

Frequency Standards

FS700 — LORAN-C frequency standard



FS700 LORAN-C Frequency Standard

- **10^{-12} long-term stability**
- **10^{-10} short-term stability (10^{-11} opt.)**
- **NIST traceable frequency standard**
- **Reception throughout most of the northern hemisphere**
- **Four 10 MHz outputs**
- **Phase detector with analog output**
- **0.01 Hz to 10 MHz TTL output**

• **FS700 ... \$2950 (U.S. list)**

Many complex electronic systems require a stable, highly accurate timebase. Communication, automatic test and measurement, and precision time-measurement systems all require accurate frequency standards. Traditionally, users have looked to atomic clocks (cesium) for high stability and accuracy. With the FS700 LORAN-C Frequency Standard, cesium-clock stability is now available at a fraction of the cost of atomic standards. The FS700 serves as a NIST traceable frequency reference in the US, Europe and Asia.

Cesium Stability

More than 50 LORAN-C transmitters are maintained throughout the Northern Hemisphere by the US Coast Guard. The timing of their transmissions is controlled by cesium clocks located at each transmitter site. The FS700 extracts the timing information from the transmitted signal and uses it to frequency-lock its own highly stable oscillator. The result is a 10 MHz output signal with the same stability as the cesium clock used to generate the LORAN-C transmissions.

Frequency Outputs and Phase Detector

Four 10 MHz sine wave outputs are available at the rear panel of the instrument, and an additional front-panel, adjustable frequency TTL source is also provided. A built-in phase detector measures the phase shift between an external timebase and the internal frequency source, allowing you to easily calibrate precision oscillators between 100 kHz and 10 MHz.

LORAN-C Station List

West Coast USA 99400 μ s	Fallon, Nevada, USA George, Washington, USA Middletown, California, USA Searchlight, Nevada, USA	Saudi Arabia North 88300 μ s	Afif, SA Salwa, SA Al Hamasin, SA Ash Shaykh Humayd, SA
Canadian West Coast 59900 μ s	Williams Lake, BC, Canada Shoal Cove, Alaska, USA George, Washington, USA Port Hardy, BC, Canada	Saudi Arabia South 70300 μ s	Al Muwassam, SA Al Khamasin, SA Salwa, SA Afif, SA
North Central USA 82900 μ s	Havre, Montana, USA Baudette, Minnesota, USA Gillette, Wyoming, USA Williams Lake, BC, Canada	Western Russia 80000 μ s	Ash Shaykh Humayd, SA Al Muwassam, SA Bryansk, Russia Petrozavodsk, Russia
South Central USA 96100 μ s	Boise City, Oklahoma, USA Gillette, Wyoming, USA Searchlight, Nevada, USA Las Cruces, New Mexico, USA	Eastern Russia 79500 μ s	Solnim, Russia Simferopol, Ukraine Syzran, Russia Aleksandrovsk, Russia
Great Lakes 89700 μ s	Raymondville, Texas, USA Grangeville, Louisiana, US Dana, Indiana, USA Malone, Florida, USA		Petrozavodsk, Russia Ussuriysk, Russia Tokachibuto, Japan Ohotosk, Russia
	Seneca, New York, USA Baudette, Minnesota, USA Boise City, Oklahoma, USA Malone, Florida, USA	East Asian 99300 μ s	Pohang, Korea Kwang-Ju, Korea Gesashi, Okinawa Nijijima, Japan
Southeast USA 79800 μ s	Grangeville, Louisiana, USA Raymondville, Texas, USA Jupiter, Florida, USA Carolina Beach, NC, USA	China North Sea 74300 μ s	Ussuriisk, Russia Rongcheng, PRC Xuancheng, PRC Helong, PRC
Northeast USA 99600 μ s	Seneca, New York, USA Caribou, Maine, USA Nantucket, Massachusetts, USA Carolina Beach, NC, USA	China East Sea 83900 μ s	Xuancheng, PRC Raoping, PRC Rongcheng, PRC Hexian, PRC
	Dana, Indiana, USA Caribou, Maine, USA Nantucket, Mass., USA Cape Race, Newfoundland, Fox Harbor, Labrador, Canada	China South Sea 67800 μ s	Raoping, PRC Chongzuo, PRC Nijijima, Japan Gesashi, Okinawa
Canadian East Coast 59300 μ s	Fox Harbor, Canada Comfort Cove, Canada Cape Race, Canada Fox Harbor, Canada	Northwest Pacific 89300 μ s	Miamitorishima, Japan Tokatibutto, Hokkaido, Japan Pohang, Korea Petropavlo, Russia
Newfoundland Coast 72700 μ s	Bo Norway Jan Mayen, Norway Berlevag, Norway	Russia-American 59800 μ s	Attu, Alaska Aleksandrovsk, Russia St. Paul, Pribilof Is, Alaska, USA
Bo 70010 μ s	Eidi, Faeroe Island, Denmark Jan Mayen, Norway Bo, Norway Vaerlandet, Norway	North Pacific 99900 μ s	Point Clarence, Alaska, USA Narrow Cape, Kodiak Is, USA Tok, Alaska, USA
Eidi 90070 μ s	Loop Head, Ireland Leassay, France Soustons, France Loop Head, Ireland	Gulf of Alaska 79600 μ s	Narrow Cape, Kodiak Is, USA Shoal Cove, Alaska, USA Port Clarence, Alaska, USA
Leassay 67310 μ s	Sylt, Germany Sylt, Germany Lessay, France Vaerlandet, Norway	Bombay 60420 μ s	Dhrangadhr, India Veraval, India Billamora, India
Sylt 74990 μ s	Sellia Marina, Italy Lampedusa, Italy Estartit, Spain Kargabaru, Turkey	Calcutta 55430 μ s	Balasore, India Diamond Harbour, India Patpur, India
Mediterranean Sea 79900 μ s			

Receiver

Sensitivity	Will lock with signal-to-atmospheric noise ratio of -10 dB or better
LORAN output	Filtered and gain controlled antenna signal, typically 6 Vpp
Station search	All available stations programmed, Auto-Seek finds and tracks strongest station
Notch filters	Six adjustable -30 dB notch filters (three at 40 to 90 kHz, three at 110 to 220 kHz)

Frequency

Frequency stability	
Long-term	10 ⁻¹² (same as LORAN-C transmitter cesium clock)
Short-term	10 ⁻¹⁰ (standard oscillator) 10 ⁻¹¹ (low phase noise option)
Outputs	Four 10 MHz outputs, 1 Vpp sine into 50 Ω
LOCK output	Rear-panel TTL indicates receiver lock
Front-panel output	TTL level output from 0.01 Hz to 10 MHz in a 1-2.5-5 sequence

Internal Oscillator

	<i>Standard</i>	<i>Option 01</i>
Frequency	10.000 MHz	10.000 MHz
Type (ovenized)	AT-cut	SC-cut
Aging	5 × 10 ⁻¹⁰ /day	5 × 10 ⁻¹⁰ /day
Allan variance (1s)	5 × 10 ⁻¹¹	5 × 10 ⁻¹²
Stability (0 to 50 °C)	5 × 10 ⁻⁹	<2 × 10 ⁻⁹
Phase noise		
10 Hz		-125 dBc/Hz
100 Hz	-130 dBc/Hz	-155 dBc/Hz
1 kHz		-165 dBc/Hz

Phase Meter

Frequency output	0.01 Hz to 10 MHz in 1-2.5-5 sequence, TTL level. Can be 50 Ω terminated.
Oscillator input	1 kΩ, 0.5 V min., 5.0 V max.
Phase output	0.01 V/degree, 0 to ±360°. Output proportional to phase difference between OSC IN and FREQUENCY OUTPUT for frequencies between 100 kHz and 10 MHz.

Computer Interface

GPIB (standard)	IEEE-488 compatible interface. All instrument functions can be controlled.
RS-232 (optional)	300 baud to 19,200 baud DCE serial interface. All instrument functions may be controlled.

Antenna

Type	100 kHz active antenna with 40 kHz bandwidth band-pass filter in base
Height	102"
Material	Fiberglass whip
Base	2" dia. × 7.5", PVC
Mounting	3/4" FIPT
Output	50 Ω nominal, female BNC
Environmental	-40 °C to 60 °C, 0 % to 100 % RH
Lightning protection module (opt.)	
Surge	18,000 A IEEE 8/20 waveform (based on ANSI C62.1)
Frequency range	DC to 30 MHz
Throughput energy	<16 μJ (based on 1 kV/nS waveform)
Insertion loss	<0.25 dB

General

Operating Power	0 °C to 50 °C 100/120/220/240 VAC, 50/60 Hz, 50 W
Dimensions	17" × 3.5" × 17" (WHD)
Weight	14 lbs.
Warranty	One year parts and labor on defects in materials and workmanship



FS700 rear panel

Ordering Information

FS700	LORAN-C receiver (w/ GPIB, rack mount kit and antenna)	\$2950
Option 01	Low phase noise oscillator	\$450
Option 02	RS-232 interface	\$350
O700ANT	Replacement antenna	\$250
O700LNG	Lightning protection module	\$100
FS710	10 MHz distribution amplifier	\$1000