Frequency Standards

FS740 — GPS/GNSS Time and Frequency System

• GPS/GNSS disciplined 10 MHz
• $1 \times 10^{-13}$ 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 ... $2950$ (U.S. list)

FS740 GNSS Time and Frequency System

The FS740 GPS/GNSS Time and Frequency System provides a 10 MHz frequency reference with a long-term stability of better than $1 \times 10^{-13}$. 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 $1 \times 10^{-9}$ short-term frequency stability and phase noise of less than $-100$ dBc/Hz (10 Hz offset). An optional OCXO (ovenized crystal oscillator) timebase provides $1 \times 10^{-11}$ short-term frequency stability and phase noise of less than $-130$ dBc/Hz (10 Hz offset). An optional
rubidium timebase provides $1 \times 10^{-12}$ short-term frequency stability, phase noise of less than $-130 \text{ dBc/Hz}$ (10 Hz offset), and a long-term holdover (lost GNSS signal) of better than 1 μs/day.

SRS timing receivers require a net gain (after cable losses) of $+20 \text{ dBi}$ to $+32 \text{ dBi}$, 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 $+5 \text{ V}$ 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.

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 $1 \times 10^{-8}$ 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.
**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 $1 \times 10^{-11}$ in 1 s, $1 \times 10^{-12}$ in 10 s, and $1 \times 10^{-13}$ 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.
## FS740 Specifications

### Standard TCXO Timebase
- **Oscillator type**: Oven controlled, 3rd OT, AT-cut crystal
- **Temp. Stability**: $<2 \times 10^{-6}$ (20 to 30 °C)
- **Aging**: $<0.5$ ppm/year (undisciplined to GPS)
- **Phase noise (SSB)**: $<-105$ dBc/Hz (typical)
- **Stability**: See graphs next page
- **Holdover**: $<40 \mu$s / 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**: See graphs next page

### 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**: See graphs next page

### GNSS Receiver
- **Satellite 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**: $\pm 0.1$ s

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

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

### Pulse Output
- **Output options**: Period/width, Freq/duty, Pulse IRIG-B
- **Period**: 40 ns to 1000 s
- **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**: $\pm 1.5$ dBm
- **Harmonics**: $<-50$ dBc
- **Spurious**: $<-90$ dBc (100 kHz BW)
- **Output coupling**: DC, 50 Ω ±2 %
- **User load**: 50 Ω
- **Reverse protection**: $\pm 5$ 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
- **Otherwise**: $<5 \times 10^{-11}$
**FS740 Time and Frequency System**

### 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
- **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

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<th>Option Code</th>
<th>Description</th>
<th>Price</th>
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<td>Option 01</td>
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<td>Option A</td>
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