

# 5071A Cesium Control Module *Option*

*GPS Disciplined Cesium Provides Ultimate Accuracy and Stability*

**The 5071A Cesium Control Module (CCM) enables the Meridian II Precision TimeBase to discipline a 5071A Cesium Primary Frequency Standard to the GPS or UTC time scale.** CCM 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.

The second generation *Meridian II* is a high-performance, modular, network-centric, time and frequency standard that hosts the CCM. At the core of the Meridian II is an EndRun GPS Timing Receiver optimized to provide an industry-best time accuracy of <10 nanoseconds RMS to UTC(USNO). The CCM interfaces the 5071A to the Meridian II that combines the extraordinary cesium stability with Meridian II's extraordinary UTC time and frequency accuracy. The CCM is also available for the Tycho II Precision TimeBase.

## KEY BENEFITS

- Disciplines 5071A cesium to the UTC or GPS time scale.
- Time accuracy: <10 nanoseconds to UTC(USNO).
- Frequency stability and accuracy:  $<1 \times 10^{-14}$  (1,000,000 seconds).
- Exceptional holdover.
- Real-time Ionospheric Corrections.
- 10 MHz low phase noise outputs.
- Remote 5071A parameter and alarm monitoring via HTTPS or SSH.
- NTP Stratum 1 holdover: 1,000,000 days.



The proprietary Meridian II GPS timing receiver supports Real-Time Ionospheric Corrections (RTIC) that measures and compensates for ionospheric delays in real-time. The GPS timing receiver with RTIC provides an optimal reference to discipline the 5071A to the GPS or UTC time scale that preserves the exceptional short to medium-term stability of the 5071A while maintaining strict, long-term adherence to the selected time scale. The 3rd order phaselock disciplining algorithm is optimized to preserve the 5071A stability for observation intervals less than the Allan deviation crossover point.

## Cesium Control Module (CCM)

The CCM option module interfaces to the 5071A enabling the Meridian II to steer its frequency, monitor its health, alarms, and set the time-of-day on its front panel. The 5071A Operation Status and Questionable Data registers are monitored to determine the overall functional state of the 5071A as well as the internal diagnostic parameters. All of this information is reported via the various Meridian II user interfaces: SSH, HTTP, SNMP and the front-panel display.

The module's DB9M connector and cable allow the RS-232 serial port of the 5071A to be connected to the Meridian II for bi-directional data communication. The module's BNC input connector and coaxial cable allow the 10 MHz output signal from Port 1 on the HP 5071A to be connected to the Meridian II. The 5071A 10 MHz signal then becomes the reference for all the Meridian II's frequency and timing signals including the GPS timing receiver. While tracking GPS, the 5071A is continuously disciplined to compensate for the fractional frequency offset and environmental effects to maintain coherence with the UTC or GPS time scale.

## Real-Time Ionospheric Corrections (RTIC)

EndRun's RTIC algorithm measures and compensates for the variable ionospheric delays that impact the stability and accuracy of the received GPS signal. RTIC significantly stabilizes the GPS reference thereby decreasing the Allan Deviation crossover point. This allows the 5071A to be disciplined with a shorter time constant and thereby converge to UTC(USNO) quicker without degrading the stability below the crossover point. EndRun's proprietary RTIC technique continuously measures and compensates for the day-to-day and diurnal variations as well as the shorter-term ionospheric delays caused by solar "storms". The innovative ionospheric corrections within Meridian II's single frequency GPS receiver meet or exceed the performance of expensive L1/L2 solutions.

# Meridian II with 5071A Cesium Control Module Specifications



5071A Cesium Control Module  
10 MHz cesium input, Serial cesium control port, 10 MHz outputs (4)

## 1 PPS TIMING CHARACTERISTICS

The following accuracy and stability specifications assume a stationary platform, 4 satellite lock, and antenna installation with a full view-of-the-sky.

- Accuracy: <10 nanoseconds RMS to UTC(USNO) when locked\*  
<2.5 nanoseconds Standard Deviation (SDEV)
- Stability Standard 5071A: TDEV <2 ns @ all  $\tau$ ,  $\sigma_y(\tau)$  <8.5x10<sup>-14</sup> @  $\tau=10^5$  secs.
- Stability High Performance 5071A: TDEV <2 ns @ all  $\tau$ ,  $\sigma_y(\tau)$  <2.7x10<sup>-14</sup> @  $\tau=10^5$  secs.
- Positive TTL pulse into 50 $\Omega$  (Zout = 50 $\Omega$ ) or RS-422 levels (option).
- User-Selectable Width: 20 us, 1 ms, 100 ms, 500 ms.
- User Calibration: +/- 500 us, 1 ns resolution.

\* See GPS-UTC Timing Specifications for details.

## 5071A EXTERNAL REFERENCE OSCILLATOR

Stability:	Std 5071A	High Perf 5071A
1 second Tau	1.2x10 <sup>-11</sup>	5.0x10 <sup>-12</sup>
10	8.5x10 <sup>-12</sup>	3.5x10 <sup>-12</sup>
100	2.7 x10 <sup>-12</sup>	8.5x10 <sup>-13</sup>
1000	8.5x10 <sup>-13</sup>	2.7x10 <sup>-13</sup>
10000	2.7x10 <sup>-13</sup>	8.5x10 <sup>-14</sup>
100000	8.5 x10 <sup>-14</sup>	2.7x10 <sup>-14</sup>
1000000	1.0x10 <sup>-14</sup>	1.0x10 <sup>-14</sup>

- Frequency Accuracy: 1.0x10<sup>-14</sup> (1,000,000 seconds)
- Ageing Rate: 0
- Environmental Stability: 1.0x10<sup>-13</sup>

## 10 MHz Low Phase Noise Outputs

Quantity:	4 (BNC connectors).		
Phase Noise:	Std 5071A	High Perf 5071A	Spurs
1 Hz Offset	-85 dBc/Hz	-100 dBc/Hz	
10	-125	-130	-120
100	-135	-135	-115
1k	-140	-140	-125
10k	-145	-145	-125
100k	-145	-145	-110

## TIME TO LOCK

- < 10 minutes after cesium is locked.

## SERIAL I/O PORT (CCM Module)

- RS-232 serial I/O on DB9M jack for 5071A interconnection.
- Default parameters at 9600 baud, 8 data bits, no parity, 1 stop bit.

## REAL-TIME IONOSPHERIC CORRECTIONS

EndRun's proprietary Real-Time Ionospheric Corrections (RTIC) are included with the 5071A CCM. RTIC compensates for ionospheric delays in real-time that optimizes the stability and accuracy of the UTC reference that the 5071A is disciplined to.

## 5071A PARAMETERS - STATUS

The following 5071A specific parameters are available via the host Meridian II network ports via SSH or HTTPs, serial port, and front panel display:

- Operation Status register
- Questionable Data register
- Cesium Beam current
- C-Field current
- Ion Pump current
- Electron-multiplier voltage
- Cesium Beam tube oven voltage
- Signal Gain percent of maximum
- 1st microwave RF amplitude percent of maximum
- 2nd microwave RF amplitude percent of maximum
- Reference oscillator oven voltage
- Reference oscillator control percent of maximum

## 5071A ALARMS

The following 5071A alarms will show on the Meridian II if any of these conditions occur on the 5071A:

- Operation Status - STANDBY or FATAL
- Questionable Data - FREQUENCY or PHASE.
- COMM\_FAULT

## ENVIRONMENTAL

- Operating Temperature/Humidity: 0° to +50° C / 5% to 90% RH, non-condensing.
- Storage Temperature/Humidity: -40° to +85° C / 5% to 95% RH, non-condensing.

## COMPLIANCE

- CE, FCC, RoHS, WEEE.

## MERIDIAN II and OPTIONS

The standard Meridian II outputs, control interfaces, and options are available when the two slot CCM module is installed:

Refer to the Meridian II datasheet for product information.

Refer to the Meridian II Options datasheet for detailed information on all options.

Refer to the Real-Time Ionospheric Corrections datasheet for details on RTIC.

