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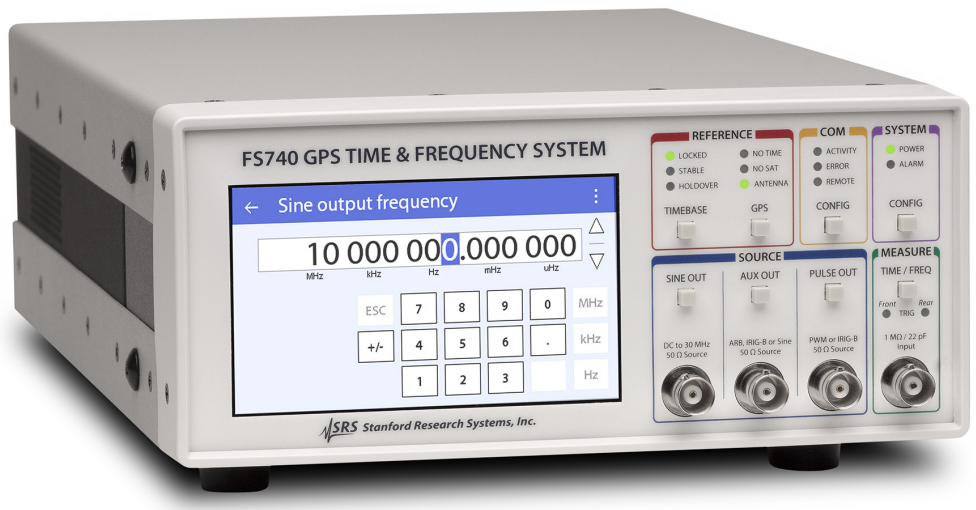
Frequency Standards

FS740 — GPS/GNSS Time and Frequency System



FS740 GNSS Time and Frequency System

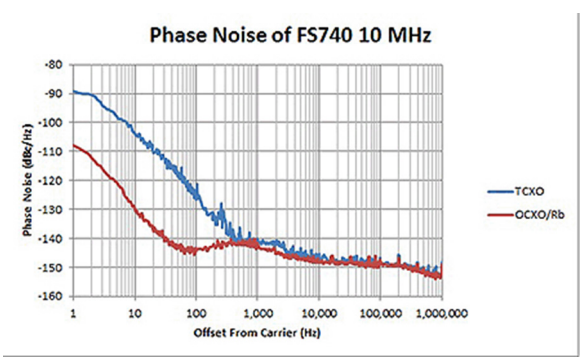
- GPS/GNSS disciplined 10 MHz
- 1×10^{-13} long-term stability
- Time tag events to UTC or GPS
- Sine, square, triangle, IRIG-B output
- Frequency counter with 12 digits/s
- Built-in distribution amplifiers
- Ethernet & RS-232 interfaces

- FS740

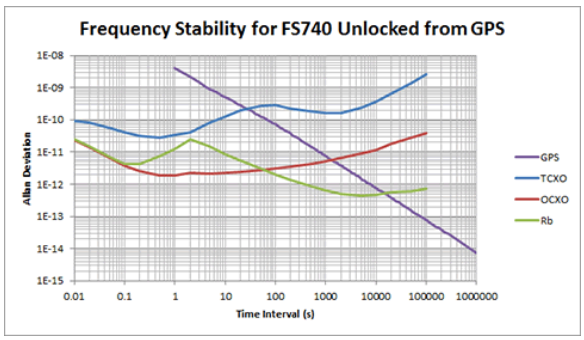
The FS740 GPS/GNSS Time and Frequency System provides a 10 MHz frequency reference with a long-term stability of better than 1×10^{-13}. The instrument can also time tag external events with respect to UTC or GPS and measure the frequency of user inputs. The instrument has DDS synthesized frequency outputs, adjustable rate (and width) pulse outputs, and an AUX output for arbitrary waveforms including an IRIGB timecode output.

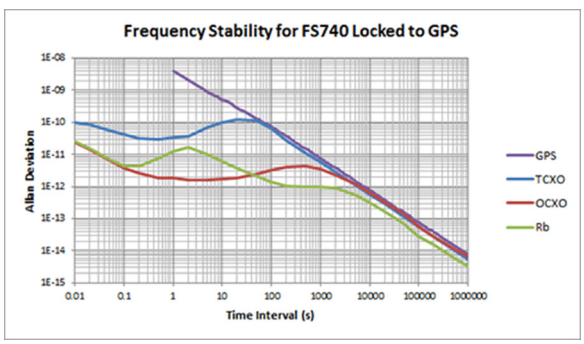
Standard, OCXO, or Rubidium Timebase

The standard timebase provides 1×10^{-9} short-term frequency stability and phase noise of less than –100 dBc/Hz (10 Hz offset). An optional OCXO (ovenized crystal oscillator) timebase provides 1×10^{-11} short-term frequency stability and phase noise of less than –130 dBc/Hz (10 Hz offset). An optional



rubidium timebase provides 1×10^{-12} short-term frequency stability, phase noise of less than –130 dBc/Hz (10 Hz offset), and a long-term holdover (lost GNSS signal) of better than 1 µs/day.





Both optional timebases (OCXO or rubidium) provide a dramatic improvement in the holdover characteristics, a 30 dB reduction in the phase noise and a tenfold reduction in the TDEV (rms timing deviation). There are some users who would not need this performance improvement. For example, users who only need time tags with 1 µs accuracy or frequency measurements with 1×10^{-8} accuracy could use the standard timebase.

GNSS Receiver

The FS740 provides bias for a remote active GNSS antenna. The unit's GNSS receiver tracks all satellites in view, automatically surveys and fixes its position, then uses all received signals to optimize its timing solution. The FS740 time-tags the 1 pps output from the receiver, corrects the result for the receiver's sawtooth error, then phase locks the timebase to the GNSS 1 pps. The TDEV between two instruments is a few nanoseconds.

If the GNSS signal is lost, the timebase is left at the last locked frequency value. The timebase will age or drift in frequency by up to ±2 ppm (for the standard timebase), ±0.05 ppm/year and ±0.002 ppm (0 to 45 °C) for the OCXO, and ±0.001 ppm/year and ±0.0001 ppm (0 to 45 °C) for the rubidium timebase.

GNSS Antennas

You may choose to purchase a GNSS antenna from SRS, or a third party, or use an existing GNSS antenna at your facility.

SRS timing receivers require a net gain (after cable losses) of +20 dBi to +32 dBi, which is a very common level from a variety of available active antennas and typical cable lengths. The antenna input to SRS timing receivers have a female BNC connector, provide +5 V bias, and have a 50 Ω input impedance.

SRS offers two antenna solutions, both of which have LNAs. All systems components have a 50 Ω characteristic impedance.

Indoor Antenna

Outdoor Antenna Kit

Graphical User Interface

A graphical user interface allows the user to configure the instrument and see the results of time and frequency measurements. The instrument can be configured in one of three modes: There are two user inputs (one on the front, one on the rear-panel) for frequency and time tag events. The inputs have adjustable thresholds and slopes. Frequencies are measured with a precision of 1×10^{-11} in 1 s, 1×10^{-12} in 10 s, and 1×10^{-13} in 100 s. Time tags are reported with 1 ps resolution which is comparable to the short-term stability of the OCXO and rubidium timebases. Time tags will have an error of about 10 ns rms with respect to UTC or GPS time.

Front and Rear Panel

The FS740 has a rear-panel low phase noise (–130 dBc/Hz at 10 Hz offset) 10 MHz sine output with an amplitude of 1 Vrms. Up to 15 additional copies of the 10 MHz output are available via optional rear-panel outputs.

The FS740 has front-panel and rear-panel SINE outputs which provide sine outputs from 1 µHz to 30.1 MHz with 1 µHz resolution, or a fixed 100 MHz, with adjustable amplitude from 100 mV to 1.2 V rms. Up to 15 additional copies of the SINE outputs are available via optional rear-panel outputs.

The FS740 has front-panel and rear-panel PULSE outputs which can provide low jitter (<50 ps rms) pulses from 1 µHz to 30.1 MHz. The PULSE outputs have adjustable phase with respect to UTC and the pulse width can be set as narrow as 5 ns, or as wide as the entire pulse period minus 5 ns, with 10 ps resolution. Up to 15 additional copies of the PULSE outputs are available via optional rear-panel outputs.

The FS740 has front-panel and rear-panel AUX outputs which can generate standard or arbitrary waveforms (sine, ramp, triangle, etc.) The AUX output can also provide an IRIG-B timecode output. Both width coded pulses and amplitude modulated sine waves (with carrier frequencies from 100 Hz to 1 MHz) are available for the IRIG-B outputs. Up to fifteen additional copies of the AUX output are available via optional rear-panel outputs.

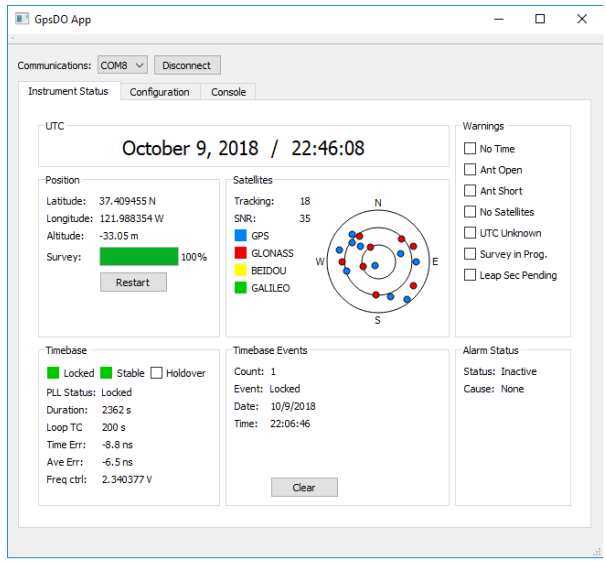
A rear-panel alarm relay is set if power is lost or under user defined conditions including: timebase fault, loss of GNSS reception, or any failure to maintain phase lock between the timebase and the GNSS signal. The relay has both normally open and closed outputs.

Distribution Amplifiers

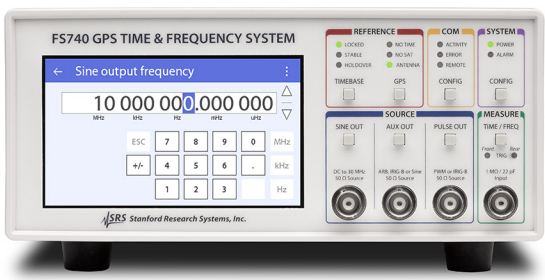
Optional distribution amplifiers, each providing six additional rear-panel outputs for the 10 MHz, SINE, PULSE, AUX or IRIG-B outputs, can be installed. Up to three distribution amplifiers can be installed and configured from the front panel. Each output has its own driver which provides high isolation between outputs.

Communication

The FS740 can be controlled and queried over its Ethernet and USB ports. The instrument is fully programmable using its extensive high-level command set, and there is also a free GNSSDO application that makes sending commands, viewing instrument status, and changing the configuration of the FS740 easy.



GNSSDO application



FS740 front panel

FS740 rear panel

Standard TCXO Timebase

Oscillator type	Oven controlled, 3rd OT, AT-cut crystal
Temp. Stability	$<2 \times 10^{-6}$ (20 to 30 °C)
Aging	<5 ppm/year (undisciplined to GPS)
Phase noise (SSB)	<–105 dBc/Hz (typical)
Stability	$<3 \times 10^{-10}$ (1 s) $<3 \times 10^{-10}$ (10 s) $<2 \times 10^{-10}$ (100 s) $<2 \times 10^{-11}$ (1000 s) $<1 \times 10^{-12}$ (24 hr)
Holdover	<40 µs / 24 hr.

OCXO Timebase

Oscillator type	Oven controlled, 3rd OT, SC-cut crystal
Temp. Stability	$<2 \times 10^{-9}$ (20 to 30 °C)
Aging	<0.2 ppm/year (undisciplined to GPS)
Phase noise (SSB)	<–130 dBc/Hz (typical)
Stability	$<1 \times 10^{-11}$ (1 s) $<1 \times 10^{-11}$ (10 s) $<1.5 \times 10^{-11}$ (100 s) $<1 \times 10^{-11}$ (1000 s) $<5 \times 10^{-13}$ (24 hr)

Rubidium Timebase

Oscillator type	Oven controlled, 3rd OT, SC-cut crystal
Physics package	Rb vapor frequency discriminator
Temp. Stability	$<2 \times 10^{-10}$ (20 to 30 °C)
Aging	<0.0005 ppm/year (undisciplined to GPS)
Phase noise (SSB)	<–130 dBc/Hz (typical)
Stability	$<3 \times 10^{-11}$ (1 s) $<1 \times 10^{-11}$ (10 s) $<3 \times 10^{-12}$ (100 s) $<2 \times 10^{-12}$ (1000 s) $<5 \times 10^{-13}$ (24 hr)

GNSS Receiver

Satelite acq. time	Less than 1 minute (typ.)
Almanac acq. time	Approximately 15 minutes when continuously tracking satellites
Optimized for static applications	Over determined clock mode enables receiver to use all satellites for timing Gates
Accuracy of UTC	<100 ns
Time wander	<15 ns rms (in over determined clock mode)
Antenna delay correction range	±0.1 s

Sine Output

Frequency range	1 mHz to 30.1 MHz
Frequency resolution	1 µHz
Frequency error	<10 pHz + timebase error × FC
Phase settability	1 mDeg
Phase accuracy	<1 ns (to internal reference)
Amplitude	10 mVpp to 1.414 Vpp
Amplitude resolution	<1 %
Amplitude accuracy	±5 %
Harmonics	<–40 dBc
Spurious	<–70 dBc
Output coupling	DC, 50 Ω ±2 %
User load	50 Ω
Reverse protection	±5 VDC

Aux Output

Output options	Sine, Triangle, Square, 100 MHz, AM IRIG-B
Frequency range	1 mHz to 10 MHz (sine) 1 mHz to 1 MHz (triangle or square) 100 MHz (100 MHz sine) 1 kHz (AM IRIG-B)
Frequency resolution	1 µHz
Frequency error	<10 pHz + timebase error × FC
Phase settability	1 mDeg (cannot adjust phase of 100 MHz sine output)
Amplitude	10 mVpp to 1.414 Vpp (sine, triangle, square) 2.75 dBm ±0.5 dBm (100 MHz)
Amplitude resolution	<1 %
Amplitude accuracy	±5 %
Harmonics	<–40 dBc
Spurious	<–70 dBc
Output coupling	DC, 50 Ω ±2 %
User load	50 Ω
Reverse protection	±5 VDC

Pulse Output

Output options	Period/width, Freq/duty, Pulse IRIG-B
Period	40 ns to 1000 s
Width	5 ns to (Period – 5 ns)
Period/width resolution	1 ps
Frequency range	1 mHz to 25 MHz
Frequency resolution	1 µHz
Frequency error	<10 pHz + timebase error × FC
Jitter	<50 ps rms
Level	+5 V CMOS logic
Transition time	<2 ns
Source impedance	50 Ω

10 MHz Output

Amplitude	13 dBm
Amplitude accuracy	±1.5 dBm
Harmonics	<–50 dBc
Spurious	<–90 dBc (100 kHz BW)
Output coupling	DC, 50 Ω ±2 %
User load	50 Ω
Reverse protection	±5 VDC

Time and Frequency Input

Time tag resolution	1 ps
Time tag jitter (rms)	<50 ps
Frequency resolution	1 µHz
Measurement stability	$<5 \times 10^{-12}$ (1 s gate), synchronous with fast averaging enabled $<5 \times 10^{-11}$ otherwise

Computer Interfaces

Ethernet (LAN)	10/100 Base-T. TCP/IP & DHCP
RS-232	4.8k-115.2k baud, RTS/CTS flow

General

AC power	90 to 264 VAC, 90 W 47 to 63 Hz with PFC
EMI Compliance	FCC Part 15 (Class B), CISPR-22 (Class B)
Dimensions	8.5” × 3.5” × 13” (WHL)
Weight	10 lbs.
Warranty	One year parts and labor on defects in materials and workmanship

Ordering Information

FS740	GPS Time and Frequency System
Option 01	OCXO timebase
Option 02	Rubidium timebase
Option A	Five 10 MHz outputs
Option B	Five Sine/Aux outputs
Option C	Five Pulse outputs
O740ANT1	Indoor antenna
O740ANT2	Outdoor antenna