

Meridian II and Tycho II Options

For Configuring Your Precision TimeBase

The modular design of the Meridian II and Tycho II Precision TimeBase allows you to choose up to five option modules for installation in an efficient 1U or 2U chassis. The modules can be installed at the factory, or you can install most of them as a plug-and-play field upgrade. A complete suite of time and frequency capabilities is available with up to 23 outputs in a 1U chassis and 36 outputs in a 2U. To achieve this level of output density in a fanless, sealed chassis, we have set a new standard in power efficiency and thermal packaging.

OPTIONS LIST

- Oscillator Upgrade Options
- Real-Time Ionospheric Corrections
- PTP/IEEE-1588
- Low-Phase-Noise Output Module
- Analog Time Code Buffer Module
- Programmable Pulse Output Module
- Telecom Clock Output Module
- SyncE with SSM
- Sine Wave Output Module
- 10 MPPS Output
- 5071A Cesium Control Module
- Alarm Output
- Programmable Pulse Output (PPO)
- DC-Shift Time Code Output
- Direct Digital Synthesizer (DDS) Output
- Once-Per-Second Serial Output, Including Sysplex Timer
- DC Power Supply Options
- Other Options Available:
Contact us at
1-877-749-3878
sales@endruntechnologies.com



Plug-and-Play Modules

Meridian II and Tycho II support five, customer-configurable option modules providing a wide variety of time and frequency outputs. The plug-and-play architecture allows the unit to be easily modified or expanded in the field to support future requirements. The system software automatically recognizes the option module changes and enables the respective user interface(s).

Software Options

Three software options are available to extend the functionality of your Meridian

II and Tycho II. The PTP/IEEE-1588 option enables Precision Time Protocol (PTP) grandmaster clock operation with eight-nano-second hardware time stamping. The PTP option can be installed on one or both ports and works in conjunction with the standard Network Time Protocol (NTP).

The Real-time Ionospheric Corrections (RTIC) option enhances stability and accuracy by directly measuring and compensating for ionospheric delays to GPS signals in real-time. This provides L1/L2 performance in an L1 receiver. To further optimize accuracy, the raw GPS pseudorange and carrier phase observations can be logged and exported in a Rinx format.

The Synchronous Ethernet (SyncE) option provides physical layer frequency synchronization with the performance of the system oscillator. Synchronization Status Messaging (SSM) communicates clock status to the SyncE network elements.

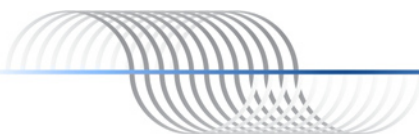
Other Options

There are other time and frequency 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.



A fully-optioned Meridian II chassis with:

- Ultra-Stable OCXO Module with four 10 MHz LPN outputs.
- 10 MHz Low-Phase-Noise Output Module (4 outputs).
- Programmable Pulse Output Module (4 outputs).
- Analog Output Module (4 outputs).
- Telecom Clock Output Module (2 outputs).



CPU Module Options



The CPU Module is always present in the Meridian II and Tycho II and provides several outputs as standard features. These are AM Code (Time Code), 1PPS, RS-232 Serial Port, and Dual Network Ports. The Network Ports include all the standard network protocols, including a high-bandwidth Network Time Protocol (NTP) server. Specifications for the standard features are listed in the Meridian II and Tycho II datasheets.

The CPU Module also supports additional, optional output(s) via a spare BNC connector on the 1U chassis (upper left image) and three spare BNCs on the 2U chassis (upper right image). These include Programmable Pulse Rates, DC-Level-Shift Time Code, Direct Digital Synthesizer (DDS), and Alarm outputs. A second RS-232 serial port option provides a once-per-second, on-time, serial time string. The Network Ports support PTP/IEEE-1588 and SyncE options.

PTP/IEEE-1588 GRANDMASTER

- Quantity: One or both network ports
- IEEE-1588-2008 (v2) with hardware timestamping.
- Parameters: Default Profile, Multicast, Hybrid (mixed Unicast/Multicast), Two-Step Clock. Delay Mechanism: E2E or P2P. Delay Interval: 32 seconds. Transport: UDP/IPv4. Sync Interval: 1, 2, 4, 8, 16, 32, 64 or 128 packets / 1 second. Announce Interval: 1 packet per 1, 2, 4, 8 or 16 seconds.
- PTP Timestamp Resolution: 8 nanoseconds.
- PTP Timestamp Accuracy to Reference Clock: 8 nanoseconds.
- GPS Receiver Reference Clock Accuracy: <10 nanoseconds Meridian II, <25 nanoseconds Tycho II.
- Connector: Rear-panel RJ-45 jacks.

See the separate [PTP/IEEE-1588 Option](#) datasheet for additional information.

Synchronous Ethernet (SyncE)

- Compliance: G.8261, G.8262, G.8264

10 MPPS OUTPUT

- Signal: TTL square wave into 50Ω or RS-422.
- Rate: 10 MPPS (other rates available).
- Accuracy: 6×10^{-14} to UTC for 100k second averaging times when locked.
- Stability (Allan Deviation): See oscillator specifications on page 8.
- Connector: Rear-panel BNC.



PROGRAMMABLE PULSE OUTPUT

- Selectable Rates: 1, 10, 100, 1k, 10k, 100k, 1M, 5M, 10M PPS, PP2S, PPM, inverted 1 PPS.
- Signal: TTL into 50Ω or RS-422.
- Duty Cycle: 50% except 1PPS (mimics the standard 1PPS pulsewidth: 20 us, 1 ms, 100 ms, 500 ms) and 1PPM (one-second wide).
- Accuracy: 6×10^{-14} to UTC for 100k second averaging times when locked.
- Stability (Allan Deviation): See oscillator specifications on page 8.
- Connector: Rear-panel BNC.

DIRECT DIGITAL SYNTHESIZER (DDS) OUTPUT

- Signal: TTL square wave 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 frequency locked to the system oscillator and are not aligned with system time.
- Connector: Rear-panel BNC.

DC-SHIFT TIME CODE OUTPUT

- This output is a digital version of the same time code format selected for the standard AM Code BNC.
- Signal: TTL into 50Ω or RS-422.
 - Formats: IRIG-B 000 (IEEE-1344/C37.118-2005), 002, 003; NASA 36, or 2137.
 - Connector: Rear-panel BNC.

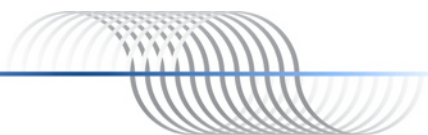
ALARM OUTPUT

- Signal: Open Collector, 40V max, 100 mA max saturation current. High impedance after signal loss or at major hardware fault.
- Connector: Rear-panel BNC or barrier strip.

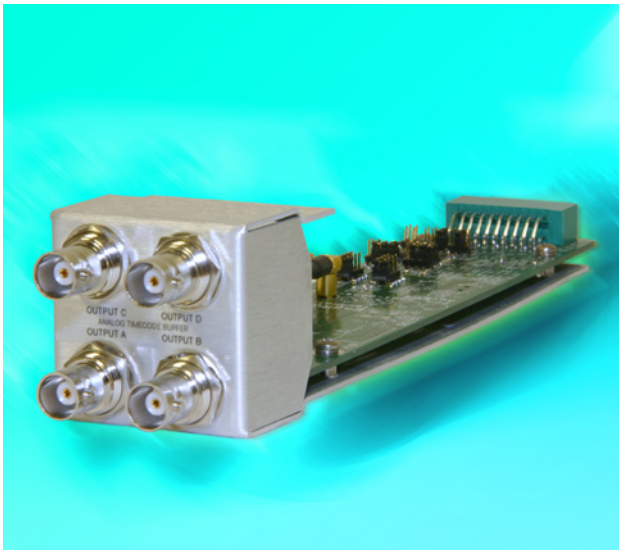
ONCE-PER-SECOND SERIAL OUTPUT

- Serial I/O: Output only port at RS-232 (or RS-422) levels.
- Baud rate/Parity: 4800, 9600, 19200, or 57600. Odd, even or none.
- ASCII Format: User-selectable to Sysplex, Truetime, EndRun, NENA or NMEA formats.
- On-Time Character: An "on-time" character is transmitted during the first millisecond of each second for baud rates 9600, 19200, 57600. The leading edge of this character's start bit is transmitted within 100 microseconds of the beginning of the second.
- Connector: Rear-panel DB-9M Connector.

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



Analog Time Code Buffer Module



The Analog Time Code Buffer Module adds four additional time code outputs to your Meridian II or Tycho II. These buffered outputs can synchronize equipment such as synchronized generators, digital fault recorders, SCADA systems, 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 time code formats are: IRIG-B, IEEE-1344, NASA36, 2137. The format can be selected by using the front-panel keypad and display (Meridian II only), network ports, or RS-232 serial port.

The Analog Timecode Buffer Module can be added as a “plug-and-play” option without hardware or software modification.

Specifications

- Quantity: Four outputs.
- Connector: Rear-panel BNCs.
- Drive: 1 Vrms into 50Ω.
- Frequency: 1 kHz.
- User-Selectable Code Format: IRIG-B120 (IEEE-1344/C37.118-2005), IRIG-B122, IRIG-B123, NASA-36, 2137.

Digital Output Module



The Digital Output Module adds four buffered TTL outputs to your Meridian II or Tycho II. This module can be added as a “plug-and-play” option without hardware or software modification. There are several different configurations available:

Programmable Pulse Outputs (PPO): Provides four on-time pulse rates from 1 PPS to 10 MPPS. Each output can be individually selected by using the front-panel keypad and display (Meridian II only), network ports, or RS-232 serial port. Available rates are: 1, 10, 100, 1k, 10k, 100k, 1M, 5M, 10M PPS, 1PPM, 1PP2S. Inverted 1 PPS available in 1U chassis only.

1PPS: Provides four on-time 1 Pulse-Per-Second (PPS) outputs.

10MPPS: Provides four on-time 10M Pulse-Per-Second (PPS) outputs.

Time Code: Provides four digital outputs of the time code format configured for the standard AM Code output (IRIG-B, IEEE-1344/C37.118-2005, NASA36, or 2137).

Direct Digital Synthesizer (DDS): Provides four copies of a user-selectable rate from 1PPS to 10MPPS in 1PPS steps including 1.544M and 2.048M PPS. The outputs are frequency locked to the reference oscillator but not on-time. Depending on your system configuration, this module may or may not be “plug-and-play”.

Specifications

- Quantity: Four outputs.
- Connector: Rear-panel BNCs.
- Drive: TTL (3V into 50Ω) or RS-422 (DB9M connector). RS-422 available in 1U chassis only.
- Duty Cycle: 50% except 1PPS (mimics the standard 1PPS pulsewidth: 20 us, 1 ms, 100 ms, 500 ms) and 1PPM (one-second wide).
- Alignment: Within 5 nanoseconds of the other TTL outputs in your unit (except DDS, if any).
- Accuracy: $< 6 \times 10^{-14}$ to UTC for 100k second averaging times when locked.
- Stability (Allan Deviation): See oscillator specifications on page 8.

Telecom Clock Output Module



This Telecom Clock Output Module adds two outputs to your Meridian II or Tycho II. The outputs can be any combination of T1, E1 and Composite Clock. Sync Status Messaging (SSM) is supported. An alarm relay is also available as an option. When the Meridian/Tycho is configured with any of the available OCXO and Rubidium oscillator upgrades, it can operate as a Primary Reference Clock that meets the requirements of ITU-T G.811/G.823/G.824 and ANSI T1.101. For detailed information on oscillator selection and holdover for telecom applications see the separate [Telecom Clock Output Module](#) datasheet.

User configuration is via the front-panel keypad/display (Meridian II only), network port, or RS-232 serial port. Framing, Alarm, and Line Build-Out (T1) are all user configurable.

The Telecom Clock Output Module can be added as a “plug-and-play” option without hardware or software modification but requires an OCXO or Rubidium oscillator to meet the respective telecom specifications.

COMPOSITE CLOCK OUTPUT

- Quantity*: Zero, one or two.
- Type: Transformer-coupled complementary-pair via 2xRJ48C. Single-ended via 2xBNC.
- Frequency: 64 kbps.
- Synchronization: Phase locked to the internal system 10 MHz.
- Data Format: All ones with user-selectable bipolar violation (BPV).
- Line Z: 110Ω nominal (complementary pair), or 75Ω nominal (single-ended).
- Pulse Shape: Conforms to ITU-T G.703.
- Pulse Amplitude: 3.4V pk into 133Ω, 3.0V pk into 110Ω, 2.4V pk into 75Ω.
- MTIE/Jitter/Wander: Conforms to ITU-T G.811/G.823 when locked.
- Line Code: Bipolar Return to Zero, Alternate Mark Inversion (AMI), 5/8 Duty Cycle. User-selectable for 64kcc AMI with no BPV, 64kcc AMI with 8 kHz BPV, or 64kcc with 8kHz BPV and missing BPV at 400 Hz.
- Alarm Code: User-selectable for BPV off (AIS) at Major (Blue) Alarm, or BPV always on. All zeros (LoS) at Critical (Red) Alarm.
- Connector*: RJ-45 style modular jack (RJ48C-compatible), 1 per output, or BNC (single-ended) or DB9M.

E1 CLOCK OUTPUTS

- Quantity*: Zero, one or two.
- Type: Transformer-coupled complementary-pair via 2xRJ48C or 1xDB9M. Single-ended via 2xBNC.
- Frequency: 2.048 Mbps.
- Synchronization: Phase locked to the internal system 10 MHz.
- Data Format: All ones. User-selectable for Unframed, Double-frame or CRC4 Multi-frame.
- Line Z: 120Ω nominal (complementary pair), or 75Ω nominal (single-ended).
- Pulse Shape: Conforms to ITU-T G.703.
- Pulse Amplitude: 3.0V pk into 120Ω, 2.2V pk into 75Ω.
- MTIE/Jitter/Wander: Conforms to ITU-T G.811/G.823 when locked.
- Line Code: Bipolar Return to Zero, Alternate Mark Inversion (AMI). (Identical to HDB3 for all ones data.)
- Alarm Code: User-selectable for Alarm Indication Signal (AIS), or Sync Status Messaging (SSM) on Sa4 through Sa8 or none at Major (Blue) Alarm. All zeros (LoS) at Critical (Red) Alarm.
- Connector*: RJ-45 modular jacks (RJ48C-compatible), 1 per output, BNC (single-ended) or DB9M.

T1 CLOCK OUTPUTS

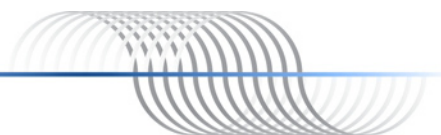
- Quantity*: Zero, one or two.
- Type: Transformer-coupled complementary-pair.
- Frequency: 1.544 Mbps.
- Synchronization: Phase locked to the internal system 10 MHz.
- Data Format: All ones. User-selectable for Unframed, D4 SuperFrame (SF) or CRC6 Extended SuperFrame (ESF).
- Line Z: 100Ω nominal.
- Pulse Shape: Conforms to ITU-T G.703.
- Pulse Amplitude: 3.0V pk.
- MTIE/Jitter/Wander: Conforms to ANSI T1 101 and ITU-T G.811/G.824 when locked.
- Line Build-Out: User-selectable for short haul DSX-1 0-655 ft.
- Line Code: Bipolar Return to Zero, Alternating Mark Inversion (AMI). (Identical to B8ZS or PDE with all ones data.)
- Alarm Code: User-selectable for Alarm Indication Signal (AIS), or Sync Status Messaging (SSM), or none at Major (Blue) Alarm. All zeros (LoS) at Critical (Red) Alarm.
- Connector*: RJ-45 style modular jacks (RJ48C-compatible), 1 per output or DB9M.

ALARM RELAY OUTPUTS

- Quantity*: Zero or three.
- Type: Form C.
- Rating: 750 mA @ 42VAC/60VDC.
- NC Contact: Closed for alarm-active condition.
- NO Contact: Closed for alarm-inactive condition.
- Minor Alarm: Active at minor clock faults.
- Major Alarm: Active at major clock fault (Blue Alarm).
- Critical Alarm: Active at clock operational fault (Red Alarm).
- Connector: DB9 Female.

* Specify outputs and connectors at time of order. Maximum quantity of E1, T1 and/or Composite Clock outputs is two and they must use the same connector type. For example: one E1 output and one T1 output both with RJ-45 connectors. Alarm Relay is an additional option.

NOTE: This module is designed to provide highly-stable Building Integrated Timing Supply (BITS) reference clock signals directly to digital equipment.



Sine Wave Output Module



This module adds four or six frequency outputs to your TimeBase. Multiple versions are available, depending on the combination and type of frequency outputs needed. Depending on your system configuration, this module may or may not be “plug-and-play”.

SINE WAVE OUTPUT MODULE

Available frequency output options are 1 MHz, 5 MHz and 10 MHz. This module is intended for those wanting sine wave outputs without the need for high-performance low-phase-noise.

Specifications

- Quantity: 4 outputs on 1U module, 6 outputs on 2U module. Uses one of five option slots.
- Signal Type: Analog sine wave.
- Output Frequency: 1, 5, and/or 10 MHz are available in various combinations.
- Output Level: +13 dBm, +/- 2 dBm into 50Ω.
- Harmonics: < 45 dBc (<40dBc with TCXO) into 50Ω.
- Connector: BNC.

DDS SINE WAVE OUTPUT MODULE

The Direct Digital Synthesizer (DDS) Sine Wave Module is an option that adds four frequency outputs to your TimeBase. It produces a sine wave that is generated from the system DDS. Frequencies from 1 Hz to 10 MHz in 1 Hz steps are available, including 1.544 MHz or 2.048 MHz. The selected frequency is phase locked to the system oscillator and is not aligned with system time.

Specifications

- Quantity: 4 outputs on 1U module. Uses one of five option slots.
- Signal Type: Analog sine wave.
- Output Frequency: User-selectable rate from 1 to 10M Hz, in 1 Hz steps.
- Drive: 1 Vrms into 50Ω.
- Connector: BNC.

Power Supply Options



The Meridian II and Tycho II can be configured with an assortment of DC power supply options in place of the standard AC power supply, or as a redundant power source. The power supplies are factory-installed and not field-swappable in the 1U chassis. The 2U chassis has modular power supplies that are field-swappable.

OPTIONAL DC POWER SUPPLIES

- Isolation: Input is fully floating. Either input polarity can be connected to earth ground.
- Four voltage ranges:
 1. 12 VDC (10-20 VDC), 6.0A max 1U. Not available in 2U.
 2. 24 VDC (19-36 VDC), 3.0A max 1U. 4.0A max 2U.
 3. 48 VDC (37-76 VDC), 2.0A max 1U. 2.0A max 2U.
 4. 125 VDC (70-160 VDC), 1.0A max. Not available in 2U.
- Connector: Three-position terminal block on rear panel.

STANDARD UNIVERSAL AC POWER SUPPLY

- 90-264 VAC/47-63Hz: 1.0A max 1U, 1.5A max 2U.
- 120 VAC/60Hz: 0.8A max 1U, 1.3A max 2U.
- 240 VAC/50 Hz: 0.5A max 1U, 0.7A max 2U.
- Connector: Three-pin IEC 320 on rear panel.

DUAL-REDUNDANT POWER SUPPLIES

The dual-redundant power supply option may be any combination of AC or DC power options. The primary and secondary power supplies are connected in a dual-redundant configuration with hitless automatic primary-to-secondary and secondary-to-primary switchover. The Meridian II/Tycho II is sourced from the primary power supply as long as it is operational and supplied with external power.

A fault detector monitors the status of each redundant power supply. When a fault is detected it will trigger a system alarm and light the front-panel Alarm LED.

The redundant power supply occupies two option slots in the 1U chassis and no option slots in the 2U.

Low-Phase-Noise Output Module



The Meridian II and Tycho II can be easily upgraded with OCXO and Rubidium disciplined oscillators. The Low-Phase-Noise Output Module works with these high-performance oscillators to provide up to 20 or 30 (2U chassis) individually buffered, spectrally pure, sine wave outputs. The levels of the contributors to spectral impurity have been carefully controlled by the design of the oscillators and option module and its integration into the rackmount chassis. Very good channel-to-channel isolation has also been achieved in these modules.

Spectral Purity

Spectral purity refers to the power spectral density (PSD) of a waveform relative to that of an ideal, pure sine wave having frequency f_0 . Such a perfect waveform would have a PSD consisting of two delta functions located at $\pm f_0$ 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. Spectral purity is important in a frequency standard when it is used as the reference for synthesizing a carrier signal for the purpose of broadcasting or receiving information. Any impurities in the spectrum will to some degree mask the information that is intentionally modulated onto the carrier prior to broadcast.

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.

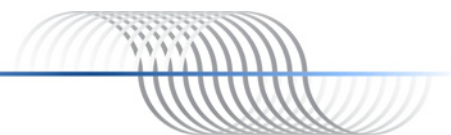
Random Impurities

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

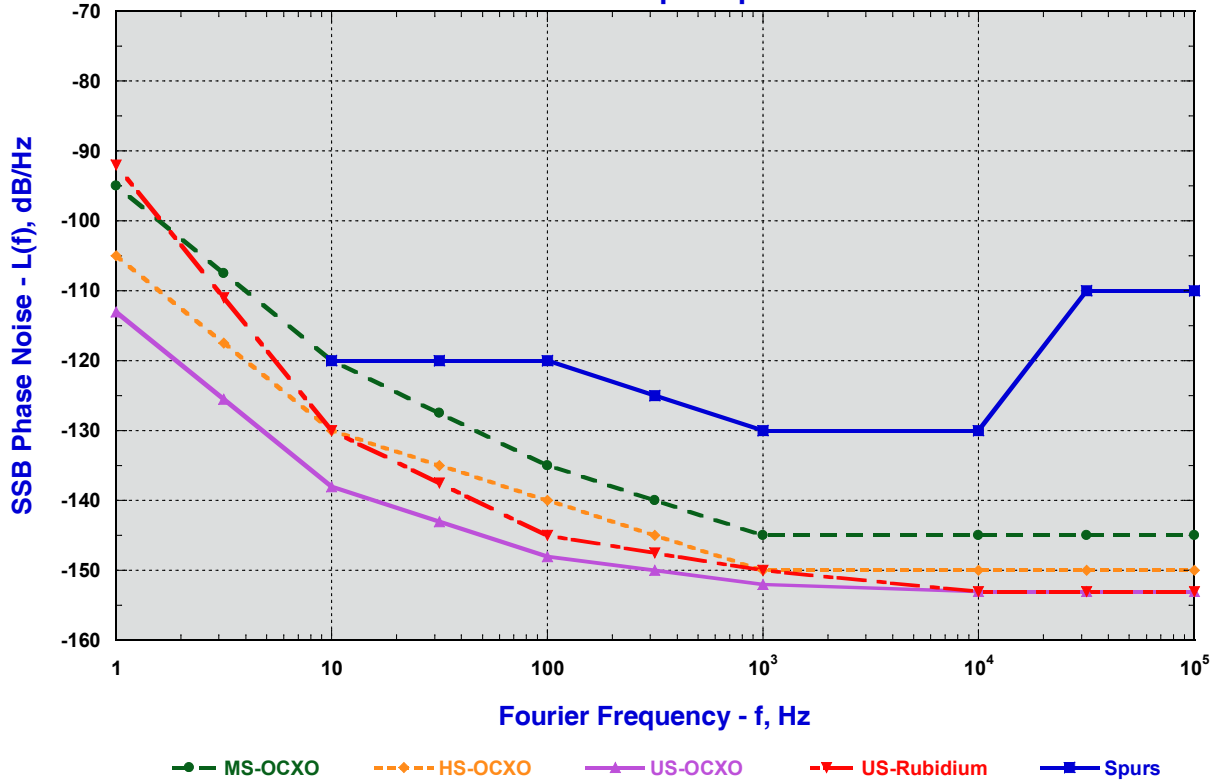
Random noise sources within a precision crystal oscillator circuit effectively modulate the signal. The modulation due to random noise is divided between amplitude modulation (AM) and phase modulation (PM). In most applications, the PM component, or phase noise, is of greatest importance. This is due 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.

We manufacture oscillators that exhibit extremely low close-in phase noise. This close-in phase noise is typically classified as flicker frequency modulation (FM). The flicker FM component of quartz oscillators is minimized by using the highest quality crystals and a healthy dose of black magic in the oscillator circuitry.



Low-Phase-Noise Output Module

Phase Noise Performance - Oscillator Options Low Phase Noise Output Option @ 10 MHz



Phase Noise dBc/Hz @ 10/5 MHz:	MS-OCXO	HS-OCXO	US-OCXO	US-Rb
1 Hz	-95/-100	-105/-110	-113/-118	-92/-92
10 Hz	-120/-130	-130/-135	-138/-143	-130/-130
100 Hz	-135/-140	-140/-145	-148/-152	-145/-135
1 kHz	-145/-150	-150/-155	-152/-155	-150/-135
10 kHz	-145/-150	-150/-155	-153/-155	-153/-135
100 kHz	-145/-150	-150/-155	-153/-155	-153/-135

QUANTITY:

- 4 outputs on 1U module.
- 6 outputs on 2U module.
- Module uses one out of five option slots.

OUTPUT FREQUENCY:

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

OUTPUT LEVEL into 50 OHMS:

- +13 dBm, +/- 2 dBm.

HARMONICS:

- < -45 dBc into 50 ohms.

CHANNEL-CHANNEL ISOLATION:

- > +75 dB.

CONNECTOR:

- BNC.



Disciplined Oscillator Options



The Meridian II and Tycho II can be upgraded with OCXO and Rubidium oscillators to improve holdover, short-term stability, and phase noise. Three grades of oven-controlled crystal oscillators (OCXOs) and a Rubidium atomic frequency standard are available to upgrade the basic temperature-compensated crystal oscillator (TCXO). The High-Stability and Ultra-Stable OCXO and Rubidium are individually characterized and hand-selected for state-of-the-art performance. We guarantee our OCXOs are free of sudden frequency steps, an industry exclusive.

OCXO Options

The Medium-Stability OCXO (MS-OCXO), High-Stability OCXO (HS-OCXO) and Ultra-Stable (US-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 outputs with exceptional close-in phase noise performance. They also deliver state-of-the-art long-term ageing performance and freedom from sudden frequency steps.

The MS-OCXO provides very good temperature stability and can support sine wave outputs with high spectral purity. The HS-OCXO improves temperature stability and close-in phase noise. Choose the US-OCXO for the ultimate temperature stability, short-term stability and phase noise. This unit halves the temperature coefficient of the HS-OCXO and provides 1-second Allan Deviation at 4×10^{-13} .

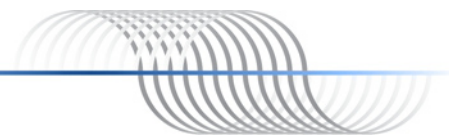
Rubidium Option

Rubidium atomic frequency standards excel in temperature stability, ageing, and medium-term stability. For the ultimate in long-term holdover performance and medium-term stability with excellent phase noise, the Ultra-Stable Rubidium option is the right choice. The US-Rb is based on an industry-leading rubidium frequency standard that delivers true, uncompromised rubidium performance with an integrated SC-cut crystal enabling low phase noise.

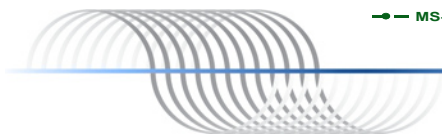
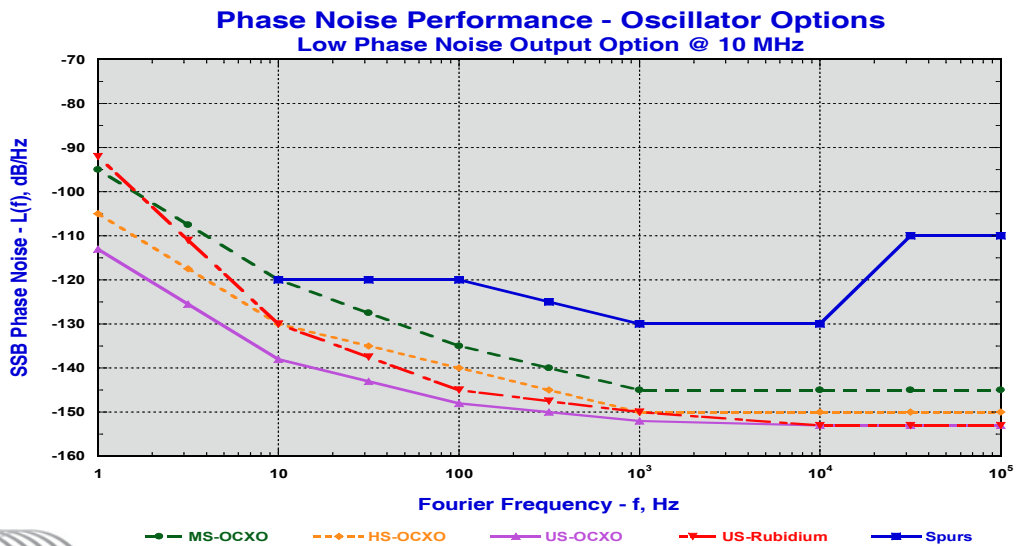
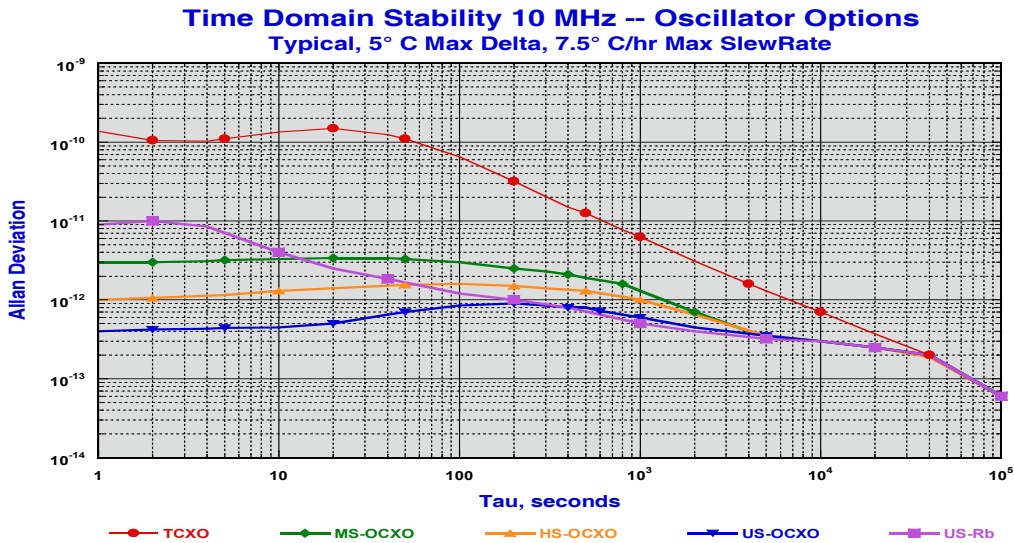
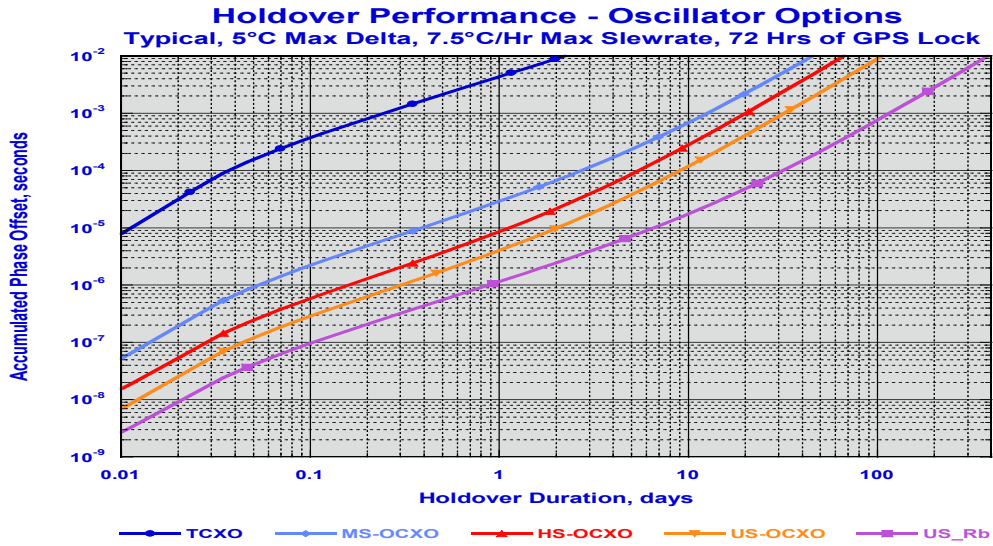
5071A Cesium Control Module

The Cesium Control Option combines the benefits of the Meridian II, 5071A, and EndRun's Real-Time Ionospheric Corrections to provide a time and frequency standard with the accuracy, stability and holdover that resides at the uppermost echelon in the industry. See the [Cesium Control Module Option](#) datasheet for performance details of this extraordinary module.

	TCXO	MS-OCXO	HS-OCXO	US-OCXO	US-Rubidium
Temp Stability	2.5×10^{-6}	4×10^{-9}	1×10^{-9}	5×10^{-10}	2×10^{-10}
Temp. Range °C	-20 to +70	0 to +70	0 to +70	0 to +70	-20 to +65
Ageing Rate/Year	1×10^{-6}	3×10^{-8}	3×10^{-8}	3×10^{-8}	5×10^{-10}
Allan Deviation @ 1 sec	2.0×10^{-10}	3.0×10^{-12}	1.0×10^{-12}	4.0×10^{-13}	1.5×10^{-11}
@ 10 secs	2.0×10^{-10}	3.9×10^{-12}	1.3×10^{-12}	5.0×10^{-13}	5.0×10^{-12}
@ 100 secs	8.0×10^{-11}	3.0×10^{-12}	1.7×10^{-12}	8.5×10^{-13}	1.4×10^{-12}
@ 1k secs	8.0×10^{-12}	2.0×10^{-12}	1.5×10^{-12}	8.0×10^{-13}	7.0×10^{-13}
@ 10k secs	8.0×10^{-13}	4.0×10^{-13}	4.0×10^{-13}	4.0×10^{-13}	4.0×10^{-13}
@ 100k secs	6.0×10^{-14}	6.0×10^{-14}	6.0×10^{-14}	6.0×10^{-14}	6.0×10^{-14}
Phase Noise dBc/Hz @ 10/5 MHz:					
1 Hz	-70/na	-95/-100	-105/-110	-113/-118	-92/-92
10 Hz	-100/na	-120/-130	-130/-135	-138/-143	-130/-130
100 Hz	-125/na	-135/-140	-140/-145	-148/-152	-145/-135
1 kHz	-135/na	-145/-150	-150/-155	-152/-155	-150/-135
10 kHz	-140/na	-145/-150	-150/-155	-153/-155	-153/-135
100 kHz	-145/na	-145/-150	-150/-155	-153/-155	-153/-135



Disciplined Oscillator Options



Real-Time Ionospheric Corrections

The Real-Time Ionospheric Corrections (RTIC) option provides the ultimate in time and frequency stability and accuracy. The RTIC option uses proprietary algorithms in EndRun's L1 GPS timing receiver to directly measure and compensate for ionospheric delay to GPS signals in real-time. This unprecedented real-time capability was previously only available with expensive dual frequency GPS L1/L2 receivers.

Ionospheric Delay and Impact to GPS Time-Transfer

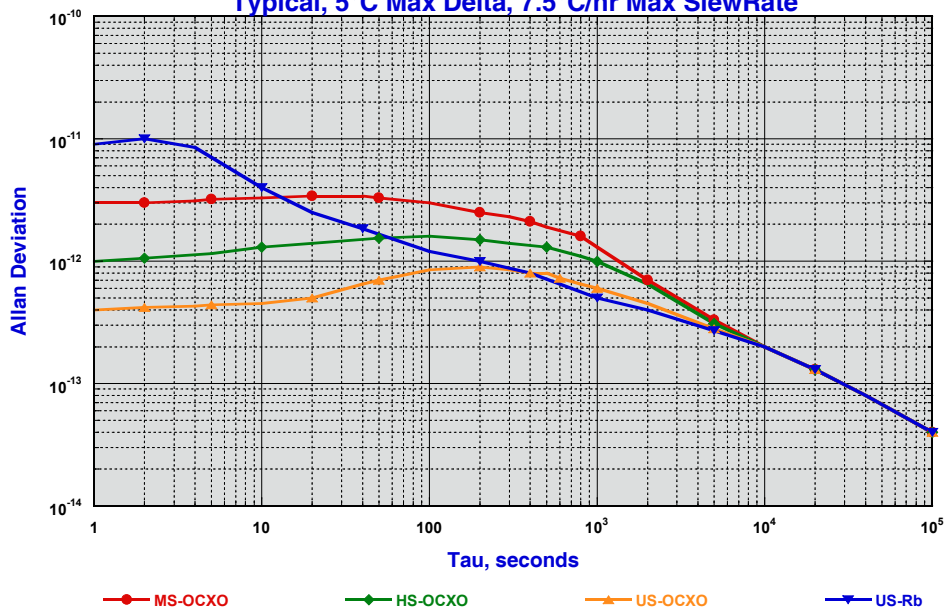
The largest contributor to GPS time-transfer error is the delay of the satellite signals as they pass through the ionosphere. The GPS satellites transmit a model (Klobuchar) for receivers to partially compensate for this delay, but it has historically provided only about 50% improvement. Dual-band GPS receivers use the differential delay of the L1/L2 signals to directly measure and remove ionospheric delay but are costly.

EndRun developed an algorithm to directly quantify the ionospheric delay with its single-frequency receiver. Measurements at national laboratories demonstrated significant improvement relative to the Klobuchar model that could be even greater during major ionospheric storm events. The chart below shows the stability of the various oscillator options with RTIC. To see the performance improvement, compare this chart with the Time Domain Stability chart on the previous page.

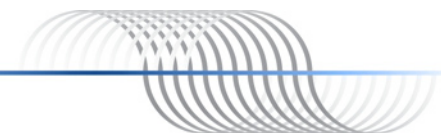
Stability and Accuracy

When locked to GPS, RTIC enhances the stability and accuracy of the Meridian II and Tycho II outputs. When combined with the US-OCXO oscillator, the stability outperforms the standard 5071A cesium at all measurement intervals for a significantly lower cost. See the separate [RTIC Option](#) datasheet for additional details.

**Time Domain Stability 10 MHz -- Oscillator Options
Real Time Ionospheric Corrections Option
Typical, 5°C Max Delta, 7.5°C/hr Max SlewRate**



	TCXO	MS-OCXO	HS-OCXO	US-OCXO	US-Rubidium
Allan Deviation @ 1 sec	2.0 x 10 ⁻¹⁰	3.0 x 10 ⁻¹²	1.0 x 10 ⁻¹²	4.0 x 10 ⁻¹³	1.5 x 10 ⁻¹¹
10 secs	2.0 x 10 ⁻¹⁰	3.9 x 10 ⁻¹²	1.3 x 10 ⁻¹²	4.5 x 10 ⁻¹³	5.0 x 10 ⁻¹²
100 secs	8.0 x 10 ⁻¹¹	3.0 x 10 ⁻¹²	1.7 x 10 ⁻¹²	8.5 x 10 ⁻¹³	1.4 x 10 ⁻¹²
1k secs	8.0 x 10 ⁻¹²	2.0 x 10 ⁻¹²	1.3 x 10 ⁻¹²	7.0 x 10 ⁻¹³	6.0 x 10 ⁻¹³
10k secs	6.0 x 10 ⁻¹³	2.0 x 10 ⁻¹³	2.0 x 10 ⁻¹³	2.0 x 10 ⁻¹³	2.0 x 10 ⁻¹³
100k secs	4.0 x 10 ⁻¹⁴	4.0 x 10 ⁻¹⁴	4.0 x 10 ⁻¹⁴	4.0 x 10 ⁻¹⁴	4.0 x 10 ⁻¹⁴
TDEV	<2 ns @ τ < 10 ⁵ secs, σ _y (τ) < 4x10 ⁻¹⁴ @ τ=10 ⁵ secs.				
Frequency Accuracy	< 4.0 x 10 ⁻¹⁴				





The rear panel of a fully-optioned Meridian II and Tycho II chassis with (from left to right):

- Receiver/CPU Module that includes: GPS Antenna Input, Time Code and 1PPS Outputs, Dual Network Ports, Serial Port.
- Sine Wave Output Modules (2) for eight 10 MHz outputs.
- Programmable Pulse Output Module for four PPO outputs.
- Analog Time code Buffer Modules (2) for eight additional Time Code Outputs.



The rear panel of a Meridian II 2U with options (from left to right):

- Receiver/CPU Module that includes: GPS Antenna Input, Time Code and 1PPS Outputs, Dual Network Ports, Serial Port.
- CPU Module Options: Port C - Serial Time. Port D - PPO. Port E: PPO. Port F: PPO.
- Sine Wave Output Modules (3) for eighteen 10 MHz outputs.
- 2 Spare output option module slots.
- Dual AC/AC modular power supplies option.

