EPSILON CLOCK
MODEL EC1S
USER'S MANUAL

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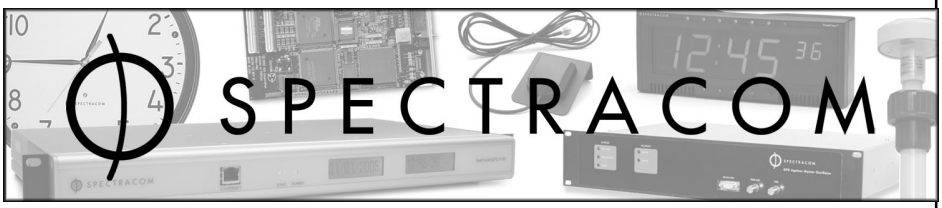

www.spectracomcorp.com
www.spectracom.fr
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SPECTRACOM LIMITED WARRANTY

LIMITED WARRANTY

Spectracom warrants each new product manufactured and sold by it to be free from defects in software, material, workmanship, and construction, except for batteries, fuses, or other material normally consumed in operation that may be contained therein AND AS NOTED BELOW, for five years after shipment to the original purchaser (which period is referred to as the "warranty period"). This warranty shall not apply if the product is used contrary to the instructions in its manual or is otherwise subjected to misuse, abnormal operations, accident, lightning or transient surge, repairs or modifications not performed by Spectracom.

The GPS receiver is warranted for one year from date of shipment and subject to the exceptions listed above. The power adapter, if supplied, is warranted for one year from date of shipment and subject to the exceptions listed above.

THE TIMEVIEW ANALOG CLOCKS ARE WARRANTED FOR ONE YEAR FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

THE TIMECODE READER/GENERATORS ARE WARRANTED FOR ONE YEAR FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

THE WIRELESS CLOCK SYSTEM TRANSMITTERS AND/OR TRANSCEIVERS AND CLOCKS ARE WARRANTED FOR TWO YEARS FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

THE EPSILON CLOCKS, BOARDS, AND SYNCHRONIZATION UNITS ARE WARRANTED FOR TWO YEARS FROM DATE OF SHIPMENT AND SUBJECT TO THE EXCEPTIONS LISTED ABOVE.

The Rubidium oscillator, if supplied, is warranted for two years from date of shipment and subject to the exceptions listed above.

All other items and pieces of equipment not specified above, including the antenna unit, antenna surge suppressor and antenna pre-amplifier are warranted for 5 years, subject to the exceptions listed above.

WARRANTY CLAIMS

Spectracom's obligation under this warranty is limited to in-factory service and repair, at Spectracom's option, of the product or the component thereof, which is found to be defective. If in Spectracom's judgment the defective condition in a Spectracom product is for a cause listed above for which Spectracom is not responsible, Spectracom will make the repairs or replacement of components and charge its then current price, which buyer agrees to pay.

Spectracom shall not have any warranty obligations if the procedure for warranty claims is not followed. Users must notify Spectracom of the claim with full information as to the claimed defect. Spectracom products shall not be returned unless a return authorization number is issued by Spectracom.

Spectracom products must be returned with the description of the claimed defect and identification of the individual to be contacted if additional information is needed. Spectracom products must be returned properly packed with transportation charges prepaid.

Shipping expense: Expenses incurred for shipping Spectracom products to and from Spectracom (including international customs fees) shall be paid for by the customer, with the following exception. For customers located within the United States, any product repaired by Spectracom under a "warranty repair" will be shipped back to the customer at Spectracom's expense unless special/faster delivery is requested by customer.

Spectracom highly recommends that prior to returning equipment for service work, our technical support department be contacted to provide trouble shooting assistance while the equipment is still installed. If equipment is returned without first contacting the support department and "no problems are found" during the repair work, an evaluation fee may be charged.

EXCEPT FOR THE LIMITED WARRANTY STATED ABOVE, SPECTRACOM DISCLAIMS ALL WARRANTIES OF ANY KIND WITH REGARD TO SPECTRACOM PRODUCTS OR OTHER MATERIALS PROVIDED BY SPECTRACOM, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Spectracom shall have no liability or responsibility to the original customer or any other party with respect to any liability, loss, or damage caused directly or indirectly by any Spectracom product, material, or software sold or provided by Spectracom, replacement parts or units, or services provided, including but not limited to any interruption of service, excess charges resulting from malfunctions of hardware or software, loss of business or anticipatory profits resulting from the use or operation of the Spectracom product or software, whatsoever or howsoever caused. In no event shall Spectracom be liable for any direct, indirect, special or consequential damages whether the claims are grounded in contract, tort (including negligence), or strict liability.

EXTENDED WARRANTY COVERAGE

Extended warranties can be purchased for additional periods beyond the standard five-year warranty for those products covered under five-year warranty. Contact Spectracom no later than the last year of the standard five-year warranty for extended coverage.

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1 Introduction

The EPSILON CLOCK MODEL EC1S generates and distributes a highly accurate and stable frequency source disciplined using GPS input. The clock has autonomous control of GPS system integrity features (TRAIM) and rejects defective satellites.

The time reference thus obtained is processed by efficient algorithms that control the built-in oscillator, which generates inner frequency and time signals. The clock continues to distribute time and frequency signals even if the GPS input signal is lost. Furthermore, “learning” from its behavior in different situations (effects attributed to aging and to temperature variations) while the GPS reference signal is present, the frequency driver improves on the accuracy of time and frequency distribution (when the GPS signal is lost).

The majority of the EPSILON CLOCK MODEL EC1S functions are software controlled. At start-up, the clock carries out a series of automatic tests, including hardware tests and verification of the built-in oscillator stability, before making an initial coarse adjustment to the distributed frequency. The clock has a serial remote control interface that is used to input all the queries and commands described in this manual.

THE EPSILON CLOCK MODEL EC1S IS FACTORY CONFIGURED TO ASSUME AUTOMATIC START-UP AND NORMAL OPERATION WITHOUT USING THE REMOTE CONTROL INTERFACE.

1.1 Basic Configuration

This document is applicable to the EPSILON CLOCK® Model EC1S. In its basic configuration, the EPSILON CLOCK® Series EC1S is equipped with:

- 1 x GPS antenna input (TNC)
- 1 x DC power supply input (19 to 36 VDC, mini Mate-n-Loc connector)
- 1 x 10 MHz sine-wave output (SMA)
- 1 x 1PPS output (TTL / 50 Ω, SMA)
- 1 x Time Of Day interface (RS232C, SubD 9)
- 1 x remote control interface (RS232C, SubD 9)
- 1 x alarm output (relay contact, SubD 9)
- 2 x LEDs for the status display

Two additional connectors (AUX1 and AUX2) are available for optional inputs or outputs through the addition of a piggy-back board.

The EPSILON CLOCK MODEL EC1S supports a wide range of oscillators depending on the customer's synchronization accuracy needs.

1.2 Standard Features

The EPSILON CLOCK MODEL EC1S is used to generate, maintain, and provide the following:

- A synchronized UTC(GPS) time reference. The clock distributes a 1PPS signal, a Time Of Day message (TOD interface), and a time-coded message (remote control interface).
- A frequency reference (one sine-wave 10 MHz).

The clock is powered by one DC power supply (19 to 36 VDC)

A remote control interface provides information on clock status and allows the user to send initialization and configuration commands. The working status of the clock is reported locally using two LEDs on the front panel.

The relay contact output of the alarm is closed in the event of hardware or software failure.
The EPSILON CLOCK MODEL EC1S is fully automatic. It requires no preventive maintenance.

1.3 Optional Functions

The EPSILON CLOCK MODEL EC1S accepts the addition of a piggy-back board to allow additional inputs or outputs such as:

- Time outputs (10MHz, 1PPS, IRIG B)
- SDH / E1 synchronization for SSU functionality and for GPS back-up for excellent holdover performance

- DDS outputs (2 fixed or 2 software-adjustable frequencies)

1.4 Oscillators

The EPSILON CLOCK MODEL EC1S accepts a wide range of oscillators depending on the customer's synchronization accuracy needs.

The standard product uses a High Performance Single Oven OCXO. An optional Double Oven OCXO is proposed for excellent temperature stability and very low aging. Spectracom also offers a Low Cost OCXO for less demanding applications (refer to *Features*).

- EC1S-SO: High Performance Single Oven OCXO
- EC1S-DO: Double Oven OCXO
- EC1S-LC: Low Cost OCXO

Other oscillators can be fitted on request. Contact Spectracom for more information.

1.5 Inventory

Before installing your Spectracom product, please verify that all material ordered has been received. If there is a discrepancy, please contact Spectracom Customer Service. Customer service is available by telephone at +33 (0) 1.64.53.39.80 (France), or +1.585.321.5800 (United States). Updated contacts information are available on web site, see "Support" page.

CAUTION:  *Electronic equipment is sensitive to Electrostatic Discharge (ESD). Observe all applicable ESD precautions and safeguards when handling the Spectracom equipment.*

NOTE: If equipment is returned to Spectracom, it must be shipped in its original packing material. Save all packaging material for this purpose.

1.6 Inspection

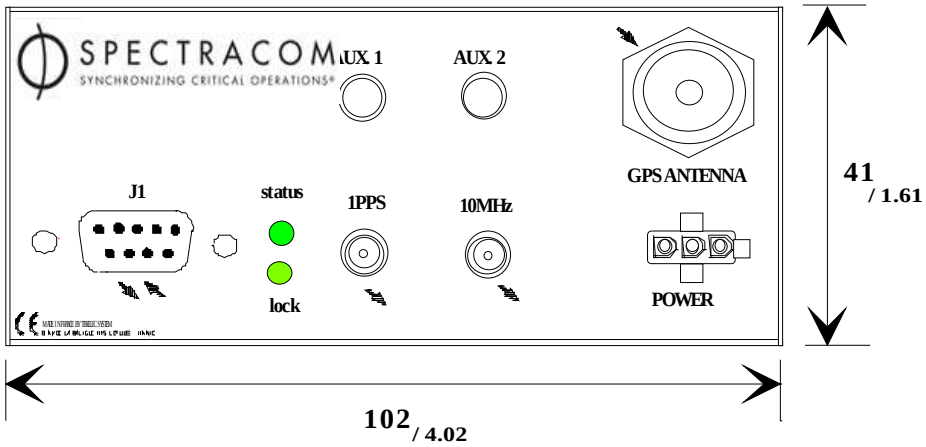
Unpack the equipment and inspect it for damage. If any equipment has been damaged in transit, please contact Spectracom Customer Service. Customer service is available by telephone at +33 (0) 1.64.53.39.80 (France), or +1.585.321.5800 (United States). Updated contacts information are available on web site, see "Support" page.

1.7 Terminology

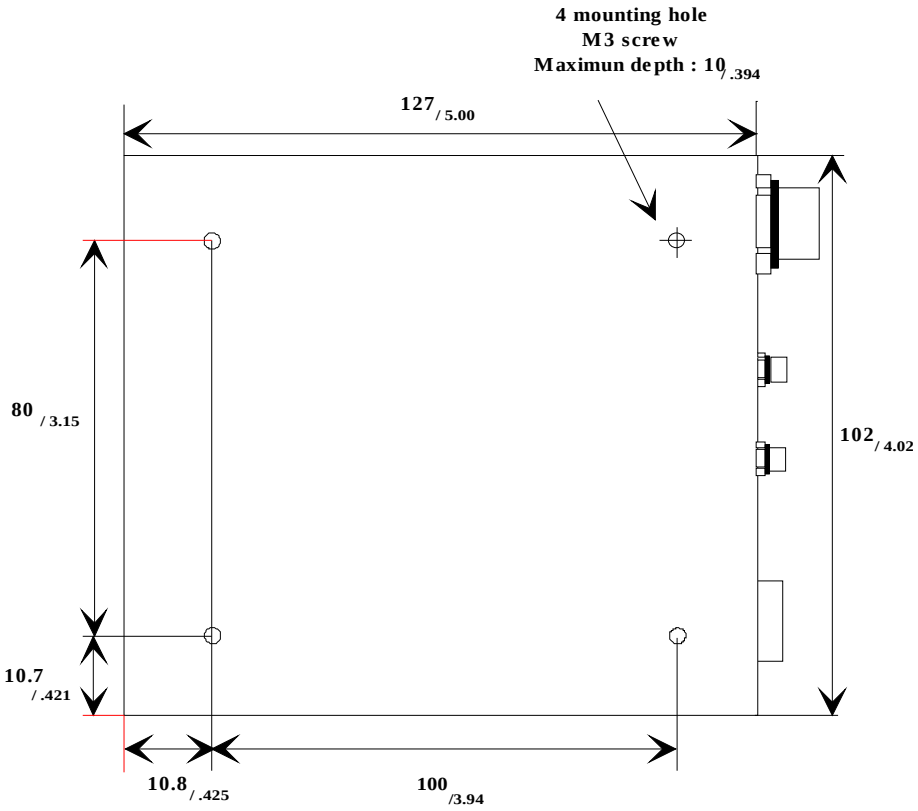
Auto Survey	In automatic mode, the EPSILON CLOCK MODEL EC1S calculates the position of the antenna and, after testing the result, imposes the position on the internal GPS receiver. The receiver therefore functions in GPS 0D reception mode: The EPSILON CLOCK MODEL EC1S is synchronized by tracking at least one satellite.
DDS	Direct Digital Synthesizer
Frequency Driver	Frequency signal generated by the built-in oscillator.
GPS	Global Positioning System
OCXO	Oven Controlled XTAL (Crystal) Oscillator
Rb	Rubidium oscillator
S/A	Selective Availability
SSU	Synchronization Supply Unit
TRAIM	Time Receiver Autonomous Integrity Monitoring
UTC	Universal Time Coordinated
1PPS	One Pulse Per Second
1 PPS Driver	Pulse signal obtained through division of the frequency driver
Holdover	If the reference input signal is lost, the EPSILON CLOCK® maintains the generation of information and of time and frequency signals.
Reliability	Concerns the positioning mode of the antenna. In automatic mode, the EPSILON CLOCK® calculates the position of the antenna and, after testing the result, imposes the reliable position on the internal GPS receiver. The receiver therefore functions in GPS 0D reception mode. The EPSILON CLOCK® is synchronized by following at least one satellite.
Frequency driver	Frequency signal generated by the built-in oscillator.
Reference input	Time and frequency source used by the EPSILON CLOCK®.
IERS	International Earth Rotation Service.

1.8 Mechanical Characteristics (Dimensions in mm)

Front side



Top side



Weight < 600g

2 Installation

2.1 Preparing for Use

Install the clock in the desired location. To facilitate the installation in user's equipment, four mounting holes with M3 screw threads (maximum depth screw 10mm) are provided on the top of the unit

The clock may be installed in a 19 inch cabinet with two flat angle brackets (refer to *Flat Angle Brackets* for more information).

Ideally, the clock should be located for natural air cooling.

CAUTION:  *Make sure the maximum operating ambient temperature does not exceed 70℃.*

2.2 Preliminary Connections

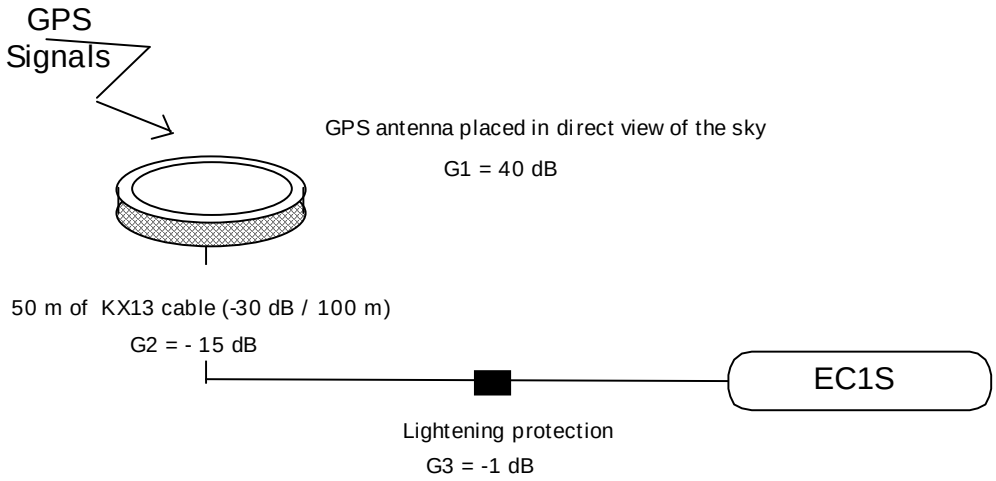
Before starting the EPSILON CLOCK®, perform the following tasks:

- Position the machine so that the upper and lower air vents are not obstructed.
- Position the GPS antenna outside with an unobstructed view of the sky over 360 degrees (on top of a mast, for example).

CAUTION:  *The EPSILON CLOCK® is designed to be used with the supplied GPS antenna ONLY. Using another antenna may cause significant damage to the unit and will void your Spectracom warranty.*

- Plug the antenna cable into the TNC "Antenna" connector. To ensure the correct reception of the GPS signal, the overall system of antenna/cable/protection requires a gain between 15 and 30 dB, with optimum reception around 24 dB.

Example:



G1 + G2 + G3 = 40 dB - 15 dB - 1 dB = 24 dB

Thus: X_{min} dB < G1 + G2 + G3 = 24 dB < X_{max} dB

X_{min} and X_{max} are defined in last updated revision of application note TF2.

- Connect the clock to the main power supply or connect the DC power supply (24V for the 2S, 48V for the 2T) to the "DC Power" connector (J2).
- The main outlet and every associated extension must provide a protective path to earth ground. The protection must not be defeated by an extension cord lacking an earth conductor.

WARNING:

If the protective conductor's path to ground is broken or defeated, the danger of electrical shock to the operator may be present.

Before disconnecting the unit from the main power supply, always switch it off. Failure to do may cause damage that voids your Spectracom warranty.

2.3 Connections Quality

Great care must be taken in setting up the GPS Antenna and its connections. Remember that your GPS antenna must have an unobstructed view of the sky.

The type of cable connecting the antenna to the clock and the length of the cable influence greatly the quality of the signal reception. Cable type and length must conform to the rules described herein.

Connections to the antenna, the accessories (surge protection, in-line amplifier) and the cable must be weatherproofed.

An improper installation could result in problems ranging from random, intermittent loss of signal to complete loss of GPS reference. The most common outcome is the inability to discipline the GPS reference correctly.

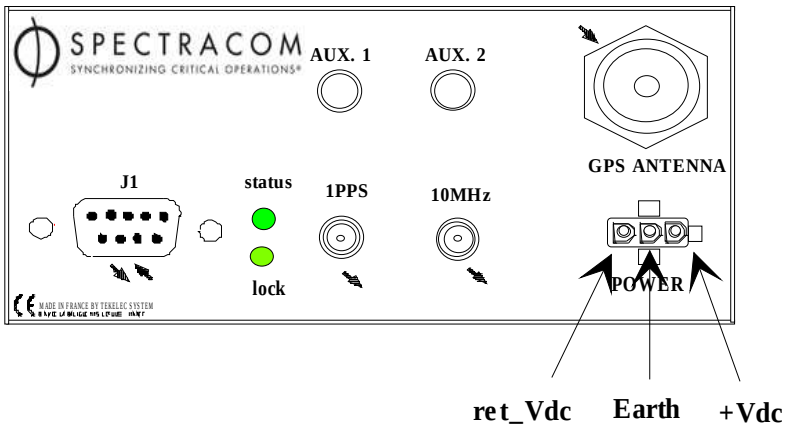
2.4 Power Connection

The power connector (J1) is an AMP mini mate-n-loc female connector (AMP part number 172329-1) with crimp pin 22-18 AWG (AMP part number 170364-1).

Pin-out

1 +VDC
2 Earth
3 Ret VDC

NOTE: The power supply must be connected between pins 1 and 3.



2.4.1 Mating Power Connector

Use the AMP mate-n-loc mating connectors following:

- Mini mate-n-loc male connector (AMP part number 172337-1) quantity 1
- Crimp socket, 22-18 AWG (AMP part number 170366-1) quantity 3

These connectors are supplied with the clock.

2.4.2 Power Characteristics

Power Supply (VDC): 19 to 36VDC (37 to 72VDC or 10 to 18VDC are available on request, contact your TEKELEC SYSTEMES sales representatives for further information).

Consumption:

	EC1-LC	EC1-SO	EC1-DO
Warm-up	7 W	10 W	14 W
Typical	6 W	7 W	11 W

NOTE: The EPSILON CLOCK MODEL EC1S are protected against reverse polarity and is hot- swappable.

2.5 Interface connector

The interface connector provides:

- 1 RS232C remote control interface which provides information on clock status and allows the user to send initialization and configuration commands. This interface supports direct connections to the RS-232 serial port on a computer. EPSILWIN32 is Windows software, trademarked to this company, which is designed to monitor and command the EC1S with an EBO OEM profile. Contact Spectracom for more information.

- 1 RS232C ToD output (ASCII message of the Time of Day)

- 1 contact relay alarm

Connector: HE501 (Sub D) 9 pin Female

Pin-out

Pin	Function	Description
1	Not used	
2	TC_TX	Transmit line output of the remote control interface. RS232C level
3	TC_RX	Receive line input of the remote control interface. RS232C level
4	Not used	
5	GND	Ground
6	Not used	
7	ALARM +	Contact of relay alarm
8	ALARM -	Contact of relay alarm
9	TOD_TX	Transmit line of the Time Of Day message interface. RS232C level

2.6 Starting the Clock

Verify that the preliminary connections have been made.

Apply 24 VDC to the mini mate-n-loc connector.

CAUTION:  *The green LED "STATUS" is off during the OCXO warm-up time (about 20 minutes). For ten seconds after start-up, the TOD and Remote Control cannot be used.*

The two front panel green LEDs are used to report the status of the clock. During start-up, the LED sequence is as follows:

	Locked	STATUS	Notes
Standard hardware automatic test	"off"	"off"	Checks the basic features of the clock
GPS hardware test	"on"	"off"	Checks GPS features
Period of synchronization	"off"	"on"	Searching for signal transmitted by GPS satellites
Synchronization	"on"	"on"	The distributed time is synchronized to $UTC_{(GPS)}$

In case of hardware or software failure, the "STATUS" led is "off" and the alarm output (on J1) is "on" (relay contact closed).

The conditions for activating this output are as follows:

- Faulty GPS receiver
- Faulty frequency driver
- Faulty frequency divider loop
- Faulty distribution of frequency or synchronization signals
- Faulty frequency or synchronization performances (a parameter that can be selected via the remote control interface).

If the failure occurs after the start-up sequence, both LEDs are "off". In this state, the Time Of Day message is not distributed and the clock will not be synchronized to the GPS source. If this occurs, contact Spectracom.

Under normal operating conditions, the EPSILON CLOCK MODEL EC1S is synchronized to $UTC_{(GPS)}$ about 25 minutes after it is switched on. When it is synchronized, both LEDs are "on".

In this state, the EPSILON CLOCK MODEL EC1S continuously delivers the following outputs slaved to the $UTC_{(GPS)}$ reference:

- The 1PPS output and the associated Time Of Day message output
- The frequency output

2.7 Turning Off the Clock

To turn off the EPSILON CLOCK®, remove power input.

3 Features

3.1 Frequency Output

Connectors: 10MHz SMA Female

Pin Settings

Center contact: Sine-wave signal

Outer contact: Ground

Signal characteristics:

	EC1S-LC	EC1S-SO	EC1S-DO
Signal waveform	1 x 10 MHz, sine-wave		
Typical level	5 dBm load 50 Ω		
Harmonic distortion / duty cycle	-25 dBc	-40 dBc	
Accuracy (Average over 24 hours when GPS locked)	$< \pm 1 \times 10^{-11}$	$< \pm 2 \times 10^{-12}$	$< \pm 1 \times 10^{-12}$
Medium stability (without GPS, constant temperature, after 2 weeks of continuous operation)	5×10^{-9} /day	2×10^{-10} /day	1×10^{-10} /day
Short term stability (Allan variance) @ 1s @10s @100s	2×10^{-11} 6×10^{-11} 6×10^{-11}	1×10^{-11} 3×10^{-11} 3×10^{-11}	5×10^{-12} 1×10^{-11} 1×10^{-11}
Temperature stability (peak to peak)	1×10^{-7} (from 10 to 30℃)	1×10^{-9} (from 0 to 60℃)	2×10^{-10} (from –5 to 70℃)
Phase noise (typical, static conditions) 10 Hz 100 Hz 1 kHz 10 kHz 100 kHz	-100 dBc / Hz -120 dBc / Hz -140 dBc / Hz -145 dBc / Hz -145 dBc / Hz	-120 dBc / Hz -130 dBc / Hz -140 dBc / Hz -145 dBc / Hz -145 dBc / Hz	-120 dBc / Hz -130 dBc / Hz -145 dBc / Hz -145 dBc / Hz -145 dBc / Hz

3.2 1PPS Output

Connector: PPS SMA Female

Pin Settings

Center contact: Periodic pulse

Outer contact: Electrical ground of the “GND” pins.

Signal characteristics:

	EC1S-LC	EC1S-SO	EC1S-DO
Signal waveform High-level Low level	> 2.4 V load 50Ω < 0.8 V load 50Ω		
Period	1s		
Active edge	rising		
Rising edge duration	< 20 ns load 50Ω		
Pulse duration	100µs ± 10µs		
Accuracy to UTC, GPS locked	± 100 ns (1σ)	± 25 ns (1σ)	± 25 ns (1σ)
Holdover mode after 4 hours 1day (at constant temperature, after 24 hours of GPS lock and 2 weeks of continuous operation)	30 µs 200 µs	0.8 µs 12 µs	0.6 µs 7 µs

If required, the squelch function of the1 PPS output can be implemented on the EC1S. This requires the user to download an alternative firmware version (to be checked with the factory).

If this function is available, the 1 PPS distribution stops in case of alarm.

3.3 Remote Control Interface (RS232C)

Serial port parameters: 9600 bps, 8 bits, 1 stop bit, odd parity
Protocol / syntax / format of messages: Refer to *Remote Control Interface*
Data: Binary (two's complement)
Order of bytes emitted: Most significant bytes first

Connector J1: Sub D (HE501) 9-pin female

Pin settings:

Pin	Setting
2	Transmit remote signal
3	Receive remote signal
5	Ground

3.4 TOD Output

Time Of Day message output:

Output: ASCII, 9600 bps, 8 bits, 1 stop bit, odd parity.
Protocole: <Message> CR LF
Format*: Day/Month/Year Hour: Minute: Second Source
e.g.: 20/03/1996_21:02:05U

Format*: Month/Day/Year Hour: Minute: Second Source
e.g.: 11/12/1996_18:14:38L

Format*: Day of Year/Year Hour: Minute: Second Source
e.g.: 317/1996_18:16:20 L

Format*: MJD** - Integer part Hour: Minute: Second Source
e.g.: _ _ _ _ _ _50399.18:20:50_U

Format*: MJD** Source
e.g.: _ _ _ _ _ _50399.762130_L

The "Source" byte holds one ASCII character which codes the reference of the time chosen

N	No reference	
U	UTC reference	
G	GPS reference	
L	Local time	
M	Manual	
-	Maximum output period*:	1 message per second
-	Output synchronization:	sent at 200 ms ±100 ms after the 1PPS signal.

* Programmable through the remote control interface.

** Modified Julian Day

Connectors: J1 Sub D (HE501) 9-pin female

Mini Din 6 pins Female

Pin settings:

Pin	Setting
9	Time Of Day message Output
5	Ground

3.5 Alarm Output

If required, the polarity of the relay can be reversed.

Type: Relay contact
Closed in a case of hardware or software failure (Standard configuration)
Open in a case of hardware or software failure (On requirement)

Resistive Contact Rating: 30VA / 250V
Connector: J1 Sub D (HE501) 9 pin female
Pin settings:
- 7: ALARM +
- 8: ALARM -

3.6 Power Supply

Power supply (VDC): 19 to 36 VDC on standard
10 to 18VDC or 37 to 72VDC on request

Protection: Reverse polarity
Hot swap insertion
Polyswitch against short-circuit

Consumption:

	EC1-LC	**EC1-SO**	**EC1-DO**
Warm-up	7 W	10 W	14 W
Typical	6 W	7 W	11 W

Connector: POWER AMP mini Mate-n-Loc female connector (AMP part number 172329-1) with crimp pin 26-22 AWG (AMP part number 170363-1)

Pin Settings

- 1: +VDC
- 2: Earth
- 3: -VDC

3.7 GPS Antenna Input/Output

Connector: ANTENNA TNC female

Pin Settings

Center contact: GPS Signal Input (L1)

Output power supply of the active antenna:

Voltage: 5V

Current: 80 mA max.

Outer contact: Electrical ground of the "GND" pins.

3.8 Operating Environment

	EC1S-LC	**EC1S-SO**	**EC1S-DO**
Operating temperature	-5℃ to 60℃		
Storage temperature	- 40℃ to 85℃		
Relative humidity	95 % non condensing		
CE compliant	EN 300 386 / EN 55022 / EN 60950		

4 SDH/E1 Option

When installed, this option provides:

- SDH / E1 synchronization for SSU functionality such as ITU G.811 GPS PRC when locked on GPS
- GPS back-up to provide excellent holdover performance.

This option is for the EC1S-SO and EC1S-DO.

4.1 2.048 MHz Output

Connector: AUX2 SMA Female

Pin Settings

Center contact: Sine-wave signal

Outer contact: Ground

Signal characteristics:

- G.703 § 13 / 75 Ω

- MTIE / TDEV: Meets the ITU G.811 recommendations when GPS-locked

4.2 2.048 MHz Input

The EPSILON CLOCK MODEL EC1S can be synchronized with an external input 2.048MHz when GPS is lost. This yields excellent holdover performance.

Before all switching, the EPSILON CLOCK MODEL EC1S must be locked on GPS at least one hour to allows a good 1PPS synchronization to the UTC.

After this delay, if an external reference is connected, the EPSILON CLOCK MODEL EC1S switch automatically on this last as soon as the GPS is lost. The led “locked” is blinking . The 1PPS and frequency drifts are in accordance with the external input 2.048MHz medium term accuracy.

The 1PPS timing performances are again guaranty respect to UTC, ½ hour after the GPS is back.

Connector: AUX1 SMA Female

Pin Settings

Center contact: Sine-wave signal

Outer contact : Ground

Signal characteristics:

- Signal level: G.703 § 13 / 75 Ω unbalanced.
- Input jitter & wander tolerances: Compliant with G811 and ESTI EN 300 462-4/6 recommendations.

5 Remote Control Interface

5.1 General

The remote control interface allows remote configuration and remote status reporting of the clock. The RS232C connection operates at 9600 bps and is set to 8 bits, 1 stop bit, and odd parity.

5.2 Protocol

The protocol used is Master (Host) / Slave (EPSILON CLOCK®) with a systematic reply to all messages. The following exceptions apply (for which no reply is expected):

- The time code message sent periodically
- The reset clock command

All messages start with the "STX" character and end with the "ETX" character.
e.g.: <STX> <Message> <ETX>

The characters " STX ", " ETX " or " DLE " to be sent within a message should be escaped (prefixed) by the "DLE" character.

Each message contains four distinct sections:

- The message "ID" (this identifies the type of message being sent):
- The count of the number of data bytes in the message (CNT),
- The data bytes (DATA(*)) of the message,
- The checksum: calculated by performing an exclusive OR on all the consecutive characters in the message (ID + CNT + DATA)

e.g.: <Message> = <ID> <CNT > <DATA(*)> <CS>
Number of bytes 1 1 N 1

(*): The encoding format of the DATA is based on "MOTOROLA big Endian" type (integer, long, float, and double data must be sent or received with the MSB first).

NOTE: The maximum length of the <DATA> section is 255 bytes.

Messages belong to one of three categories:

- Queries (requests for information from the EPSILON CLOCK®)
- Commands (functions that initialize or configure the EPSILON CLOCK®)
- Error Messages (returned by the clock if errors are detected in the Queries or Commands sent by the user)

When a user sends a message to the EPSILON CLOCK®, it replies within the current second. This reply, or acknowledgement, is formatted as follows:

- The format of the message is identical to the message sent by the user

- The contents of sections <ID> and <CNT> are identical to those sent by the user
- The content of the <DATA > section:
  - Is identical to that sent by the user if the message was a Command
  - Contains the information supplied by the clock, if the message was a Query

The acknowledgement to a Command is an exact copy of the message sent.

The reply to a Query is the copy of the Query message with the <DATA> section completed by the EPSILON CLOCK®. In a query, the <DATA> field is not taken into account by the EPSILON CLOCK® command interpreter.

An Error message is generated by the clock if one of the following errors occurs:

- The message contains an unknown ID
- The number of bytes in the <DATA> section does not correspond to the <CNT> value
- An overflow is detected in a parameter within the <DATA> section

NOTE: If the clock detects a checksum error, it does not take into account the message and it does not transmit any error message.

5.3 Commands description

5.3.1 TOD output setup

This command allows the user to modify the contents of the periodical messages transmitted by the clock on the TOD output. In standard mode, the default message transmitted contains the current date and hour according to the codes provided herein. In diagnostic mode, the message transmitted contains information regarding the disciplining of the frequency driver to the GPS reference. This mode is used by the manufacturer during the “good” working verification phases.

5.3.2 TOD output transmission period

This command defines the transmission period to the TOD message on the corresponding special link. This period is quantified in seconds; the value 0 inhibits permanently the transmission of the message.

5.3.3 Clock reset

This command generates the re-initialization of the clock.

5.3.4 GPS mode setup

This command defines the clock functioning mode with regards to the GPS signals received. Three modes are available: Automatic, Manual, or Mobile.

The Automatic mode is the default mode during the clock initialization. In this mode, the clock averages during 1 hour the antenna position supplied by the receiver in order to make it reliable. After this period and providing that a minimum of 4 satellites were received at all times, the position is fixed and the clock requires only one satellite for time transfer. This 1 hour reliability procedure of the position is initialized every time the clock is switched on and is maintained as long as a minimum of 4 satellites are not received continuously.

The manual mode allows the user to instantaneously force the GPS receiver to function in one satellite mode. The user is required to enter the date and the geographic position of the antenna.

The Mobile mode is useful when the clock is moved while functioning. This command prevents the GPS receiver from switching to the 1 satellite mode. It is therefore necessary in this case to receive a minimum of 4 satellites continuously to ensure a good disciplining of the frequency source.

5.3.5 GPS positioning

This command allows the initialization of the antenna position. This is necessary in Manual mode. This command also allows the user to define which time reference is used. The two possibilities are as follows:

- The Universal Time Coordinated,
- The GPS Atomic Time.

The difference between these two time references is equal to a whole number of seconds, which changes with every leap second insertion in the UTC reference.

The GPS Atomic Time reference is recommended when the user's application requires a perfectly continuous time reference. In effect, the GPS Atomic Time is not subject to leap second insertion.

5.3.6 Local time

The cable between the antenna and the clock generates a propagation delay of the GPS signal. This delay corresponds to a time shift of the synchronizing signal. This time shift can be compensated for using this command. The correction is entered in nanoseconds, and the value corresponding to the delay is linked to the type of cable and its length. As a rule of thumb, the value for the delay of a coaxial cable is about 5 nano seconds per meter.

5.3.7 Antenna delay correction (phase correction)

The cable between the antenna and the clock generates a propagation delay of the GPS signal. This delay corresponds to a time shift of the synchronizing signal. This time shift can be compensated for using this command. The correction is entered in nanoseconds, and the value corresponding to the delay is linked to the type of cable and its length. As a general rule of thumb, the value for the delay of a coaxial cable is about 5 nanoseconds per meter.

5.3.8 Leap second

The UTC time reference, maintained by the GPS clock, is subject to leap second corrections, the purpose of which is to maintain the difference between the atomic time represented by UTC and the astronomic time. These corrections decided by the IERS are published in Bulletin C and D.

If the time reference used by the clock is UTC, these corrections are automatically made in real time provided the GPS signal is received correctly. This command allows the clock to maintain a

reliable time reference by programming in advance the leap second correction, ensuring it will be applied even in the case of loss of GPS signal input.

This command does not apply to the other time references.

5.3.9 Force holdover mode

The initial functioning mode of the clock is always synchronized on the GPS reception. However, the user may configure the clock in the holdover mode, specifically, the disciplining of the driver frequency and if the 1 PPS is stopped.

5.3.10 Display

This command defines the format of the hour transmitted by the TOD message and displayed on the front panel display screen if this option was chosen.

The five formats available are as follows:

- Day / Month / Year Hour: Minute: Second
- Month / Day / Year Hour: Minute: Second
- Day of year / Year Hour: Minute: Second
- MJD (Modified Julian Day)
- MJD integer part Hour: Minute: Second

With this command, the user defines whether the output of the hour is issued from the UTC or GPS time reference, or from the local hour with the programmed shift.

5.3.11 Alarms limits

If the GPS input signal is lost, the clock's internal oscillator is no longer disciplined. The frequency accuracy and the distributed synchronization start to degrade slowly according to the ageing of the oscillator.

Using the alarms limits commands, the user may define the accuracy limits outside of which the output signals are deemed invalid. These limit values are in the form of a time difference for the 1 PPS and in the form of a relative frequency difference for the frequency outputs.

When these limit values are reached, a fault is generated, the LED “STATUS” is fixed “off,” and the contact relay is closed.

5.4 Time distribution on the remote control interface

The time message is transmitted to the remote control interface. The format and the output TOD are selected by the "display" function. The transmission is synchronous with the 1PPS.

Format 1: ID: 193
CNT: 8
DATA: day/month/year/hour/min/sec/source

Format 2: ID: 194
CNT: 8
DATA: day/month/year/hour/min/sec/source

Format 3: ID: 195
CNT: 8
DATA: Day of Year/year/hour/min/sec/source

Format 4: ID: 196
CNT: 9
DATA: MJD/source

Format 5: ID: 197
CNT: 8
DATA: MJD integer part/hour/min/sec/source

The "Source" byte holds an ASCII character, which codes the time reference:

N No reference
U UTC reference
G GPS reference
L Local time
M Manual

Encoding type:

Day	: char	
Month	: char	
Year	: integer	(2 bytes)
Min	: char	
Sec	: char	
source	: char	
MJD integer part	: long	(4 bytes)
MJD	: double	(8 bytes)

5.5 Command or query syntax

Designation	Command ID	query ID	Number of bytes	Command validity conditions
TOD output setup	1	65	1	(1)
Status	---	80	37	(1)
Emission period of the time message on the TOD interface and on the remote control interface	2	66	4	
Reset	16	---	0	(1)
GPS Date init	4	68	7	(1)
Local Time	7	71	2	(1) et (3)
Phase Correction	8	72	4	(1) et (3)
Leap Second	9	73	6	(1) et (4)
GPS Positioning	10	74	19	(1) et (3)
Display	13	77	2	(1)
Alarm limits	14	78	10	(1)
Version	---	67	10	(1)
Forced holdover mode	15	79	1	(1)
Manual time setting	17	81	7	(1) et (5)
Manual correction ±1s	21	85	1	(1) et (5)
Remote control mode	18	82	1	(2)

(1): Command authorized if the clock is in remote control mode.
(2): Command always authorized.
(3): Command authorized if the clock is not in forced holdover mode.
(4): Command authorized if the current time reference is UTC.
(5): Command authorized if the clock is in forced holdover mode.

The tables that follow contain the format of the commands and the requests.

Name	Identifier		Bytes	Byte No.	Encode Type	Settings	Description
	Query	Command					
Status	80	-	37	0 to 3	1 long	$b_0 = 1$ $b_0 = 0$	Clock is synchronized to the reference input (GPS) Clock is not synchronized (the clock is in hold over mode after the loss of the reference input signal).
						b_1 to b_7	Reserved bits.
						$b_8 = 1$ $b_8 = 0$	GPS 1PPS failure. GPS 1PPS operational.
						$b_9 = 1$ $b_9 = 0$	Frequency driver failure. Frequency driver operational.
						$b_{10} = 1$ $b_{10} = 0$	1PPS driver failure. 1PPS driver operational.
						b_{11} 0	Reserved bit.
						$b_{12} = 1$ $b_{12} = 0$	1PPS output failure. 1PPS output operational.
						$b_{13} = 1$ $b_{13} = 0$	Phase limit alarm: loss of synchronization, programmed phase-limit exceeded. Phase limit not exceeded.
						$b_{14} = 1$ $b_{14} = 0$	Frequency or limit alarm: loss of synchronization (if the programmed limit is set to 0) or loss of synchronization and limit exceeded or synchronization period too short to provide the programmed frequency limit. Programmed frequency or limit not exceeded: the clock is synchronized during a period of time sufficient enough to provide the frequency inside the programmed limit or the loss of synchronization is not sufficiently long to exceed the programmed limit.
						b_{15}	Reserved bit
						b16 = 1 b16 = 0	EPSILON CLOCK MODEL EC1S hardware failure. EPSILON CLOCK MODEL EC1S hardware operational.
						b17	Reserved
						b18 = 1 b18 = 0	Antenna not connected. Antenna connected.
						b19 = 1 b19 = 0	Antenna short circuit alarm. No antenna short circuit.
						b20 to b31	Reserved
				4	1 char	Char value: 1 or 5	GPS reception, mode 0D: The EPSILON CLOCK MODEL EC1S is synchronized using a single satellite. Mode set to manual positioning of the GPS antenna or after auto survey of the GPS antenna coordinates in automatic positioning mode.
						Char value: 2 or 6	GPS reception mode 2D: The EPSILON CLOCK MODEL EC1S is synchronized using 3 satellites. This mode can only operate if the antenna positioning mode is set to mobile, or automatic and when the auto survey is in progress.
						Char value: 3 or 7	GPS reception mode 3D: The EPSILON CLOCK MODEL EC1S is synchronized using 4 or more satellites and the antenna positioning mode is set to mobile, or automatic and when the auto survey is in progress.

Name	Identifier		Bytes	Byte No.	Encode Type	Settings	Description
	Query	Command					
				5 to 20	8 integers	Odd bytes (5 to 19)	For each byte, the number of the satellite being tracked is set on bits b_0 to b_6. The locking to satellite indicator is given by bit b_7 (b_7=0 ; locked).
						Even bytes (6 to 20)	SNR (0 to 255) of the followed satellites. The even byte O_i gives the SNR of the satellite indicated by the byte O_{i-1} e.g.: O_3 = 140 (80 HEX + 12 decimal) O_4 = 120 Satellite 12 is locked and its SNR is 120.
				21 to 22	1 integer	---	Reserved
				23 to 26	1 long	-324,000,000 ... 324,000,000 (-90°S ... +90°N)	Latitude of the GPS antenna (ms) in WGS 84 Datum Ellipsoid.
				27 to 30	1 long	-648,000,000 ... 648,000,000 (-180°W .. +180°E)	Longitude of the GPS antenna (ms) in WGS 84 Datum Ellipsoid.
				31 to 34	1 long	-100,000 ... 1,800,000 (-1,000 m to 18,000 m)	Altitude of the GPS antenna (cm) in WGS 84 Datum Ellipsoid.
				35	1 char	1 0	GPS receiver failure GPS receiver operational.
				36	1 char	---	Reserved
TOD output setup	65	1	1	0	1 char	1 0	Clock diagnostic output. TOD message output.
Time message period of emission	66	2	4	0 to 3	1 long	0 ... 100,000 (0 ... 100,000 sec)	Period of the emission of the time message on the TOD interface and on the remote control interface.
Reset of the clock	---	16	0		---	---	Stops and restarts the clock (warm-reboot).
GPS date int	68	4	7	0	1 char	1 ... 31 (Days)	Sets the GPS receiver date and time.
				1	1 char	1 to 12 (Months)	
				2 to 3	1 integer	1992 ... 2016 (Years)	
				4	1 char	0 ...23 (hours)	
				5	1 char	0 ... 59 (minutes)	
				6	1 char	0 ... 59 (seconds)	

Name	Identifier		Bytes	Byte No.	Encode Type	Settings	Description
	Query	Command					
GPS positioning	74	10	19	0	1 char	1 2 3	Antenna positioning mode: Automatic Antenna positioning mode: Manual Antenna positioning mode: Mobile
				1 to 4	1 long	-324,000,000 ... 324,000,000 (-90°S ... +90°N)	Latitude (ms) in WGS 84 Datum Ellipsoid.
				5 to 8	1 long	-648,000,000 ... 648,000,000 (-180°W .. +180°E)	Longitude (ms) in WGS 84 Datum Ellipsoid.
				9 to 12	1 long	-100,000 ... 1,800,000 (-1,000 m to 18,000 m)	Altitude (cm) in WGS 84 Datum Ellipsoid.
				13 to 17	5 char	---	Reserved
				18	1 char	1 0	UTC time scale reference. GPS time scale reference.
Local time	71	7	2	0	1 char	-23 ... +23 (hours)	Difference, in hours and minutes, between local time and the clock reference time.
				1	1 char	-59 ... +59 (minutes)	
Phase correction	72	8	4	0 to 3	1 long	0 ... 1,000 ns	Programmed difference between the distributed 1PPS signal and the built-in reference (to correct antenna cable delay).
Leap second	73	9	6	0	1 char	1 0	No leap second. Use leap second.
				1	1 char	1 2	Leap second addition. Leap second subtraction.
				2 to 3	1 integer	1 ... 366 Days	Day of the year to be used.
				4 to 5	1 integer	1992 ... 2127	Year to be used
Display	77	13	2	0	1 char	0	Day / Month / Year format
						1	Month / Day / Year format
						2	Day of year / Year format
						3	MJD format
						4	MJD format integer part hh/mn/sec
				1	1 char	---	Reserved
Alarm limits	78	14	10	0 to 3	1 long	0 ... 1,000 µs	Phase alarm limit 0 = no phase alarm.
				4 to 7	1 long	0 ... 1,000 10-9	Frequency alarm limit 0 = alarm immediate if synchronization is lost.
				8 to 9	1 integer	---	Reserved

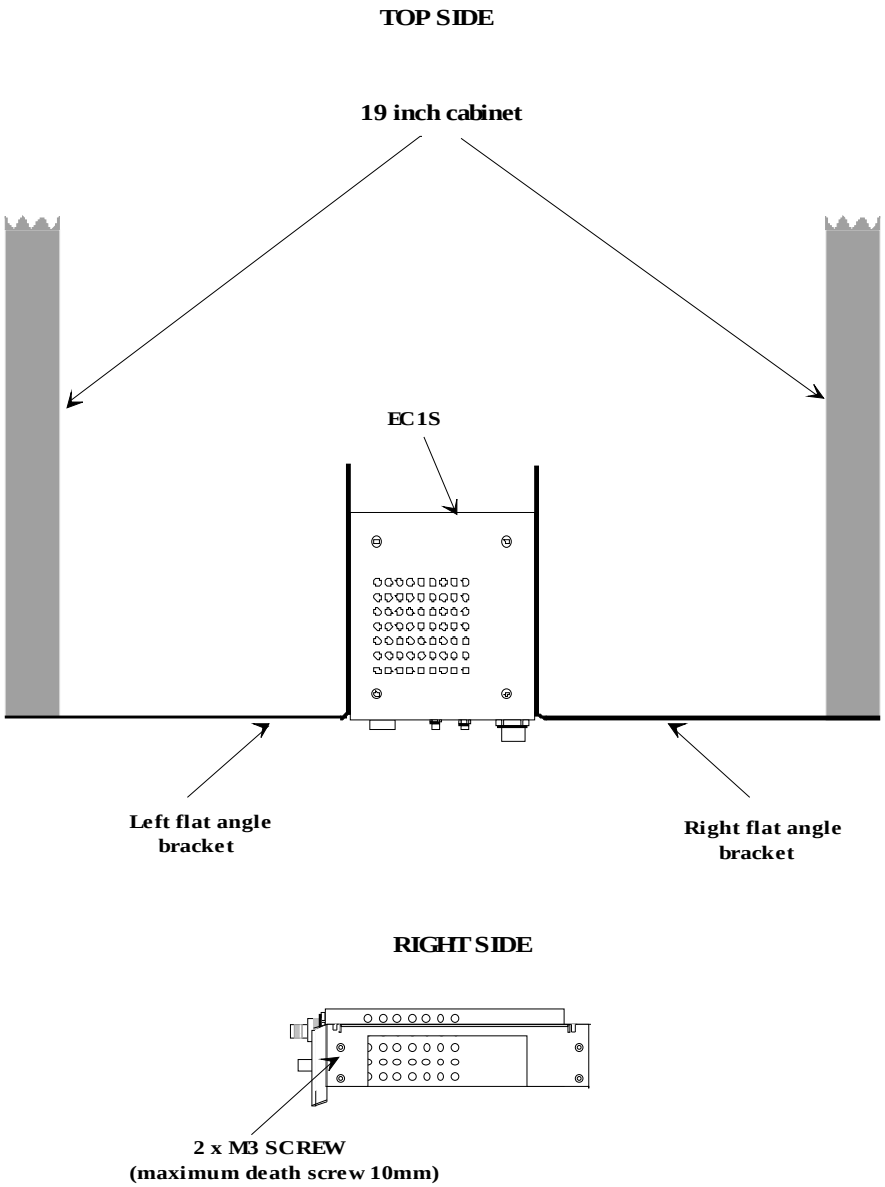
Name	Identifier		Bytes	Byte No.	Encode Type	Settings	Description
	Query	Command					
Version	67		10	0 to 3	1 long	---	Reserved
				4	1 char	0 ... 255	Software version.
				5	1 char	0 ... 255	Update version number.
				6 to 9	1 integer	---	Reserved
				8	1 char		EPLD version number
				9	1 char	---	Reserved
Error (ID = 64)			2	0	1 char	X	Invalid message ID
				1	1 char	0	Incorrect number of useful bytes
						1	Unknown message ID
						2	Unauthorized parameter in <DATA> section.
						3	Command not valid
						4	Remote command not authorized
Forced holdover mode	79	15	1	0	1 char	1 0	Functioning mode: disciplining authorized Functioning mode: holdover forced
Manual time setting	81	17	7	0	1 char	1 ... 31 (days)	Manual setting of the clock (authorized only in forced holdover mode).
				1	1 char	1 ... 12 (months)	
				2 to 3	1 integer	1992 ... 2127 (years)	
				4	1 char	0 ...23 (hours)	
				5	1 char	0 ... 59 (minutes)	
				6	1 char	0 ... 59 (seconds)	
Manual correction ±1s	85	21	1	0	1 char	1: - 1 second 0: + 1 second	Manual second correction (authorized only in forced holdover mode).
Remote control mode	82	18	1	0	1 char	0: remote control mode authorized 1: remote control not authorized	Authorization or not of new remote control commands.

6 Flat Angle Brackets

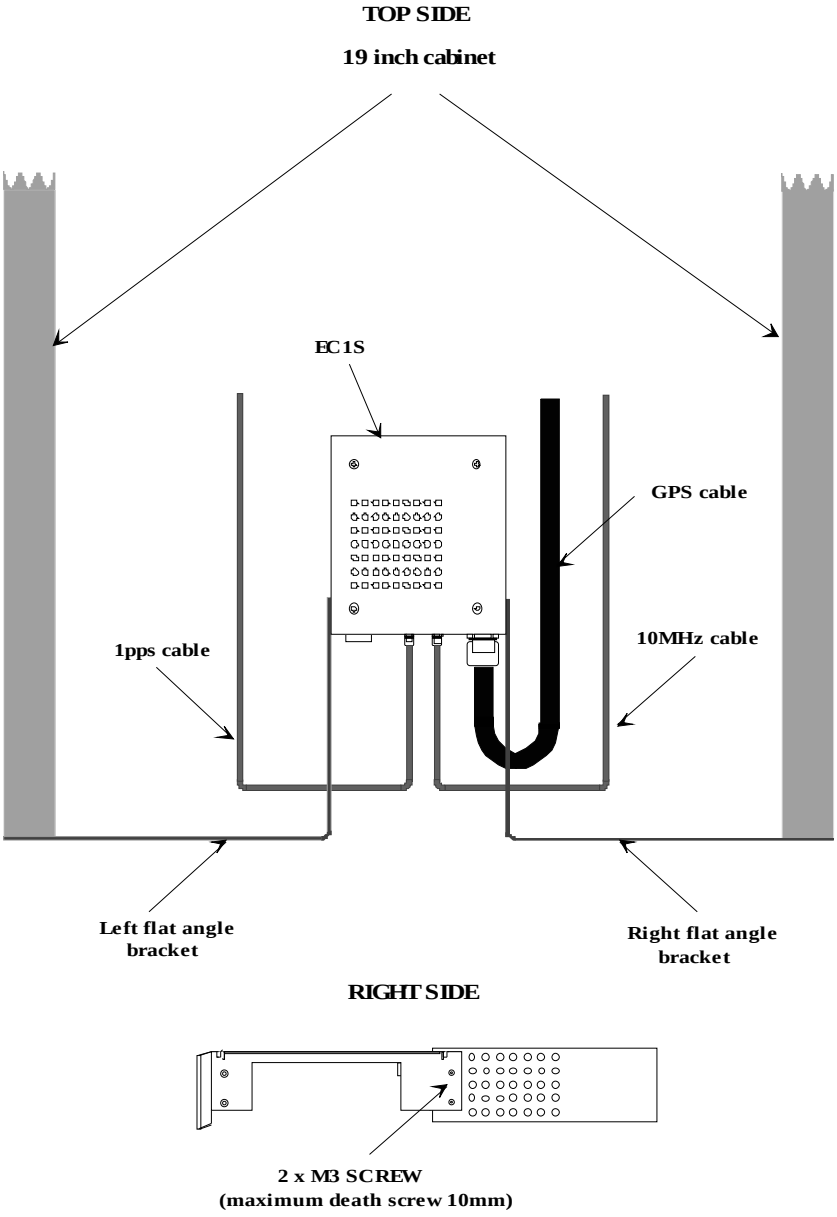
The Epsilon clock EC1S accepts two flat angle brackets for installation inside a 19 inch cabinet. Two methods of installation are possible:

- Front of the cabinet
- Inside the cabinet

6.1 Front of the Cabinet



6.2 Inside the Cabinet



7 Interconnection SAS Cables Kit

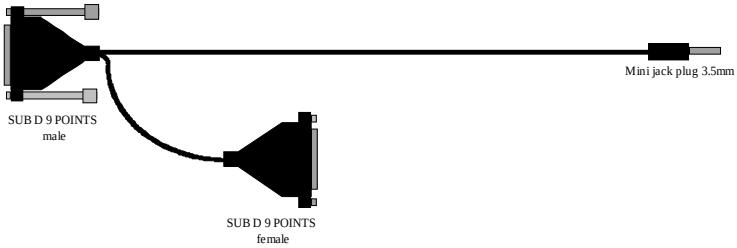
This section describes how to interface the εSAS with two EC1S units, using the interconnection SAS cables kit.

7.1 Composition

The interconnection SAS cables kit includes:

4 BNC-SMA RG58 cable length 1,5m

2 SubD-Minijack cable length 1,5m



7.2 Procedure

1) First, make sure that the εSAS doesn't monitor the TOD (refer to the εSAS instruction manual).Other signals must be monitored.
2) Connect the 1PPS of EC1S A on connector J1 of the εSAS with a BNC-SMA cable.
3) Connect the 10MHz of EC1S A on connector J2 of the εSAS with a BNC-SMA cable.
4) Connect the J1 of EC1S A on connector J4 of the εSAS with a SubD-MiniJack cable.

   NOTE: The SubD 9-pin female connector on this cable provides direct access on the RS232 remote control interface of the EC1S when this cable is connected on J1.

5) Connect the 1PPS of EC1S B on connector J30 of the εSAS with a BNC-SMA cable.
6) Connect the 10MHz of EC1S B on connector J29 of the εSAS with a BNC-SMA cable.
7) Connect the J1 of EC1S B on connector J27 of the εSAS with a SubD-MiniJack cable.

NOTE: The SubD 9-pin female connector on this cable provides direct access on the RS232 remote control interface of the EC1S when this cable is connected on J1.

REVISION HISTORY

Revision Level	***ECN Number***	***Description***
A	01/12/03	Creation / First draft
B	01/04/04	Power connection
C	15/09/04	Phase noise / Mechanical characteristics SDH/E1 option, interconnection SAS cables kit
D0	09/06/08	First iteration of this Spectracom documentation, converted from previous documentation.

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