EndRun TECHNOLOGIES
"Smarter Timing Solutions"

Meridian *Options*

For Customizing the Meridian Precision GPS TimeBase

The new Meridian Precision GPS TimeBase is a high-performance, full-featured system that provides unparalleled accuracy and reliability. The modular design allows for easy, field-installable upgrades that can satisfy virtually any time and frequency requirement. Advanced packaging techniques, coupled with compact card design, permit the installation of up to five option boards in a single 1U chassis.

Highly-Reliable, Modular Design

A complete suite of time and frequency capabilities with an exceptionally high number and variety of outputs are provided in a 1U chassis. To achieve this level of output density in a fanless, sealed chassis, EndRun Technologies has set a new standard in power efficiency and thermal packaging. The solid-state design yields a conservative MTBF of 25 years, and a wide range of option cards make it easy to tailor the unit to support your application. In addition, the modular, plug-and-play design allows EndRun engineers to easily develop customized options specifically for your requirements.

Plug-and-Play Options

The optional modules described in this datasheet are all plug-and-play options. The built-in option card recognition software lets you swap out modules at ease, without having to change your software. The Meridian software will automatically recognize the change and behave accordingly.

Custom Solutions

The engineers at EndRun Technologies have decades of experience delivering precise time and frequency solutions. There are other options available that are not listed in this datasheet. If you do not see what you are looking for then call us with your requirements. We will work with you to develop the specifications and design the products to fulfill your needs.

OPTIONS LIST

- Analog Timecode Buffer Module
- Programmable Digital Output Module
- Low-Phase-Noise Output Module
- 10 MPPS Output
- Alarm Output
- Programmable Pulse Rate Output
- DC-Shift Time Code Output
- Direct Digital Synthesizer (DDS) Output
- Once-Per-Second Serial Output, Including Sysplex Timer
- Oscillator Upgrade Options

A fully-optioned Meridian chassis with a High-Stability OCXO, two 10 MHz Low-Phase-Noise Boards (8 outputs) and three Analog Timecode Buffer Boards (12 outputs)..

CPU Module Options

The CPU Module is always present in the Meridian Precision TimeBase. It provides several outputs as standard features. These are the AM Code (Time Code) Output, the 1PPS Output, the Serial Port and the Network Port. The Network Port includes all the standard network protocols plus the Network Time Protocol (NTP). Specifications for these standard features are listed on the Meridian Datasheet.

In addition to the standard features the CPU Module can support several options via the two upper left BNC connectors. These include a Programmable Pulse Rate Output, a DC-Level-Shift Time Code Output, a DDS Output, an Alarm Output, and a second RS-232 serial port with a once-per-second, on-time, serial timestring. Specifications are below:

10 MPPS OUTPUT

- Quantity: One or two.
- Connector: Rear-panel BNC labeled "10 MPPS".
- Drive: TTL squarewave into 50Ω.
- Rate: 10 MPPS (other rates available).
- Accuracy: $< 10^{-13}$ to UTC for 24-hour averaging times when locked.
- Stability: See Stability Specifications for Programmable Pulse Rate Output below.

PROGRAMMABLE PULSE RATE OUTPUT

- Quantity: One or two.
- Connector: Rear-panel BNC labeled "Prog TTL".
- Drive: TTL squarewave into 50Ω.
- User-Selectable Rates: 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS or DC Time Code.
- Accuracy: $< 10^{-13}$ to UTC for 24-hour averaging times when locked.
- Stability (Allan Deviation):

Tau in Secs	TCXO	MS-OCXO	HS-OCXO	Rb	HS-Rb
1	$1x10^{-9}$	$3x10^{-12}$	$1x10^{-12}$	$2x10^{-11}$	$2x10^{-11}$
10	$4x10^{-10}$	$4x10^{-12}$	$1.2x10^{-12}$	$6.7x10^{-12}$	$6.67x10^{-12}$
100	$5x10^{-11}$	$5.5x10^{-12}$	$1.8x10^{-12}$	$2.5x10^{-12}$	$2x10^{-12}$
1000	$7x10^{-12}$	$5x10^{-12}$	$2.2x10^{-12}$	$1.4x10^{-12}$	$9x10^{-13}$
10000	$1x10^{-12}$	$1x10^{-12}$	$1x10^{-12}$	$8x10^{-13}$	$5x10^{-13}$
100000	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$

DIRECT DIGITAL SYNTHESIZER (DDS) OUTPUT

The DDS Output is an add-on to the Programmable Pulse Rate Output listed above.

- Quantity: One or two.
- Connector: Rear-panel BNC labeled "Prog TTL".
- Signal: TTL squarewave into 50Ω.
- Drive: TTL squarewave into 50Ω.
- User-Selectable Synthesized Rates: 1 PPS to 10M PPS in 1 PPS steps, including 1.544M PPS and 2.048M PPS. These rates are phase locked to the system oscillator.

DC-SHIFT TIME CODE OUTPUT

The DC Time Code Output is included with the Programmable Pulse Rate Output. When you choose DC Time Code as your selection then it will be a TTL version of the same time code format that is being output on the AM Code BNC.

- Quantity: One or two.
- Connector: Rear-panel BNC labeled "Prog TTL".
- Signal: TTL squarewave into 50Ω.
- User-Selectable Formats: IRIG-B000 (IEEE-1344), IRIG-B002, IRIG-B003

ALARM OUTPUT

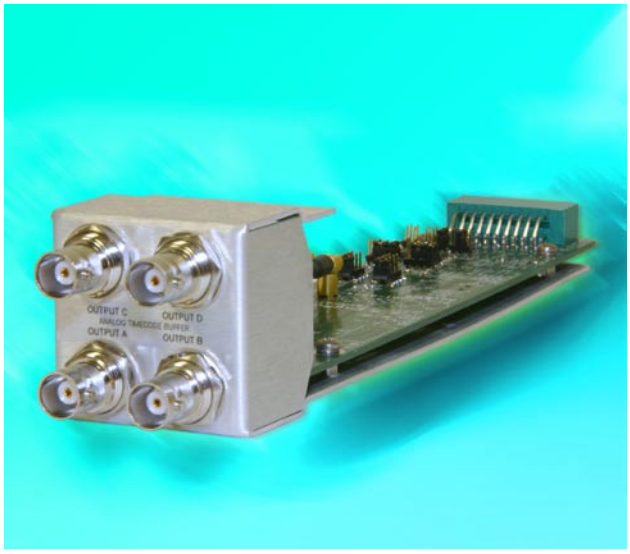
- Quantity: One.
- Connector: Rear-panel BNC labeled "Alarm" or Barrier Strip (replaces 2 upper BNCs - not shown).
- Open Collector, 40V Max, 100 mA Max Saturation Current.
- High impedance after signal loss or at major hardware fault.

ONCE-PER-SECOND SERIAL OUTPUT

- Quantity: One.
- Connector: Rear-panel DB-9M Connector (replaces 2 upper BNCs - not shown).
- Serial I/O: Output only port at RS-232 levels. Baud rate 9600.
- ASCII Format: Two different formats are available and must be configured at the factory.
  Sysplex Timer Compatible Format: <SOH>DDD:HH:MM:SSQ<CR><LF>
  or EndRun Format: T YYYY:DDD:HH:MM:SS zZZ m<CR><LF>
  where: <SOH> is the Start-of-Header character (0x01).
  T is the Time-Figure-Of-Merit (TFOM) character.
  YYYY is the Year.
  DDD is the Day-of-Year.
  HH is the Hour-of-Day.
  MM is the Minutes.
  SS is the Seconds.
  Q is the Quality Indicator.
  z is the sign of the offset to UTC, + or -
  ZZ is the magnitude of the offset to UTC in units of half-hours.
  m is the time mode character (G=GPS, U=UTC, L=Local).
  <CR> is the Carriage Return character (0x0D).
  <LF> is the Line Feed character (0x0A).
  : is the Colon character (0x3A).
- On-Time Character: is <SOH> for the Sysplex format and T for the EndRun format. The on-time character is transmitted during the first millisecond of each second.

Other options and configurations are available - call us with your requirements.

Analog Timecode Buffer Module



The Analog Timecode Buffer Module adds four additional time code outputs to your Meridian Precision TimeBase. These buffered outputs can provide synchronization of equipment such as synchronized generators, digital fault recorders, SCADA systems, and time displays, and are suitable for recording onto magnetic tape or for transmission over another medium such as coaxial cable. These time code outputs are duplicates of the standard AM Code Output on the CPU Module. Available timecode formats are: IRIG-B, NASA36, or 2137. The format can be selected by using the front-panel keypad and display, the network port, or the RS-232 serial port.

The Analog Timecode Amplifier Module can be added to the Meridian Precision TimeBase as a "plug-and-play" option without hardware or software modification. The Meridian has built-in option card recognition software that lets you swap out modules with ease. It will automatically recognize the module change and behave accordingly.

SPECIFICATIONS

- Quantity: Four outputs
- Connector: Rear-panel BNCs.
- Drive: 1 Vrms into 50Ω.
- Frequency: 1 kHz.
- User-Selectable Code Format: IRIG-B120 (IEEE-1344 compatible), IRIGB122, IRIGB-123, NASA-36, 2137.

Programmable Digital Output Module

The Programmable Digital Output Module adds four independently programmable TTL outputs to your Meridian Precision TimeBase. These buffered outputs provide on-time pulse rates from 1 PPS to 10 MPPS, or a DC time code output. Each output can be individually selected by using the front-panel keypad and display, the standard network port, or the RS-232 serial port. If time code is selected it will be a DC version of the time code format being output on the standard AM Code BNC.

The Programmable Digital Output Module can be added to the Meridian Precision TimeBase as a "plug-and-play" option without hardware or software modification. The Meridian has built-in option card recognition software that lets you swap out modules with ease. It will automatically recognize the module change and behave accordingly.

An additional upgrade provides access to the DDS that is resident in the Meridian TimeBase. Programmable synthesized pulse rates from 1 PPS to 10 MPPS in 1 PPS steps are available, including 1.544 MPPS or 2.048 MPPS. The selected pulse rate is phase locked to the system oscillator.

SPECIFICATIONS

- Quantity: Four outputs
- Connector: Rear-panel BNCs.
- Drive: TTL (3V into 50Ω).
- Duty Cycle: 50%.
- User-Selectable On-Time Pulse Rates: 1, 10, 100, 1K, 10K, 100K, 1M, 5M, 10M PPS.
- Accuracy: $< 10^{-13}$ to UTC for 24-hour averaging times when locked.
- Stability (Allan Deviation):

Tau in Secs	TCXO	MS-OCXO	HS-OCXO	Rb	HS-Rb
1	$1x10^{-9}$	$3x10^{-12}$	$1x10^{-12}$	$2x10^{-11}$	$2x10^{-11}$
10	$4x10^{-10}$	$4x10^{-12}$	$1.2x10^{-12}$	$6.67x10^{-12}$	$6.67x10^{-12}$
100	$5x10^{-11}$	$5.5x10^{-12}$	$1.8x10^{-12}$	$2.5x10^{-12}$	$2x10^{-12}$
1000	$7x10^{-12}$	$5x10^{-12}$	$2.2x10^{-12}$	$1.4x10^{-12}$	$9x10^{-13}$
10000	$1x10^{-12}$	$1x10^{-12}$	$1x10^{-12}$	$8x10^{-13}$	$5x10^{-13}$
100000	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$	$1x10^{-13}$

- User-Selectable Time Code Formats: IRIG-B000 (1344), IRIG-B002, IRIG-B003.
- User-Selectable DDS Rates: 1 PPS to 10 MPPS in 1 PPS steps, including 1.544 MPPS and 2.048 MPPS. DDS rates are phase locked to the system oscillator.

Low-Phase-Noise Output Module

The Meridian Precision TimeBase can be configured with several different, high-performance, 10-MHz oscillators. The Low Phase Noise Output Option works with these disciplined oscillators to provide up to 20 individually buffered, spectrally pure, sinewave outputs. The levels of the contributors to spectral impurity have been carefully controlled by the selection of the oscillators that are offered, and by the design of the option module and its integration into the rackmount chassis. Very good channel-to-channel isolation has also been achieved.

Spectral Purity

Spectral purity refers to the power spectral density (PSD) of a waveform relative to that of an ideal, pure sinewave having frequency f_0, i.e. two delta functions located at +/- f_0 on the Fourier frequency axis. Real world waveforms do not attain this level of purity and exhibit a power spectrum that contains additional periodic and random PSD components.

Periodic Impurities

The periodic impurity components are further sub-classified as harmonic and non-harmonic. The harmonic components reside at Fourier frequencies that are integer multiples of f_0. Their levels are generally minimized by using passive bandpass filtering and ultra-linear output drivers.

Non-harmonic components are also commonly called spurious components, or "spurs". They can appear at any Fourier frequency and may arise from a variety of conditions. Usually they are generated externally to the oscillator, though not always, and are allowed to contaminate the output waveform due to inadequate shielding and power supply filtering or improper grounding techniques.

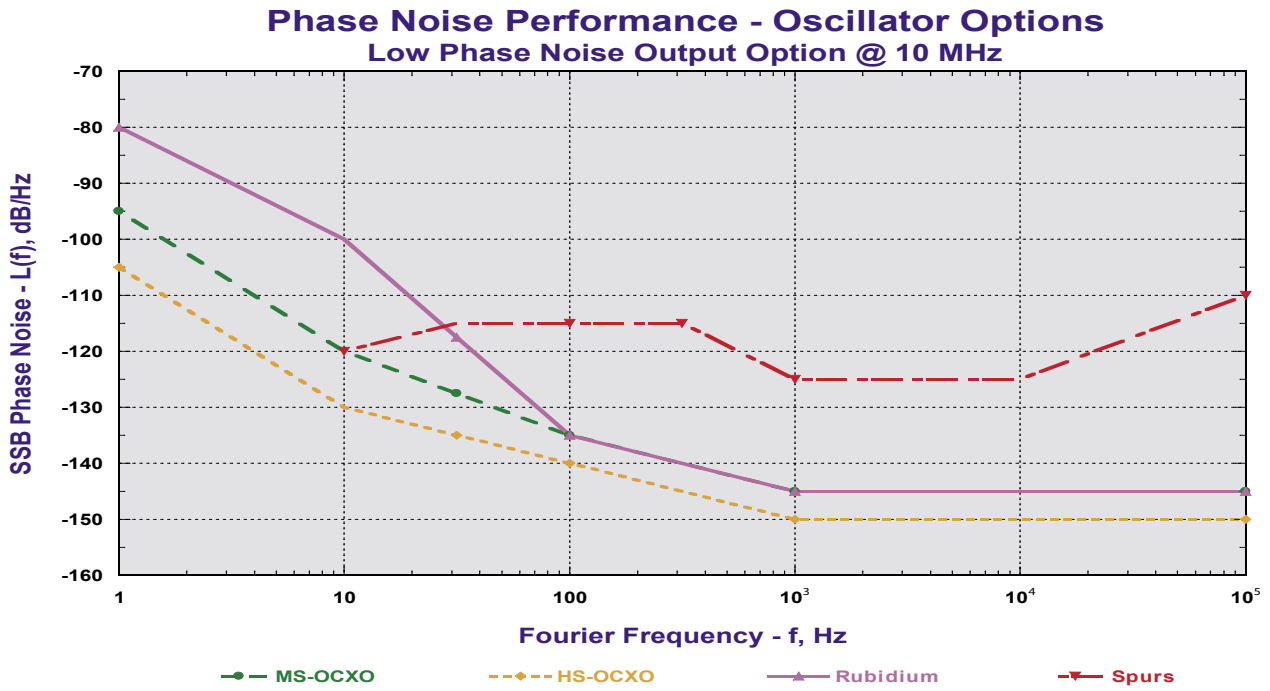
Random Impurities

The random impurities are broadband in nature and make up the PSD "noise floor". Because of the ubiquitous nature of noise, the PSD of a real world waveform is at no point equal to zero. Precision frequency sources based on quartz crystal resonators exhibit extremely low levels of random noise, but it is still easily measurable. The PSD measured close to the source frequency f_0, is generally produced within the oscillator itself, and depending upon the point at which the noise has entered the oscillating circuitry, exhibits different PSD signatures. Selection of high-quality oscillators is the only way to control this aspect of spectral purity.

Phase Noise

Random noise sources within a precision crystal oscillator circuit effectively modulate the signal. The modulation due to random noise is divided between amplitude modulation (AM) and phase modulation (PM). In most applications, the PM component, or phase noise, is of greatest importance. This is due to the multiplicative effect on phase noise that occurs when we multiply the frequency of a precision source in order to synthesize a carrier wave. For example, one milliradian of phase noise at the f_0 = 10 MHz source is multiplied to one radian of phase noise at the 10 GHz carrier frequency.

Low-Phase-Noise Output Module



QUANTITY:
- 4 outputs (uses one slot)
- 8, 12, 16 or 20 outputs (requires additional slots)

OUTPUT FREQUENCY:
- 5 or 10 MHz
- Contact factory for other output frequencies.

OUTPUT LEVEL @ 50 OHMS:
- +13 dBm, +/- 2 dBm

HARMONICS @ 50 OHMS:
- < -45 dBc

CHANNEL-CHANNEL ISOLATION:
- > +75 dB

CONNECTOR:
- BNC

PHASE NOISE dBc/Hz @ 10 & 5 MHz

- With Medium-Stability OCXO:

1 Hz	-95	-100
10 Hz	-120	-130
100 Hz	-135	-140
1 KHz	-145	-150
10 KHz	-145	-150
100 KHz	-145	-150

- With High-Stability OCXO:

1 Hz	-105	-110
10 Hz	-130	-135
100 Hz	-140	-145
1 KHz	-150	-155
10 KHz	-150	-155
100 KHz	-150	-155

- With Rubidium:

1 Hz	-80	-80
10 Hz	-100	-100
100 Hz	-135	-135
1 KHz	-145	-145
10 KHz	-145	-145
100 KHz	-145	-145

Disciplined Oscillator Options

The Meridian TimeBase can be easily upgraded with various disciplined oscillators. An oscillator upgrade is indicated when your application requires either improved holdover accuracy while not locked to the GPS synchronization signal, or improved short-term stability and phasenoise whether locked to the GPS synchronization signal or not. Choices include two grades of oven-controlled quartz oscillators (OCXOs) and two grades of compact Rubidium vapor atomic frequency standards. The high-stabilty grades of both the OCXO and Rubidium options are individually characterized and hand-selected for state-of-the-art performance. We also guarantee that our OCXOs are free of sudden frequency steps, an industry exclusive.

OCXO Options

Both the medium-stability OCXO (MS-OCXO) and high-stability OCXO (HS-OCXO) feature SC-cut crystals for fast warmup, low ageing and phase noise. By using premium, high-Q 5 MHz crystals and a frequency doubler, these units provide both 5 and 10 MHz outpus with exceptional close-in phase noise performance while delivering state-of-the-art long term ageing performance and freedom from sudden frequency steps.

The MS-OCXO provides very good temperature stability. Since it has very good phase noise characteristics, it can support sinewave outputs with high spectral purity. Choose the HS-OCXO for the ultimate, calibration laboratory grade OCXO performance. This unit improves the temperature stability four times relative to the MS-OCXO option and provides 1 second Allan Deviation at parts in 10^{13}. With excellent close-in phase noise performance, it can also support sinewave outputs with very high spectral purity.

Compact Rubidium Options

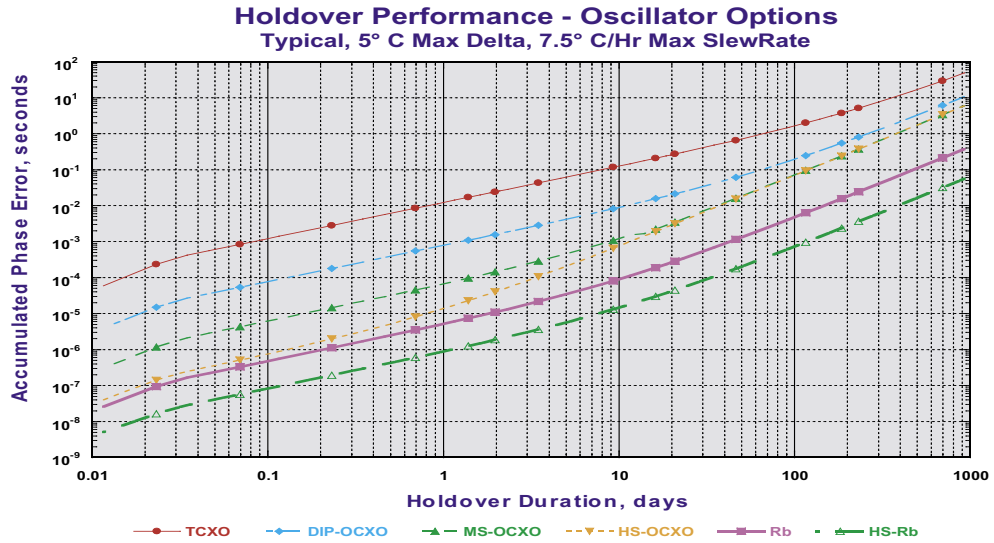
Phase noise and short-term stability of Rubidium vapor atomic frequency standards are inferior to that of quality OCXOs, so in many situations the HS-OCXO is a better choice, offering comparable holdover performance for periods of several hours, superior short-term stability and much lower cost. But if you need the ultimate in long-term holdover performance and medium-term stability, a Rubidium option is the right choice.

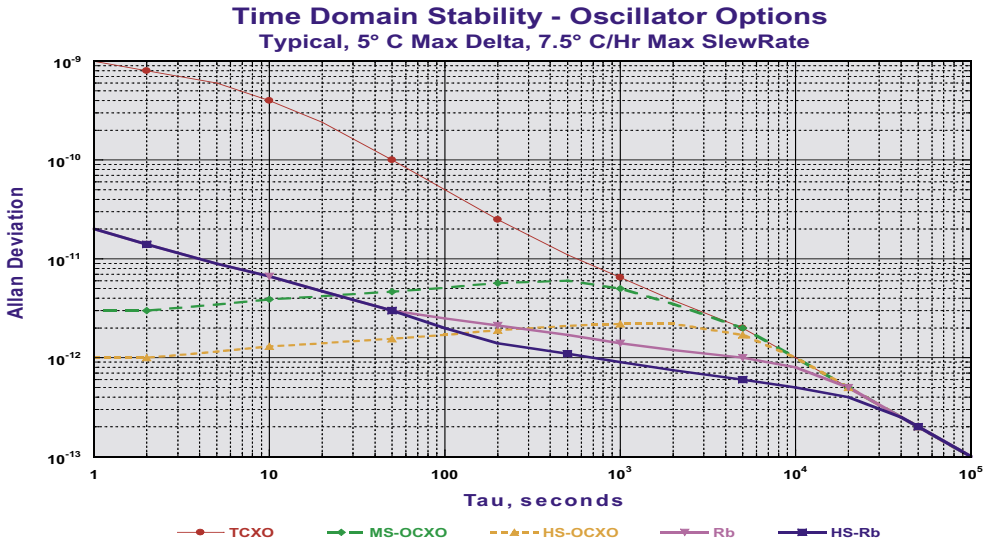
Relative to the HS-OCXO, the temperature stability of the standard Rubidium option is improved only slightly, but its long-term ageing is reduced by more than an order of magnitude. For the ultimate in temperature stability and long-term ageing performance we offer the high-stability HS-Rubidium option.

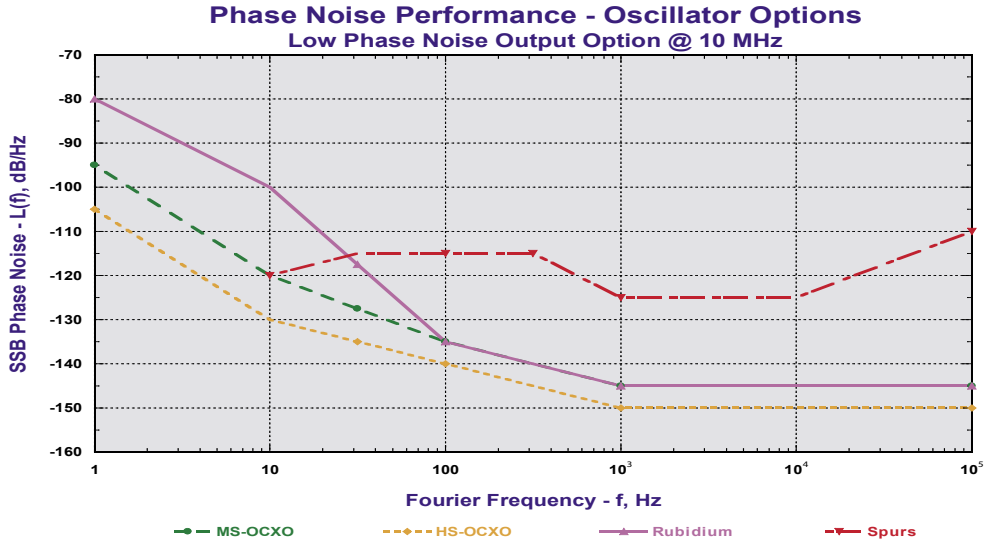
Oscillator Options
Summary Performance Data

	TCXO	MS-OCXO	HS-OCXO	Rubidium	HS-Rubidium
Product Type	All	Rackmount	Rackmount	Rackmount	Rackmount
Temp Stability	2.5×10^{-6}	4×10^{-9}	1×10^{-9}	1×10^{-9}	1×10^{-10}
Temp. Range °C	-20 to +70	0 to +70	0 to +70	-20 to +70	-20 to +70
Ageing Rate/Year	1×10^{-6}	3×10^{-8}	3×10^{-8}	1×10^{-9}	5×10^{-10}
Allan Deviation @ 1 sec	1×10^{-9}	3×10^{-12}	1×10^{-12}	2×10^{-11}	2×10^{-11}
Phase Noise dBc/Hz @ 10 MHz:					
1 Hz	-70	-95	-105	-80	-80
10 Hz	-100	-120	-130	-100	-100
100 Hz	-125	-135	-140	-135	-135
1 KHz	-135	-145	-150	-145	-145
10 KHz	-140	-145	-150	-145	-145
100 KHz	-145	-145	-150	-145	-145
Phase Noise dBc/Hz @ 5 MHz:					
1 Hz	-70	-100	-110	-80	-80
10 Hz	-100	-130	-135	-100	-100
100 Hz	-125	-140	-145	-135	-135
1 KHz	-135	-150	-155	-145	-145
10 KHz	-140	-150	-155	-145	-145
100 KHz	-145	-150	-155	-145	-145

Disciplined Oscillator Options







A fully-optioned Meridian chassis with (from left to right):
the standard CPU Module with 2 Optional Programmable Pulse Rate Outputs, GPS Antenna Input,
Timecode and 1PPS Outputs, Network and Serial Ports,
also 12 Low-Phase-Noise Outputs, 4 T1 Outputs, and 4 additional Timecode Outputs.

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