5071B

Primary Frequency Standard

Summary

The 5071B primary frequency standard is the successor to the 5071A. The unit has been designed as a complete form, fit and function replacement of the 5071A. All connections and commands remain unchanged. The internal electronics of the 5071B were updated with modern circuitry, including Microchip microprocessors (MPUs), to ensure continuity of supply for all components into the next decade and RoHS compliance. The 5071B has undergone over 18 months of long-term stability testing and extensive qualifications to ensure the 5071B meets or exceeds all performance specifications.

Features

- Easy to use with automatic startup and intuitive menu structure
- Fast warm up ±5.0 x 10^{-13} accuracy in 30 minutes or less for high-performance tube
- Integrated clock and message displays
- Multiple timing and frequency inputs and outputs with easy access at front and rear
- Automatic synchronization of 1PPS signal
- Remote interface and control including alarm output
- Meets requirements in the new ITU-T G.811.1 ePRC standard

Benefits

- Maintains exceptional accuracy and stability even in unstable environments—unsurpassed stability in the lab or field
- Accuracy ±5.0 × 10^{-13} for high performance
- Stability ≤5.0 × 10^{-12} for high performance (for 1 second averaging time)
- Environmental stability ±8.0 × 10^{-14} for high performance (frequency change for any combination of environmental conditions)
- Long-term stability ≤1.0 × 10^{-14} for high performance (for 5-day averaging time)
- Proven reliability with an average mean time between failures (MTBF) of greater than 160,000 hours
- Full traceability to NIST
- AC and DC input and internal battery back-up

The 5071B primary frequency standard has the accuracy and stability you need for both laboratory and field applications. A stability specification for 30-day averaging time means the 5071B will keep extremely predictable time and phase for long periods. Further, the 5071B can be used for long-term averaging of noisy signals such as GPS.

The 5071B is easy to use. No more manual start-up steps or complicated adjustments—everything is automatic. A logical menu structure simplifies front panel operations, selections, and status reporting. Remote control features tailor the 5071B for complete operation and manageability in virtually any location.

Meeting the Needs of Leading- Edge Metrology and Calibration Labs

Timekeeping and National Standards Laboratories verify the stability and accuracy of their in-house cesium standards to Coordinated Universal Time (UTC), provided by the Bureau International des Poids et Mesures (BIPM) in Paris. A standard's accuracy and reliability determine the quality of service these timekeeping labs provide. Of even greater concern is the stability of a standard. Stability directly affects a laboratory's ability to deliver timekeeping and calibration services to its clients.

The 5071B offers exceptional stability and is the first cesium standard to specify its stability for averaging times longer than one day. The instrument takes into account environmental conditions that can heavily influence a cesium standard's long-term stability. Digital electronics continuously monitor and optimize the instrument's operating parameters.

Thus, the 5071B's response to environmental conditions such as temperature and humidity are virtually eliminated. The 5071B primary frequency standard maintains its accuracy and stability, even in unstable environments.

Satellite Communications

Stable frequency generation is required to transmit and receive signals properly between ground terminals and communication satellites. Frequency flexibility is also needed to adjust for satellite-to-satellite carrier-frequency differences. The 5071B's state-of-the-art technology produces offset and primary frequencies with the same guaranteed stability.

For secure communications, precise timing synchronization ensures that encrypted data can be recovered quickly. Frequency-agile signals also require exact synchronization between transmitter and receiver during channel hops.

The 5071B automates the synchronization to any external 1PPS signal, greatly simplifying this aspect of satellite communications.

The 5071B and GPS

The 5071B primary frequency standard can work very well with a GPS timing receiver to produce and maintain highly accurate time and frequency.

The GPS system provides accurate time, frequency, and location information worldwide by means of microwave radio broadcasts from a system of satellites. Timing accuracy for the GPS system is based, in large part, on the accuracy and stability of a number of 5071B primary frequency standards. These standards are maintained by the GPS system, the US Naval Observatory, and various timing laboratories around the world that contribute to UTC, the world time scale.

Because of their accurate time reference, GPS signals processed by a good GPS timing receiver can provide highly accurate time and frequency outputs. However, since GPS receivers rely on very low level microwave signals from the satellites, they sometimes lose accuracy because of interfering signals, local antenna problems, or bad satellite data.

In spite of these problems, a GPS timing receiver can be an excellent backup and reference to a local 5071B primary frequency standard. The GPS receiver provides an independent reference that can be used to verify the accuracy of a caesium standard, or it can be used as a temporary backup should the cesium standard need repair. The local 5071B standard has better stability, better output signal quality, and is not perturbed by interfering signals, intermittent signal loss, or bad satellite data.

With these characteristics, the synergy created by combining a good quality GPS timing receiver and a 5071B primary frequency standard can produce a highly robust, inexpensive, and redundant frequency and time system.

Exceptional Accuracy

The intrinsic accuracy of the improved cesium beam tube (CBT) assures that any high performance 5071B will power up to within $\pm 5.0 \times 10^{-13}$ of the accepted standard for frequency. This is achieved under full environmental conditions in 30 minutes or less, and without the need for any adjustments or alignments.

Unsurpassed Stability

The 5071B high-performance cesium beam tube guarantees stability to be better than 1.0×10^{-14} for averaging times of five days or greater. The 5071B is the first cesium standard to specify stability for averaging times longer than 1.0×10^{5} seconds (approximately one day).

The 5071B is also the first cesium standard to specify and guarantee a flicker floor. Flicker floor is the point at which the standard's stability ($\sigma_y (2, \tau)$) does not change with longer averaging. The high performance 5071B flicker floor is guaranteed to be 1.0×10^{-14} or better. Long-term measurements at the National Institute of Standards and Technology (NIST) show that the flicker floor is typically better than 5.0×10^{-15}.

Unstable environments are normal for many cesium standard applications. The 5071B features a number of microprocessor controlled servo loops which allow it to virtually ignore changes in temperature, humidity, and magnetic fields.

The 5071B delivers exceptional performance over very long periods of time, greatly increasing the availability of critical time and frequency services. Actual measurements made at NIST have demonstrated that a 5071B with the high-performance CBT will drift no more than 5.0×10^{-14} over the entire life of the CBT.

Traditional Reliability

The 5071B design is based off its predecessor, the 5071A, which has demonstrated an average mean time between failures (MTBF) of greater than 160,000 hours since its introduction in 1992. This data is based on actual field repair data. Backing up this reliability is a 10-year warranty on the standard long-life cesium beam tube and a 5-year warranty for the high performance tube.

Complete repair and maintenance services are available at our repair center in Beverly, Massachusetts.

Full Traceability to NIST

Microchip provides NIST traceability to the accuracy measurements made on every 5071B. Traceability to NIST is maintained through the NIST-supplied Time Measurement and Analysis System (TMAS). This service exceeds the requirements of MIL-STD-45662A and can be a valuable tool in demonstrating traceability to your customers.

Stability (Allan Deviation)

Average Time (s)	Standard Performance	High Performance
0.01	$\leq 7.5 \times 10^{-11}$	$\leq 7.5 \times 10^{-11}$
0.1	$\leq 1.2 \times 10^{-11}$	$\leq 1.2 \times 10^{-11}$
1	$\leq 1.2 \times 10^{-11}$	$\leq 5.0 \times 10^{-12}$
10	$\leq 8.5 \times 10^{-12}$	$\leq 3.5 \times 10^{-12}$
100	$\leq 2.7 \times 10^{-12}$	$\leq 8.5 \times 10^{-13}$
1,000	$\leq 8.5 \times 10^{-13}$	$\leq 2.7 \times 10^{-13}$
10,000	$\leq 2.7 \times 10^{-13}$	$\leq 8.5 \times 10^{-14}$
100,000	$\leq 8.5 \times 10^{-14}$	$\leq 2.7 \times 10^{-14}$
10 days	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$
30 days	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$
Flicker floor: Guaranteed	$\leq 5.0 \times 10^{-14}$	$\leq 1.0 \times 10^{-14}$
Flicker floor: Typical	$\leq 1.5 \times 10^{-14}$	$\leq 5.0 \times 10^{-15}$