orolia FemtoStepper 100fs Resolution Phase Stepper User Manual

Contents

cecotec EssentialVita Hyden 600 Electric Lever Juicer

FemtoStepper System Description

The FemtoStepper provides a highly stable MHz signal, available on four outputs, that is adjustable in phase and frequency with an extremely high resolution. In addition to the MHz outputs, the micro-stepper provides a one pulse per second (PPS) signal available on four outputs generated from the MHz output. The FemtoStepper provides a MHz signal that is derived from a high performance, ultra low phase noise crystal oscillator which is

phase locked to an external MHz reference input. It allows for adjusting the outputs in phase and frequency without disturbing the reference signal source, and precautions are taken to minimize added noise. The design is based on a double heterodyne architecture where a first structure is used for positive phase/frequency adjustment and the second structure for negative adjustment. The device is controlled remotely through an RS-232 serial link, which provides a prompt with a defined list of commands. All commands are parsed for correct syntax and operational range prior to execution. Commands that contain errors are rejected.

FemtoStepper Installation

Safety

Ensure proper safety precautions are taken during installation and use of the FemtoStepper system.

Environmental Responsibility

Follow environmental regulations and guidelines for the disposal of the FemtoStepper system.

Unpacking

When unpacking the FemtoStepper system, carefully remove all components and verify that everything is included as per the product documentation.

Electrical & Indicator Interfaces

Refer to the product documentation for detailed information on the electrical and indicator interfaces of the FemtoStepper system.

Connections

Make the necessary connections as specified in the product documentation to ensure proper functioning of the FemtoStepper system.

Recommendations

Follow the recommendations provided in the product documentation for optimal performance and longevity of the FemtoStepper system.

System Power-Up|

Refer to the product documentation for instructions on how to power up the FemtoStepper system.

System Control

Control the FemtoStepper system remotely using RS-232 commands. Refer to section 4 of the user manual for a list of available commands and their usage.

RS232 Commands

Command	Description
Frequency Adjustment	Adjust the frequency offset of the output MHz OCXO
Phase Adjustment	Adjust the output phase with picosecond resolution
Microprocessor control and PPS (pulse per second) fa cility	Control the FemtoStepper functions and manage the PPS signal

Mechanical

Refer to the product documentation for detailed mechanical information about the FemtoStepper system.

FemtoStepper System Description

The FemtoStepper provides a highly stable ˜°MHz, available on four outputs, that is adjustable in phase and frequency with an extremely high resolution. In addition to the ˜°MHz outputs, the micro-stepper provides a one pulse per second (˜PPS) available on four outputs generated from the ˜°MHz output.
The FemtoStepperprovides a ˜°MHz signal that is derived from a high performance, ultra low phase noise crystal oscillator which is phase locked to an external ˜°MHz reference input. It allows to adjust the outputs in phase and frequency without disturbing the reference signal source and precautions are taken in order to minimize the added noise.
The design is based on a double heterodyne architecture where a ÿrst structure is used for positive phase / frequency adjust-ment and the second structure for negative adjustment.
The device is controlled remotely through an RS-¸˙¸ serial link. which provides a prompt with a deÿned list of commands. All commands are parsed for correct syntax and operational range prior to execution. Commands that contain errors are rejected.

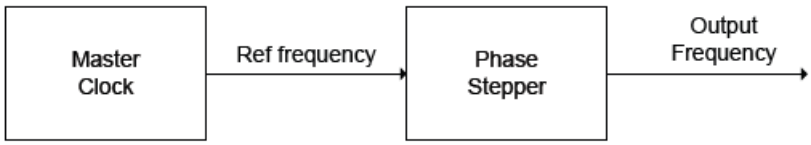


Figure 1- Application Diagram

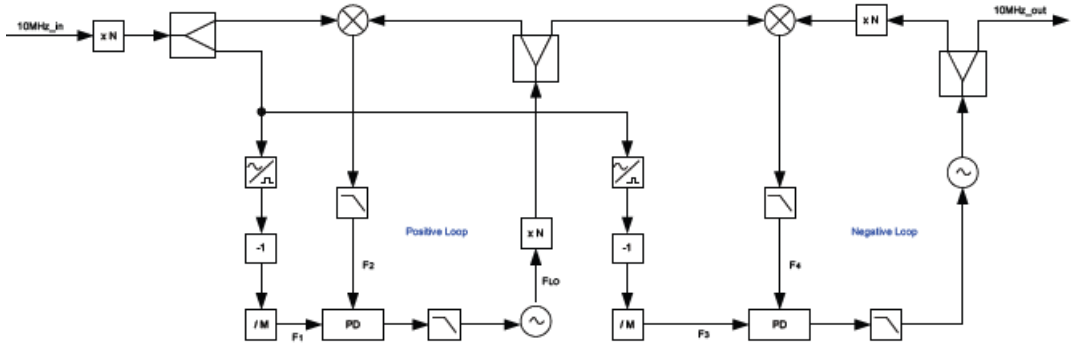


Figure 2- Block Diagram

Frequency Adjustment
The frequency oˆset is applied to the output ˜°MHz OCXO through the double heterodyne structure in order to increase the resolution.

$$F_{out} = F_{in} + \frac{\Delta f}{G}$$

Where :
G : Heterodyne Gain of ˜°˘.
˘f is managed by the microprocessor.
The relationship between the output frequency and the input frequency is the following : Where :
N : Frequency oˆset by ˜°-˜ steps.
The frequency oˆset is always the absolute value from the ˜°MHz input.
The output range is limited nearly x ˜°-˜°)

$$F_{out} = \frac{F_{in}}{1 - \frac{N}{10^{17}}}$$

Phase Adjustment
The output phase is adjustable with °.˜ picosecond resolution over a maximum range of in order to cover an entire period of the ˜°MHz output signal. The phase adjustment is performed under microprocessor control.

Microprocessor control and PPS (pulse per second) facility
The microprocessor is controlling the functions. It is clocked by the ˜° MHz_out. A division by ˜ is made, providing the PPS_ out. The PPS_out can be aligned to a reference PPS_ref within ¸°° ns when the command AL˜ is issued. .

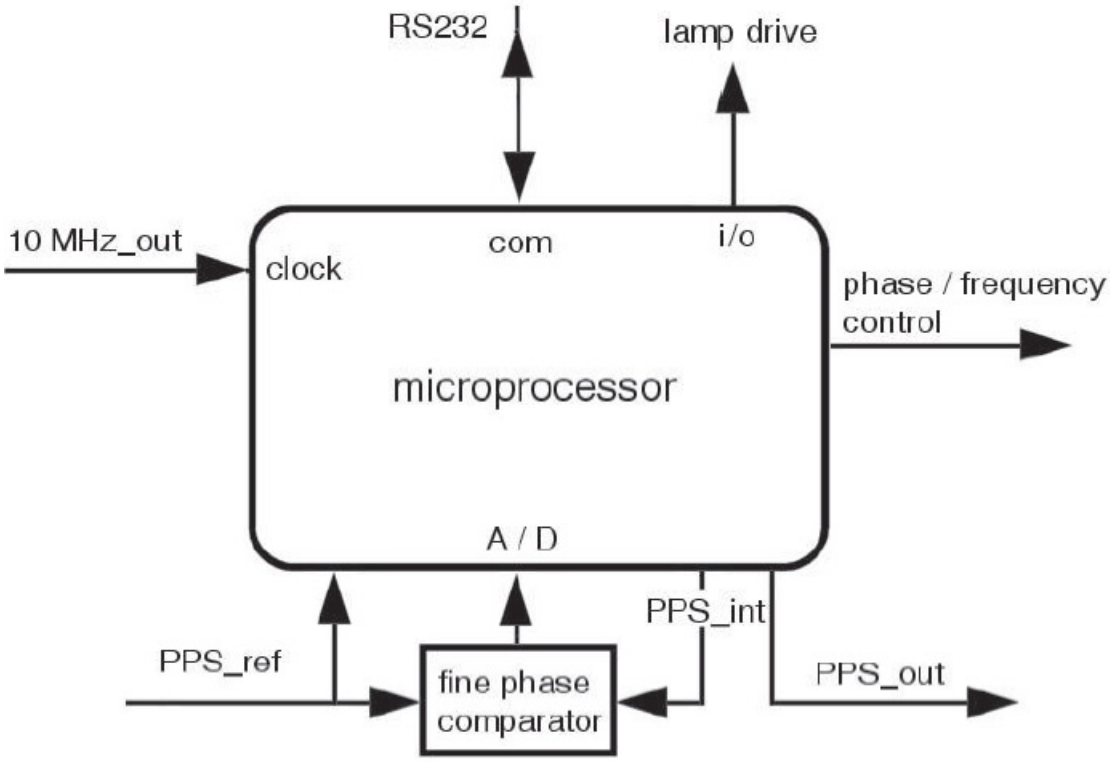


Figure 3 – The microprocessor and its surrounding

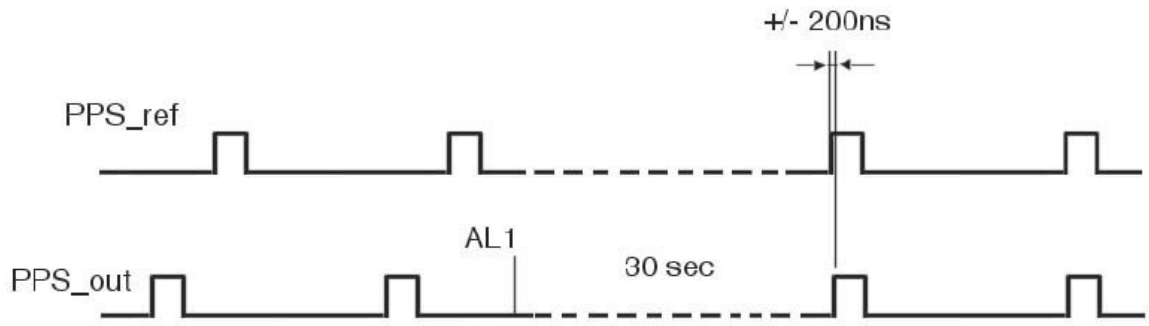


Figure 4 – The PPS_out can be aligned to the PPS_ref.

FemtoStepper Installation

Safety

- Use proper ESD precautions
- Ensure that all cables are properly connected

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

Environmental Responsibility

- The equipment contains materials, which can be either re-used or recycled.
- Do not deposit the equipment as unsorted municipal waste. Leave it at an authorized local WEEE collection point or return to Orolia Switzerland SA to ensure proper disposal.
- To return the appliance :
    - Download and ÿll up the RMA form (from www.orolia.com) and send it to clocksupport@orolia.com
    - Once the RMA is approved, we will contact you with shipment process details.

Unpacking
Unpack and carefully inspect the unit. Check for physical damage. If physical damage is observed, then immediately contact SpectraTime.

Unit Supply:

- FemtoStepper Rack
- Cable SUB-D pins male/female
- Euro power cable
- Brackets for rack mount (only with standard version)
- Connector for Backup DL power supply

Electrical & Indicator Interfaces

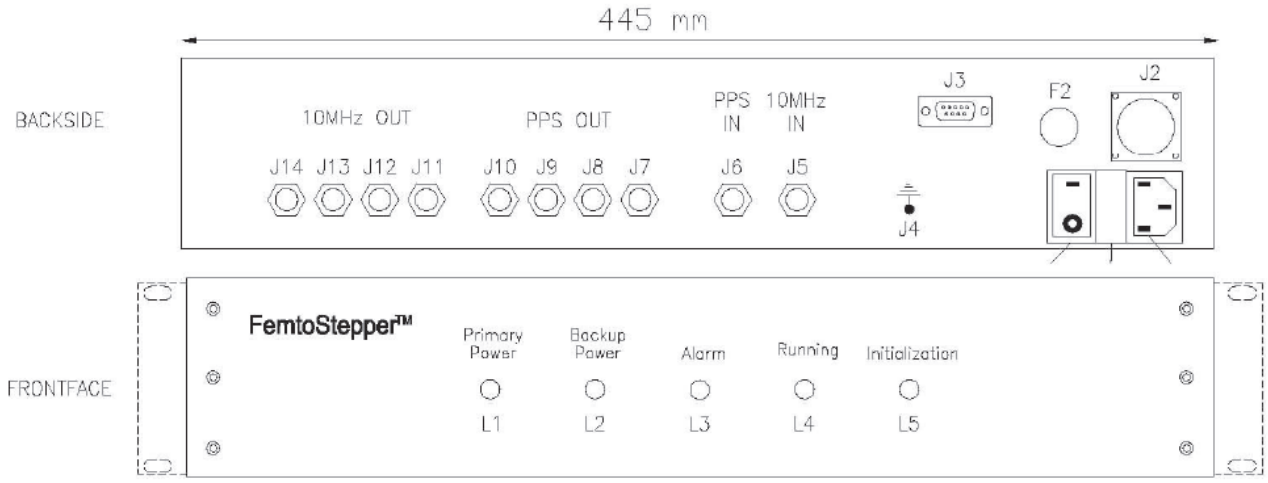
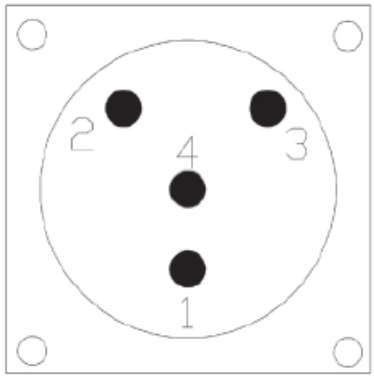


Fig. 3 Interfaces

N°	In/ Out	Designation	Type
J1	In	23OVAC primary po wer	Schurter KM OO.11OS.11
J2	In	+24VDC backup po wer	Jaeger S3O 6OO4OO6
J3	In/ Out	COM Interface	Sub-D-9P-F EM
J4	–	Ground connection	Screw M4
JS	In	1O MHz reference si gnal	SMA
J6	In	PPS reference signa l	SMA
J7-J 1O	Out	4x PPS output	SMA
J11- J14	Out	4x 1OMHz output	SMA
S1	–	On/Off switch	
F1	–	Primary power suppl y fuse – T 3,1SA	
F2	–	Backup power suppl y fuse – T 1,6A	
L1	–	Primary power indic ator	Green
L2	–	Backup power indic ator	Green
L3	–	Alarm indicator	Red
L4	–	Running indicator	Green
LS	–	Initialization indicato r	Yellow

	Pin	Designation
J2	1	GND VDC backup p ower
J2	2	+24 VDC backup power
J2	3	+24 VDC backup power
J2	4	GND VDC backup p ower

Table 2: Backup Power Connector



Connections

- Connect the ˜°MHz input reference to the FemtoStepper unit (J).
- Connect, if PPS functionality is desired, the PPSref signal (J˘).
- Connect the male SUB-D- to the unit (J˙) and female SUB-D- to the computer.
- Connect the primary power cable (¸˙°VAC) to the unit (J˜).
- Connect the backup power cable (¸VDC) to the unit (J¸).
- Optionally, connect the device to ground (J).
- Switch on the unit (S˜).

Recommendations

- Warm-up FemtoStepper several hours before to start any applications.
- To reduce warm-up time, keep FemtoStepper powered-up at all times even when an input reference signal is no avt ailable.
- To ensure a continuous operation, connect a uninterruptable backup ¸V power source.
- Avoid locations of the unit with variable air ow and temperature changes.
- Avoid to place FemtoStepper close to vibration environment and high magnetic ÿelds changes.

System Power-Up

- Switch on the unit (S˜).
- If the primary power is connected, L˜ indicator is green.
- If the backup power is connected, L¸ indicator is green.
- The alarm indicator (L˙) is red while warming-up.
- During the ÿrst ÿve seconds, the microprocessor is performing an initialization. At the end of the initialization sequence, L switches oˆ.
- After approximately ÿfteen minutes, the alarm (L˙) indicator have to switch oˆ. If still red, check if an input reference is connected (J).
- When ready to operate the running indicator (L) becomes green.
- When a frequency oˆset is applied, the running indicator (L) is blinking.

System Control

The device is controlled remotely through an RS-¸˙¸ serial link. which provides a prompt with a deÿned list of commands. All commands are parsed for correct syntax and operational range prior to execution. Commands that contain errors are rejected.
The RS¸˙¸ protocol is :
bits/s
data bits
No parity
stop bit
No handshake
FemtoStepper accepts the following basic ASCII commands: Data is in decimal ASCII code.

Command name	Syntax command	Data field (if any)	Response syntax	Response data (if any)
Identificatio n	ID CR LF	–	TNTMPS-aaa/rr/s.ss CR LF	aaa: OO1 rr: revision number s.s s: software version
Serial numb er	SN CR LF	–	xxxxxx CR LF	xxxxxx : 6 digits serial nbr

Status	ST CR LF	–	yyxx CR LF	yy : always OO (for future use) xx : HEX ASCII Bit signification : Bit 7 :- Bit 6 :backup power active Bit S :primary power active Bit 4 :frequency drift not O Bit 3 :frequency offset not O Bit 2 : stepping activity Bit 1 : OOL – Bit O : OOL +
Single Phase Step	PSs CR LF	s= + : Positive Step s= – : Negative Step	s CR LF	s: signe s= + : Positive Step s= – : Negative Step
Packet Phase Step	PSsdddddd CR LF	s=+ : Positive Packet Step s=- : Negative Packet Step dddddd: number	sdddddd CR LF	s:signe s=+ : Positive Packet Step s=- : Negative Packet Step dddddd: value
Actual phase offset	PH CR LF		sdddddd CR LF	s:signe s=+ : Positive Packet Step s=- : Negative Packet Step dddddd: value From OOOOOO To SOOOOO
Frequency offset	FAsddddddddd CR LF	s= + : Positive offset s= – : Negative offset ddddd ddd: number	sddddddddd CR LF	s= + : Positive offset s= – : Negative offset ddd ddddd: value
Actual frequency offset	FR CR LF		sddddddddd CR LF	s= + : Positive offset s= – : Negative offset ddd ddddd: value
Frequency drift	FDsddddd CR LF	s= + : Positive drift s= – : Negative drift	sddddd CR LF	s= + : Positive drift s= – : Negative drift ddddd : value in 1E-17/day frequency drift
Align PPSOUT to PPSREF	ALd CR LF	d= 1 : align d= ? : alignment status	d CR LF	d= O: ready for alignment d= 1: alignment in progress d= 2 : no PPS REF

Set PPSOUT delay (rounded to 2OO ns)	DEddddddddd CR LF	ddddddddd=delay in ns. Max 9999998OO ????????? :interrogation	ddddddddd=delay in ns. Max 9999998OO ????????? :interrogation	ddddddddd=delay in ns. Min OOOOOOOOO Max 9999998OO
Send information every second	BTx CR LF	x= O : Stop to send x= 3 : PPSRef position x = S : Status	x= 3 : aaaaaaaaa sbbb CR LF x= S : yyxx CR LF	aaaaaaaaa= PPSOUT vs PPSREF delay in ns. sbbb= fine phase comparator value in approx. ns yyxx= see ST command

RS232 Commands

ID[] : Identification
Answer : TNTMPS-aaa/rr/s.ss
aaa : 001
rr : revision number
s.ss : software version
Example : ID answers TNTMPS-001/01/1.00

Serial number
SN[] : Serial number
Answer : xxxxxx xxxxxx : 6 digits serial number
Example : SN answers 000015

Status
ST[] : Status
Answer : yyxx yy : always 00 (reserved for future use) xx : HEX ASCII status : bit 7 :– bit 6 : backup power active bit 5 : primary power active bit 4 : frequency drift not 0 bit 3 : frequency of set not 0 bit 2 : stepping activity bit 1 : OOL negative loop bit 0 : OOL positive loop
Example : ST answers 0068 (backup and primary power active, frequency of set applied, no frequency drift, system locked)
Note : BT5 send status once per second in the same format.

Single Phase Step
PSs[] : Single phase step
s = +: 1 positive phase step of 10-13 second
– : 1 negative phase step of 10-13 second
Answer : s s : sign of the single phase step
Example : PS+ answers +
Note : Phase adjustment are not absolute value.

Packet phase step
PSsdddddd[] : Packet phase step
s = +: positive phase adjustment
– : negative phase adjustment
dddddd : phase adjustment in 10-13 second
000000 to 500000

000001 : minimum phase adjustment (±1×10-13 s)
500000 : maximum phase adjustment (±5×10-9 s)
000000 : no phase adjustment
Answer : sdddddd sdddddd : phase adjustment value
Example : PS+000100 answers +000100 (a positive phase adjustment of 10-11 second is asked)
Note : Phase adjustment are instantaneous phase changes and are cumulative with previous phase changes.

Actual Phase Adjustment PH[]
Actual phase adjustment Answer : sdddddd
s = +: positive phase adjustment
– : Negative phase adjustment
dddddd : phase adjustment value in 10-13 second step
Example : PH answers -000020 (an total actual negative phase adjustment of 2×10-12 second has been applied)
Note : The actual phase is the accumulated phase changes from the starting of the system. A frequency of set different from 0 reset the phase adjustment to 0.
Example : At To the command PS+000002 has been sent, At T1 the command PS-000007 has been sent, At T2 the command PS+000009 has been sent, At T3 the command PH answers +000004 which corresponds to the total accumulated phase adjustment applied until T3 (2-7+9=4×10-13 second)

Frequency Off set
FAsddddddddd[] : Frequency of set
s = +: positive frequency of set
– : Negative frequency of set
ddddddddd : frequency of set in 10-17 step
00000000 to 10000000
00000001 : minimum frequency of set (±1×10-17)
99999999 : maximum frequency of set (±9.9999999×10-10)
00000000 : no frequency of set
Answer : sddddddddd sddddddddd : frequency of set value
Example : FA+00010000 answers +00010000 (a positive frequency of set of 10-13 relative to input reference frequency is asked)
Note : Frequency of set are absolute value from input reference frequency. A new frequency of set overwrite the previous one.

Actual Frequency Of set
FR[] : Actual frequency of set
Answer : sddddddddd
s = +: positive frequency of set
– : negative frequency of set
ddddddddd : frequency of set in 10-17 step
Example : FR answers -00100000 (a negative frequency of set of 10-12 relative to input reference frequency is applied)
Note : Frequency of set are absolute value from input reference frequency. A new frequency of set overwrite the previous one.
Example : At To the command FA+00600000 has been sent, At T1 the command FA-00020000 has been sent, At T2 the command FR answers -00020000 which is the actual frequency of set (it corresponds to the last frequency of set command applied before T2.)

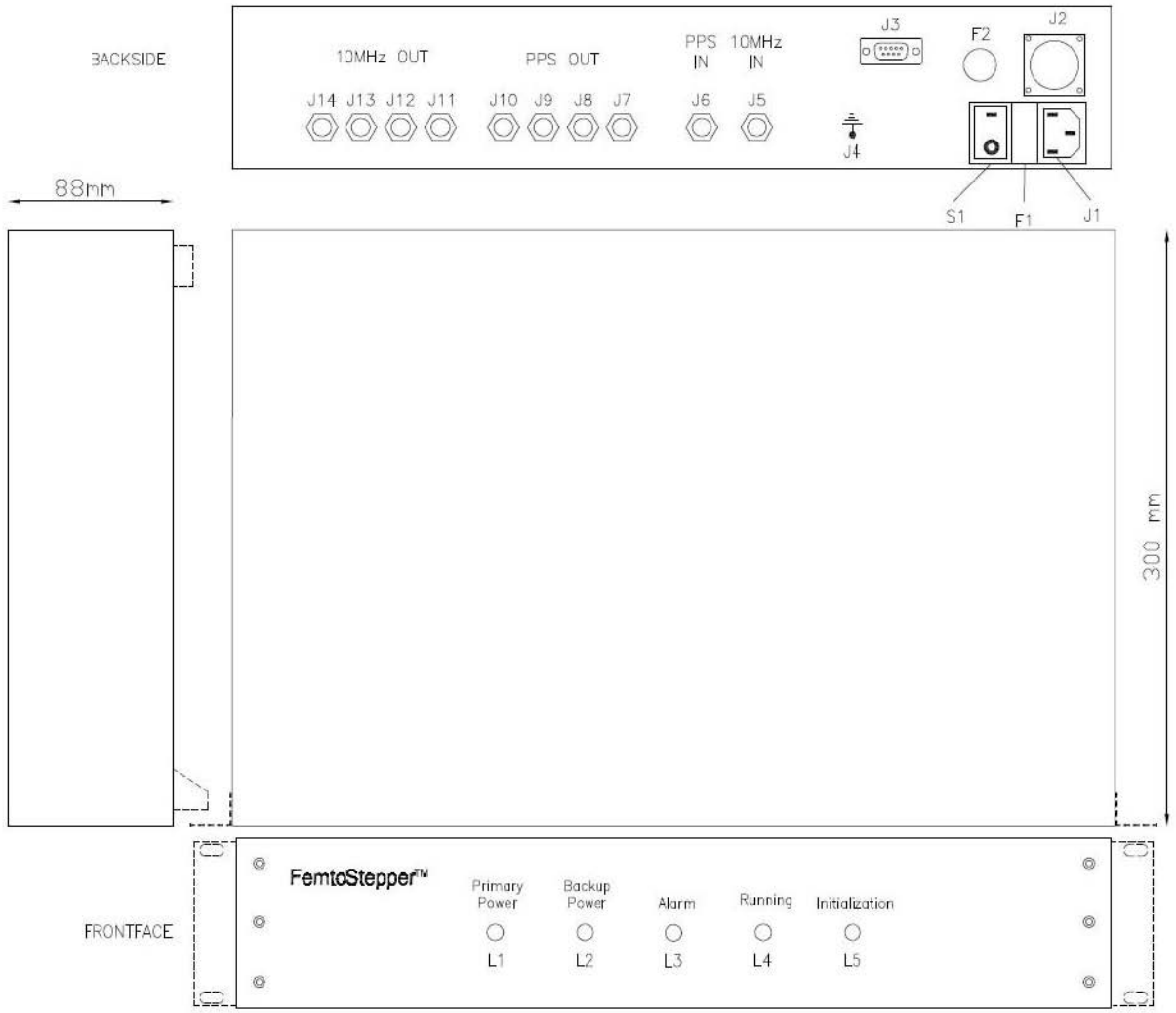
Frequency Drift
FDsdddddCR[LF] : Change the frequency during time
s : positive frequency drift
– : negative frequncy drift
ddddd : frequency drift in E/dayno drift
?????? interrogation
Answer: sddddd : just asked drift or drift actually active
Example: FD??????CR answers . The frequency is increased seconds and this
value can be read back with the command FR.

Pulse Per Second Alignment
ALdCR[LF] : PPSOUT alignment to PPSREF
d : align
? : interrogation
Answer : dCRLF
ready for alignment
alignment in progress
no PPSREF
Example : answers
Notes: While the command is in progress, an internal PPSLOCAL is aligned to PPSREF. This can take up to seconds.
The alignment is done within ns.
After an alignment DE????????? answers
This command has no influence on the MHz output.

PPSOUT Delay
DEddddddddCR[LF] : Set a PPSOUT delay
ddddddddd : delay in ns
no delay
minimum delay
maximum delay
????????? : interrogation
Answer : ddddddddCRLF
ddddddddd : just asked delay
Example : DE?????????CR answers CRLF
Notes : After power on / Reset, the PPSOUT position is random.
After the command AL, the PPSOUT is aligned to PPSREF and the delay is settled to .
This command has no influence on the MHz output.

Information Every Second
BTxCR[LF] : send information once per second on the serial port
x : stop to send
Answer : none
x : PPSOUT vs PPSREF position
Answer : aaaaaaaaa sbbbCRLF once per second
aaaaaaaaa : raw PPSOUT vs PPSREF position in ns, rounded to ns steps
PPSOUT aligned to PPSREF
minimum value
maximum value
????????? : no PPSREF
sbbb : s : sign /- ; bbb : analog ne PPS comparator value in approximately ns. PPSLOCAL vs PPSREF.
PPSLOCAL and PPSREF are perfectly aligned.
lowest value
highest value
Remark : the command ALCRLF must be sent first to bring the PPSLOCAL in the PPS phase comparator working range.
x : Status
Answer : yyxxCRLF once per second
See Status command for details

Mechanical



29 November 2022. Patented FemtoStepper
Specifications subject to change or improvement without notice

www.orolia.com
sales@orolia.com

Documents / Resources

	orolia FemtoStepper 100fs Resolution Phase Stepper [pdf] User Manual FemtoStepper 100fs Resolution Phase Stepper, 100fs Resolution Phase Stepper, Resolution Phase Stepper, Phase Stepper, Stepper

References

- Safran | Navigation and Timing - The World Leader in Resilient PNT