iSync+® Smart SRO SynClock+® Manual

Revision: November 22nd, 2007

Low Cost & Profile GPS/Reference Synchronized Rubidium Oscillator (SRO-100)

Patented SRO-100 SynClock+®

Auto-Adaptive SmarTiming+™ Technology Inside

Telecom | Navigation | Broadcast | Defense | Instrument

Applications

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Revision list :

Software Revision :			Hardware Revision :
Date	**Version**	**Comment**	
11 Jun 2002	1.01	Internal Correction	
09 Jul 2002	1.02	Now commands PW and TC store data in EEPROM	
23 Jul 2002	1.03	Internal Correction	
19 sep 2002	1.04	New command "MCsdd" for interfacing with GPS receiver	
27 Sep 2002	1.05	Internal Correction	
07 Feb 2003	1.06	New command DT, Date. New command COsddd, time comparator offset	
11 Mar 2003			New low power version <17W
19 Aug 2003	1.07	Improved behavior at the start of tracking. Frequency save (FSx) improved. Command MCsdd extended. New commands VS, view PPSRef stability, VT, view time constant. Internal corrections	
23 Sep 2003	1.08	New command RAsddd. Internal corrections.	
25 Feb 2004	1.09	Back to simple start of tracking. GPS messages for Jupiter-Pico, SuperStar II. NMEA messages.	
05 Sep 2007	1.095	Other initial settings	

1 INTRODUCTION

The Models SRO-XXX Rubidium Ultra-Stable Oscillators are sub-miniature, atomic resonance-controlled oscillators with extended PPS (Pulse Per second) facilities. The standard version provides following signals:

- Extremely stable 10 MHz sinus. (5 and 15 MHz in option).
- 60 MHz VCXO frequency.
- PPS Out.

This device can track a PPS Ref signal provided by a stable reference like a GPS receiver. The SRO is 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 SRO.

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 lists all specifications and operation requirements of the SRO.

Chapter 4 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 SRO SYSTEM DESCRIPTION

2.1 PRINCIPLE OF OPERATION AND BASIC CONFIGURATION

The SRO 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). Fig. 2-1 visualises the atomic energy levels and transitions involved in the optical pumping process.

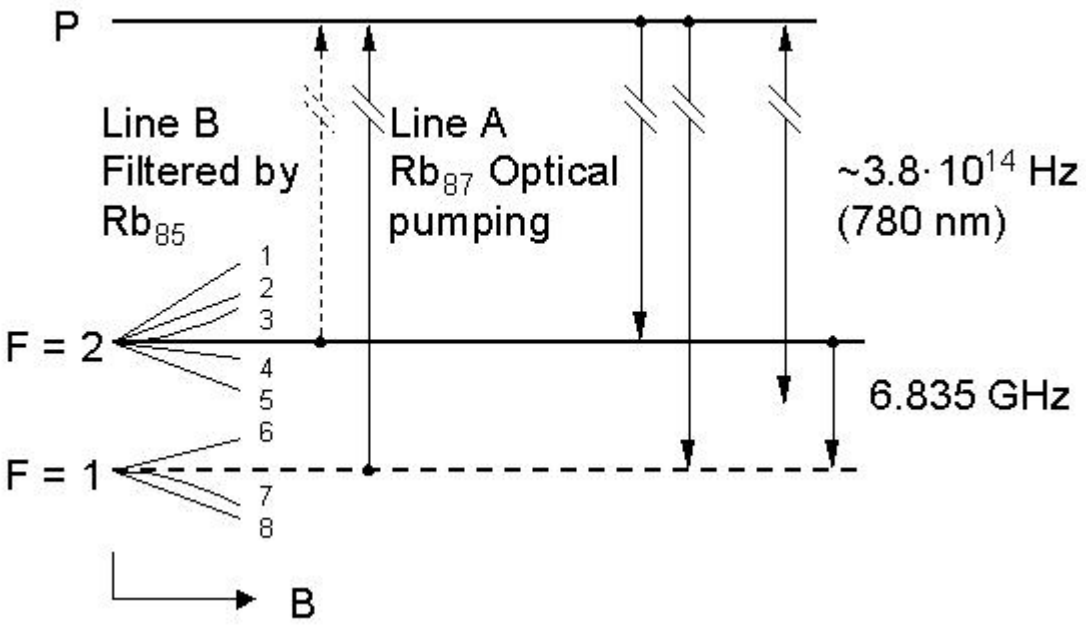

Fig. 2-1: Energy levels and transitions in Rb87 atoms during SRO operation.

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.

2.1.1

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® 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.

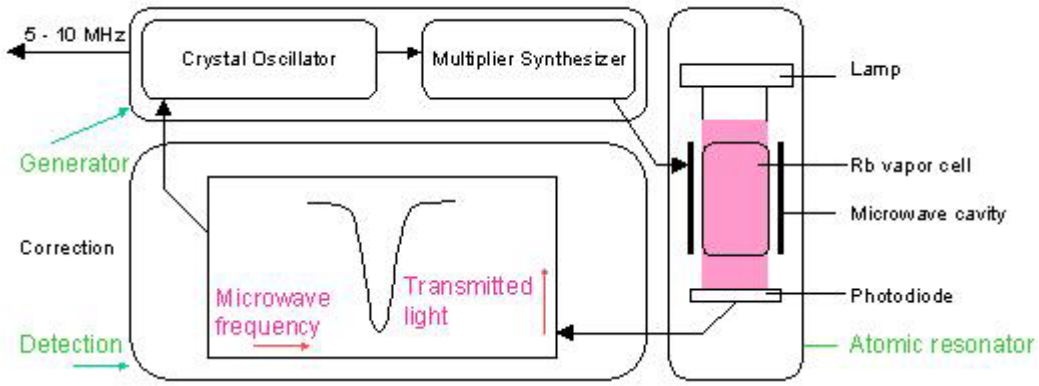

Fig. 2-2 : Rubidium atomic clock principal block diagram.

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.

Fig. 2-2 gives a basic overview of the different function blocks of the Rubidium atomic clock. The SRO 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 Fig. 2-3, 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 2-3 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 oscillate 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.

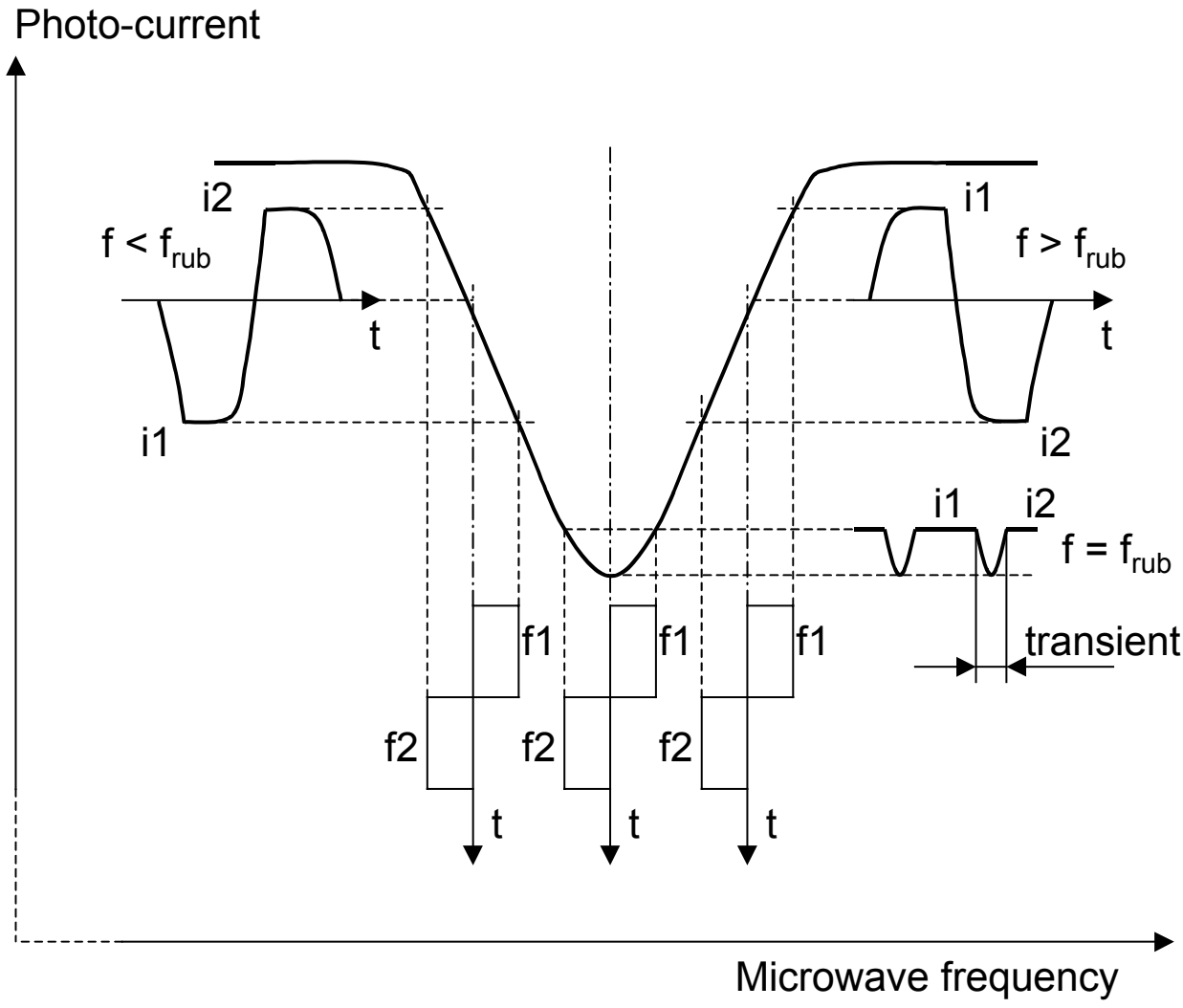

Fig. 2-3 : Dip minimum detection.

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 SRO output frequency (10 MHz) with a resolution of $5.12 \cdot 10^{-12}$ 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.

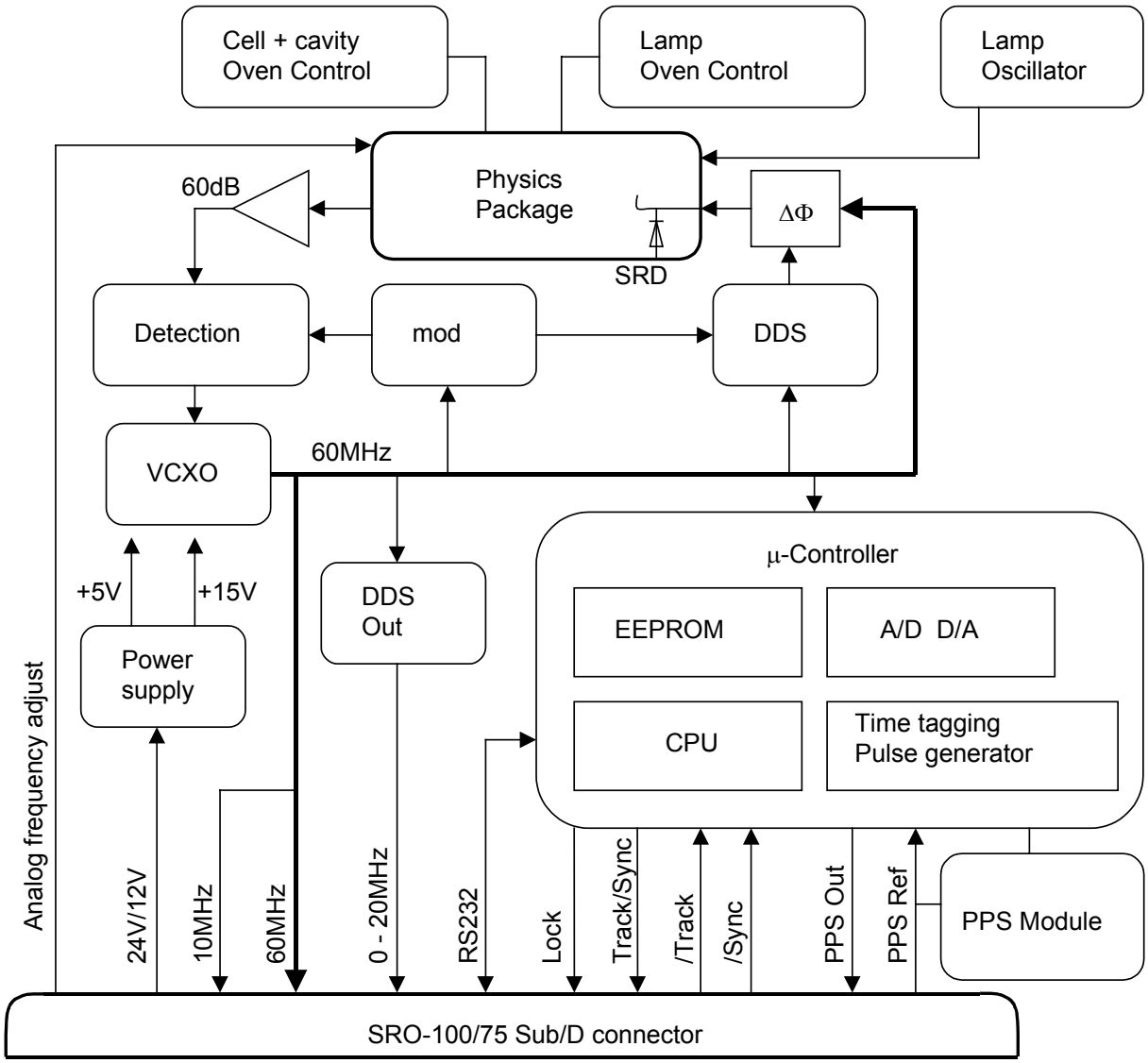

Fig. 2-4 : SRO block diagram.

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 effect.

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 SRO 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 SRO is successfully tracking an external PPSREF, a TTL signal goes high.(“Track/Sync”).

The power section of the SRO 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 SRO is given in Fig. 2-4.

2.4 THE TIMING AND TRACKING SYSTEM

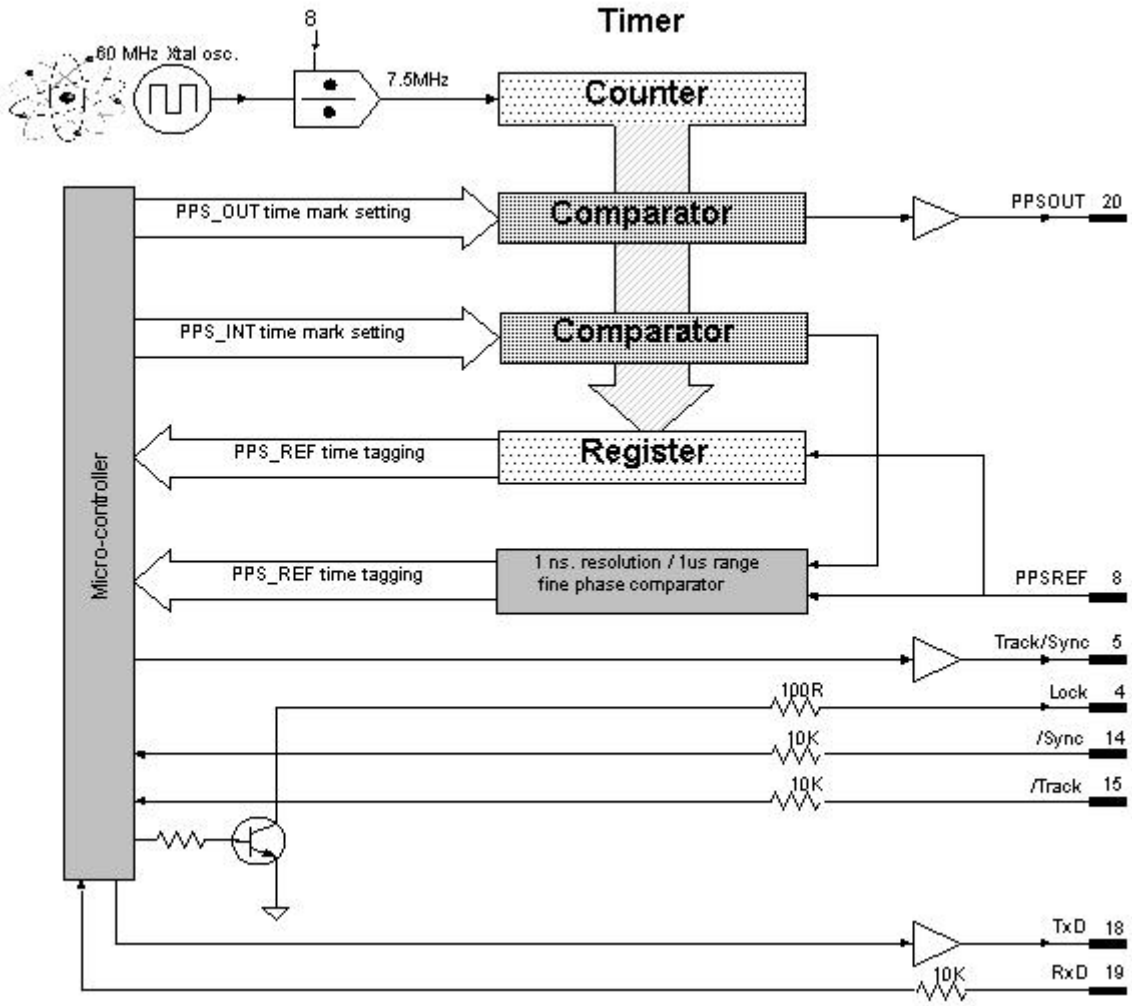

Fig. 2-5: Timing system.

The SRO 100/75 models includes extended PPS (Pulse Per Second) facility. The hardware of this facility consists of two modules. The first module is a timer clocked at 7.5 MHz. This timer tag the PPSREF connected to the SRO and generates two other PPS. The first one is called PPSINT and is used internally. The second one is called PPSOUT and appear on pin 20 of the connector.

The second module is a 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 SRO without adjustments by hard or software.

A tracking can be initiated by grounding pins and if the tracking is successful, the pin “Track/Sync” will be set in high TTL level.
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.

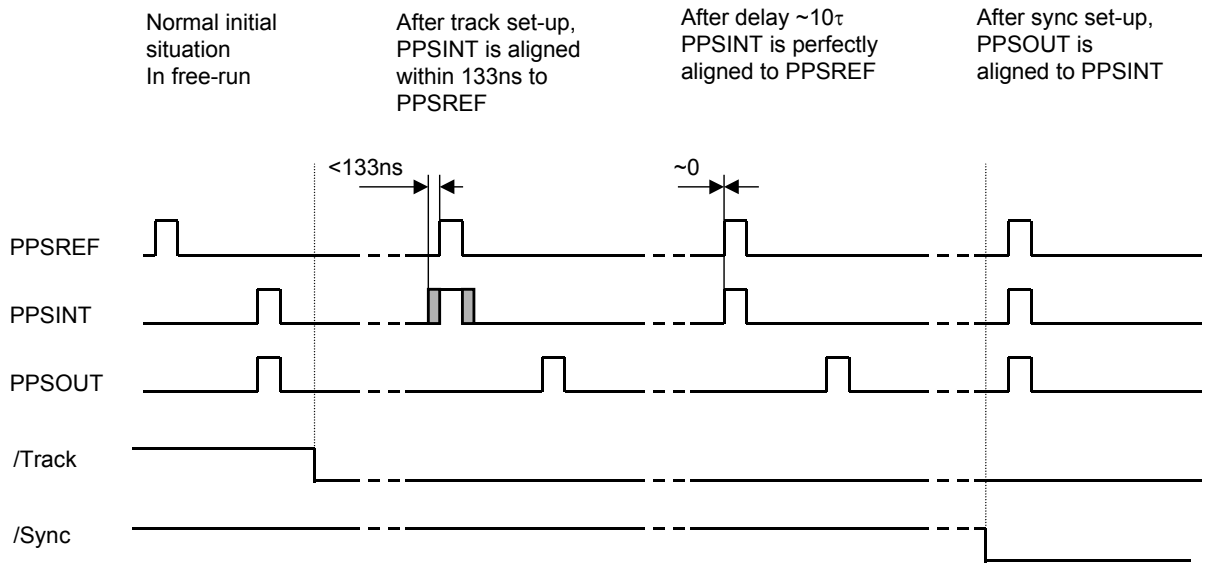

Fig. 2-6 : “Track” mode and “Sync” mode.

When “track” mode is set-up, the PPSINT is aligned to the PPSREF within 133 ns. Then the phase comparator starts the mid-term frequency stability analysis of the PPSREF. The tracking loop time constant is adjusted in consequence and the SRO start to track the PPSREF.
During all of this operations, the position of the PPSOUT is not changed. The PPSREF timer is working on an independent way. So the PPSOUT will not suddenly jump when the SRO starts to track a PPSREF.

When “sync” mode is set-up, the PPSOUT is aligned to PPSINT. “Sync” mode can only be set-up when the SRO is already tracking successfully a PPSREF.
If “sync” mode is set-up just after the SRO start to track a PPSREF, the phase-time difference between PPSOUT and PPSREF can be as big as 133 ns. Of course, the tracking loop will reduce this difference and will bring it nearly to null in case the noise of the PPSREF is low.

2.4.2 THE FREQUENCY LEARNING

When the SRO is tracking the PPSREF of a master oscillator, in reality, it align it's 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 SRO 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 ever be read by the user.
The command to read this register is: FC+99999<CR>.
On a SRO connected through the serial interface to a terminal, it is possible to follow the evolution of the tracking by this way.

The frequency, or frequency correction in use in different situations is as following:

- After a Reset or Power-On, the frequ. corr. is copied from the EEPROM to the RAM and then is used.
- After the start of a tracking, the internal frequ. corr. is the one of the EEPROM.
- During a tracking, the frequ. corr. in use changes continuously to align as good as possible the PPSINT to the PPSREF. By default, the average value is saved in EEPROM every 24 hours.
- If the SRO is stopped in its tracking, and put in FREE RUN mode by the user, with the command TR0 for example, the frequ. corr. in EEPROM is retrieved and loaded in RAM to be used.
- If the tracking is stopped because the PPSREF signal disappears suddenly or is strongly degraded, the integral part value of the regulation loop becomes active. This is to avoid a frequency jump in case the PPSREF signal comes back again. This mode of operation is called hold-over.

2.4.4 USER FREQUENCY CORRECTION

This correction is only possible in Free Run mode and is made with the command FCsxxxxx.
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 SRO 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 TCxxxxxx.

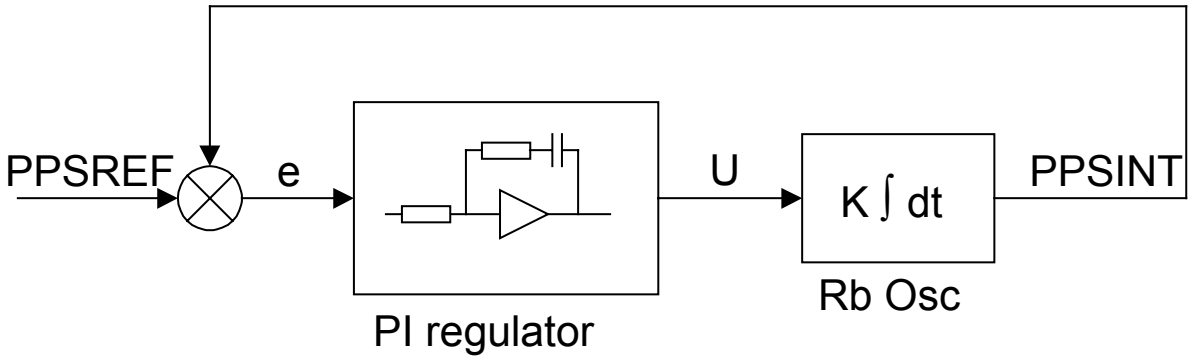

Figure 2-7 Schematic of the PPSREF regulation loop.

By default, the optimum loop time constant is computed by the SRO from information's like PPSREF noise and temperature fluctuations. In this case, if the fine phase comparator cannot give valid information's, the time constant is forced to 1000s.
But the loop time constant can also be forced by the user to a fixed value. In this case, the time constant, is ever the one asked by the user. The command to do that is TCxxxxxx<CR>.

2.4.6 TRACKING LIMITS AND ALARMS

If the frequency between the SRO and the master to track is too large, after some time, the phase time error between PPSINT and PPSREF can become too big for some applications.
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 Awxxx.
By default its value is 015 counter steps or ~± 2μs.
The value of the half tracking window can be changed by the user with the command Twxxx.
By default its value is 015 counter steps or ~± 2μs.
For more details, see the Chapter "TIMING AND TRACKING COMMANDS".

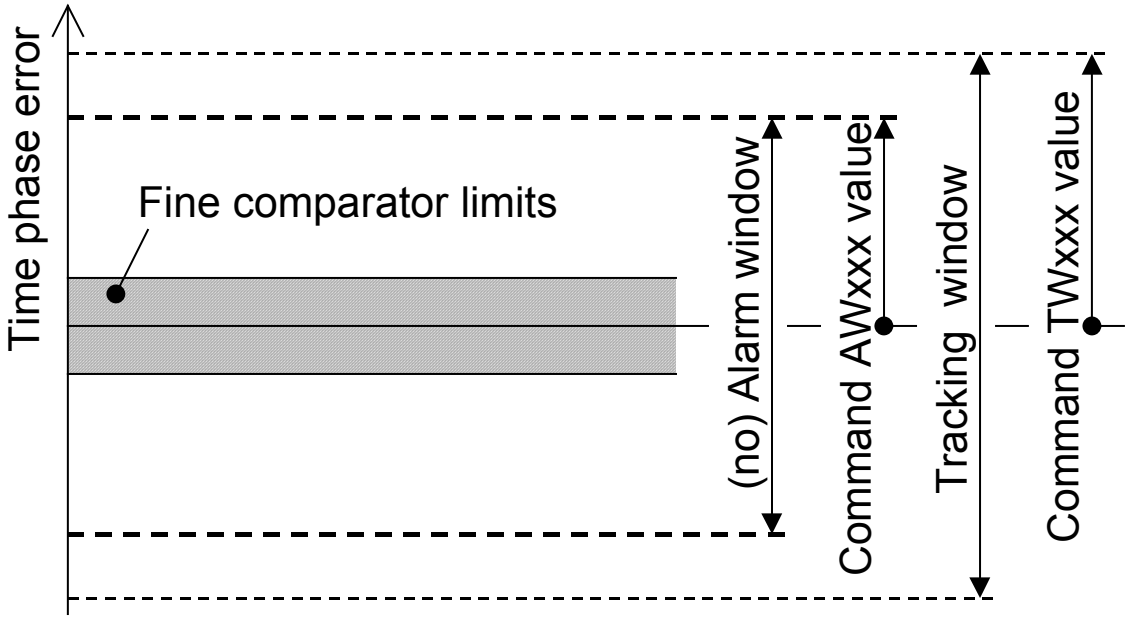

Figure 2-8 Tracking limits.

2.4.7 FREQUENCY FLUCTUATIONS DURING THE TRACKING

To track a PPSREF, the SRO have to change it's frequency. The authorized frequency variations are limited by factory to $\pm 1 \cdot 10^{-8}$. That mean the variations of the register DDSUSER are limited to ±19531 during a tracking. Or in hexa to ±$4C4B. But this value can be changed by factory setting to any other value.
Any limitation can also be left of by factory setting. In this case, the limitations are simply the limits of the signed integer DDSUSER, in other words +32767/-32768, or to $\pm 1.6 \cdot 10^{-8}$ in relative frequency.
If during the tracking of a PPSREF the SRO reach the frequency limit, the frequency will be limited to this frequency and no error will be raised up as long the phase time error is staying in the (no) alarm window.
If the SRO is connected to a terminal through the serial port, the user can read out the actual frequency limitation in use by typing R14<CR> , R15<CR>. The returned values are the MSB and the LSB of a signed integer coded on 2 bytes representing the authorized frequency variations in $5.12 \cdot 10^{-13}$ steps.
The user can also check out if the DDSUSER is actually limited by typing R4F<CR>. If there is a problem, the bit 1 and bit 2 of this register will not be set to 0.

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>

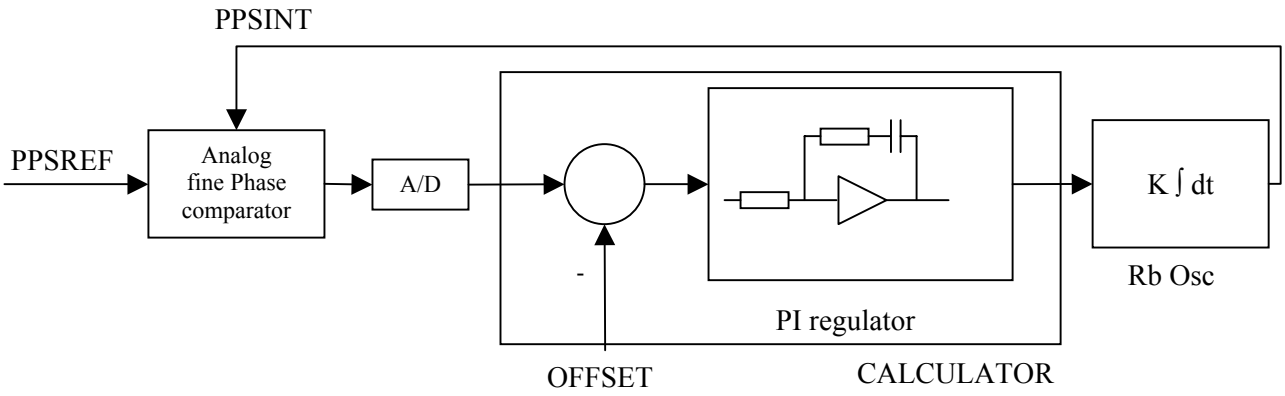

Figure 2-9 schematic of the analog fine phase comparator regulation loop

2.4.9 STARTING THE TRACKING, PRECAUTIONS

The SRO don't have the ability to re-start a tracking by it self in case the PPSREF is moved to another stable position. This behavior can induce some starting problems in case the SRO is disciplined by a GPS receiver.
In such case the PPSREF from the GPS may be derived from a free running xtal as long the first fix is not done.
If a tracking is started in such situation, the SRO will be disciplined on the free running xtal of the GPS receiver.
When the "true" PPSREF from the GPS will be arrived, the SRO will stack for ever with the general status 5.
The only way to come out of this situation is to re-start a tracking by letting the pin 15 open (internal pull-up) or High Level for at least 2 seconds, and then to put it again to GND. It is also possible to make it with the command TR0, waiting for 2 seconds, and then sending out the command TR1 again.
The best solution to avoid this problem is to configure the GPS receiver so it don't send out a PPSREF as long the first fix is not done and if the quality of the PPSREF is not good enough. See the TRAIM function of your GPS receiver.
Remark: The software Version 1.07 and 1.08, had the ability to re-start a tracking in some conditions. Facing a lot of problems by the definition of this conditions, we preferred to give up and came back to the simple solution like in Version 1.06 and before. If you liked Version 1.07 and 1.08 and are facing problems now, please contact our support department.

3 SRO SPECIFICATIONS

Latest version of the SRO-100 specification can be downloaded from http://ww.spectratime.com - pdf files / SRO-100

4 SRO INSTALLATION AND OPERATION

4.1 INTRODUCTION

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

4.2 SHIPPING AND RECEIVING INFORMATION

The SRO 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

SPECTRATIME SA
PHONE: +41 32 732 16 66
FAX: +41 32 732 16 67
CH-2000 NEUCHATEL / SWITZERLAND

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 SRO to ensure that the maximum acceleration due to a choc 50g/ 18ms is not exceeded.

SRO contains glass bulbs, crystal resonators and crystal filters.

When SRO 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.

4.3 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).

This maximum temperature can be reached when operating the unit into forced air flow at 60°C or by mounting the unit into user equipment with thermal interface corresponding to a thermal resistance of less than 1°C/W between the SRO unit and the ambient.

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

The SRO 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.

4.3.1 SRO-100 PACKAGE.

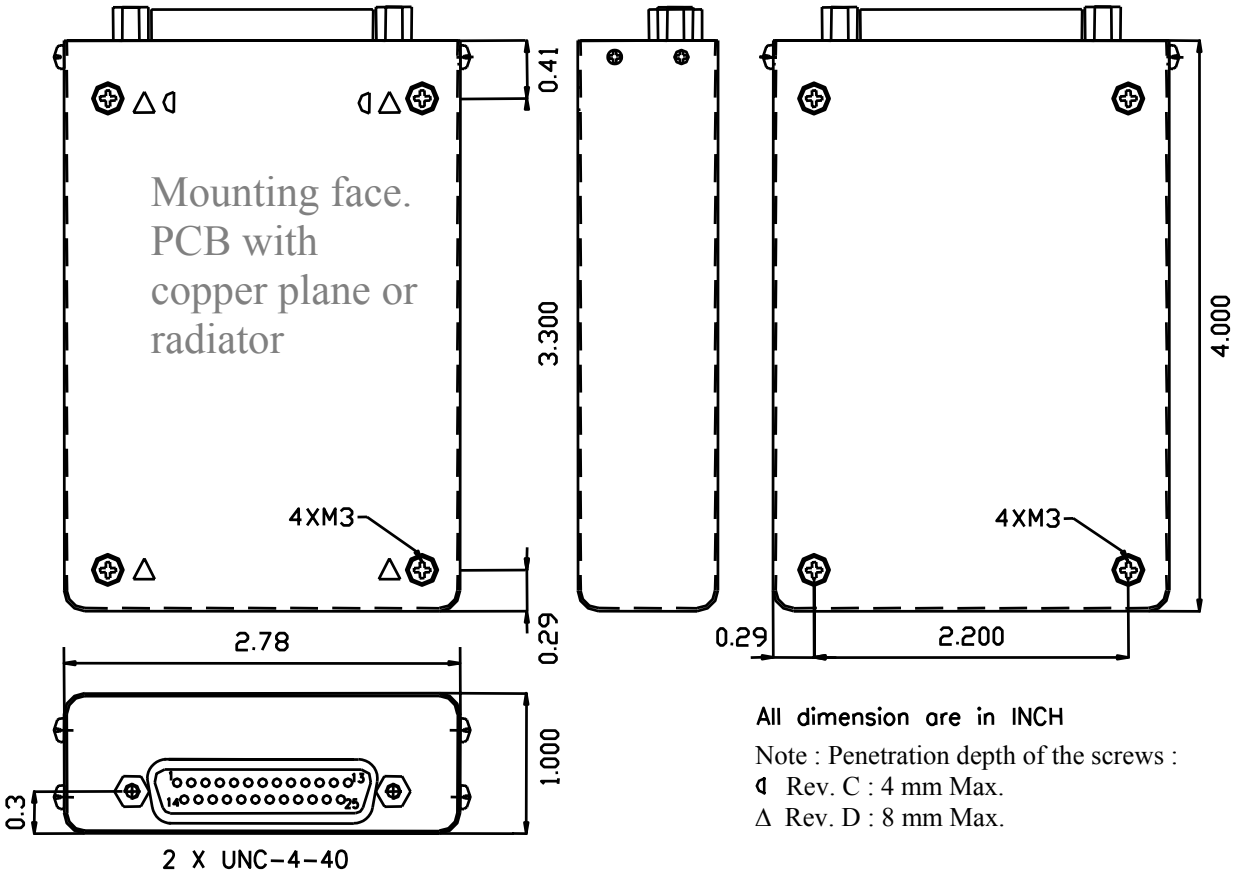

Fig. 4-1 : Mechanical layout of the SRO-100. All dimensions are in inches, except screws, not to scale.

4.4 PIN FUNCTION LAYOUT for SRO-100

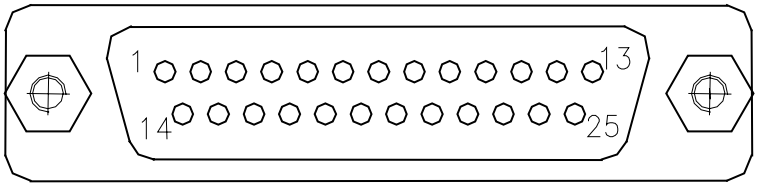

Fig. 4-3 : Pin-out of both SRO-100.

The complete pin layout is given in following figure:

Pin nbr.	SRO-100	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	**DDSOUT** (DDS square wave output) **(OPTIONAL)**	Output
12	**GND**	Ret
13	**60M** (60 MHz square 3.3V output)	Output
14	**/Sync**(synchronize PPSOUT to PPSREF)	Input
15	**/Track** (PPSREF phase tracking)	Input
16	**NC (Factory use or diagnostics)**	In-Out
17	**/Reset** (SRO micro controller)	Input
18	**TxD** (RS232 Transmit 0-5V)	Output
19	**RxD** (RS232 Receive 0-5V)	Input
20	**PPSOUT** (output time pulse from internal clock)	Output
21	**GND**	Ret
22	**GND**	Ret
23	**GND**	Ret
24	**RFOUT**(**5** or **10** or **15**MHz sinus 7dBm into 50Ω)	Output
25	**GND**	Ret

4.5 NORMAL OPERATION

When 24 Vdc (or 12V) is applied to pins 1/2 (+) and 3/10/12/21/22/23/25 (-), 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.

4.5.1 THE “LOCK” MONITORING

The unit is able to provide 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 4.9).

4.5.2 ANALOG FREQUENCY PULLING

The SRO 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. SRO 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).

4.5.3 PPS FACILITIES

Immediately after power-on, a PPSOUT signal is provided.
Once the SRO is “lock”, a tracking to a PPSREF can be initiated by grounding the pin 15 (“/Track”).
When the SRO is successfully tracking this PPSREF, the pin 5 goes to the high TTL state.
The PPSOUT can be aligned to the PPSREF by grounding the pin 14 (“/Sync”).

If the pin 15 (/Track) is continuously grounded, the SRO initiates immediately to track a PPSREF after “lock”:
If the pin 14 (/Sync) is continuously grounded, the SRO will immediately align PPSOUT to PPSREF after it starts to track this PPSREF.

4.5.4 OTHER PROVIDED SIGNALS

- XTAL frequency on pin 13.

4.5.5 OPTIONAL SIGNALS

- DDSOUT frequency on pin 11. This frequency can only be changed via the serial interface.

4.6 SIMPLE SERIAL INTERFACE OPERATION

4.6.1 INTRODUCTION

The SRO 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.

4.6.2 SERIAL INTERFACE CONNECTION

The data transfer from the SRO 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

IMPORTANT NOTE:

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.

4.6.3 SRO INTERNAL PARAMETERS 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 SRO 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 actual voltage applied to pin 6 of the SRO 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 SRO 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:

4.6.4 CENTRE FREQUENCY ADJUSTMENT WITH THE SERIAL INTERFACE

A single character command is available to the user for center 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.

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

- In track state, the user frequency correction is changed internally by the software for optimum alignment.
- The basic command FCsdddddd do the same. See chapter 4.7.

Examples:
C0000<CR> : return to the nominal value (factory setting)
C7FFF<CR> : the actual frequency is increased of 16.7 ppb. 10'000'000.000 Hz become 10'000'000.167 Hz.
C8000<CR> : the actual frequency is decreased of 16.7 ppm. 10'000'000.000 Hz become 9'999'999.833 Hz.

4.6.5 CENTER FREQUENCY READ-BACK

R05<CR>[LF] : read-back high byte of user frequency correction actually in use.
R06<CR>[LF] : read-back low byte of user frequency correction actually in use.
L05<CR>[LF] : read-back high byte of user frequ. corr. in use after RESET or power-ON.
L06<CR>[LF] : read-back low byte of user frequ. corr. in use after RESET or power-ON.

- In track state, the value of all of these registers is subject to change by the software for optimum alignment.

4.6.6 DDS OUT FREQUENCY SETTING **(OPTIONAL)**

There is a command to set the DDSOUT frequency :

Txxxxxxxx<CR>[<LF>] : DDS OUT frequency setting. Where xxxxxxxx is an unsigned 32 bits in hexa coded ASCII stored in EEPROM.

$$Frequency = \frac{xxxxxxxx}{2^{32}} \cdot 60MHz$$

The DDS OUT frequency is changed after RESET or power-ON.

4.7 PPS SERIAL INTERFACE

The SRO use the same serial interface to set and control the PPS and timing facilities.
For this purpose, a more complex supervision of the device is introduced.

4.7.1 GENERAL STATUS OF THE SRO

The SRO can send through the serial port once per second or “à la demande” its general internal status. The meaning of this status is:

General status:

0 Warming up. This happens when the SRO is just powered on and the temperature of the cells is not high enough.
1 Tracking set-up: The SRO is in this state when it goes from free-run status to the track status after a track set-up. The duration of this state should not exceed 3 minutes.
2 Track to PPSREF. PPSINT is aligned to PPSREF.
3 Sync to PPSREF. PPSINT and PPSOUT are aligned to PPSREF.
4 Free Run. Track off.
5 Free Run. PPSREF unstable. The stability of the PPSREF is too low to be tracked.
6 Free Run. No PPSREF was detected.
7 Factory used.
8 Factory used.
9 Fault or Rb Out Off Lock. This happens when the VCXO is scanning to find the Rb line.

4.7.2 TIMING AND TRACKING COMMANDS FORMAT

The commands are not case sensitive. But they should have the exact length. The termination character is <CR>. An additional <LF> is tolerated and have no effect. Blank characters are not tolerated. Chained commands are tolerated if the total length is not exceeding ~30 characters.

TIMING AND TRACKING COMMANDS

ID<CR>[<LF>] : Identification

Answer: **TNTSRO-aaa/rr/s.ss<CR><LF>**
aaa: 100 if SRO-100
rr: revision number
s.ss: software version

Example: ***ID<CR>***, answer: ***TNTSRO-100/01/1.00<CR><LF>***

SN<CR>[<LF>] : Serial number

Answer: **xxxxxx<CR><LF>**
xxxxxx: 6 digits serial number

Example: ***SN<CR>***, answer: ***000098<CR><LF>***

ST<CR>[<LF>] : General Status

Answer: **s<CR><LF>**
s: status
0: warming up
1: tracking set-up
2: track to PPSREF
3: sync to PPSREF
4: Free Run. Track OFF
5: Free Run .PSREF unstable
6: Free Run. No PPSREF
7: factory used
8: factory used
9: Fault or Rubidium out off lock

Example: ***ST<CR>***, answer: ***4<CR><LF>*** (Free Run. No tracking)

TRx<CR>[<LF>] : Set tracking mode of PPSINT to PPSREF
x: tracking mode setting
0: Track never, Free Run. (0→EEPROM)
1: Track now.
2: Track ever. (1→EEPROM)
3: Track now + ever (1→EEPROM)
9: Interrogation

Answer: **x<CR><LF>**
x: Tracking enable at power-up
0: Not enabling tracking at power-up
1: Enabling tracking at power-up

Notes:

- The tracking mode setting is kept in EEPROM.
- The SRO can also be set in tracking mode by grounding the pin 15 of the connector.
- Whatever from software or from hardware, the Track mode 1 has the priority. The answer takes this situation into account.
- The SRO needs a few minutes to be in tracking state. During this delay, ST<CR> answers 1.
- The command TRx has no influence on the phase of PPSOUT if the command SY9<CR> answers 0<CR><LF>.
- When track mode is set to 1 by hardware or software, the tracking of PPSINT to PPSEXT starts when General Status goes from 9 to 4.
- This command doesn't give out the actual tracking state. For that, use the command ST<CR>.(answers 2 <CR><LF> when tracking)

Example: ***TR3<CR>***, answer: ***1<CR><LF>***. Will ever be in tracking mode. If not yet in this mode, start to track PPSREF.
TR0<CR>, answer: ***1<CR><LF>***.In tracking mode because pin 15 is grounded.

SYx<CR>[<LF>] : Set synchronization PPSOUT to PPSINT mode.
x: synchronization mode setting
0: synchronize never (0->EEPROM)
1: synchronize now
2: synchronize ever (1->EEPROM)
3: sync. now + Ever (1->EEPROM)
9: interrogation

Answer: **x<CR><LF>**
x: synchronize command status
0: synchronization mode 0.
1: synchronization mode 1.

Notes:
- The synchronization mode setting is kept in EEPROM.
- The SRO can also be set in sync. mode by grounding the pin 14 of the connector.
- Whatever from software or from hardware, the synchronization mode 1 state has priority. The answer takes this situation into account.
- When sync. mode is set to 1 by hardware or software, the synchronization of PPSOUT to PPSINT happens when General Status goes from 1 to 2.
- This command doesn't give out the actual sync. state. Therefore, use the command ST<CR>.(answer 3 <CR><LF> when synchronized.)

Example: ***SY9<CR>***, answer: ***1<CR><LF>***. Sync. done when General Status goes from 1 to 2.

DEddddddd<CR>[<LF>] Set the delay of PPSOUT pulse vs PPSINT.
ddddddd: Delay in 133 ns steps.
0000001: minimum delay.
7499999: maximum delay .(approx. 1 s)
0000000: sync. to PPSINT, the same as SY1.
9999999: interrogation.

Answer: **ddddddd**: Delay in 133 ns steps.
9999999: Delay information not valid.

Reset value: 0000000

Notes:
- When going into tracking state, the information delay become no longer valid and the SRO will respond 9999999<CR><LF>.
- In tracking state, after a command SY1<CR><LF>, PPSOUT is aligned to PPSINT and the answer is 0000000<CR><LF>.
- In tracking state, after a command DEddddddd<CR><LF>, the PPSOUT is delayed vs PPSINT and the answer is correct.

Example: ***DE9999999<CR>***, answer: ***0000000<CR><LF>***

PWddddddd<CR>[<LF>] : Set the PPSOUT pulse width.
ddddddd: Pulse width in 133ns steps.
0000001: minimum pulse.
7499999: maximum pulse.
0000000: no pulse.
9999999: interrogation.

Answer: **ddddddd**: Pulse width in 133 ns steps.
Factory setting : 0001000 (133 us)
Reset value : Last Value stored in EEPROM
Example: ***PW9999999<CR>***, answer: ***0001000<CR><LF>***

TD<CR>[<LF>] : Send out the time of day
Answer: **hh:mm:ss<CR><LF>**
hh: Hours mm: Minutes ss: seconds
Notes:

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

Example: ***TD<CR>***, answer: ***16:30:48<CR><LF>***

TDhh:mm:ss<CR>[<LF>] : Set the time of day
hh:mm:ss<CR><LF>
hh: Hours mm: Minutes ss: seconds
Answer: **hh:mm:ss<CR><LF>**
hh: Hours mm: Minutes ss: seconds
Reset value: 00:00:00

Notes:

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

Example: ***TD13:00:00<CR>***, answer: ***13:00:00<CR><LF>***

DT<CR>[<LF>] : Send out the date
Answer: **yyyy-mm-dd <CR><LF>**
yyyy: Year mm: Month dd: Day
Notes:

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

Example: ***DT<CR>***, answer: ***2003-12-08<CR><LF>***

- The calendar works from 2000-01-01 to 2099-12-31

DTyyyy-mm-dd<CR>[<LF>] : Set the date
yyyy-mm-dd<CR><LF>
yyyy: Year mm: Month dd: Day
Answer: **yyyy-mm-dd<CR><LF>**
yyyy: Year mm: Month dd: Day
Reset value: 2000-01-01

Notes:

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

Example: ***DT2003-12-08<CR>***, answer: ***2003-12-08<CR><LF>***

- The calendar works from 2000-01-01 to 2099-12-31

BTx<CR>[<LF]> : Beat every second on the serial port
x: parameter to beat.
0: Stop beat.
1: Beat effective time interval PPSOUT vs PPSREF.
Answer: **ddddddd<CR><LF>**
ddddddd: delay in 133 ns steps.

2: Beat phase comparator value.
Answer: **sppp<CR><LF>**
s: +/- sign ppp: phase error, approx. in ns

3: Beat effective time interval PPSOUT vs PPSREF + phase comparator value.
Answer: **ddddddd sppp<CR><LF>**
ddddddd: delay in 133 ns steps.
s: +/- sign ppp: phase error, approx. in ns

4: Beat time of day.
Answer: **hh:mm:ss<CR><LF>**
hh: Hours mm: Minutes ss: Seconds

5: Beat general status.
Answer: **x<CR><LF>**
x: general status. (See command STx)

6: Beat **<CR><LF>.**

7: Beat Date, Time, Status
Answer: **yyyy-mm-dd hh:mm:ss x <CR><LF>**
yyyy : Year mm: Month dd: Day

A: Beat Date, Time, Counter data in NMEA 0183 proprietary format
Answer: **$PTNTA,**yyyymmddhhnnss,q,**T3**,rrrrrrr,sfff,x,y*cs**<CR><LF>**
(See NMEA PROPRIATARY FORMAT Chapiter)

B: Beat Frequencies, Tra. loop parameters in NMEA 0183 proprietary format
Answer: **$PTNTS,B,**s,ffff,iiii,aaaa,x,y,s,cccccc,ggg.gg,x,y*cs**<CR><LF>**
(See NMEA PROPRIATARY FORMAT Chapiter)

Notes:

- The answer is delayed a few ms after the PPSINT pulse. This delay can vary a little.
- When beating time interval PPSOUT vs PPSREF, the answer is 9999999<CR><LF> if no pulse is found.
- This can happen when the SRO is going to tracking state, General Status = 1.
- 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.

Example: ***BT5<CR>***, answer ***9<CR><LF> 9<CR><LF>*** ... ***4<CR><LF> 4<CR><LF>***. This means the quartz oscillator is just locked to the Rubidium line.

FCsddddd<CR>[<LF>] : Set user frequency correction

sddddd: frequency correction in $5.12 \cdot 10^{-13}$ step.
+00000: no correction.
+32767: highest pull-up, +16.7 ppb.
-32768: lowest pull-down, -16.7 ppb.
+99999: interrogation.

Answer: **sddddd<CR><LF>**
sddddd: frequency correction actually in use.

Factory setting: +00000

Reset value: Last value stored in EEPROM.
In free-run state, the last value stored with the commands FCsddddd or Cxxxx.
In track state, the last value stored automatically or with the command FSx.

Notes:
- In track state the user frequency correction is changed internally by the software for optimum alignment.
- This command should never be used in track state. (Exept FC+99999).

FSx<CR>[<LF>] : Set frequency save mode.

x: mode.
0: no saving. (0→EEPROM)
1: save integral part of tracking correction in EEPROM every 24 hours. (1→EEPROM)
2: save integral part of tracking correction in EEPROM now.
3: save user frequency in EEPROM now.
9: interrogation.

Answer: **x**: frequency save mode as written in EEPROM
0: no saving.
1: save integral part of tracking correction in EEPROM every 24 hours.

Factory setting: 1

Reset value: Last value stored in EEPROM.

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

Example: ***FS9<CR>***, answer ***1<CR><LF>***.

TWddd<CR>[<LF>] : Set tracking window. Set the window in which time interval PPSINT vs PPSREF should stay. Stored in EEPROM.

ddd: half tracking window, from 1 to 255 steps of 133 ns.
999: interrogation

Answer: **ddd**: half tracking window in 133 ns steps.
Factory setting: 015 (~± 2μs)
Reset value: Last value stored in EEPROM.
Notes:

- If the time interval PPSINT vs PPSREF becomes bigger than the tracking window, the tracking stop.

Example: ***TW020<CR>***, answer ***020<CR><LF>***.

AWddd<CR>[<LF>] : Set alarm window.

An alarm is raised up if time interval PPSINT vs PPSREF become bigger than this value. Stored in EEPROM.
ddd: half alarm window, from 1 to 255 steps of 133 ns.
999: interrogation

Answer: **ddd**: half alarm window in 133 ns steps.
Factory setting: 015 (~± 2μs)
Reset value: Last value stored in EEPROM.
Notes:

- This command is limited to track state.
- A tracking alarm puts the pin 5 of the output connector to high. The General Status becomes 5. (PPSREF unstable).
- The alarm window cannot be bigger than the tracking window. This window may be reduced by the command TWddd.

Example: ***AW999<CR>***, answer ***015<CR><LF>***.

TCdddddd<CR>[<LF>] Set tracking loop time constant.

dddddd: time constant in seconds.
000000: change to auto selection mode.
001000: minimum value, 1000 s.
999999: maximum value, 999999 s.
000099: interrogation.

Answer: **dddddd**: last time constant selected, in seconds.
Factory setting: 000000
Reset value: 000000
Notes:

- In auto selection mode, the time constant is automatically adapted to the PPSREF noise.
- In auto selection mode, if the time interval PPSREF vs PPSINT goes out of the phase comparator range, approx. +/-500 ns, the time constant is set to 1000 s.

Example: ***TC000099<CR>***, answer ***000000<CR><LF>***

MCsxx[cc..c]<CR>[<LF>] Set module customization

s : action to do
L : Load parameter
S : Set parameter, only data Type is RAM or eeprom
B : Load the behavior at the start of the clock
A : Activate a message at the start of the clock
C : Cancel a message at the start of the clock
H : Load Help message
T : Load data Type
xx : message number, from 00 to FF
cc…c : parameter, up to 24 ACSII character if it is the user message

Answer:
cc…c : message, answer to MCLxx or to MCHxx
or
0/1 : Behavior of a message at the start of the clock, answer to MCBxx
or
xy : data Type, answer to MCTxx
x=0 in RAM, x=1 in eeprom, x=2 in Flash
y=0 byte, y=1 sbyte, y=2 word, y=3 sword, y=4 dword, y=5 sdword,
y=6 lword, y=7 slword, y=8 string ASCII, y=9 string binary

Pos.	Active.(Def)	Parameter(Default)	Comment
00	1	TNTSRO-100/00/1.07	Factory welcome message
01	0	**Free for user message**	User welcome message
02	--	**05**	GPS configuration delay
03	--	**03**	GPS configuration interval
07	--	**01**	Error message send
10	0	@@En..	Time RAIM setup (OnCore, Jupiter –T)
11	0	@@At..	Position hold, site survey (OnCore, Jupiter –T)
20	0	@@Gd..	Position control message (M12+)
21	0	@@Gc..	PPS control message (M12+)
22	0	@@Ge..	Time RAIM algorithm (M12+)
23	0	@@Gc..	Time RAIM alarm message (M12+)
30	0	Binary	Quiet (Jupiter-Pico)
40	0	Binary #63	InitLink, quiet (SuperStar II)
41	0	Binary #81	Set mask angle (SuperStar II)
42	0	Binary #69	Set timing parameter (SuperStar II)
43	0	Binary #80	Set operating mode (SuperStar II)

- Pameters in **bold** can be modified by the user
- Pos. $01 Message can be modified by the user and is stored in EEPROM.
- Pos. $02 and $03 Parameters are the delay, resp. the interval of time in second at witch the GPS configuration messages are sent out at Start up.
- Pos. $10-$11 are GPS messages to configure an Oncore or Jupiter-T receiver for timing application.
- Pos. $20-$23 are GPS messages to configure an M12+ receiver for timing application.
- Pos. $30 is a GPS message to make a Jupiter-Pico quiet.
- Pos. $40-$43 are GPS messages to configure a SuperStar II receiver for timing application.
- This command was renewed and extend since Version 1.07.
- This command is best used with the free program iSyncMgr.exe, since Version 1.07.

Example : MCS01An user message ***<CR>, MCA01 <CR>*** send the following message after start : An user message ***<CR><LF>***

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
+999: interrogation.

Answer: **sddd<CR><LF>**
sddd: phase offset actually in use.
Factory setting: +000
Reset value: Last value stored in EEPROM.

Notes:
- This command stores the value in EEPROM

VS<CR>[<LF>] : view the Sigma of PPSRef. In tracking Status 2 or 3.

Answer: **ddd.d<CR><LF>**
ddd.d: Sigma in ns

VT<CR>[<LF>] : view the time constant of the tracking loop.

Answer: **dddddd<CR><LF>**
dddddd: Time constant in s

RAsddd<CR>[<LF>] : raw phase adjust
sddd: raw phase adjust in 133 ns steps
+127: highest adjust
-128: lowest adjust
+999: interrogation, ever +000
Answer: **sddd<CR><LF>**
sddd: raw phase adjust asked in 133 ns steps

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

Example : ***DE9999999 <CR>***, answer ***00000000<CR><LF>*** . Now we do ***RA+003***, answer ***+003 <CR><LF>***. And then we do ***DE9999999<CR>***, the answer is ***7499997<CR><LF>***

RAQUIK<CR>[<LF>] : this command quickly align PPSINT to PPSREF

Answer: **+000<CR><LF>**

Warning:
- This command can strongly degrade the initialisation and current value of some parameters
- This command can be useful when the device is used as timing machine and there is no time so that "TR1" takes effect
- This command is given to liking well but without guarantee none regarding the integrity and good continuation of the program. It is to the user to make sure that the parameters are initialised correctly after the use of this command

RESET<CR>[<LF>] : this command reset the SRO micro controller

Answer: (Standard identification and welcome messages, may be followed by GPS configuration binary)

4.8 NMEA PROPRIATARY FORMAT

Since software Version 1.09, the SynClock+® is able to give out once per second NMEA 0183 proprietary format messages. This behavior is activated by the command BTx.

DATE, TIME, COUNTER:

$PTNTA,yyyymmddhhnnss,q,**T3**,rrrrrrr,sfff,x,y*cs**<CR><LF>**

Activated by BTA<CR><LF>

yyyymmddhhnnss: year, month, day, hour, minute, second
q: timing quality indicator, 0: Rb line not locked, 1: Free Run, 2: Disciplined
T3: format of the following 5 data. **T3** means:
rrrrrrr: time interval PPSREF vs PPSOUT, from 0000000 to 7499999 in 133 ns steps
sfff: phase comparator, from –511 to +512, in approx. 1 ns steps
s: general SRO status
x: don't care, for future use
y: don't care, for future use
cs: checksum in hexa, xor of the characters between **$** and *

Example: **$PTNTA,20040130160834,2,T3,0000000,+019,3,,*16**

FREQUENCIES, TRACKING LOOP PARAMETERS

Activated by BTB<CR><LF>

$PTNTS,B,s,ffff,iiii,aaaa,x,y,s,cccccc,ggg.gg,x,y*cs**<CR><LF>**

s: general SRO status
ffff: actual frequency offset, signed hexa, steps of $5.12 \cdot 10^{-13}$
iiii: integral part of tracking loop, signed hexa, steps of $5.12 \cdot 10^{-13}$
aaaa: average frequency on 24 hours, signed hexa, steps of $5.12 \cdot 10^{-13}$
x: don't care, for future use
y: don't care, for future use
s: loop time constant mode 0: fixed value, 1: automatic
cccccc: loop time constant in use, from 001000 to 999999 seconds
ggg.gg: sigma (1s) of PPSRef in approx. ns.
x: don't care, for future use
y: don't care, for future use
cs: checksum in hexa, xor of the characters between **$** and *

Example: **$PTNTS,B,3,00B3,00BA,00C1,,,1,001000,000.00,,*12**

4.9 TTL OR CMOS LEVEL "LOCK MONITOR" GENERATION

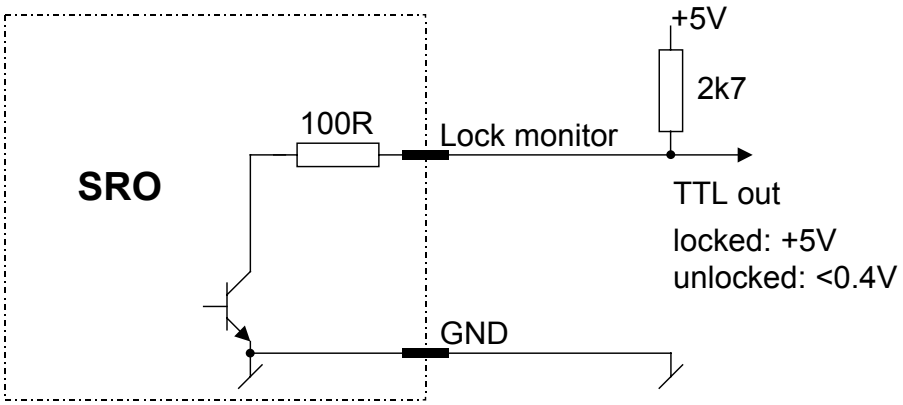

Fig. 4-4 : The lock monitor can be directly connected to the TTL load, or a pull-up resistor can be added for CMOS compatibility.

4.10 DIRECT VISUAL "OUT OF LOCK" SIGNAL GENERATION

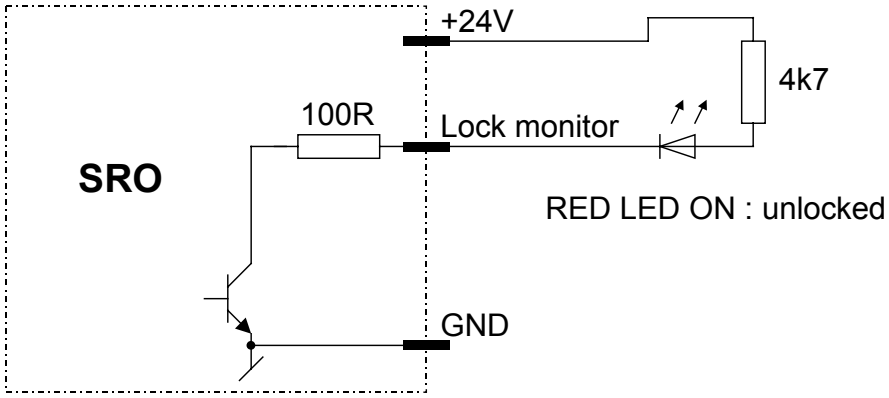

Fig. 4-5 : Visual "Out Off Lock" generation. The value of the 4k7 resistor should be adapted to the LED drive current.

4.11 CONNECTING A PPSREF TO THE SRO

The SRO 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 SRO, 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 SRO 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.

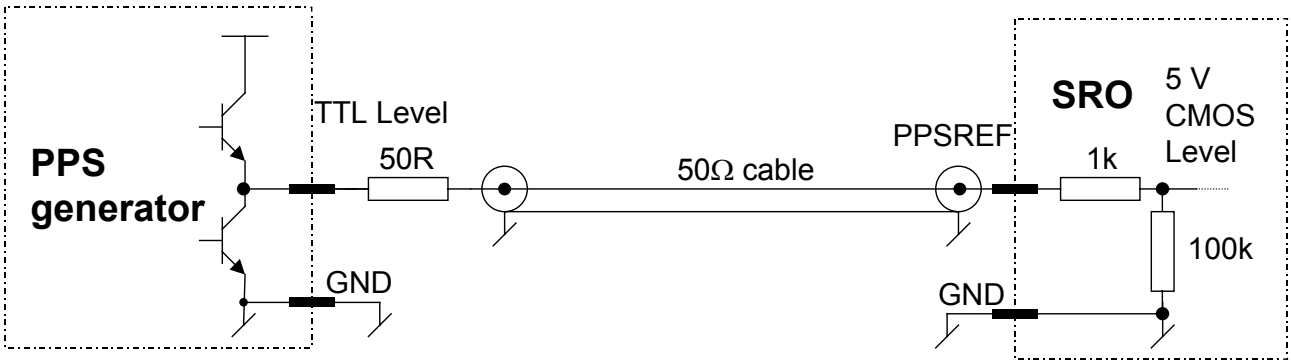

Figure 4-6 This schematic is recommended to connect a PPSREF to the SRO on distances up to 10 m.