

FemtoStepper - 100fs Resolution Phase Stepper

Easy-to-Use RF Device & Digital Control



Applications

Calibration | Time Transfer | Doppler Shift Compensation | Instrument

Key Application Features

- Easy to use
- High resolution
- Low noise performance
- Digital Control
- COM standard interface

Key Applications

- Time Keeping
- Time Lab device
- Time Transfer
- Frequency Drift Compensation
- Doppler Shift Compensation

FemtoStepper Features

- Input Frequency : 10 MHz
- Output Frequency : 4 x 10MHz (5MHz optional)
- PPS capability : 4 x 1PPS
- Phase-Time Step size : 100fs
- Output Frequency Adjustment : 1E-17 resolution
- RS232 standard interface : 9600 b/s
- No calibration required
- Internal Bit Alarm
- Adaptable mechanical outline : 2U rack mounted chassis
: Instrument with feet
- Main Power Supply : AC input 85-264VAC / 47-63Hz
- Backup Power Supply : DC input 22-28VDC

System Description

The main feature of FemtoStepper is to adjust the output phase or frequency without changing the behavior of the master reference clock. The architecture based on heterodyne technique allows obtaining an extremely high resolution down to 100 femto-seconds. The output is generated from an ultra low-noise crystal oscillator phase-locked to the input improving the phase noise characteristic. The output frequency range is $\pm 1\text{E}-9$ with a fractional resolution of $1\text{E}-17$. The build-in 10MHz signal is used to generate the 1PPS output signal. Through a dedicated command, the 1PPS output can be aligned to a reference 1PPS input signal.

Phase and frequency adjustment function is very useful in applications where users need to compensate the master clock frequency drift (or the Doppler shift in satellite communications system) without changing its internal parameters. Thus, the behavior of the master clock can be assessed during a complete experiment.

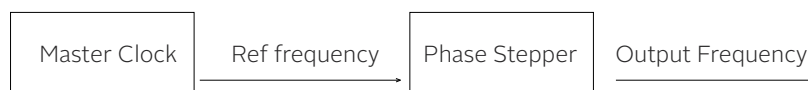


Figure 1- Application Diagram

The output phase or frequency is controlled using a RS232 digital interface through a set of defined commands. Status commands are also included. All commands are checked for correct syntax and valid range before execution.

Mechanic

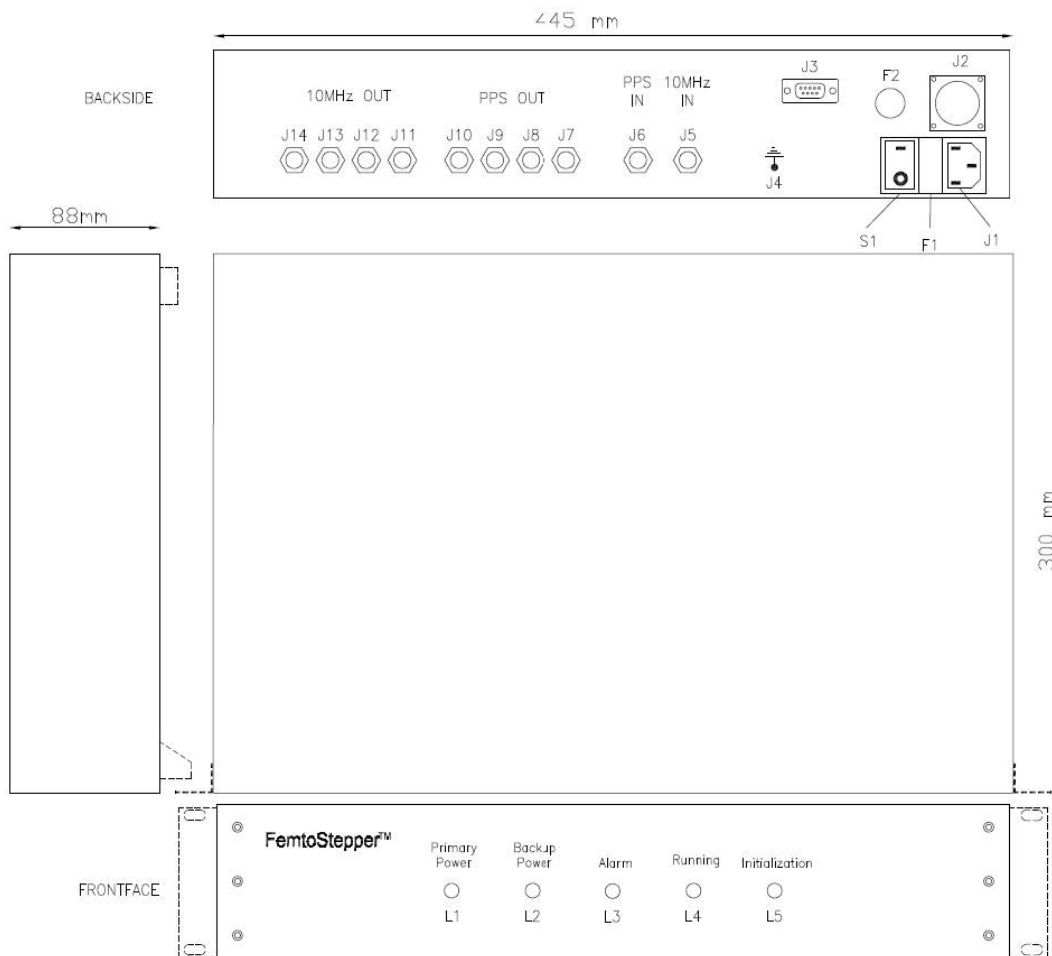


Figure 1- Mechanical Outline

N°	In/Out	Designation	Type
J1	In	230VAC primary power	Schurter KM00.1105.11
J2	In	+24VDC backup power	Jaeger 5306004006
J3	In/Out	COM Interface	Sub-D-9P-FEM, Pin 2 TxD / Pin 3 RxD / Pin 5 GND
J4	-	Ground connection	Screw M4
J5	In	10 MHz reference signal	SMA
J6	In	PPS reference signal	SMA
J7-J10	Out	4x PPS output	SMA
J11-J14	Out	4x 10MHz output	SMA
S1	-	On/Off switch	
F1	-	Primary power supply fuse T 3.15A	
F2	-	Backup power supply fuse T 1.6A	
L1	-	Primary power indicator	Green
L2	-	Backup power indicator	Green
L3	-	Alarm indicator	Red
L4	-	Running indicator	Green
L5	-	Initialization indicator	Yellow

RS-232 Command

The FemtoStepper can accept 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)
Identification	ID <CR><LF>	-	TNTMPS-aaa/rr/s. ss<CR><LF>	aaa: 001 rr: revision number s.ss: software version
Serial number	SN <CR><LF>	-	xxxxxx<CR><LF>	xxxxxx : 6 digits serial nbr
Status	ST <CR><LF>	-	yyxx<CR><LF>	yy : always 00 (for future use) xx : HEX ASCII <u>Bit signification :</u> Bit 7 :- Bit 6 :backup power active Bit 5 :primary power active Bit 4 :frequency drift not 0 Bit 3 :frequency offset not 0 Bit 2 :stepping activity Bit 1 : OOL - Bit 0 : OOL +
Single Phase Step	PS s<CR><LF>	s= + : Positive Step s= - : Negative Step	s<CR><LF>	s: signe s= + : Positive Step s= - : Negative Step
Packet Phase Step	PS sdxxxxx<CR><LF>	s=+ : Positive Packet Step s=- : Negative Packet Step dxxxxx: number	sxxxxx<CR><LF>	s:signe s=+ : Positive Packet Step s=- : Negative Packet Step dxxxxx: value
Actual phase offset	PH <CR><LF>	-	sxxxxx<CR><LF>	s:signe s=+ : Positive Packet Step s=- : Negative Packet Step dxxxxx: value From 000000 To 500000
Frequency offset	FA sxxxxxxxx<CR><LF>	s= + : Positive offset s= - : Negative offset dxxxxxxx: number	sxxxxxxxx<CR><LF>	s= + : Positive offset s= - : Negative offset dxxxxxxx: value in 1E-17 relative frequency offset
Actual frequency offset	FR <CR><LF>	-	sxxxxxxxx<CR><LF>	s= + : Positive offset s= - : Negative offset dxxxxxxx: value in 1E-17 relative frequency offset
Frequency drift	FD sxxxxx<CR><LF>	s= + : Positive drift s= - : Negative drift	sxxxxx<CR><LF>	s= + : Positive drift s= - : Negative drift dxxxx : value in 1E-17/day frequency drift
Align PPSOUT to PPSREF	AL d<CR><LF>	d= 1 : align d= ? : alignment status	d<CR><LF>	d= 0: ready for alignment d= 1: alignment in progress d= 2: no PPSREF
Set PPSOUT delay (rounded to 200ns)	DE xxxxxxxx<CR><LF>	xxxxxxxx=delay in ns. Max 999999800 ???????? :interrogation	xxxxxxxx<CR><LF>	xxxxxxxx=delay in ns. Min 000000000 Max 999999800
Send information every second	BT x<CR><LF>	x= 0 : Stop to send x= 3 : PPSRef position x= 5 : Status	x= 3 : aaaaaaaa sbbb<CR><LF> x= 5 : yyxx<CR><LF>	aaaaaaaa= PPSOUT vs PPSREF delay in ns. sbbb= fine phase comparator value in approx. ns yyxx= see ST command

Table 1 : Serial commands summary

SPECIFICATIONS

ELECTRICAL

Type	FemtoStepper	
	Standard version	
10MHz input frequency	10MHz	
10MHz input amplitude	+9dBm to +15dBm	
10MHz input impedance	45Ω to 55 Ω	
Number of 10MHz outputs	4 x10MHz	(Option code : ' 5M') 4 x 5MHz
10MHz output amplitude	+11dBm to +15dBm	
10MHz output impedance	45Ω to 55Ω	
10MHz output connector	SMA female	
10MHz output to output isolation	≥ 50dB	
10MHz output phase noise 5MHz (typical -6dBc from 10MHz figures)	-90dBc / 1Hz -110dBc / 10Hz -130dBc / 100Hz -140dBc / 1KHz -150dBc / 10KHz -150dBc / 100KHz	(Ordering Code S) -100dBc / 1Hz -125dBc / 10Hz -140dBc / 100Hz -150dBc / 1KHz -155dBc / 10KHz -160dBc / 100KHz
Frequency Stability (with a relative frequency adjustment ≤1E-12)	3x10 ⁻¹³ / 1s 4x10 ⁻¹⁴ / 10s 7x10 ⁻¹⁵ / 100s 4x10 ⁻¹⁵ / 1'000s 2x10 ⁻¹⁵ / 10'000s	
Relative frequency offset resolution	1E-17	
Phase step resolution on 10MHz output	0.1 ps	
Maximum frequency offset range	± (1x10 ⁻⁹ -1x10 ⁻¹⁷)	
Temperature sensitivity (input reference to outputs)	≤ 20ps / °C	
1PPS input amplitude	TTL compatible level	
1PPS input impedance	45Ω to 55Ω	
Number of PPS outputs	4x 1PPS	
1PPS output amplitude	≥ 2.3V	
1PPS output impedance	45Ω to 55Ω	
1PPS output pulse width	18μs to 22μs	
1PPS output rise time	≤ 5ns	
Phase offset between outputs	≤ 10ns	
Phase stepping command	By RS232	
Frequency offset command		
Status command		
Bit alarm		

ENVIRONMENT

Type	FemtoStepper	
	Temperature	Relative Humidity
Operating	20 to 30°C	10% - 85%
Recommended operating	25°C ± 1%	50% ± 10%
Storage	-25 to 55°C	
Transportation	-25 to 70°C	

POWER REQUIREMENTS

Type	FemtoStepper	
	Standard version	
Input Range	85-264 VAC or 22-28 VDC	
Frequency	47 - 63 HZ	
Power Consumption @25°C	< 40W after warm-up	
Connector Type	230VAC IEC plug	

PHYSICAL:

Type	FemtoStepper	
	Standard version	
Size	445 x 300 x 88 mm (2U)	
Weight	6.0 Kg	
	Front connector Rack (Option R)	

