time constant is automatically adapted to the PPSREF noise. The starting value is 1000 s and the maximum value is 30000 s.
- In automatic mode, if the time interval PPSREF vs PPSINT goes out of the fine phase comparator range, approx. +/-500 ns, the time constant goes slowly to 1000 s.

Example

Command	Answer	Comment
TC??????<CR>	000000<CR><LF>	automatic mode

FSx<CR><LF>*	Set frequency save mode.	
	x:	mode.
	0:	no saving every 24 hours.
	1:	save holdover frequency in EEPROM every 24 hours.
	2:	save holdover frequency in EEPROM now.
	3:	save current frequency in EEPROM now.
	?:	interrogation.
Answer:	y<CR><LF>	
	y:	frequency save mode.
	y = 1	no saving every 24 hours.
	y = 0	save holdover frequency in EEPROM every 24 hours.
Factory setting:	1	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	last value stored in EEPROM.	

Notes

- In frequency save mode 1, the saving is only done if the LNRCLOK is in track state. (General Status 2 or 3).
- If PPSREF are missing or rejected, the 24 hours period is increased.

Example

Command	Answer	Comment
`FS?<CR>`	`1<CR><LF>`	In tracking, frequency save every 24 hours.

COsddd<CR><LF>*	fine phase comparator offset.	
	sddd:	fine phase offset in approx. 1 ns steps
	+000:	no offset
	+127:	highest offset
	-128:	lowest offset
	????:	interrogation
Answer:	sddd<CR><LF>	
	sddd:	phase offset currently in use.
Factory setting:	+000	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	last value stored in EEPROM.	

Note

- Usefull for precise phase calibration.

Example

Command	Answer	Comment
CO????<CR>	+000<CR><LF>	In tracking, no fine phase offset.

RAsddd<CR><LF>	raw phase adjust in 66 ns steps.	
	sddd:	raw phase adjust
	+000:	no jump
	+127:	highest ahead jump
	-128:	highest behind jump
	????:	interrogation (response always +000)
Answer:	sddd<CR><LF>	
	sddd:	just asked jump in 66 ns steps
Factory setting:	-	
Store in EEPROM:	no.	
MAv access:	no.	
Reset value:	-	

Notes

- This command moves the PPSINT by itself.
- This command can be useful for some timing applications to bring the fine phase comparator into an area where it works.
- This command doesn't move the PPSOUT pulse and don't modify the reading of BT1 or BT3.
- This command has an influence on the delay value, command DEddddddd, as the delay is in fact referenced to PPSINT.

Example

Command	Answer	Comment
RA+001<CR>	+001<CR><LF>	66 ns ahead jump of PPSINT.

3.10.3. PPSOUT COMMANDS

PWddddddddd	Set the PPSOUT pulse width.
DEddddddddd	PPSOUT delay.
PPdddeee	Set PPSOUT cadence and initial phase.

PWddddddddd<CR><LF>*	Set the pulse width of PPSOUT.	
	ddddddddd:	Pulse width in ns, rounded to 66 ns.
	000000000:	No PPSOUT.
	000000066:	minimum pulse width
	999999933:	maximum pulse width
	?????????:	interrogation
Answer:	**ddddddddd<CR><LF>**	
	ddddddddd:	Pulse in ns, rounded to 66 ns.
Factory setting:	000100000	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	last value stored in EEPROM	

Example

Command	Answer	Comment
`PW100000000<CR>`	`100000000<CR><LF>`	Setting a PPSOUT pulse width of 1/10 second

DEddddddddd<CR><LF>	Set the delay of PPSOUT pulse vs PPSINT. Read the effective measured delay PPSOUT vs PPSINT.	
	ddddddddd:	Delay in ns, rounded to 66 ns.
	000000000:	sync. to PPSINT, the same as SY1.
	000000066:	minimum delay.
	999999933:	maximum delay.
	?????????:	interrogation.
Answer:	**ddddddddd<CR><LF>**	
	ddddddddd:	Delay in ns, rounded to 66 ns.
Factory setting:	(000000000)	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	000000000	

Notes

- When going in tracking, Status=1, the delay vary continuously, as PPSINT is aligned on PPSREF.
- After a command SY1, PPSOUT is aligned to PPSINT and DE=000000000.

- Setting command: the answer is the just entered value.
- Interrogation command: the answer is the measured value.

Example

Command	Answer	Comment
DE?????????<CR>	000000000<CR><LF>	-

PPdddeee<CR><LF>*	Set PPSOUT cadence and initial phase.	
	ddd:	cadence. PPSOUT active every ddd second. From 001 to 255.
	eee:	offset to GPS epoch (1980-01-06 00:00:00) in second. From 000 to 255.
	000000:	no PPSOUT.
	??????:	interrogation.
Answer:	dddeee<CR><LF>	
	ddd:	cadence. PPSOUT active every ddd second. From 001 to 255.
	eee:	offset to GPS epoch (1980-01-06 00:00:00) in second. From 000 to 255.
Factory setting:	001000	
EEPROM modification :	Yes * Warning : This command is acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	Last value stored in EEPROM.	

Notes

- Synchronization to local GPS time if delay between ppsout and ppsint is lower than +/- 1ms. From DE999000000 to DE001000000.
- Outside of this +/-1 ms delay, the pulse is emitted at a fixed interval, with no relationship to GPS time.
- This mean if the iSync is in sync mode with Status=3, the output pulse will be for sure synchronized to GPS time, if available.

Examples

Command	Answer	Comment
PP??????<CR>	001000<CR><LF>	normal pulse per second
PP002000<CR>	002000<CR><LF>	pulse every 2 seconds. Synchronized to even GPS second.
PP002001<CR>	002001<CR><LF>	pulse every 2 seconds. Synchronized to odd GPS second.
PP060000<CR>	060000<CR><LF>	pulse every minute. Synchronized to minute since GPS epoch.

3.10.4. DATE / TIME COMMANDS

DT	Send out the date.
DTyyyy-mm-dd	Set the date.
TD	Send out the time of day.

TDhh:mm:ss	Set the time of day.

DT<CR><LF>	Send out the date.	
Answer:	yyyy-mm-dd<CR><LF>	
	yyyy-mm-dd:	year - month - day
Factory setting:	2000-01-01	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	2000-01-01	

Notes

- After reception of this command, the device responds following the rules of the command BTx. This means the answer is not immediate, but can be delayed up to 1 s.
- The calendar works from 2000-01-01 to 2099-12-31.

Example

Command	Answer	Comment
DT<CR>	2008-04-28<CR><LF>	-

DTyyyy-mm-dd<CR><LF>	Set the date.	
	yyyy-mm-dd:	year - month - day
Answer:	yyyy-mm-dd<CR><LF>	
	yyyy-mm-dd:	year - month - day
Factory setting:	2000-01-01	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	2000-01-01	

Notes

- After reception of this command, the device responds following the rules of the command BTx. This means the answer is not immediate, but can be delayed up to 1 s.
- The calendar works from 2000-01-01 to 2099-12-31.

Example

Command	Answer	Comment
DT2008-04-29<CR>	2008-04-29<CR><LF>	-

TD<CR><LF>	Send out the time of day.	
Answer:	hh:mm:ss<CR><LF>	
	hh:mm:ss:	hours : minutes : seconds
Factory setting:	00:00:00	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	

Reset value:	00:00:00

Notes

- After reception of this command, the device responds following the rules of the command BTx. This means the answer is not immediate, but can be delayed up to 1 s.

Example

Command	Answer	Comment
TD<CR>	15:08:38<CR><LF>	-

TDhh:mm:ss<CR><LF>	Set the time of day.	
	hh:mm:ss:	hours : minutes - seconds
Answer:	hh:mm:ss(+1)<CR><LF>	
	hh:mm:ss:	hours : minutes - seconds(+1)
Factory setting:	00:00:00	
EEPROM modification :	No	
Data in :	RAM	
MAv access :	No	
Reset value:	00:00:00	

Notes

- After reception of this command, the device responds following the rules of the command BTx. This means the answer is not immediate, but can be delayed up to 1 s.
- It is a pulse - message system. That mean the time information is referenced to the PPSINT just before the command arrival.
  As the answer is coming after the next PPSINT, it is 1 second ahead.

Example

Command	Answer	Comment
TD08:25:37<CR>	08:25:38<CR><LF>	The difference from 37 to 38 seconds is due to the pulse - message system.

3.10.5. SETTING COMMANDS

FCsddddd	Change frequency.
MAvxx..	Module adjust. Set and read internal parameters.

FCsddddd<CR><LF>*	set new frequency	
	sddddd:	new frequency in $5.12 \cdot 10^{-13}$ step
	+00000:	back to factory setting
	+32767:	highest pull-up, +16.7 ppb
	-32768:	lowest pull-down, -16.7 ppb
	??????:	interrogation
Answer:	sddddd<CR><LF>	
	sddddd:	frequency in use
Factory setting:	+00000	

EEPROM modification :	(Yes) * Warning : This command can act into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated). See MAv06: 4 parameters to cancel the writing in eeprom.
Data in :	RAM, EEPROM
MAv access :	No
Reset value:	Last value stored in EEPROM.

Notes

- In track state the frequency is changed internally by the software for optimum alignment.
- This command should never be used in track state. (Exept FC??????).

Example

Command	Answer	Comment
FC+01000<CR>	+01000<CR><LF>	10.00000000000MHz becomes 10.00000000512MHz.

MAvxx..<CR><LF>*	Module adjust. Set and read internal parameters.	
	v:	action verb.
	xx:	parameter number. From 00 to FF.
MARxx<CR><LF>	Read the ram value of the parameter number xx.	
MALxx<CR><LF>	Read the eeprom value of the parameter number xx.	
MAFxx<CR><LF>	Read the flash value of the parameter number xx.	
Answer:	yy<CR><LF> parameter value, or yyyy<CR><LF> or yyyyyyyy<CR><LF> or yyyyyyyyyyyyyyyy<CR><LF> or aaaaaa..<CR><LF> or bbbbbb..	
hexa coded ascii	yy:	unsigned 1 byte, type=y0 signed 1 byte, type=y1
	yyyy:	unsigned 2 byte, type=y2 signed 2 byte, type=y3
	yyyyyyyy:	unsigned 4 byte, type=y4 signed 4 byte, type=y5
	yyyyyyyyyyyyyyyy:	unsigned 8 byte, type=Y6 signed 8 byte, type=y7
	aaaaaa..:	string ascii, type=y8
	bbbbbb..:	string binary, type=y9
MAWxx(z)<CR><LF>	Change the ram value of the parameter number xx.	
MASxx(z)<CR><LF>*	Change the eeprom value of the parameter number xx.	
Parameter (z): hexa coded ascii	yy:	unsigned 1 byte, type=y0 signed 1 byte, type=y1
	yyyy:	unsigned 2 byte, type=y2 signed 2 byte, type=y3
	yyyyyyyy:	unsigned 4 byte, type=y4 signed 4 byte, type=y5
	yyyyyyyyyyyyyyyy:	unsigned 8 byte, type=y6 signed 8 byte, type=y7

Parameter (z):	aaaaaa..:	string ascii, type=y8 up to 24 characters
Answer:	<CR><LF>	
MATxx<CR><LF>	Read data type of the parameter number xx.	
Answer:	xy<CR><LF>	
	x= 4	memorized in ram
	x= 2	memorized in eeprom
	x= 1	memorized in flash
	y= 0	unsigned, 1 byte
	y= 1	signed, 1 byte
	y= 2	unsigned, 2 byte
	y= 3	signed, 2 byte
	y= 4	unsigned, 4 byte
	y= 5	signed, 4 byte
	y= 6	unsigned, 8 byte
	y= 7	signed, 8 byte
	y= 8	string ascii
	y= 9	string binary
MABxx<CR><LF>	Read a flag related to parameter number xx. Behavior at power on /reset.	
Answer:	x<CR><LF> x=1 : activated, x=0 : cancelled	
MAAxx<CR><LF>*	Active a flag related to parameter number xx. Behavior at power on /reset.	
Answer:	<CR><LF>	
MACxx<CR><LF>*	Cancel a flag related to parameter number xx. Behavior at power on /reset.	
Answer:	<CR><LF>	
MAHxx<CR><LF>	Read help message related to parameter number xx.	
Answer:	blabla..<CR><LF>	
MAHxxy<CR><LF>	Read help message related to parameter number xx, bit y=0 to y=7. 1 byte data type used as flags.	
Answer:	blabla..<CR><LF>	

Note:
* Warning: This command can acting into non volatile memory. Numbers of commands sent during the whole unit life time limited to 100'000 in total (all commands cumulated).

Example

Command	Answer	Comment
MAH05<CR>	Timing / Frequency<CR><LF>	Timing/frequency flags.

3.10.6. OTHER COMMANDS

FREEZEx	Freeze frequency.
RESET	Hot Reset.

FREEZEx<CR><LF>	LNRCLOK : Freeze DDS gear between 10MHz and Rb line.	
	x:	freeze state 1: frozen 0:no.
	?:	interrogation.
Answer:	x<CR><LF>	
	x:	freeze state 1: frozen 0:no.
Factory setting:	0	
EEPROM modification :	No	
Data in :	RAM, EEPROM	
MAv access :	Yes	
Reset value:	Last value stored in EEPROM.	

Notes

- No tracking possible.
- Status=7 is issued in this state.

Example

Command	Answer	Comment
FREEZE?<CR>	0<CR><LF>	-

RESET<CR><LF>	Hot Reset the micro-controller.
Answer:	(Normal messages after Power-on, Reset)
Factory setting:	-
EEPROM modification :	-
Data in :	-
MAv access :	-
Reset value:	-

Notes

- If a PPSREF is present during a RESET command, the PPSINT is aligned to this PPSREF.
- The RESET command is a substitute to the former "RAQUIK" command.
- All parameters will be loaded with their EEPROM default value.
- During a Hot Reset, a partial hardware initialization is done. It is to avoid when a long term stability test is underway.

Example

Command	Answer	Comment
RESET<CR>	SPTLNRCLOK-1/00/3.10<CR><LF>	-

3.11. DEVICE STATUS

3.11.1. STATUS BROADCASTED BY MESSAGES

0	warming up or no light	The device was just powered on.
1	tracking set-up	The device is going in tracking after this one was initiated.
2	track to PPSREF	Frequency tracking of PPSREF.
3	sync to PPSREF	PPSINT, PPSOUT and PPSREF are aligned.
4	Free Run. Track OFF.	
5	PPSREF unstable(holdover)	The stability of the PPSREF is too low to be tracked.
6	No PPSREF(holdover)	No PPSREF was detected.
7	FREEZE	Frequency is frozen.
8	factory used	
9	searching Rb line	Scanning the frequency to find the Rb line.

3.11.2. PIN #4 AND #5 STATUS LEVELS

Status	**Pin # 4 *** Xtal not locked to Rb line	**Pin # 5** Track/Synch alarm	
	Rb lock (open collector)	In Track Mode (TTL + 1K)	In Sync Mode (TTL + 1K)
s=0 : warming up or no light	Low (<.2 V / 5 mA)	High	High
s=1 : tracking set-up	High	High	High
s=2 : track to PPSREF	High	Low	High
s=3 : sync to PPSREF	High	High	Low
s=4 : Free Run. Track OFF.	High	High	High
s=5 : PPSREF unstable (holdover)	High	High	High
s=6 : No PPSREF(holdover)	High	High	High
s=7 : FREEZE	High	High	High
s=8 : factory used	High	High	High
s=9 : searching Rb line	Low (<.2 V / 5 mA)	High	High

(*) Since ID: SPTLNR-001/00/3.10 2014-08-04, this behavior may be changed by MAv parameter 0x04:4

3.12. THE MAvxx.. SYSTEM

3.12.1. INTRODUCTION

The MAvxx.. command is a computer and human oriented command to tune quickly.

- Manage parameters:
  - Read, MARxx, and write, MAWxx.., parameters in ram (working parameters).
  - Load, MALxx, and store, MASxx.., parameters in eeprom (non volatile memory).
  - Load parameters in flash, MAFxx, (permanent memory).

- Load the parameter localization and data type, MATxx :
  The answer is: yz, 2 hexa
  - y = 4, in ram
  - y = 2, in eeprom
  - y = 1, in flash

  A combination is possible. Example: y = 7, means the parameter is in ram, eeprom and flash.

  - z = 0, unsigned, 1 byte, also used for bit field
  - z = 1, signed, 1 byte
  - z = 2, unsigned, 2 byte
  - z = 3, signed, 2 byte
  - z = 4, unsigned, 4 byte
  - z = 5, signed, 4 byte
  - z = 6, unsigned, 8 byte
  - z = 7, signed, 8 byte
  - z = 8, string ascii
  - z = 9, string binary
- There is a help for each parameter, a textual description of the parameter, MAHxx
- The help is also available for each bit in a bit field, MAHxxy
- A flag in eeprom is associated with each parameter :
  - MABxx : load the flag Answer: 0[CR][LF] or 1[CR][LF]
  - MAAxx : flag activated Answer: [CR][LF] if success
  - MACxx : flag cancelled Answer: [CR][LF] if success

  The actual function of this flag is to transmit or not a message, data type y = 8, 9, at power-on, Reset.
  Currently, only MAv00, Factory welcome message and MAv01, User welcome message, are concerned. So it is possible to activate or to cancel these messages at Power ON / Reset.

3.12.2. MAVxx.. PARAMETERS DESCRIPTION FOR THE LNRCLOK

Numerical values are in hexa coded ascii.

3.12.3. Clock main parameters

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
00	-	-	x	ascii	SPTLNRCLOK-1/00/3.10	Factory welcome message
01	-	x	x	ascii	Free for user message	User welcome message
02	-	x	x	u 1byte	05	GPS configuration delay (s)
03	-	x	x	u 1byte	03	GPS configuration interval (s)
04	x	x	x	u 1byte	0B	Timing / Frequency
05	x	x	x	u 1byte	10	Tracking
06	x	x	x	u 1byte	02	Tracking start
07	-	x	x	u 1byte	01	Communication control
08	-	x	x	u 1byte	00	Holdover. Don't touch.
09	-	x	x	u 1byte	20	Aging. Under dev. Don't touch.
0A	-	x	x	u 1byte	01	Environment.
0B	x	x	x	u 1byte	00	Messages at T=0ms, T=250ms
0C	x	x	x	u 1byte	00	Messages at T=500ms, T=750ms
0D	x	x	x	u 1byte	F0	[A] validity life(hours).
0E	x	x	x	u 1byte	00	Warmup in 32s time interval
12	x	x	x	u 4byte	000186A0	Pulse width.
13	x	x	x	u 1byte	04	Tracking window.
14	x	x	x	u 1byte	04	Alarm window.
15	x	x	x	u 4byte	00000000	Tracking loop time constant
16	x	x	x	s 1byte	00	Fine comparator offset
17	x	x	x	u 1byte	01	Pulse every d second
18	x	x	x	u 1byte	00	Pulse origin
19	x	x	x	u 2bytes	7FFD	Frequency limit

u: unsigned, s:signed

3.12.4. GPS main parameters

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
20	x	x	x	u 1byte	00	GPS type
21	x	x	x	u 1byte	00	GPS language

22	x	x	x	u 1byte	00	GPS resource utilization
24	x	x	x	s 4byte	00000000	GPS longitude
25	x	x	x	s 4byte	00000000	GPS latitude
26	x	x	x	s 4byte	00000000	GPS altitude
27	x	x	x	s 2byte	0010	Time GPS-UTC offset

u: unsigned, s:signed

GPS GDK-1. Motorola OnCore legacy (depreciated)

Parameter Nb	*ram*	*eeprom*	*flash*	*Data type*	*Value(default)*	*Help*
30			*x*	*String binary*	--	*@En Time RAIM setup*
31			*x*	*String binary*	--	*@At Position hold, site survey*

GPS GDK-1. Motorola M12 legacy (depreciated)

Parameter Nb	*ram*	*eeprom*	*flash*	*Data type*	*Value(default)*	*Help*
34			*x*	*String binary*	--	*@Gd Position control message*
35			*x*	*String binary*	--	*@Gc PPS control message*
36			*x*	*String binary*	--	*@Ge Time RAIM algorithm*
37			*x*	*String binary*	--	*@Gc Time RAIM alarm message*

GPS GDK-1. Zodiac binary (depreciated)

Parameter Nb	*ram*	*eeprom*	*flash*	*Data type*	*Value(default)*	*Help*
38			*x*	*String binary*	--	*Zodiac binary quiet*

GPS GDK-1. Novatel SSII (depreciated)

Parameter Nb	*ram*	*eeprom*	*flash*	*Data type*	*Value(default)*	*Help*
3A			*x*	*String binary*	--	*Novatel SSII InitLink*
3B			*x*	*String binary*	--	*Novatel SSII set Rover*
3C			*x*	*String binary*	--	*Novatel SSII mask 5 deg.*
3D			*x*	*String binary*	--	*Novatel SSII set tim. para.*
3E			*x*	*String binary*	--	*Novatel SSII set survey 24h*

3.12.5. Factory welcome message

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
00	-	-	x	ascii	SPTLNR-001/00/3.10	Factory welcome message

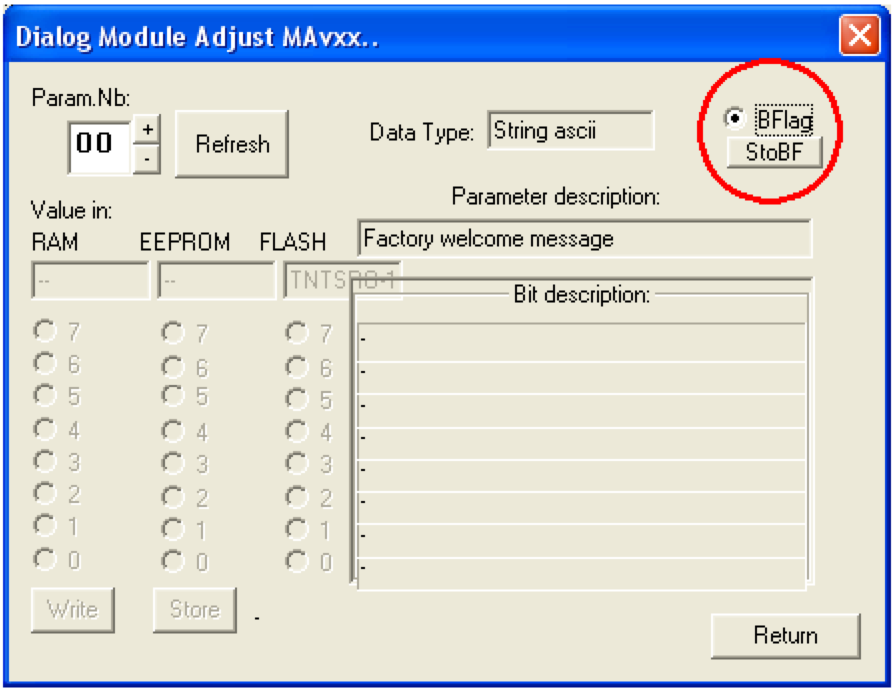
Message description

This message is transmitted on pin 18 (TxD1) some delay after Power on /Reset.
As it is stored in flash only, it cannot be modified.

Message behavior control

- To read the behavior : MAB00<CR>   Answer : 0 : cancelled; 1 : activated
- To cancel the message : MAC00<CR>
- To activate the message : MAA00<CR>

Changing the message behavior with the Monitoring program:



3.12.6. User welcome message

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
01	-	x	x	ascii	Free for user message	User welcome message

Message description

This message is transmitted on pin 18 (TxD1) some delay after Power on /Reset.
As it is stored in eeprom, it can be modified.

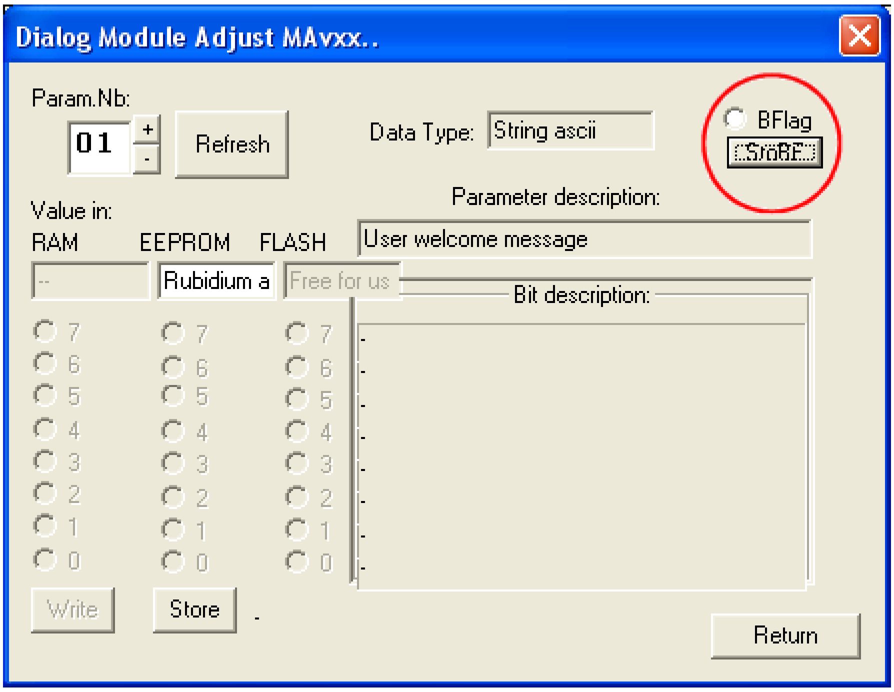
Message modification

MAS01Rubidium and Crystal<CR> (message length is limited to 24 characters.)

Message behavior control

- To read the behavior : MAB00<CR>   Answer : 0 : cancelled; 1 : activated
- To cancel the message : MAC01<CR>
- To activate the message : MAA01<CR>

Changing the message behavior with the Monitoring program:



3.12.7. Messages delay

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
02	-	x	x	u 1byte	05	GPS configuration delay (s)

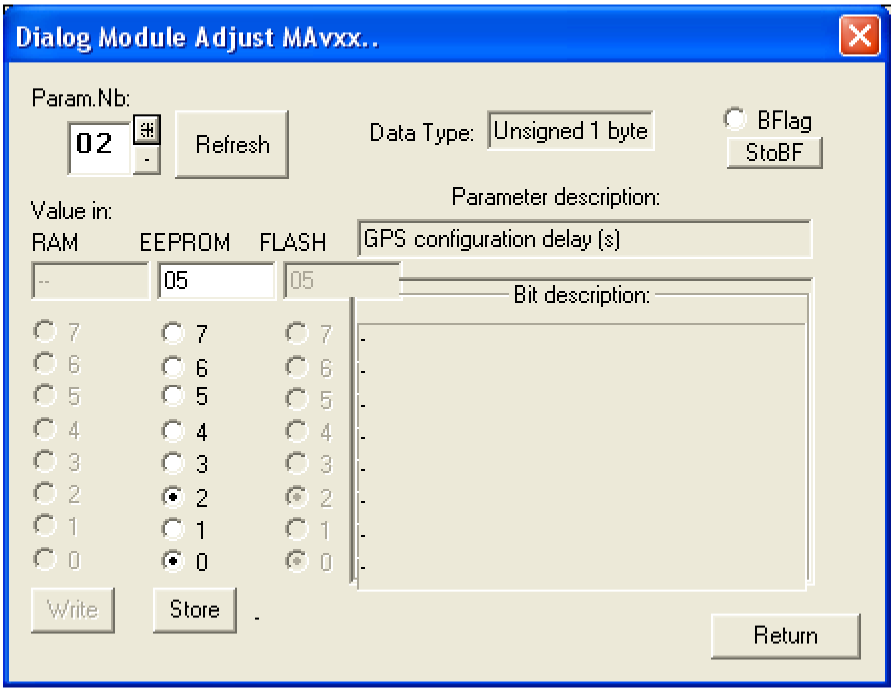
Description

This value is the delay in seconds before the first activated message is transmitted on pin 18 (TxD1) after Power on /Reset.
If activated, the messages are sent in the following order: 0x00, 0x01, *0x30, etc..*
As it is stored in eeprom, it can be modified.

Messages delay modification

MAS020A<CR> put a delay of 10 seconds.

Messages delay modification with the Monitoring program:



3.12.8. Messages interval

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
03	-	x	x	u 1byte	03	GPS configuration interval (s)

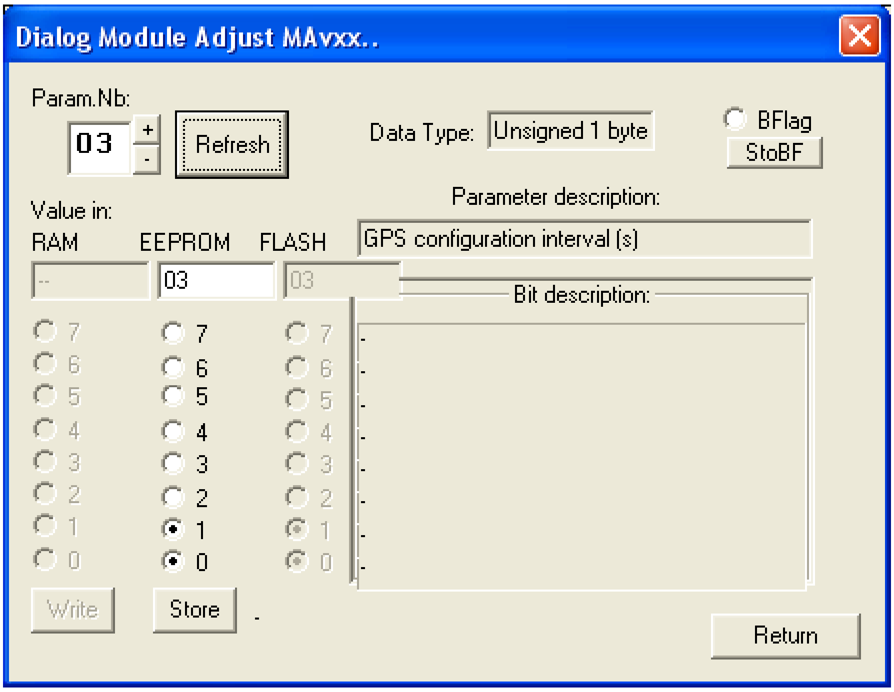
Description

This value is the interval in seconds between messages that are transmitted on pin 18 (TxD1) after Power on / Reset.
If activated, the messages are sent in the following order : 0x00, 0x01, *0x30, etc..*
As it is stored in eeprom, it can be modified.

Messages interval modification

MAS0305<CR> put an interval of 5 seconds.

Messages interval modification with the Monitoring program :



3.12.9. Timing and frequency flags

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
04	x	x	x	u 1byte	0B	Timing / Frequency

Bit description

bit	State	Default value	Help	Comment
4	1: pin #4 is high when Out Of Lock 0: pin #4 is low when Out Of Lock	0	Rb OOL inversion	NC
3	1: thermal compensation active 0: no thermal compensation	1	Therm. comp.	Useful for noise reduction
2	1: DDS value (LNRCLOK)	0	Freeze	Useful for phase noise measurement
1	1: PPSREF active 0: behave like no PPSREF	1	PPSREF	Useful for holdover simulation
0	1: pin 20, PPSOUT active 0: pin 20 grounded	1	PPSOUT	Useful in low noise application

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information about some bit

bit 2, freeze

It is recommended to not use commands that change the frequency when freeze is active.

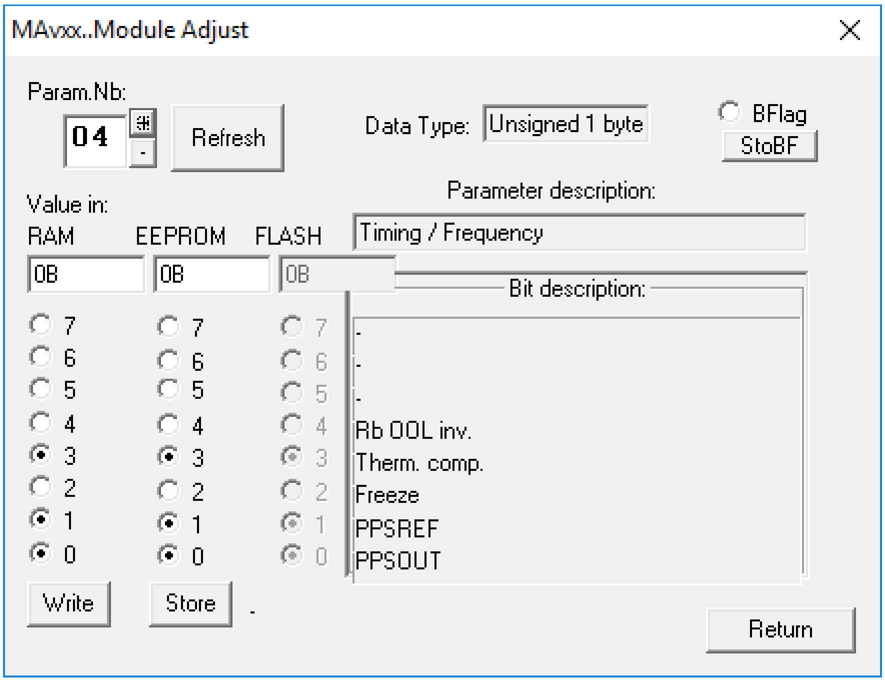
1. Freeze activation.
2. No commands like TR1,..
3. Freeze not active.

The "Freeze" value can also be changed with the command FREEZEx.

bit 0, PPSOUT

- There are 3 possibilities to stop PPSOUT:
  1. bit0 of parameter 0x04 (this one), to low.
  2. Pulse width to 0, command PW000000000.
  3. PPSOUT cadence to null, command PP000000.

Changing timing and frequency flags with the Monitoring program :



3.12.10. Tracking flags

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
05	x	x	x	u 1byte	10	Tracking

Bit description

bit	State	Default value	Help	Comment
4	1: save frequency every 24 hours 0: no frequency saving	1	24h save	Average frequency is saved in eeprom every 24 hours
3	1: Tracking message on 0: Tracking message off	0	Track NMEA	Track a $GPRMC message on Port RxD1, pin 19
2	-	0	-	-
1	1: align PPSOUT to PPSINT 0: no alignment	0	Sync	Useful to be in Sync to GPS time
0	1: track the PPSREF 0: no tracking	0	Track	Align PPSINT to PPSREF during tracking setup

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information about some bit

bit 4, 24h save

In case of successful tracking, the average frequency value is saved in eeprom.
The "24h save" value can also be changed with the command FSx.

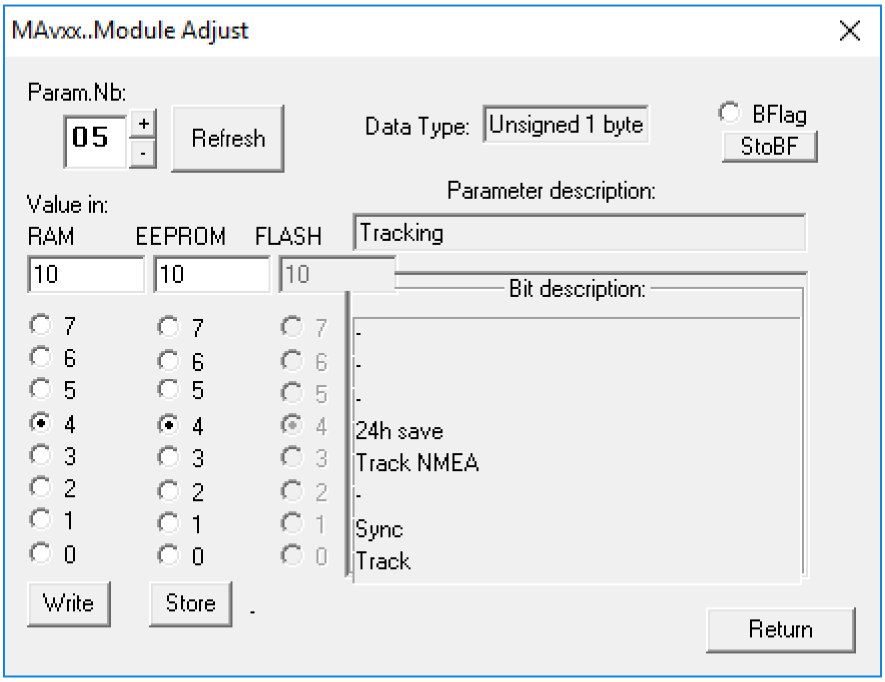
bit 1, Sync

The "Sync" value can also be changed with the command SYx.

bit 0, Track

The "Track" value can also be changed with the command TRx.

Changing tracking start flags with the Monitoring program :



3.12.11. Tracking start flags

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
06	x	x	x	u 1byte	02	Tracking start

Bit description

bit	State	Default value	Help	Comment
4	1: cancel FC writing in eeprom 0: FC is writing in eeprom	0	FC not in eeprom	Custom tracking made with the command FCsddddd
3	1: keep frequency 0: optimize frequency	0	Keep frequency	To simplify frequency behavior

2	1: tracking re-start allowed 0: no tracking re-start	0	Restart tracking	Useful in lab conditions.
1	1: align to PPSREF frequency 0: no alignment	1	Frequency align	Fast frequency alignment
0	1: test active 0: no test	0	Frequency test	Test frequency of PPSREF during tracking setup

Changing the value in ram: the new parameter is taken account immediately. Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information about some bit

bit 4, control of the writing in eeprom of the command FCsddddd

It is possible to avoid the writing in eeprom of the commands FCsddddd and Cxxxx

If this bit is settled, the command FCsddddd and Cxxxx will just write in RAM. To force the transfer of the frequency value from RAM to eeprom, send the command FS3.

bit 3, keep frequency

When this flag is set, the last frequency is always kept. Exceptions:

- During free run, with the command FCsddd.
- During a tracking.

bit 2, restart tracking

After 254 seconds with a PPSREF out of tracking window, but stable, a new tracking is initiated if this flag is set.

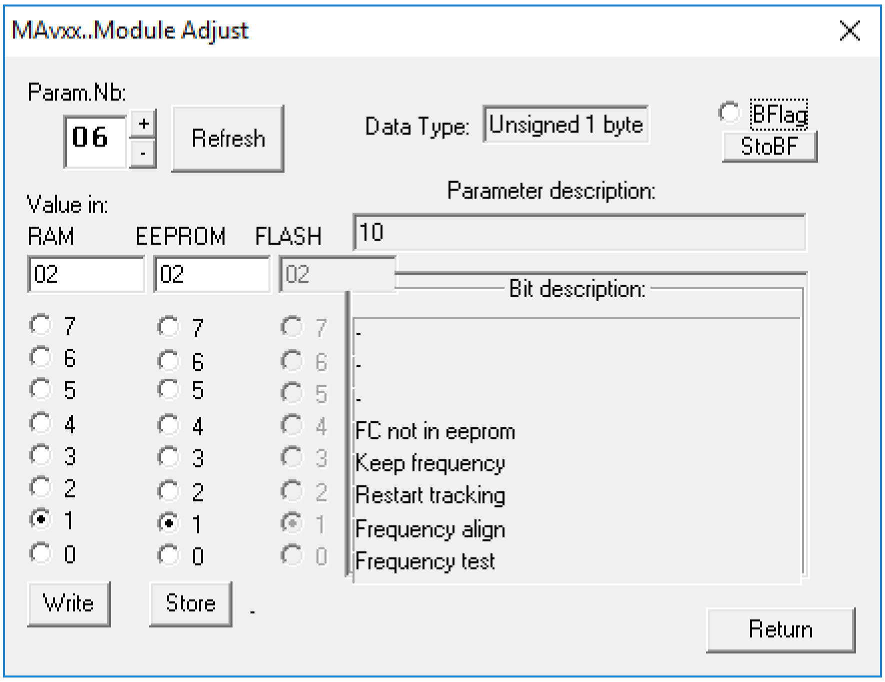
bit 1, Frequency align

A frequency determination of PPSREF is done during tracking setup. After that, a sudden frequency alignment is done just before tracking start. Status=5 is issued if the new frequency is out of +/-25'000 range. (FC)

bit 0, Frequency test

A frequency determination of PPSREF is done during tracking setup. If the frequency offset is larger than 5'328 e-12 for the LNRCLOK, Status=5 is issued.

Changing tracking start flags with the Monitoring program :



3.12.12. Communication flags

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
07	-	x	x	u 1byte	01	Communication control

Bit description

bit	State	Default value	Help	Comment
2	1: transparent communication to a GPS 0: normal	0	Normal/Transparent GPS	For GPS receiver debugging
1	1: incoming messages are not decoded 0: normal behavior	0	XON/XOF	Useful in multiple devices systems
0	1: send "?" by unknown command 0: send nothing by unknown command	1	? by unknown command	Behavior in test equipment

Changing the value in eeprom: the new parameter is taken account after power on / reset.

- More information about some bit
- bit 2, Normal / Transparent GPS

Direct communication to a GPS receiver connected to the iSync.

Related to command @@@@GPS. See special_commands for more information.

- bit 1, XON / XOF

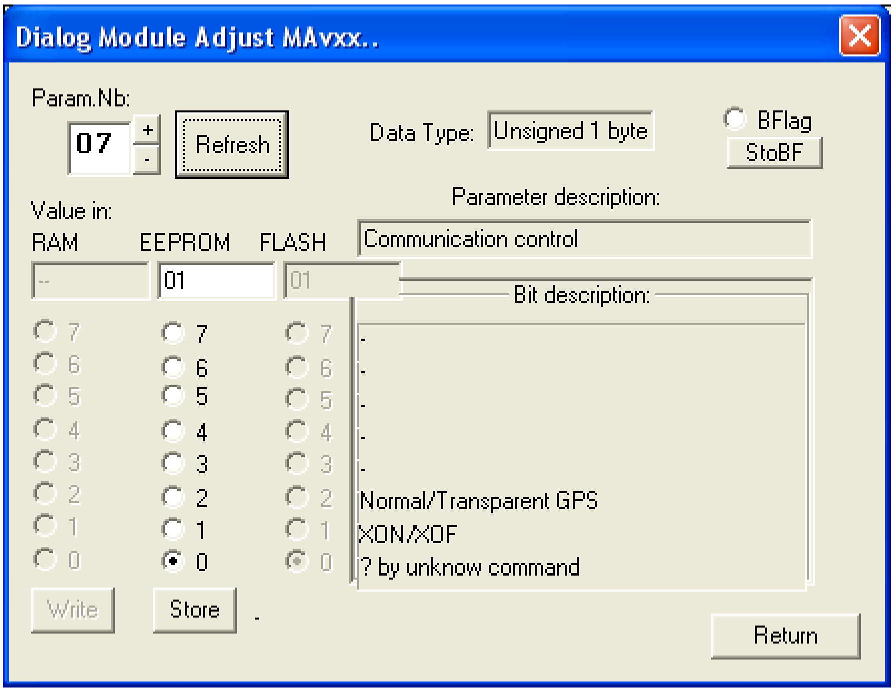
Incoming messages are stopped.

Related to command @@@@XOF. See special_commands for more information.

- bit 0, ? by unknown command

Although the new value is stored in eeprom, the new behavior is active immediately.

Changing communication flags with the Monitoring program :



3.12.13. Holdover

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
08	-	x	x	u 1byte	00	Holdover. Don't touch.

Description

LNRCLOK, sw 3.10 : under development, please don't touch.

3.12.14. Aging

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
09	-	x	x	u 1byte	20	Aging. Under dev. Don't touch.

Description

LNRCLOK, sw 3.10 : under development

3.12.15. Environment flag

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help

0A	-	x	x	u 1byte	01	Environment.

Bit description

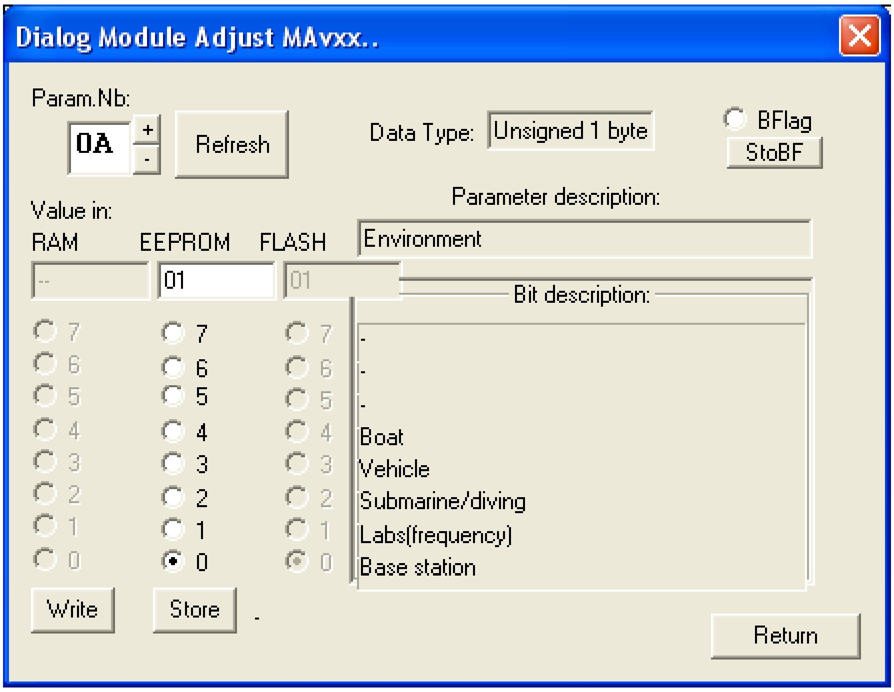
bit	Help
4	Boat
3	Vehicle
2	Submarine/diving
1	Labs(frequency)
0	Base station

Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Only one bit should be selected.
- In case of multiple selection, only the lowest bit is taken account.
- **LNRCLOK, sw 3.10** : In fact only 2 situations are taken account:
  - Bit1 or lower selected, GPS not in movement.
  - Bit2 or higher selected, GPS in move.
- **LNRCLOK, sw 3.10, since ID:** *SPTLNR-001/00/3.10 2012-12-10*, and GPS LEA-xT, this Flag is not considered, because the GPS is no more configured by the iSync firmware.

Changing environment flag with the Monitoring program :



3.12.16. Messages coming out every second

MAv parameters 0x0B and 0x0C.

The iSync is able to send one message every second at 4 time slot positions: ~3ms, ~250ms, ~500ms, ~750ms. At each time slot, 1 of 4 messages is possible.

At	~3ms	~250ms	~500ms	~750ms
Activation commands	MAWØBØx	MAWØBxØ	MAWØCØx	MAWØCxØ
Activation after power on	MASØBØx	MASØBxØ	MASØCØx	MASØCxØ

Ø : zero.

Signification of x:

0: nothing

1: NMEA $GPRMC

2: NMEA $ZDA

3: -

4: -

5: -

6: -

7: -

8: -

9: -

A: $PTNTA

B: $PTNTS,B

C: -

D: -

E: -

F: -

Example:

Commands:

1. MAWØBBA<CR><LF>
2. MAWØC21<CR><LF>

The iSync will send at:

1. t=~3ms, the NMEA message $PTNTA.
2. t=~250ms, the NMEA message $PTNTS,B.
3. t=~500ms, the NMEA message $GPRMC.
4. t=~750ms, the NMEA message $GPZDA.

Notes

- The reference for time slot is PPSINT.
- Position information of message $GPRMC is updated as soon as new information from the GPS receiver are available. This mean if this message is activated 4 times, position information may vary.
- For quick debugging command BTx can also be used.

3.12.17. Validity duration of the A / V flag, message $GPRMC

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
0D	X	x	x	u 1byte	Rb:F0 Crystal:18	[A] validity life(hours).

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

In the message $GPRMC, the flag A / V is the quality indicator for the GPS date/time transfer. After a successfully date/time transfer due to a correct GPS message, the flag is A. If the GPS antenna is disconnected during more than the number of hours of this parameter, the flag become V.

Value :

- 0 : The flag become immediately V after a GPS failure.
- 1 to 254 : delay in hours before the flag become V after a GPS failure.
- 255 : The flag always A after a GPS successfully date/time transfer. Only a failure of the clock can make it become V.

In the message $PTNTA, this parameter determine the duration before the quality indicator of the time transfer go from 3 to 2.

1.1.1 Warm-up delay

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
0E	X	x	x	u 1byte	0	Warmup in 32s time interval

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

After power ON / Reset in a crystal based clock and after the Rb lock in a Rubidium based clock, a delay is added in the Status determination system in order to cancel a too fast going in tracking.
This delay is mainly intended for situations where the tracking state is permanently settled by software or by hardware. The unit of the delay is 32 seconds.

3.12.18. Pulse width

Parameter description

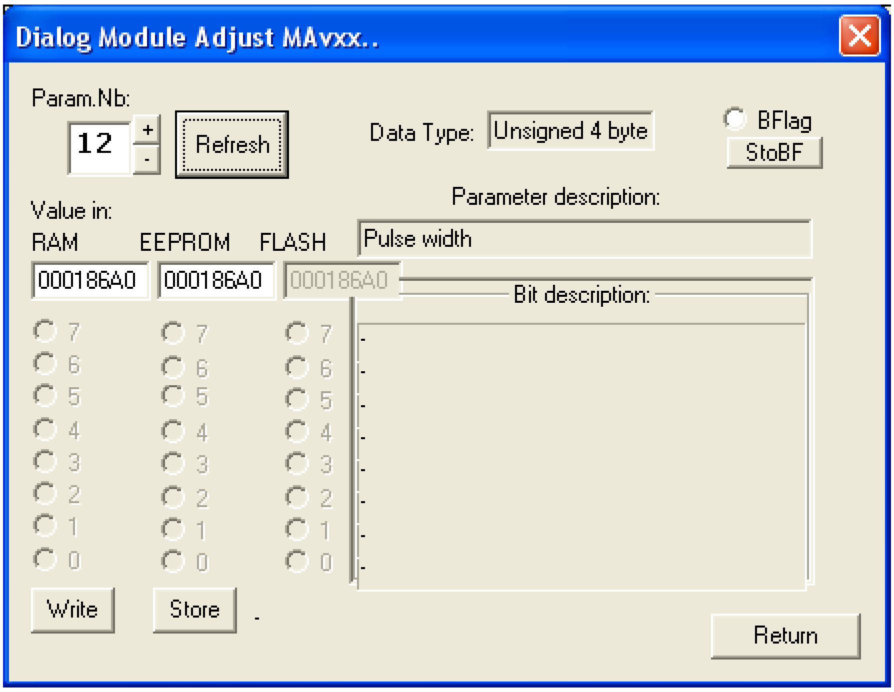
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
12	X	x	x	u 4byte	000186A0	Pulse width.

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Pulse width of the PPSOUT in ns.
- The pulse width is rounded to 66 ns for the LNRCLOK.
- See also command PWddddddddd.
- 0x000186A0 equal 100'000 ns.

Changing the pulse width with the Monitoring program :



3.12.19. Tracking window

Parameter description

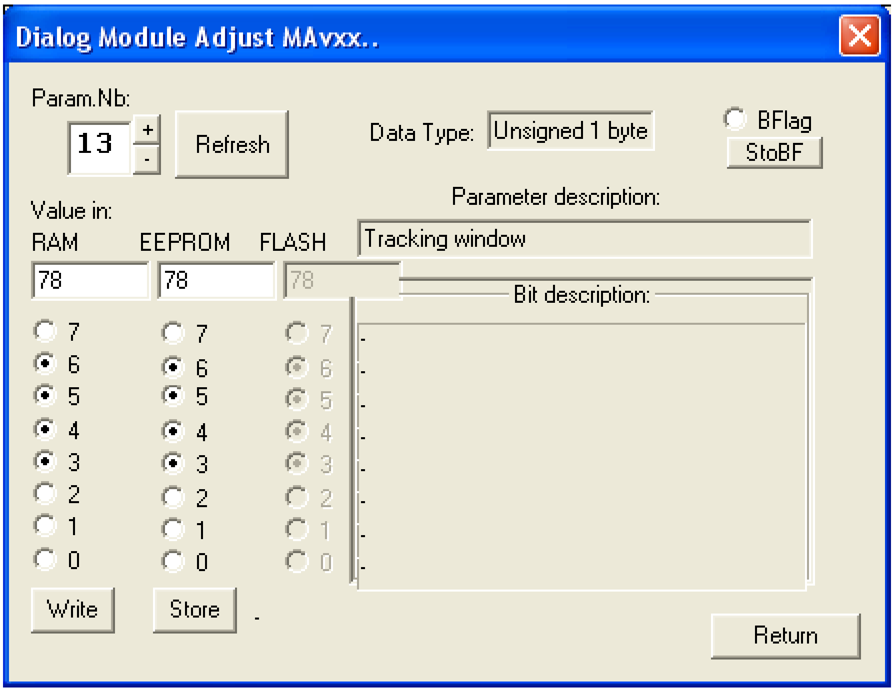
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
13	x	x	x	u 1byte	LNRCLOK : 4	Tracking window.

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Tracking window in use.
- In tracking, no error as long | ppsint - ppsref | < Tracking window.
- See also command TWddd.

Changing the tracking window with the Monitoring program :



3.12.20. Alarm window

Parameter description

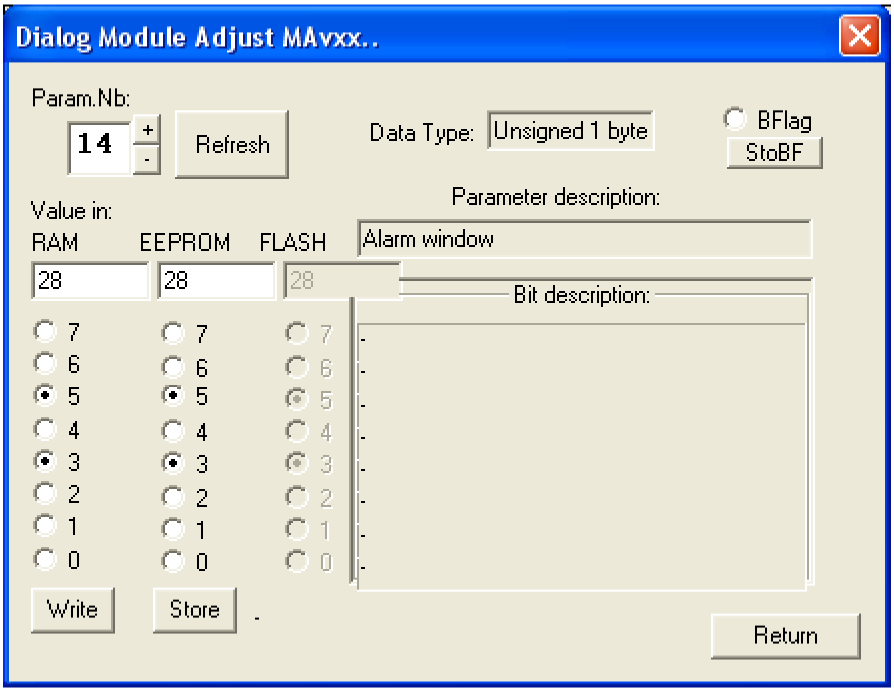
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
14	x	x	x	u 1byte	LNRCLOK : 04	Alarm window.

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Alarm window in use.
- In tracking, no alarm as long | ppsint - ppsref | < Alarm window.
- See also command AWddd.

Changing the alarm window with the Monitoring program :



3.12.21. Tracking loop time constant

Parameter description

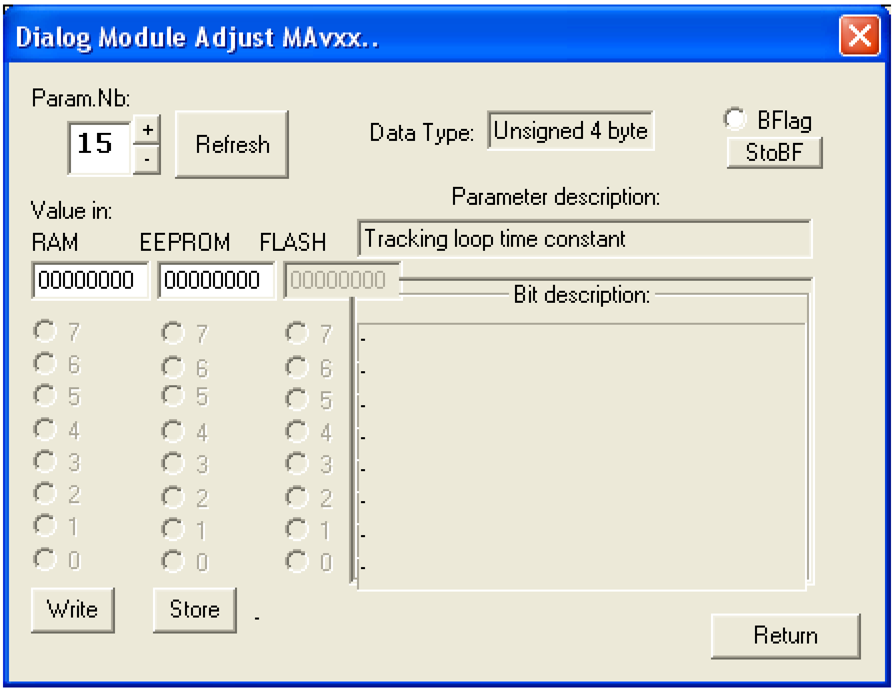
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
15	x	x	x	u 4byte	00000000	Tracking loop time constant

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Time constant of the tracking loop in second.
- For the LNRCLOK, from 100 second to 999999 second.
- See also command TCdddddd.

Changing the tracking loop time constant with the Monitoring program :



3.12.22. Fine comparator offset

Parameter description

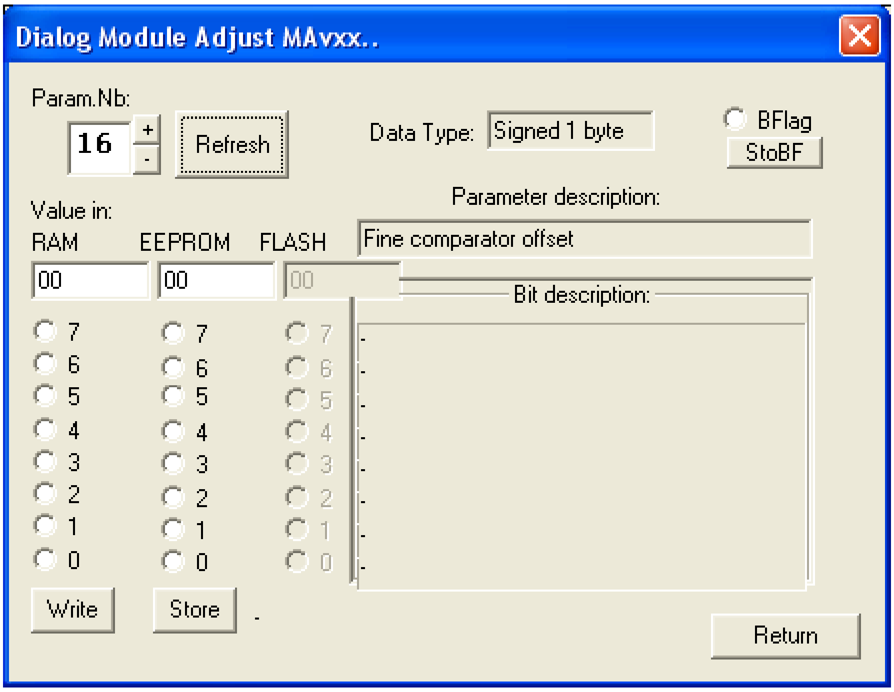
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
16	x	x	x	s 1byte	00	Fine comparator offset

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Fine comparator offset in approx. ns.
- + 127 / -128 range.
- See also command COsddd.

Changing the fine comparator offset with the Monitoring program :



3.12.23. Pulse every d second

Parameter description

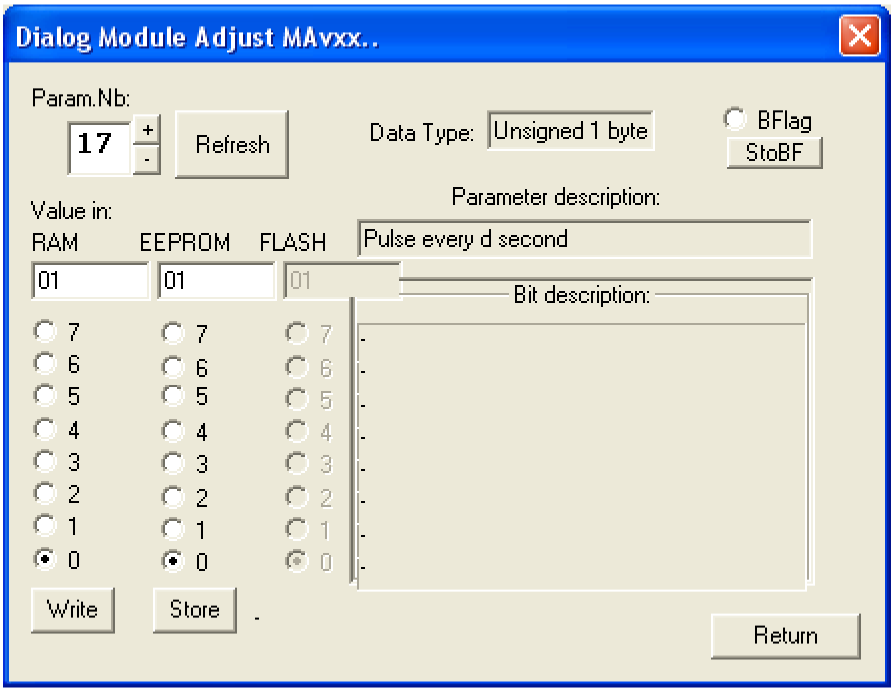
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
17	x	x	x	u 1byte	01	Pulse every d second

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- PPSOUT cadence .
- 1 pulse every 1 to 255 second.
- See also command PPdddeee.

Changing the PPSOUT cadence with the Monitoring program :



3.12.24. Pulse origin

Parameter description

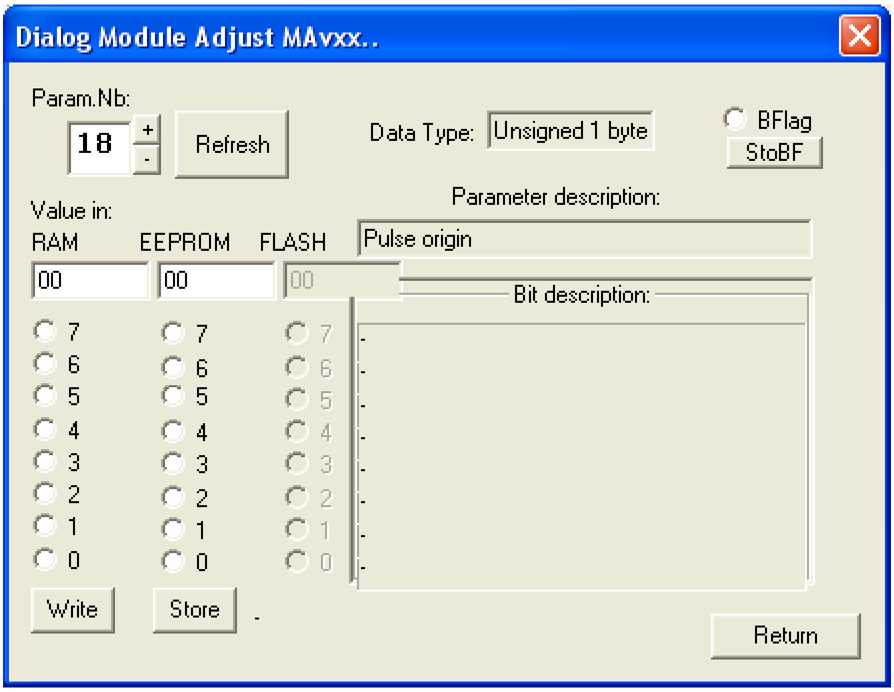
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
18	x	x	x	u 1byte	00	Pulse origin

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- Offset in second to GPS origin that is 1980-01-06 00:00:00.
- In fact useful in pp2s situation to choose in between odd or even pulse.
- See also command PPdddeee.

Changing the PPSOUT origin with the Monitoring program :



3.12.25. Frequency limit

Parameter description

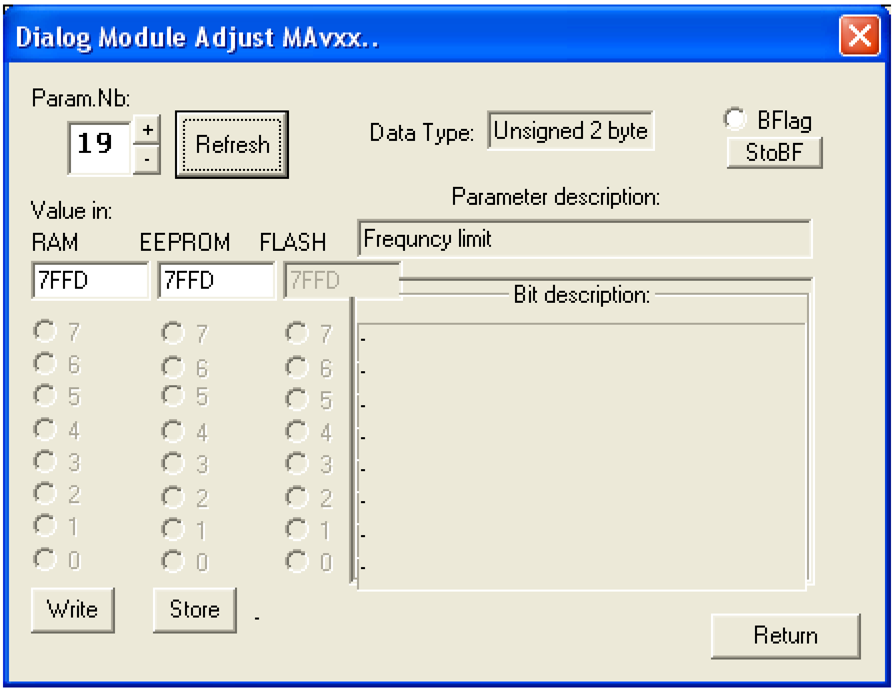
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
19	x	x	x	u 2byte	7FFD	Frequency limit

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- The tracking of the PPSREF is only possible in the +/- frequency range.

Changing the frequency limit with the Monitoring program :



3.12.26. GPS type

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
20	x	x	x	u 1byte	00	GPS type

Description

LNRCLOK, sw 3.10 : the software don't take account this parameter.

3.12.27. GPS language selection

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
21	x	x	x	u 1byte	00	GPS language

Possible values

Value	Help
08	NMEA $GPRMC
07	Furuno NMEA
06	Trimble TSIP
05	Novatel SSII
04	UBlox LEA-T
03	Motorola @@A2
02	Motorola @@A1
01	Zodiac binary
00	No selection

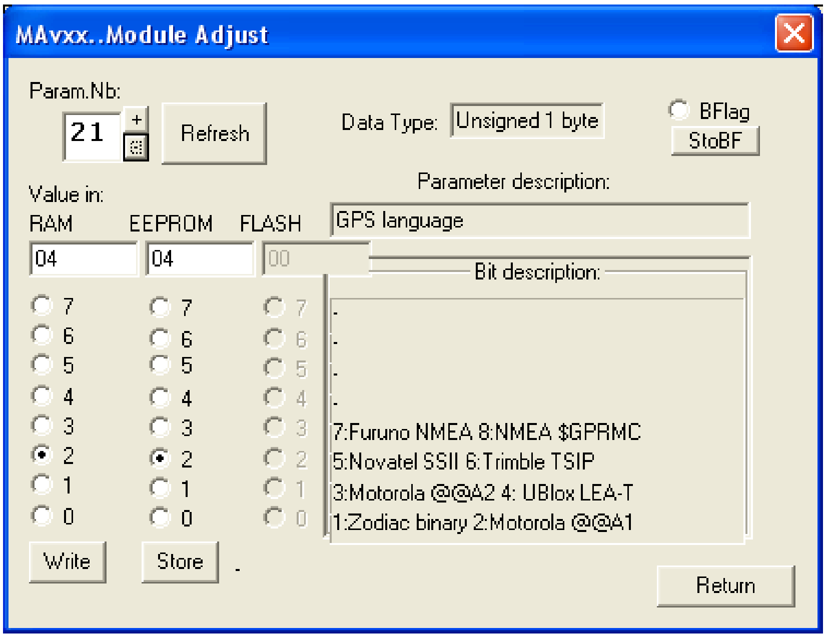
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- **Situation in October 2012, sw 3.10** : It is recommended to work with 2 languages:
    - 04 UBlox LEA-xT.
    - 08 NMEA $GPRMC.

Other languages are possible, but it is recommended to inform SpecTratime before to work with them.

Changing GPS language with the Monitoring program:



3.12.28. GPS resource utilization

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
22	x	x	x	u 1byte	00	GPS resource utilisation

Bit description

bit	State	Default value	Help	Comment
4	1: Position transfer from GPS to the iSync 0: no Position transfer from GPS	0	GPS Position transfer	Pick the Position GPS information for the NMEA messages
3	1: Date/Time transfer from GPS to the iSync 0: no Date/Time transfer from GPS	0	GPS Date/Time transfer	Pick the date/time GPS information to use it in the iSync
2	1: consider the granularity message 0: do not consider the granularity message	0	Consider granularity mess.	To cancel the noise due to the GPS ppsref granularity
1	1: the iSync must configure the GPS 0: GPS receiver already configured	0	Configure GPS	-
0	1: consider GPS messages 0: do not consider GPS messages	0	Consider GPS messages to track	Main bit to consider or not a GPS receiver

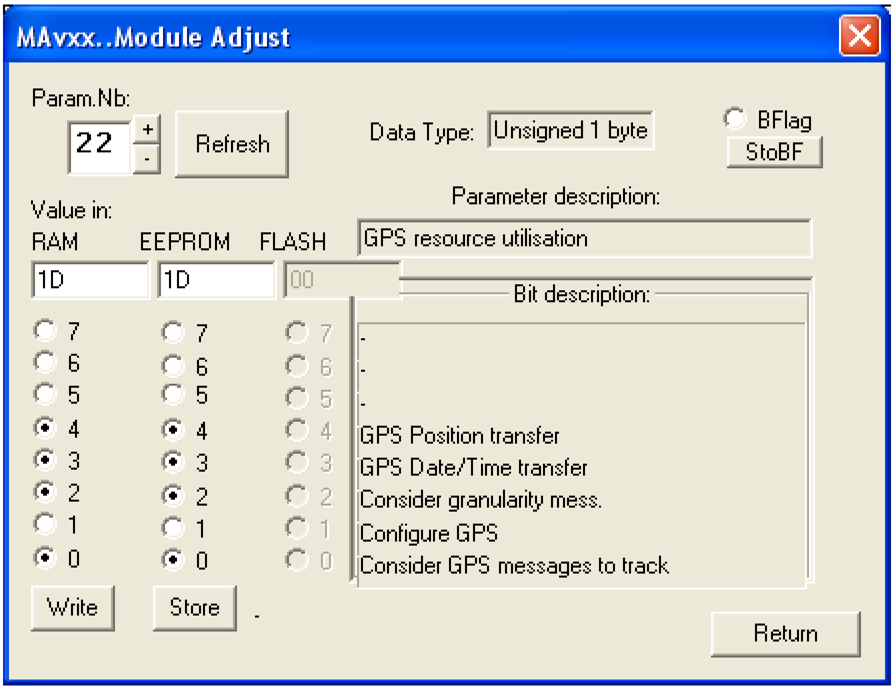
Changing the value in ram: the new parameter is taken account immediately. Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information about some bit

bit 0, Consider GPS messages to track

If this bit is settled and the expected GPS messages are not present, it will be Status=6 in tracking.

Typical configuration for LEA-xT:



3.12.29. GPS longitude

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
24	x	x	x	s 4byte	00000000	GPS longitude

Description

Units: tbd (e-7deg)

LNRCLOK, sw 3.10 : nothing is done with this parameter.

3.12.30. GPS latitude

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
25	x	x	x	s 4byte	00000000	GPS latitude

Description

Units: tbd (e-7deg)

LNRCLOK, sw 3.10 : nothing is done with this parameter.

3.12.31. GPS altitude

Parameter description

Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
26	x	x	x	s 4byte	00000000	GPS altitude

Description

Units: tbd (mm)

LNRCLOK, sw 3.10 : nothing is done with this parameter.

3.12.32. GPS- UTC offset

Parameter description

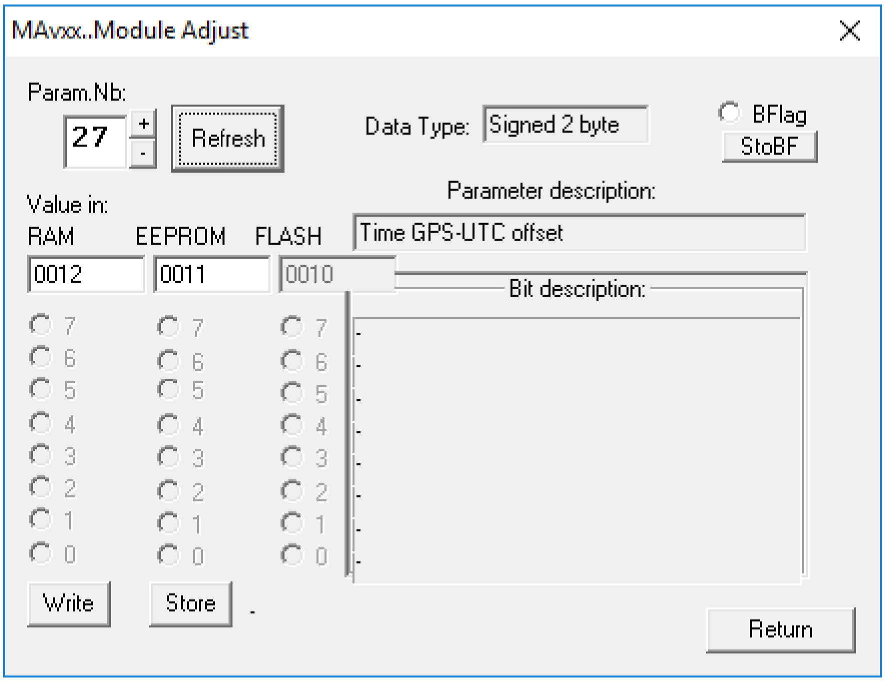
Parameter Nb	ram	eeprom	flash	Data type	Value(default)	Help
27	x	x	x	s 2byte	0010	Time GPS-UTC offset

Changing the value in ram: the new parameter is taken account immediately.
Changing the value in eeprom: the new parameter is taken account after power on / reset.

More information

- If the iSync is receiving information from a LEA-xT, the value in RAM is up-dated automatically.
- The value in eeprom is not up-dated automatically.
- Offset value at 2019-07-29: 18 seconds (0x12)

Changing the offset with the Monitoring program :



3.13. SERIAL COMMUNICATION INTERFACE 2

3.13.1. INTRODUCTION

The device has a second serial port to communicate directly with a GPS receiver. Important information like GPS time and position can be transmitted. The GPS receiver is also monitored and a PPSREF tracking can be stopped in case of dysfunction.

3.13.2. SERIAL 2 INTERFACE CONNECTION

Following parameters are standard :

bit rate : 9600 bits/s
parity : none
start bit : 1
data bits : 8
stop bit : 1
output "mark" voltage : 5 V
output "space" voltage : 0 V
input "mark" voltage : 2.5 to 5 V (CMOS)
input "space" voltage : 0 to 2.5 V (CMOS)

- Depending on GPS receiver type, these parameters may be changed internally.
- RxD2 and TxD2, are possibly connected to pins #12, resp. #16, if there is no GPS receiver inside the LNRCLOK. See THE REFERENCE DESIGN FOR THE LNRCLOK

3.14. The NMEA messages

Up to 4 messages can be transmitted by the device every second at 4 time slots. By the exception of the communication speed, the messages follow the NMEA 0183 standard.

3.14.1. Conditions :

Communication port : TxD1. Pin 18. Configuration : 9600,n,8,1
See THE REFERENCE DESIGN FOR THE LNRCLOK

3.14.2. Messages activation :

For debugging, with the command BTx. Possibilities : BTA, BTB, BTR, BTZ.
Temporary or permanently after power-on / Reset, with MAv parameters 0x0B and 0x0C.

3.14.3. Messages cancellation :

Messages activated with BTx can be cancelled with the command BT0.

Messages activated with the MAv parameters 0x0B and 0x0C can be temporary cancelled with the commands MAW0B00 and MAW0C00. And permanently cancelled after power-on / Reset with the commands MAS0B00 and MAS0C00.

3.15. The NMEA messages list:

$PTNTA $PTNTS,B $GPRMC $GPZDA

3.15.1. Message NMEA $PTNTA

Proprietary SpectraTime general iSync indicator.

At	~3ms	~250ms	~500ms	~750ms
Activation commands	BTA, MAWØBØA	MAWØBAØ	MAWØCØA	MAWØCAØ
Activation after power on	MASØBØA	MASØBAØ	MASØCØA	MASØCAØ

Ø : zero.

Example:

$PTNTA,20000101001558,1,T4,663542250,-511,4,1,0*1F<CR><LF>

$PTNTA:	message header that never change.
20000101001558:	date/time in format year, month, day, hour, minute, second. In GPS time or manual setting.
1:	oscillator quality 0:warming up, 1:freerun, 2:disciplined.
T4:	always T4. Format indicator.
663542250:	interval ppsref-ppsout in [ns]. Blank if no ppsref.
-511:	fine phase comparator in approx. [ns]. Always close to -500 or +500 if not disciplined. Blank if no ppsref.
4:	iSync Status. See documentation.
1:	GPS messages indicator. 0:do not take account, 1:take account, but no message, 2:take account, partially ok, 3:take account, totally ok.
0:	transfer quality of date/time. 0:no, 1:manual, 2:GPS, older than x hours, 3:GPS, fresh.
*1F:	xor checksum in between $ and *.

Note

- Regarding the parameter x, age of the last GPS date/time transfer, this one can be modified. The default value is 240 hours (10 days) for a Rb based clock, and 24 hours for a crystal based clock.

3.15.2. Message NMEA $PTNTS,B

Proprietary SpectraTime details iSync indicator.

At	~3ms	~250ms	~500ms	~750ms
Activation commands	BTB, MAWØBØB	MAWØBBØ	MAWØCØB	MAWØCBØ
Activation after power on	MASØBØB	MASØBBØ	MASØCØB	MASØCBØ

Ø : zero.

Example:

$PTNTS,B,2,F6B6,F688,F644,,,1,001500,001.50,,*16<CR><LF>

$PTNTS,B:	message header that never change.
2:	iSync Status. Status=2 means in tracking. See documentation.

F6B6:	current frequency, signed hexa, steps of 5.12e-13.
F688:	holdover frequency, signed hexa, steps of 5.12e-13.
F644:	eeprom frequency, signed hexa, steps of 5.12e-13.
1:	loop time constant mode 0: fixed value, 1: automatic.
001500:	loop time constant in use, from 000100 to 999999 seconds.
,001.50:	sigma (1s) of PPSRef in approx. ns.
*16:	xor checksum in between $ and *.

3.15.3. Message NMEA $GPRMC

Legacy NMEA minimum message.

At	~3ms	~250ms	~500ms	~750ms
Activation commands	`BTR, MAWØBØ1`	`MAWØB1Ø`	`MAWØCØ1`	`MAWØC1Ø`
Activation after power on	`MASØBØ1`	`MASØB1Ø`	`MASØCØ1`	`MASØC1Ø`

Ø : zero.

Example:

$GPRMC,134550.00,A,4659.3554,N,00654.4072,E,,,090507,,,E*58<CR><LF>

$GPRMC	: message header that never change.
134550.00	: hour, minute, second in UTC. **.00**: always this value.
A	: message (Time / Date) is valid. If V: message is not valid.
4659.3554	: **46**: latitude in degree. **59.3554**: latitude residual in minute.
N	: north hemisphere. If S: south hemisphere.
00654.4072	: **006**: longitude in degree. **54.4072**: longitude residual in minute.
E	: eastern of Greenwich. If W: western of Greenwich.
090507	: **09**: day. **05**: month. **07**: year.
E	: mode indicator. Always E.
*58	: xor checksum in between $ and *.

Notes

- As the iSync device is timing oriented, the meaning the validity flag "A" is somewhat different. Exact meaning of the flag "A" : - The device was in tracking and the time/date was settled by a correct GPS timing message during the last x hours.
- The parameter x can be modified. For a Rb based clock it is by default 240 hours (10 days). For a crystal based clock it is by default 24 hours.
- The time/date information are always present.
- The position information are present in the $GPRMC message only if :
  - A correct message from a GPS device is present.
  - The position information of the GPS message is correct.

3.15.4.Message NMEA $GPZDA

Legacy NMEA timing message.

At	~3ms	~250ms	~500ms	~750ms
Activation commands	BTZ, MAWØBØ2	MAWØB2Ø	MAWØCØ2	MAWØC2Ø
Activation after power on	MASØBØ2	MASØB2Ø	MASØCØ2	MASØC2Ø

Ø : zero.

Example:

$GPZDA,133358,09,05,2007,,*4E<CR><LF>

$GPZDA : message header that never change.

133358 : hour, minute, second in UTC.

09 : day.

05 : month.

2007 : year.

*4E : xor checksum in between $ and *.

3.16. THE NMEA $GPRMC mode

The iSync device can track a ppsref and update its internal GPS time system with information coming from a NMEA message $GPRMC.

Conditions:

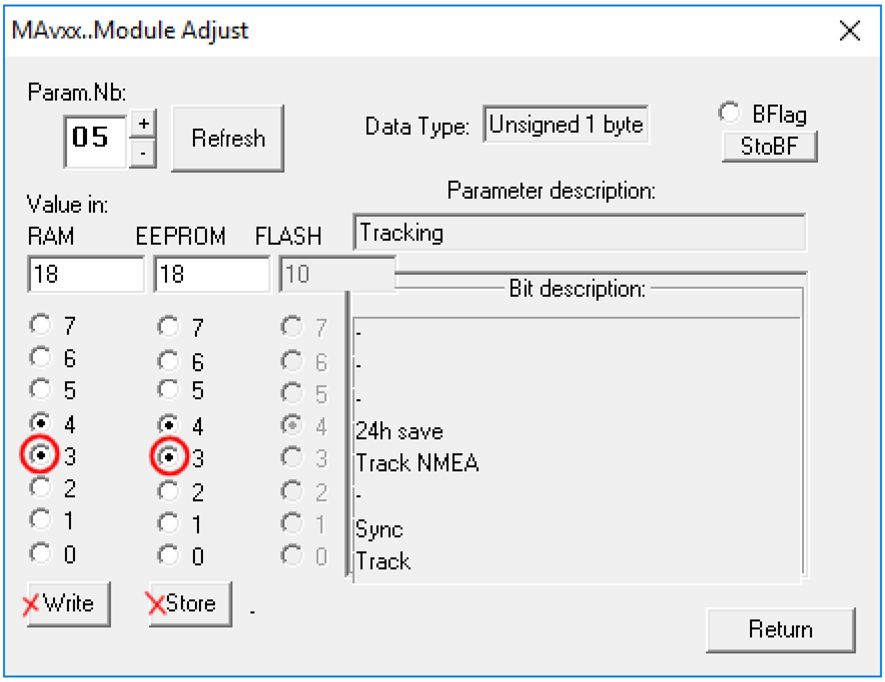
Communication port : RxD1. Pin 19. Configuration : 9600,n,8,1
PPSREF : Pin 8.
See THE REFERENCE DESIGN FOR THE LNRCLOK

Message : $GPRMC,
See Message $GPRMC
It is a pulse - message system. See Time of Day Command Synchronization.

Setting:

The bit 3 of parameter 0x05 must be settled, so the incoming $GPRMC messages will be accepted. This can be done with Hyperterminal : p.ex. : MAW0518 in ram. To store this behavior permanently in eeprom : MAS0518.

With the Monitoring program :



3.17. Special commands

These special commands are for debugging. It is not recommended to include them in a standard development.

Command `@@@@GPS<CR>[<LF>]`

Use Open a transparent serial communication way between a terminal and a GPS receiver connected to the iSync device.
Setting: 9600,n,8,1
`Terminal -> pin19:RxD1 -> iSync -> pin16:/TxD2 -> GPS`
`Terminal <- pin18:TxD1 <- iSync <- pin12:/RxD2 <- GPS`

Remark Messages transmitted normally by the iSync to pin18:TxD1 and to pin16:/TxD2 are not stopped. To stop them: `BT0, MAW0B00, MAW0C00 and MAW2100.`

Command `@@@@`

Use Cancellation of `@@@@GPS` command.

Command `@@@@XOF<CR>[<LF>]`

Use Stop decoding incoming messages from terminal to iSync. Outgoing messages are not stopped.

Remark Messages transmitted normally by the iSync to pin18:TxD1 and to pin16:/TxD2 are not stopped. To stop them: `BT0, MAW0B00, MAW0C00 and MAW2100.`

Command `@@@@XON<CR>[<LF>]`

Use Cancellation of `@@@@XOF` command.

Command `OT<CR>[<LF>]`

Answer xxxx[space]yyyy [CR][LF]

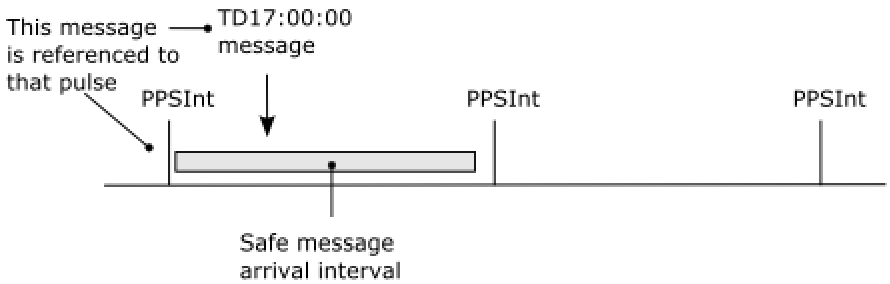
xxxx: number of full days in operation in ASCII / hex coded
yyyy: number of starts in ASCII / hex coded
Limited to 0x1388 to preserve eeprom

Remark This function and command are since version ID: *SPTLNR-001/00/3.10 2018-02-28*

3.18. Time of Day Command Synchronization

Important
Rb LNRCLOK sw 3.10 : has a different behavior than former sw version. There is now a pulse - message system.

- The reference for timing is ppsint.
- The time information is referenced to the ppsint just before the command arrival.
- **TD17:00:00** means it was 17:00:00 at the last ppsint.
- The safe message arrival interval is approx. 3 ms after reference ppsint and 50 ms before next ppsint.
- Rem.: with **SY1** ppsint and ppsout are aligned.



3.19. TTL OR CMOS LEVEL "LOCK MONITOR" GENERATION

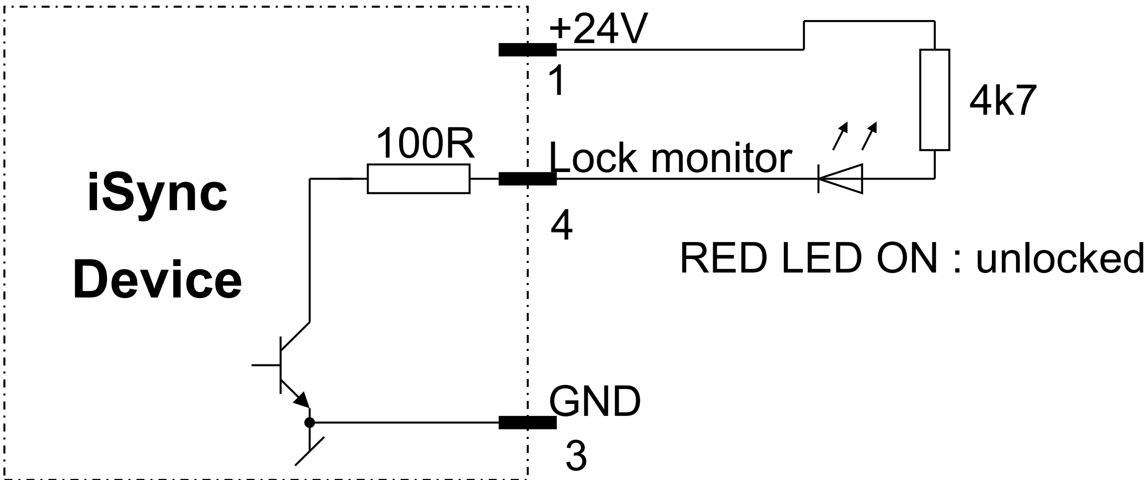


Figure 11: The lock monitor can be directly connected to the TTL load, or a pull-up resistor can be added for CMOS compatibility.

3.20. DIRECT VISUAL "OUT OF LOCK" SIGNAL GENERATION

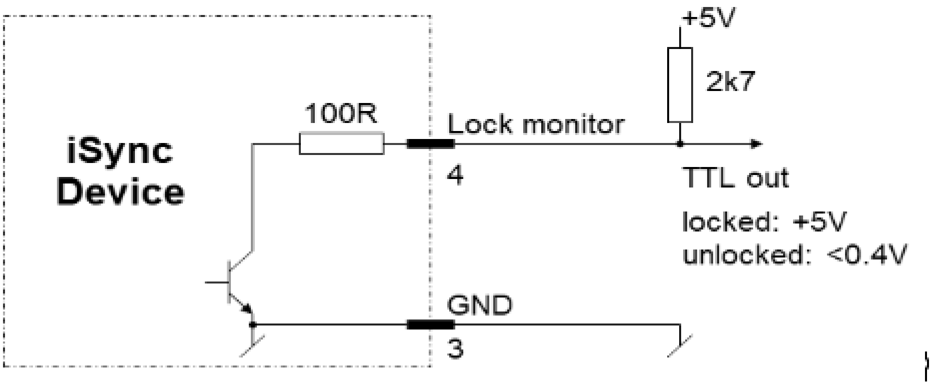


Figure 12: Visual "Out Off Lock" generation. The value of the 4k7 resistor should be adapted to the LED drive current.

3.21. CONNECTING A PPSREF TO THE LNRCLOK

The LNRCLOK PPSREF input is equipped with a simple CMOS buffer. The PPSREF signal should swing between 1 V and 4 V with abrupt enough edges. To connect a PPSREF to the LNRCLOK, a simple shielded cable should be enough for distances up to 2 m. For longer distances, up to 10 m, a transmission cable is recommended. As the LNRCLOK input needs enough voltage level, it is not possible to match the impedance on both sides of the cable. So it is recommended to match the impedance only on the side of the PPSREF source with a resistor in serial. The splitting of the cable to feed another PPSREF receiver is to be avoided absolutely. For distances longer than 10 m, a line receiver is recommended.

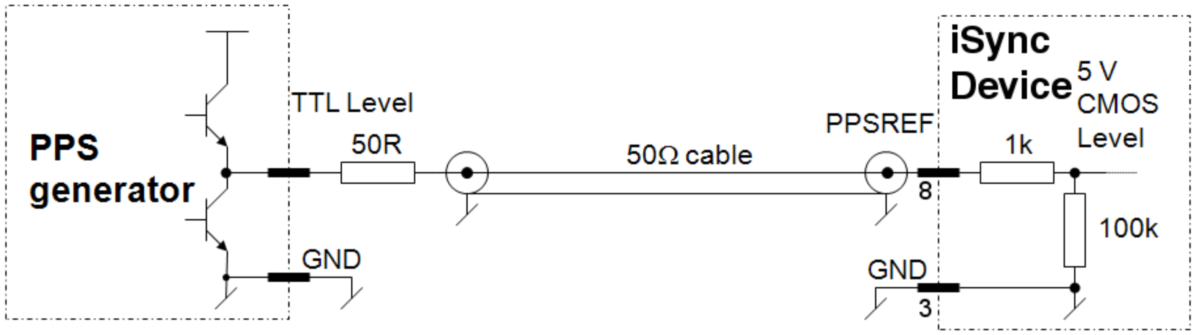


Figure 13: This schematic is recommended to connect a PPSREF to the LNRCLOK on distances up to 10m.

3.22. Time tagging on the PPSREF input and the BT8 command

It is possible to make time tagging on the PPSREF input.

- Activation command : BT8.
- Origin of time stamp : 2000-01-01 00:00:00.
- Referenced to PPSINT.
- Fine phase comparator not activated.
- Tagging of an independent signal not possible during a tracking.
- A stamp message is transmitted on the serial pin 18, TxD1, up to 10 ms after the pulse arrival. See BTx command.

3.23. Signification of the BT9 message

Every second, the GPS send data to the iSync.This data contains information about timing and navigation parameters. A bit is settled for each parameter when the iSync found pertinent data about it and BT9 send a message as soon the information is arrived. This way, several messages may follow if the information is scattered over several GPS messages. Note: Only the information

"Validation" is followed by a CR LF. It is therefore possible that BT9 sends long messages without any CR LF if no satellite is tracked by the GPS.

Signification of each bit :

Bit	Comment
7	Leap second
6	UTC offset
5	ND
4	Position
3	Date / Time
2	Granularity
1	ND
0	Validation

Typical BT9 messages for some GPS :

GPS type	Param. 21	Param. 22	Good working message
LEA-xT	04	1D	10400C01
NMEA $GPRMC	08	19	19

3.24. Time and date in use in the iSync clock

Parameter 0X27

- The internal time of the iSync clock is the GPS time. Message with GPS time: $PTNTA. Commands that gives out GPS time: DT, TD, BT4, BT7, BT8, BTA.
- UTC time is used in messages: $GPRMC, $GPZDA. Commands that gives out UTC time: BTR, BTZ.
- UTC time = GPS time - Offset.
- Offset is retrieved from GPS receiver messages if available.
- Offset is stored in eeprom. The storage is not automatic. It is possible to modify the offset value with the MAv.. system, parameter 0x27. Exemple: Command to store an offset of 16 second in eeprom : MAS270010 <CR><LF>
- Offset value at 2019-07-29: 18 seconds.

3.25. The time constant of the PI loop. Rb LNRCLOK

In automatic mode (TC000000 <CR><LF>)

- At the beginning of a tracking, the time constant is settled to 1000 second. After that this value can climb up to 30'000 second, depending on the |ppsref - ppsint| noise.
- The noise determination can only be done in the range |ppsref - ppsint| < 500 ns.
- Over this range, there is no noise information. In such situation, the time constant goes gently to 1000 second, whatever the initial value.
- In really noisy environment, with ppsref jumps larger than 500 ns, it is recommended to not work in automatic time constant mode because the time constant will never go over 1000 seconds.

```
The following relationships are available:

(ppsref noise)[ns] < 10 ns :

   (ppsref noise)[ns] x 1000 -> (time constant)[s]

(ppsref noise)[ns] > 10 ns :

   SQR((ppsref noise)[ns]) x 3162 -> (time constant)[s]
```

3.26. LNRCLOK simplified state machine and Status indication

```
Situation                                                      Status

|warming up|--------------------------------------------------(0)

|iddle|-------------------------------------------------------(4)

|tracking setup|-----------|ppsref|---|ppsref stable|---------(1)
                       |
                       ---/|ppsref|---------------------------(6)
                       |
                       ---/|ppsref stable|--------------------(5)
                       |
                       --|consider GPS|--/|GPS message|-------(6)

|holdover|----------------------------------------------------(5)

|tracking|--------|ppsref|---|ppsref in alarm window|---------(2)
            |
            --|sync|--|(ppsout - ppsref) in alarm window|-----(3)
            |
            -----/|ppsref|-----------------------(holdover)--(6)
            |
            -----/|ppsref in alarm window|--------(tracking)--(5)
            |
            -----/|ppsref in tracking window|-----(holdover)--(5)
            |
            ---|consider GPS|--/|GPS message|-----(holdover)--(6)

|whatever|--------|FREEZE=1|-------(DDS value = cst)----------(7)
```

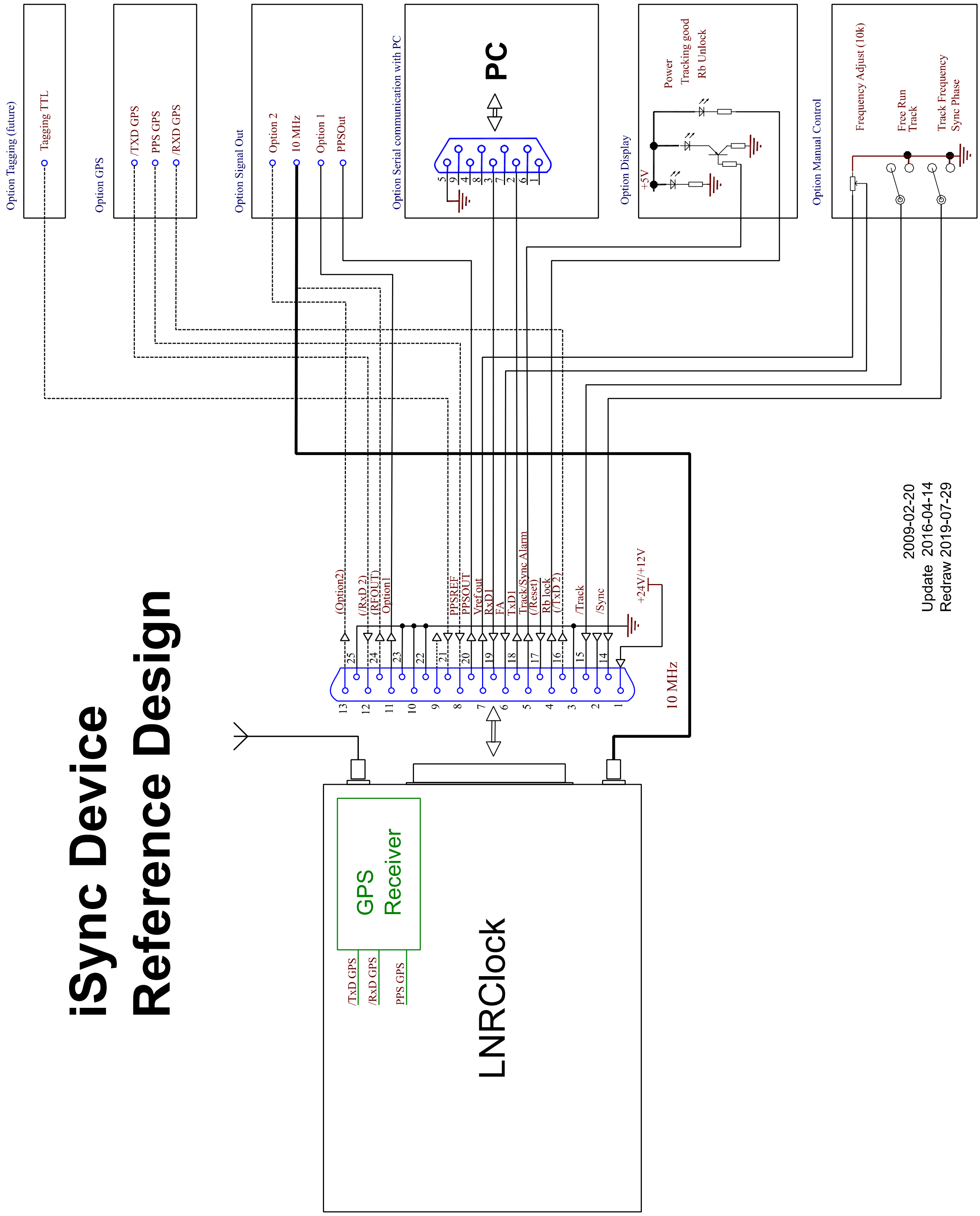
Notes:

This is a simplified representation. The conditions that make the transitions between |warming up|, |tracking setup|, |holdover|, |tracking| possible are not showed here.

The transition from |tracking setup| to |tracking| goes for a short time through |holdover|. That is why Status=5 can appear for a short time in such situation.

4. Annexes

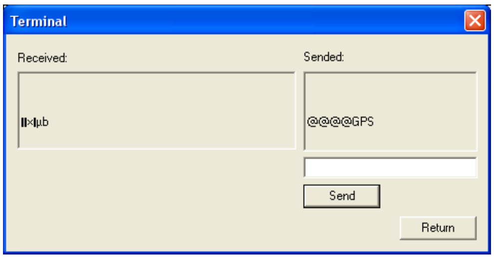
4.1. THE REFERENCE DESIGN FOR THE LNRCLOK



4.2. PLAYING WITH THE GPS RECEIVER

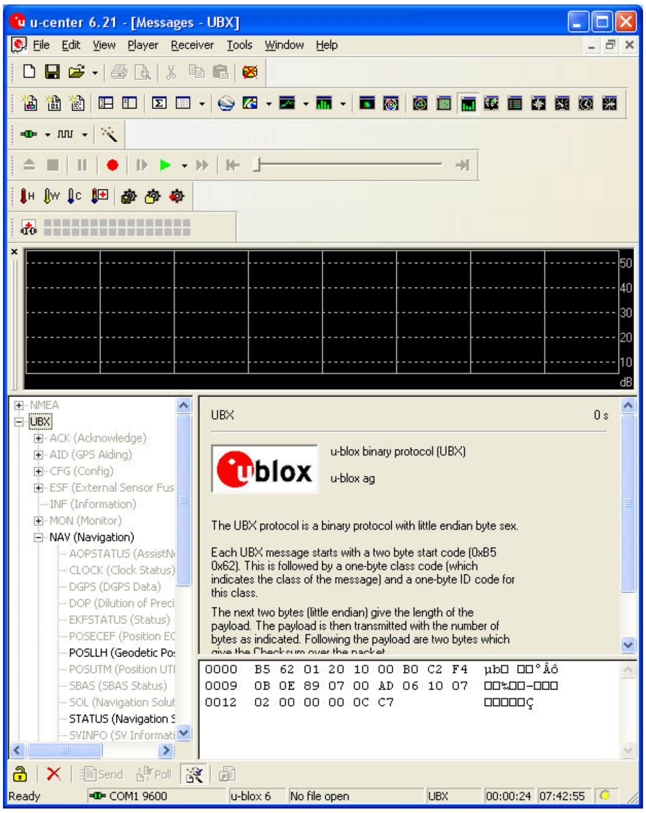
4.2.1. Direct communication with the GPS receiver

The iSync has a reduced set of standard NMEA messages limited to $GPZDA and $GPRMC. It is possible to take profit of the rich messaging system of the LEA-6T by sending them out through the Micro-Controller.



To initiate the link between the internal GPS port and the external serial port, send the debug command "@@@@GPS" from the "Terminal" window of the iSync Manager program. Immediately after the setting of the link, strange characters are displayed in the "Received" box. It is binary from the GPS. To continue, close the "Terminal" window as well the iSync Manager program.

With the u-center program from U-Blox it is now possible to control the GPS receiver LEA-6T.



First, connect the right serial port with the corresponding icon or from the menu Receiver/Port. Then open the Message window with the short key F9 and make it big. The messages needed by the iSync for stationary timing are highlighted. With the help of the U-Blox documentation, it is now possible to cancel messages, make other messages active or fully change the LEA-6T configuration.

Important note:

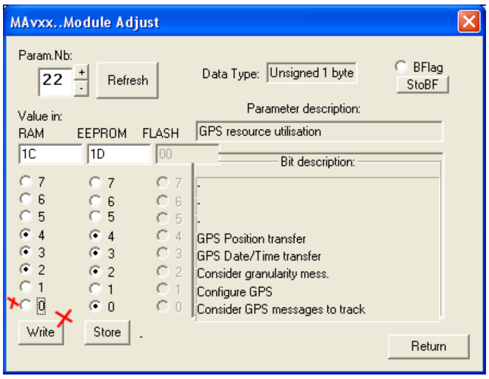
The changes made "on the fly" are not saved in eeprom. By power down / Power ON the iSync, the old configuration comes back. But there is a way to save the current configuration in eeprom. (CFG/CFG). SpectraTime is not responsible of malfunction due to changes in the GPS configuration.

With the standard configuration, the iSync will go in holdover, if it was in tracking, after the setting of the direct link to the GPS. In fact the messages are no more decoded by the iSync in such situation. But it is possible to consider the GPS just as a "PPSREF generator" and to configure the iSync accordingly, see the Chapter 4.2.2 Tracking the internal GPS while in communication with it.

To break the direct link to the GPS, run the iSync Manager, window "Terminal" and send "@@@@".

4.2.2. Tracking the internal GPS while in communication with it.

It is possible to track the PPSREF of the internal GPS while staying in communication with it.:

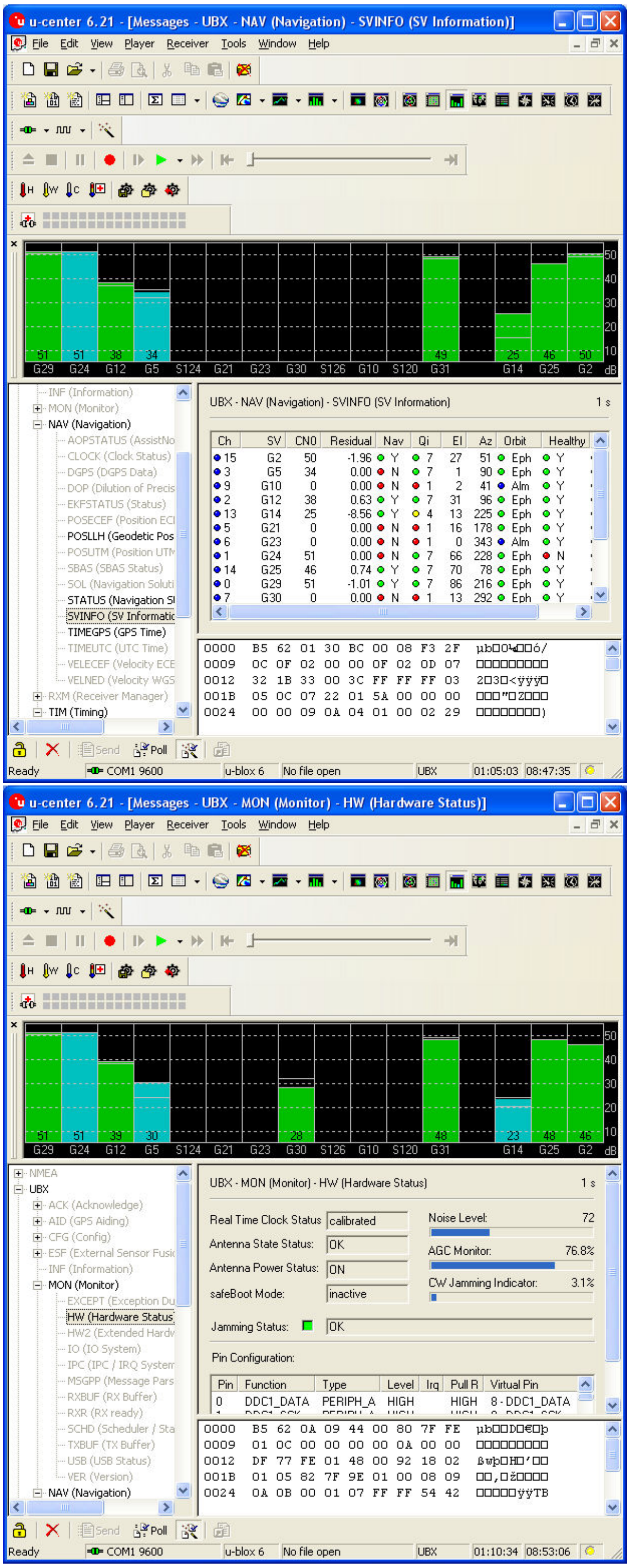


To activate this option at power ON, cancel MAv parameter 0x22, bit 0.

In such situation, it is also recommended to avoid any regular message from iSync by cancelling MAv parameters 0x0B and 0x0C. .

4.2.3. Testing the GPS jamming

If the iSync is placed near RF emitting devices, it can be helpful to see how the embedded GPS receiver is jammed. The LEA-6T has useful tools to make some tests. First initiate a direct link to the GPS, see the Chapter "Direct communication with the GPS receiver" and run the u-center program.



- From UBX / NAV / SVINFO, activate the SV level indication. Right click / Enable message.
- From UBX / MON / HW, activate the jamming indication. Right click / Enable message

There are 3 criteria to evaluate jamming:

1) Regarding the level, it must be said that our GPS antenna is not well located. Therefore we estimate that 1 SV with a signal level over 50 dB•Hz and 3 SV over 48 dB•Hz are good.
2) The "Jamming Status" is the most important criteria. It must be "Green, OK".
3) The "CW Jamming Indicator" is always under 4% in a not jamming situation. Values up to 10% are acceptable as long the "Jamming Status" is staying "Green, OK".

5. Safran Technical Support

For technical support, you can visit https://safran-navigation-timing.com/support-hub/ to submit a support request.

For product specifications and additional documentation, visit our product page at https://safran-navigation-timing.com/product/lnrclok-1500-rubidium-clock/

Safran Electronics & Defense safran-navigation-timing.com