Errata

Title & Document Type: 5061B Cesium Beam Frequency Standard Operating Information

Manual Part Number: 05061-9074

Revision Date: April 1986

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

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We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

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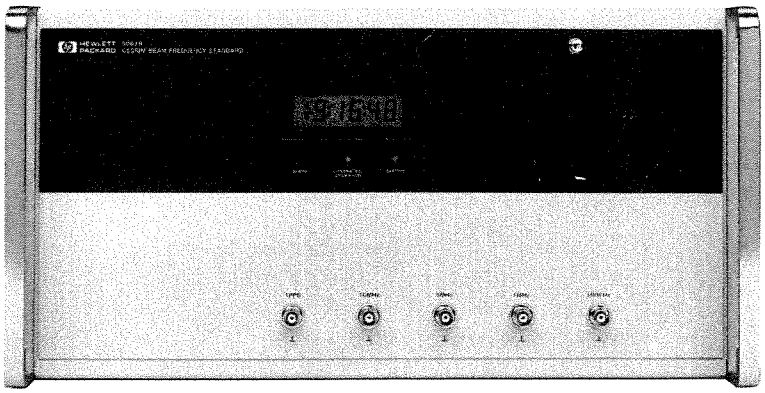
Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

OPERATING INFORMATION

5061B
Cesium Beam Frequency Standard



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CERTIFICATION

Hewlett-Packard Company certifies that this instrument met its published specifications at the time of shipment from the factory. Hewlett-Packard Company further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from the date of shipment except that in the case of certain components listed in Table 1-1 of this manual, the warranty shall be for the specified period. Hewlett-Packard will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard, and provided the preventive maintenance procedures in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HEWLETT-PACKARD IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

Service contracts or customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

TRLR

OPERATING INFORMATION

5061B
Cesium Beam Frequency Standard
(Including Options 003 and 004)

SERIAL PREFIX: 2612A

This manual applies directly to HP Model 5061B Cesium Beam Frequency Standards having Serial Prefix 2612A.

OPTIONS

This manual applies directly to Model 5061B instruments with Option 003 (Time Standard and Standby Power Supply) and Option 004 (High Performance Beam Tube).

TECHNICAL MANUAL REQUEST

This manual provides all the necessary information required to operate the HP 5061B. To obtain a copy of the Operating and Service Manual, fill out, detach, and return the TECHNICAL MANUAL REQUEST form to Hewlett-Packard. This form immediately precedes this title page.

MANUAL PART NUMBER: 05061-9074
MICROFICHE PART NUMBER 05061-9075

PRINTED: APRIL 1986

HEWLETT PACKARD

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SAFETY CONSIDERATIONS

GENERAL

This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

This product is a Safety Class I instrument (provided with a protective earth terminal).

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to Section II, Installation.

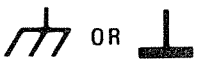
SAFETY EARTH GROUND

An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

SAFETY SYMBOLS

Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.

Indicates hazardous voltages.



Indicates terminal is connected to chassis when such connection is not apparent.

Alternating current.

Direct current.

WARNING

The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

CAUTION

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

SAFETY INFORMATION

WARNING

Any interruption of the protective grounding conductor (inside or outside the instrument) or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury. (Grounding one conductor of a two conductor outlet is not sufficient protection.)

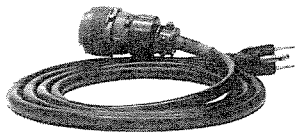
Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation.

If this instrument is to be energized via an autotransformer (for voltage reduction) make sure the common terminal is connected to the earthed pole terminal (neutral) of the power source.

Instructions for adjustments while covers are removed and for servicing are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform such adjustments or servicing unless qualified to do so.

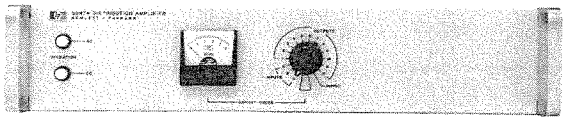
For continued protection against fire, replace the line fuse(s) only with 250V fuse(s) of the same current rating and type (for example, normal blow, time delay). Do not use repaired fuses or short circuited fuseholders.

Figure 1-1. Model 5061B and Accessories

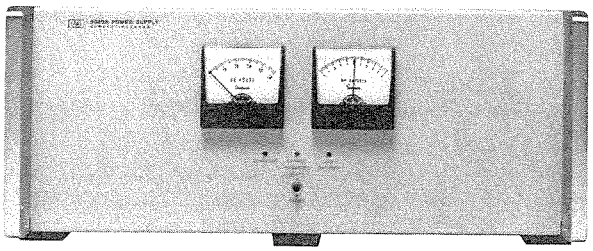


AC POWER CABLE

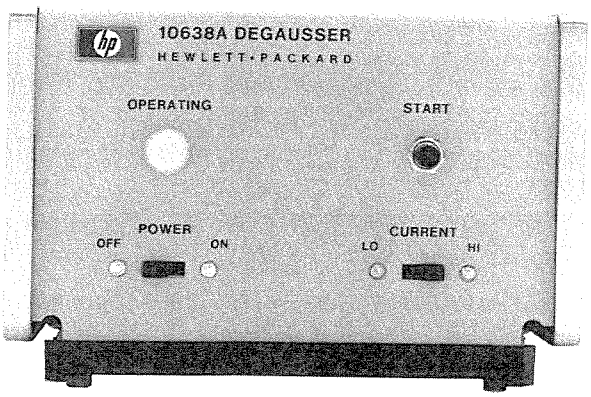
5061B



5087A
DISTRIBUTION AMPLIFIER
(ACCESSORY)
SEE TABLE 1-3

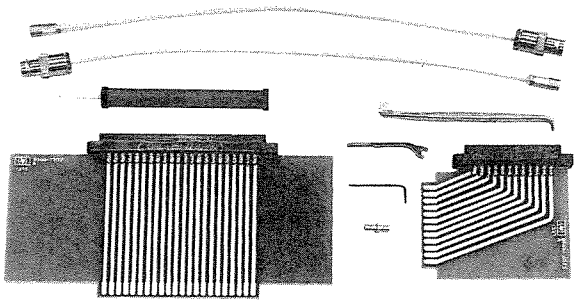


5089A
STANDBY POWER SUPPLY
(ACCESSORY)
SEE TABLE 1-3



10638A
DEGAUSSER
(ACCESSORY)
SEE TABLE 1-3

DC POWER
CONNECTOR



ACCESSORY KIT
(INCLUDED)
SEE TABLE 1-2

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. The Hewlett-Packard Model 5061B Cesium Beam Frequency Standard is a compact, self-contained frequency standard which uses a cesium beam tube resonator to stabilize the output frequency of a quartz crystal oscillator. Solid state components and the closed-loop, self-checking control circuit provide excellent accuracy. When the high-performance tube Option 004 is installed in the HP 5061B, accuracy is increased. Available output frequencies are 10 MHz, 5 MHz, 1 MHz, and 100 kHz. *Figure 1-1* shows the HP Model 5061B and accessories.

1-3. In the beam tube, a state-selected beam of Cesium 133 atoms passes through a microwave cavity. When the frequency of the applied microwave magnetic field, derived by multiplying the quartz crystal oscillator frequency, is near the hyperfine transition frequency of Cesium 133 (9,192,631,770.0 Hz.), the microwave signal induces transitions from one hyperfine energy level to another. Those atoms which have undergone such a transition are detected by a hot wire ionizer and electron multiplier. The microwave field is frequency modulated at a low frequency of 137 Hz. When the microwave frequency deviates from the center of the atomic resonance, the current from the electron multiplier contains a frequency component which is the same as the modulation frequency. The magnitude of this component is proportional to the frequency deviation, and the phase indicates whether the microwave signal is above or below the transition frequency. This component is filtered, amplified, and synchronously detected to provide a dc voltage proportional to the frequency deviaton. The integral of this dc voltage automatically corrects the quartz oscillator frequency. The standard cesium beam tube exhibits outstanding reliability for its guaranteed life.

1-4. MANUAL SUMMARY

1-5. This manual is divided into three sections, each covering a particular topic for operation of the HP 5061B. The topics by section are:

SECTION I, GENERAL INFORMATION. Provides the instrument specifications, instrument identification, description of options and accessories, and a list of recommended test equipment.

SECTION II, INSTALLATION. Provides information about initial inspection, storage and shipment, and electrical power connections.

SECTION III, OPERATION. Provides information about operating controls and indicators; operating modes (including options), turn-on procedures, and in-cabinet performance tests.

1-6. OPTIONS

1-7. Several options are available. They are:

a. Option 003 Time Standard and Standby Power Supply: This option includes a 24-hour clock display and switches to allow the clock display to be set to the nearest second. A one pulse-per-second output at front and rear panel BNC connectors is provided by this option. An internal "sync" button permits automatic synchronization of the 1PPS output to an external "sync" pulse. By the use of seven 10-position thumbwheel switches, the output clock pulse is adjustable from 0.1 microseconds to one second with respect to a reference pulse. Standby power capability for a minimum of 45 minutes is provided by an internal battery. Recharging occurs internally whenever the battery is not supplying power to the instrument. A front panel LED indicates when the battery is being used.

b. Option 004 High Performance Cesium Beam Tube: (see *Table 1-1* for performance specifications) Option 004 provides improvement in specifications such as accuracy, settability, reproducibility, and short-term stability.

c. Option 908 Rack Mounting Kit is available, at additional cost, when ordered at the same time as the HP 5061B. If ordered separately, the rack mounting kit is HP Part Number 5060-8742.

d. Option 910 adds a second copy of the Operating and Service manual at additional cost when ordered at the same time as the HP 5061B.

1-8. TERMINOLOGY

1-9. The following definitions apply to terms used:

a. UNIVERSAL COORDINATED TIME (UTC). An internationally agreed upon time scale which has the same rate as Atomic Time. UTC is corrected by step adjustments of exactly one second, as needed to remain within 0.7 seconds of Astronomical Time (UT1). The "Bureau International de L'Heure" (BIH) determines when step adjustments are needed.

b. ATOMIC TIME. Time scale based on the hyperfine resonance of Cesium 133.

c. CESIUM BEAM TUBE. Passive atomic resonator using the hyperfine resonance of Cesium 133.

d. "C" FIELD. Magnetic field within the cesium beam tube for fine frequency adjustments.

e. ZEEMAN TRANSITIONS. Transitions excited by application of the Zeeman frequency. These additional energy levels in the hyperfine structure are caused by applying the "C" field (Zeeman splitting). They are used to accurately measure the magnetic field inside the beam tube.

f. LOW FREQUENCY TRANSITIONS. These frequencies appear in the spectrum and are dependent upon the "C" field value. They can be excited independent of the microwave power source.

g. MASS SPECTROMETER. Directs cesium ions to the electron multiplier and prevents impurity ions from reaching the electron multiplier.

h. HOT WIRE IONIZER. Heated tantalum ribbon ionizes cesium atoms which strike it.

i. ELECTRON MULTIPLIER. Amplifies the electron current initiated by a cesium ion striking the first dynode.

j. BEAM CURRENT. Current resulting from the action of the hot wire ionizer and electron multiplier.

k. ION PUMP. Maintains a vacuum in the cesium beam tube by continuously pumping when the HP 5061B is on.

1-10. SPECIFICATIONS

1-11. *Table 1-1* lists the technical specifications for the HP 5061B. Specifications describe the instrument's warranted performance. Supplemental characteristics are intended to provide information useful in applying the instrument by giving TYPICAL or NOMINAL, but nonwarranted performance parameters.

1-12. INSTRUMENT IDENTIFICATION

1-13. Hewlett-Packard instruments have a 10-character serial number (0000A00000). The four-digit serial prefix identifies instrument changes. The five-digit number is the serial number of each instrument. If the serial prefix does not appear on the title page of the manual, there are differences between your instrument and the manual. A manual supplement included with the manual describes the differences. If the supplement is missing, contact the nearest Hewlett-Packard Sales and Service office listed on the inside rear cover of this manual.

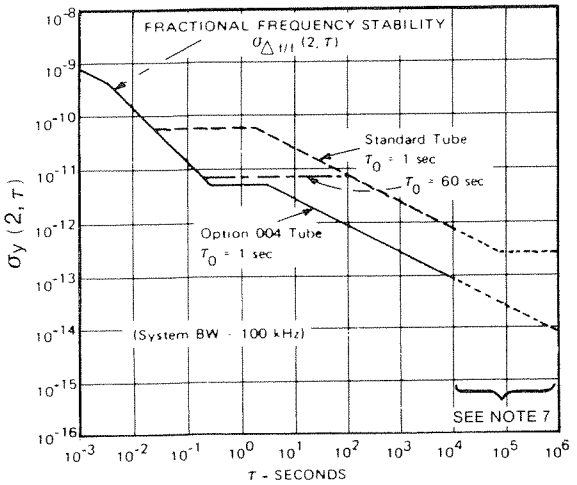
1-14. SAFETY CONSIDERATIONS

1-15. The Model 5061B is a Safety Class I instrument provided with a protective earth terminal. The instrument is designed and tested to international standards. Safety information pertinent to the operation and servicing of this instrument is included in appropriate sections of this manual.

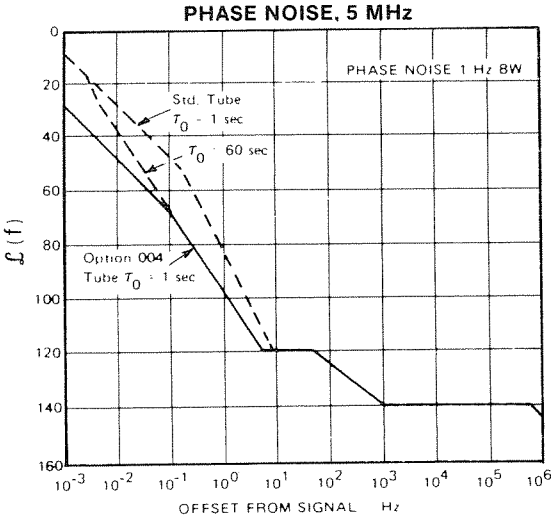
Table 1-1. Specifications

	Standard Beam Tube	Option 004 High Performance Beam Tube
Accuracy(1): Maintained over a temperature range of 0 to 50°C and magnetic fields up to 0.2 millitesla (2 gauss) or any combination thereof.	$\pm 1\times10^{-11}$	$\pm 7\times10^{-12}$
Accuracy — Limited Temp. Range(5)	$\pm 6\times10^{-12}$	$\pm 4\times10^{-12}$
Reproducibility(1) (2)	$\pm 5\times10^{-12}$	$\pm 3\times10^{-12}$ (3)
Retrace(1)	$\pm 6\times10^{-12}$	$\pm 1\times10^{-12}$ (6)
Settability (Frequency) (1)	$\pm 7\times10^{-13}$	$\pm 1\times10^{-13}$ (3)
Long-term stability (for life of cesium beam tube)	$\pm 3\times10^{-12}$	$\pm 2\times10^{-12}$
DC Magnetic Field Stability, frequency change, any orientation in a 2 gauss field.	$\pm 2\times10^{-12}$	$\pm 2\times10^{-13}$
Time Constant, quartz oscillator control loop (τ_0)	1 and 60 s(4)	1 s
Warm-up time at 25°C	45 min.	30 min.
Beam Tube Warranty	3 years	1 year

FREQUENCY STABILITY(1), 5 MHz



PHASE NOISE, 5 MHz



Notes:
(1) See definitions, page 1-5
(2) See *Figure 1-2*
(3) With 10638A Degausser
(4) Use 60 second time constant for increased short-term stability in controlled environments.
(5) Over any ±2.5°C Range at any temperature between 15 and 35°C
(6) With degaussing — Retrace is less than $\pm 2\times10^{-12}$ without degaussing
(7) For values of τ(s) > 10^4 seconds, instruments are not subjected to frequency stability testing on a regular basis. This portion of the curve (i.e., τ(s) >10^4 seconds) provides information useful in formulating applications for the HP 5061B.

	FREQUENCY STABILITY*	
τ (s)	Standard Tube	Option 004 Tube
10^{-3}	8.2×10^{-10}	8.2×10^{-10}
10^{-2}	1.5×10^{-10}	1.5×10^{-10}
10^{-1}	5.6×10^{-11}	1.5×10^{-11}
10^{0}	5.6×10^{-11}	5×10^{-12}
10^{1}	2.5×10^{-11}	2.7×10^{-12}
10^{2}	8×10^{-12}	8.5×10^{-13}
10^{3}	2.5×10^{-12}	2.7×10^{-13}
10^{4}	8×10^{-13}	8.5×10^{-14}

*These measurements are made with a servo loop time constant of 1 sec. (τ_0 = 1 second)

	PHASE NOISE,* (dB Below the Carrier)	
Δf	Standard Tube	Option 004 Tube
10^{-3}	-8	-28
10^{-2}	-28	-48
10^{-1}	-48	-68
10^{0}	-82	-96
10^{1}	-120	-120
10^{2}	-125	-125
10^{3}	-140	-140
10^{6}	-146	-146

*These measurements are made with a servo loop time constant of 1 sec. (τ_0 = 1 second)

Table 1-1. Specifications (Continued)

SINUSOIDAL OUTPUTS

10 MHz, 5 MHz, 1 MHz, and 100 kHz, front and rear panel BNC.

Output Voltage: >1 Vrms into 50 ohms.

Harmonic Distortion: Down more than 40 dB from rated output.

Non-Harmonically Related Output: Down more than 80 dB from rated output.

QUARTZ OSCILLATOR

The high quality internal oscillator may be used without turning on the cesium beam tube.

Aging Rate: $<5 \times 10^{-10}$ per 24 hours.

Frequency Adjustments:

Fine: 5×10^{-8} range, with dial reading parts in 10^{10} (nominal).

Coarse: 1×10^{-6} range, screwdriver adjustment at front panel.

ENVIRONMENTAL:

Temperature: Operating, 0 to 50°C. Stability for high performance (Option 004) beam tubes, $<\pm 5 \times 10^{-12}$ change over 0 to 50°C range. For the standard tube, $<\pm 5 \times 10^{-12}$ change from 25°C reference. Non-operating, <-40 to +75°C.

Supplemental Characteristics (Typical):

Production units have passed type testing as follows:

Humidity: Operating, to 95% at 40°C.

Altitude: $<2 \times 10^{-12}$ change up to 12.2 km (40,000 ft.) operating.

AC Magnetic Field: Less than 2×10^{-12} for 0.2 millitesla (2 gauss) peak for 50, 60 or 400 Hz fields.

Shock: MIL-T-28800C, Class 3 (30 g's, 11 ms)

Vibration: Meets the provisions of MIL-T-28800C (survival only) and MIL-STD-167-1.

EMI: MIL-STD-461B, Part 7, Class B (CE03 broadband requires relaxation of 20 dB below 40 kHz).

POWER: 115V ±10%, 48 to 440 Hz, 230V ±10%, 48 to 66 Hz, or 22 to 30 Vdc.

Approximate power required:

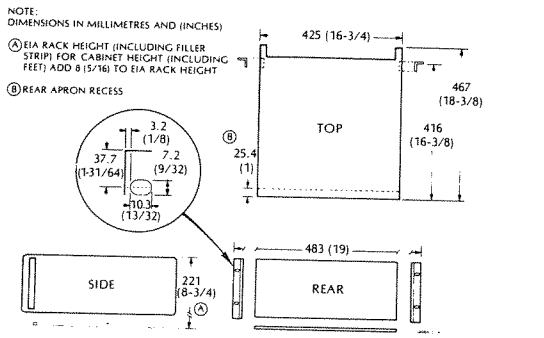
	DC	AC
5061B and 5061B with Option 004	30W	44W
Option 003	Add 5W	Add 16W
Note: The above figures do not apply during instrument warmup.		

NET WEIGHT: 29.1 kg (64 lbs); Option 003, add 2.7 kg (6 lbs.); Option 004, add 1.8 kg (4 lbs.); Options 003 & 004, add 4.5 kg (10 lbs.). Add 9.1 kg (20 lbs.) for standard instrument's and 25 kg (55 lbs) for Option 004 instrument's shipping weight.

ACCESSORIES FURNISHED: Power Cord, 180 cm (6 ft.), detachable. Accessory Kit, HP 05061-6070, includes two extender boards, test cables, maintenance tools, and a mating connector 1251-0126 for EXT DC input.

ACCESSORIES AVAILABLE: EXT DC cable connects 5061B to 5089A Standby Supply, 05089-60101. 10638A Degausser for use with Option 004 High Performance Tube. See page 1-6 for details. Rack Mounting Kit, Option 908.

DIMENSIONS:



MATING CONNECTORS:

EXT DC Input: 1251-0126 (5-contact), Cannon MS 3106E-14S-5S (Series ME) furnished.

AC Line: 1251-2457, Cannon MS3106A-18-22SW.

Degausser: 1251-2797, Bendix PT06A-14-18P1005.

WARRANTY: Instrument, 1 year; optional battery, 1 year (see page 1-3 for beam tube warranty).

OPTION 003
TIME STANDARD AND STANDBY POWER SUPPLY

TIME STANDARD

CLOCK DISPLAY: 24 hour LCD readout in hours, minutes, and seconds driven by Clock Pulse.

Rate: 1 pulse-per-second.

Amplitude: +10V ±10% peak.

Width: 20 μsec minimum.

Rise Time: <50 ns.

Fall Time: <50 ns.

Jitter: <1 ns rms pulse-to-pulse and pulse-to-5 MHz.

Output: Buffered front and rear BNC connectors. All specs are with 50Ω load.

SYNCHRONIZATION (REAR BNC): Automatic, 100 ns (±100 ns) delayed from the reference input pulse. Manual adjustable to <±50 ns. Reference pulse must be >+5V, with a rise time of <50 ns.

STANDBY POWER SUPPLY

CAPACITY: 45 minutes minimum at 25°C at full charge from sealed nickel-cadmium batteries.

CHARGE CONTROL: Automatic when ac power is connected.

INDICATOR: A front panel light flashes when ac power is interrupted and battery is being used.

OPTION 004
HIGH PERFORMANCE CESIUM BEAM TUBE

Replaces standard beam tube and may be installed with any of the above options. See page 1-3 for specifications and warranty. For optimum performance, the 10638A Degausser should be ordered.

Table 1-1. Specifications (Continued)

DEFINITION OF TERMS

Accuracy

The degree to which an oscillator frequency corresponds to that of an accepted definition. The currently accepted definition is that of the 13th General Conference of Weights and Measures. In practice, this involves comparison with some generally accepted physical embodiment of this definition such as the NBS Frequency Standard. The specified accuracy of the 5061B Cesium Beam Frequency Standard is intrinsic to it and is achieved without calibration.

Reproducibility

The degree to which an oscillator will produce the same frequency from one occasion to another after proper alignment. This does not include calibration.

Retrace

The degree to which a cesium standard will produce the same frequency from one occasion to another after cessation of power for periods up to one month without a re-alignment. This does not include calibration.

Intrinsic Reproducibility

The intrinsic reproducibility of the 5061B (see Figure 1-2) is the measure of the repeatability from one independently aligned unit to another. The small spread indicates that any HP 5061B with an Option 004 High Performance Tube will produce a frequency within $\pm 3 \times 10^{-12}$ without calibration. The data was acquired by continuous phase comparison for an interval of 48 hours or more against the Hewlett-Packard House Standard. The intrinsic reproducibility of the 5061B is the same as that of the 5061A. All individual units are tested to meet this specification.

Settability

The degree to which the frequency of an oscillator may be adjusted to correspond with a reference. This is also termed calibration.

Stability

A. Long-Term frequency is defined as the absolute value (magnitude) of the fractional frequency change with time. An observation time sufficiently long to reduce the effects of random noise to an insignificant value is implied. Frequency changes due to environmental effects must be considered separately.

B. Short-Term stability is defined as the standard deviation of fractional frequency fluctuations due to random noise in the cesium standard. It may also be expressed as a standard deviation of phase. This specification must include the number of samples, the averaging time, the repetition time, and the system bandwidth.

See "Statistics of Atomic Frequency Standards" by David W. Allan, Proceedings of IEEE, Feb. 1966. P. 221, and HP Application Note 116 for measurement details.

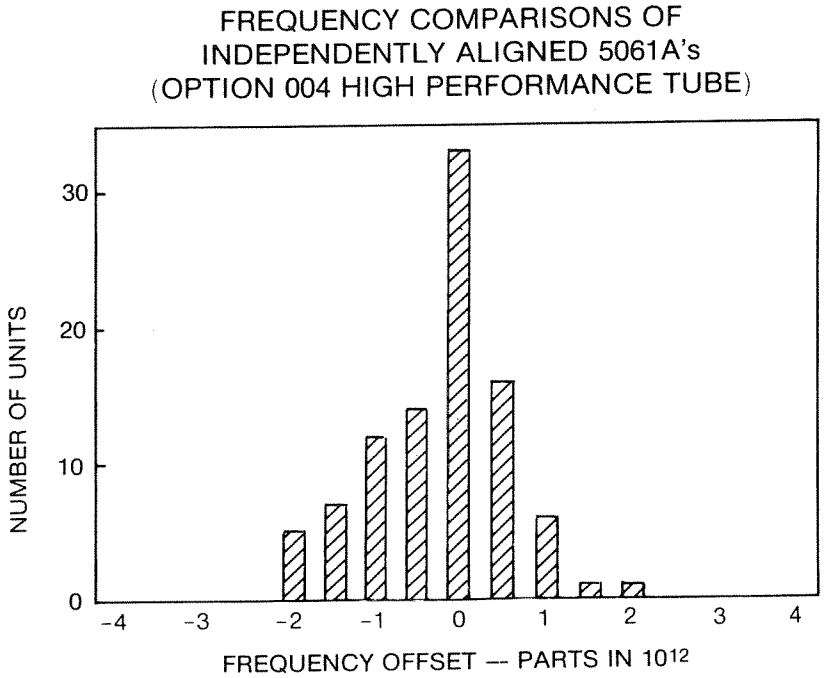


Figure 1-2. Frequency of Independently Aligned 5061A Cesium Beam Standards with with Option 004 High Performance Tubes

1-16. ACCESSORIES

1-17. *Table 1-2* lists equipment supplied and *Table 1-3* lists accessories available for the HP Model 5061B.

Table 1-2. Equipment Supplied

Equipment	Description	HP Part No.
AC Power Cable	Three-conductor with ground pin	05061-6091*
Accessory Kit:		05061-6070
1. Adapter	Micon,male-to-male	1250-0813
2. Connector	Plug (female)	1251-0126
3. Screwdriver	Ceramic	8710-0033
4. Wrench	Key, 4 Spline	8710-0055
5. Screwdriver	Offset	8730-0007
6. Wrench	1/8 inch open-end	8710-1111
7. Board Extender	22 pin	5060-7202
8. Cable Assembly	Test, Micon-to-BNC (2 supplied)	05060-6116
9. Extender, 90° bend	12 pin	05061-6073

*This part number will vary depending on country of destination. See *Figure 2-1* for additional power cable part numbers that are available.

Table 1-3. Accessories Available

Accessory	Description	HP Part No.
Standby Power Supply	22 to 28 Vdc, 2-amp supply with 15 amp-hours standby capacity (at 25°C).	5089A
Cable	Connects 5061B to the 5089A dc output.	05089-60101
(a) Extension Slides, and (b) Slide Adapter	Permits sliding instrument out and tilting from rack-mounted position.	(a) 1490-0718 (b) 1490-0721
Degausser	For degaussing Option 004 High Performance Cesium Beam Tube.	10638A
Rack Mounting Kit	Provides conversion from bench to rack.	5060-8742
Distribution Amplifier	Amplifies and allows 5061B output RF signal distribution to remote locations.	5087A

1-18. RECOMMENDED TEST EQUIPMENT FOR THE HP 5061B

1-19. Recommended test equipment for performance testing is listed in *Table 1-4*. Other test instruments may be used if their specifications equal the required characteristics. The recommended measuring systems must be composed of a number of standard and special instruments connected together. Therefore, the performance of the measurement system is being checked as well as the performance of the Cesium Beam Frequency Standard. Some measurement systems will require considerable effort to duplicate and also to verify that an out-of-specification measurement is traceable to the instrument being tested or to the test equipment.

Table 1-4. Recommended Test Equipment

Instrument	Required Characteristics	Use	Model
Primary Frequency Standard	Frequency: 5 and 1 MHz Output level: 1 Vrms @ 50Ω Accuracy: $<\pm 7 \times 10^{-12}$	Performance Check	HP 5061B with Option 003 and 004
Electronic Counter	Frequency Range: 0 to 90 MHz Sensitivity: 20 mVrms EXT STD input: 5 MHz	Performance Check	HP 5345A
Electronic Counter*	Frequency: 0 to 100 MHz Pulse Width A: 5 ns to 10 ms Rise/Fall Time A: 30 ns to 10 ms Time Interval A to B: -1 ns to 10^3 sec	Adjustments Performance Check	HP 5334A
Feedthrough Termination	50Ω male and female BNC	Performance Check	No Recommendation
Spectrum Analyzer	Frequency Range: 1 kHz to 110 MHz Response: ±0.5 dB Sensitivity: -130 dBm Scan Width: 2 kHz to 100 MHz Stability: Residual FM <20 Hz peak-to-peak	Performance Check	HP 141T with HP 8552B and HP 8553B
Vector Voltmeter**	Frequency: 1 MHz to 1 GHz Voltage Range: 1.5 mV to 1 Vrms	Performance Check	HP 8405A
Phase Comparator**	Frequency Range: 100 kHz to 10 MHz Input Sensitivity: 0.1 Vrms Output: 1V into 100 kΩ for 360° phase change	Performance Check	HP K34-59991A
Strip Chart Recorder	Chart Speed: 1 in/hr. Spans: 1V Full Scale Input Resistance: 200 kΩ/Volt Accuracy: 0.2% full scale	Performance Check	No Recommendation
Audio Oscillator	Frequency Range: 5 Hz to 1.2 MHz Dial Accuracy: ±3% Output Impedance: 600Ω	Performance Check Adjustments	No Recommendation
Time Interval Counter	Resolution of >2 nsec per measurement	Performance Check	HP 5370A/B
RMS Voltmeter	Voltage Range: 1 mV to 3V full scale Frequency Range: 10 Hz to 10 MHz Accuracy: ±5% full scale	Performance Check	HP 3400A
RF Voltmeter	Voltage Range: 1 mV to 3V full scale Frequency Range: 10 kHz to 1.2 GHz	Performance Check	HP 3406A

Table 1-4. Recommended Test Equipment (Continued)

Instrument	Required Characteristics	Use	Model
Oscilloscope	Vertical Frequency Response: dc to 100 MHz Sensitivity: 0.005 V/cm Calibrated Sweeps: 1 sec to 0.05 μsec/cm Input Coupling: 50Ω	Performance Check	No Recommendation
Fixed Attenuator	Attenuation: 20 dB ±.6 dB Frequency Range: dc-12.4 GHz Impedance: 50Ω nominal Maximum Power Input: 2 Watt	Performance Check Troubleshooting	HP 8491A Option 020, 20 dB pad (2 each)
Degausser***		Performance Check	HP 10638A

*The HP 5334A is recommended as an alternative approach to the 1 PPS parameter check (pulse width and rise/fall time) for the Option 003. It is also useful in the manual synchronization of the 1 PPS output (Option 003) with an external clock reference.

**The HP 8405A or the HP K34-59991A may be used for frequency comparison measurements. It is not necessary to have both units.

***The HP 10638A Degausser is designed for use with the Option 004 High Performance Beam Tube to achieve settability of $\pm 1 \times 10^{-13}$ and reproducibility of $\pm 3 \times 10^{-12}$.

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section presents information for unpacking, inspection, installation and storage of the HP 5061B.

2-3. UNPACKING AND INSPECTION

2-4. If the shipping carton is damaged, inspect the instrument for visible damage: scratches, dents, broken parts or marks. If the instrument is damaged, notify the carrier and the nearest Hewlett-Packard Sales and Service office immediately. (HP offices are listed at the back of this manual.) Keep the shipping carton and all packing material for the carrier's inspection. The HP Sales and Service office will arrange for repair or replacement of your instrument without waiting for the claim against the carrier to be settled.

2-5. STORAGE AND SHIPMENT

2-6. Environment

2-7. The shelf life of the cesium beam tube is two years at storage temperatures up to +35°C (+95°F) if the ion pump is operated 2 or 3 times a year. If the ion pump is not operated to maintain the vacuum within the cesium beam tube, the expected shelf life is reduced.

2-8. Temperatures during storage and shipment should be limited as follows:

a. Maximum temperature: +75°C (+167°F). Long term storage: +35°C (+95°F).

b. Minimum temperature: -40°C (-40°F).

NOTE

When storing the HP 5061B for 6 months or longer, set the MODE switch to CS OFF and apply continuous ac line power to the instrument. This enables the ion pump to maintain the vacuum within the cesium beam tube with the cesium beam tube off.

2-9. Packaging

2-10. The packaging materials used to ship the Cesium Beam Frequency Standard must comply with local and international regulations as applicable. These materials are immediately available if the shipping containers that the unit was received in are preserved. If the original packaging material is not available, specific details about appropriate materials can be obtained from your local Hewlett-Packard office or a local freight transportation company. Here is a recommended method for packaging a standard 5061B unit:

a. Wrap the instrument in heavy paper or plastic. (If shipping the unit to a Hewlett-Packard office or service center, attach a tag indicating type of service required, return address, model number, and full serial number.)

b. Obtain a "same-size" carton (HP Part Number 9211-1102). Into the bottom of this carton, install a protector pad (HP part number 9220-1304).

c. Place the wrapped instrument into the "same-size" carton.

d. When the carton is sealed, install four polyurethane foam post-packs (HP Part Number 9220-1875) on each corner of the carton.

e. Install the boxed instrument into a final cardboard outer carton (HP Part Number 9211-1730), seal the carton effectively and label it properly.

f. Mark shipping container FRAGILE to ensure careful handling.

g. In any correspondence, refer to the instrument by model number and complete serial number.

NOTE

When shipping either a 5061B with Option 004 (Cesium Beam Frequency Standard with High Performance Cesium Beam Tube) or a 05061-6101 (High Performance Cesium Beam Tube Assembly), and the original packaging is not available, contact your nearest Hewlett-Packard office for shipping instructions. Hewlett-Packard Cesium Beam Tubes contain between 0.5 and 5.0 grams of cesium. This substance is not radioactive. The U.S. Department of Transportation, the International Civil Aviation Organization, and the International Air Transportation Association all have explicit requirements for the packaging and shipment of the element cesium. For instance, the U.S. Department of Transportation currently requires that the 5061B/Option 004 be packaged in a cleated plywood crate in addition to the packaging required for a standard unit (see paragraph 2-10).

2-11. Tagging for Service

2-12. If the 5061B is being returned to Hewlett-Packard for service, please complete one of the blue repair tags (HP Part No. 9320-3896) located at the end of Section III and attach it to the instrument.

2-13. ELECTRICAL POWER CONNECTIONS

2-14. AC Line Voltage

2-15. Before reading further, read the CAUTION below. The HP 5061B can be operated from either 115- or 230-volt power lines. A slide switch on the rear panel permits quick conversion for operation from either voltage. Insert a narrow-blade screwdriver in the switch slot and set the switch to expose the correct numbers to correspond to the line voltage used (*Table 2-1*). The instrument is supplied with a 115-Volt fuse; change this fuse for 230-Volt line operation (*Table 2-1*). AC power requirements are listed in *Table 1-1*.

CAUTION

Before connecting ac power to the instrument, be certain the LINE SELECTOR switch is properly positioned for 115- or 230-Volt operation.

Table 2-1. 115/230 Volt Conversion

Conversion	115 Volts	230 Volts
Slide Switch	Right	Left
AC Line Fuse	1.25A	0.8A

2-16. DC Line Voltage

2-17. In addition to ac power capability, the HP 5061B can also be operated from an external dc source with a voltage range of +22 to +30 Vdc. The dc power source may be applied simultaneously, with the ac power source. DC power requirements are as listed in *Table 1-1*. DC power connections are through the rear panel EXT DC connector. (See paragraph 2-23 for additional DC Power Connector information.)

2-18. POWER CABLES

WARNING

BEFORE SWITCHING ON THIS INSTRUMENT, THE PROTECTIVE EARTH TERMINALS OF THIS INSTRUMENT MUST BE CONNECTED TO THE PROTECTIVE CONDUCTOR OF THE (MAINS) POWER CORD. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE (GROUNDING) CONDUCTOR.

2-19. The HP 5061B is equipped with a detachable ac power cable and a dc power connector which can be used to make a dc power cable. The type of power cable shipped with each instrument depends on the country of destination. Refer to *Figure 2-1* for the part numbers of the power cable and plug configurations available.

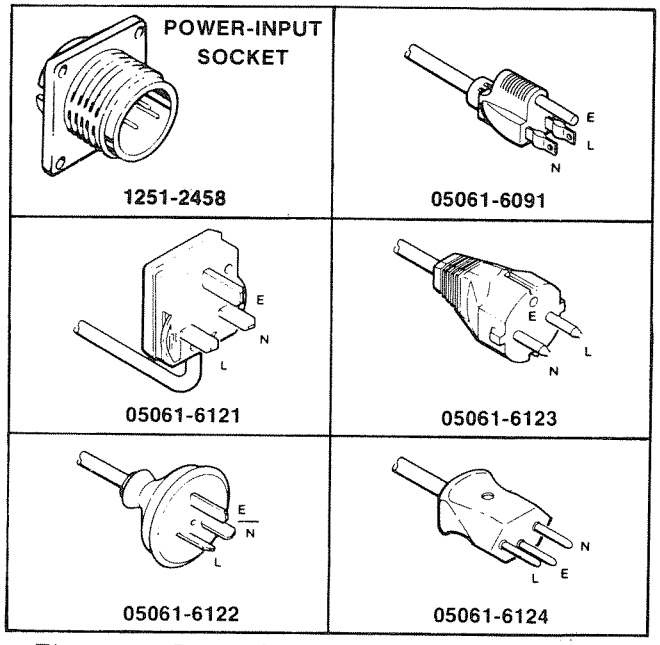


Figure 2-1. Power Cable HP Part Numbers versus Mains Plugs Available

2-20. AC Power Cable Installation

2-21. Perform the following steps to use the ac power cable:

a. Put the round three-conductor female plug in the LINE jack on the HP 5061B rear panel.

b. The HP 5061B is shipped with a three-wire ac power input cable (power cord). When the power cord (W33) is connected to an appropriate ac source, it connects the instrument chassis to earth ground.

WARNING

TO REDUCE THE RISK OF ELECTRIC SHOCK WHEN CONNECTING THE HP 5061B TO AN AC OUTLET (MAINS), THE MILITARY-TYPE CONNECTOR OF THE POWER CORD MUST BE CONNECTED TO THE AC LINE CONNECTOR (J20) ON THE REAR PANEL OF THE INSTRUMENT BEFORE INSERTING THE MAINS PLUG IN AN OUTLET SOCKET. TO DETACH THE POWER CORD, THE MAINS PLUG MUST BE DISCONNECTED FROM THE OUTLET SOCKET BEFORE REMOVING THE OTHER END OF THE CORD FROM THE INSTRUMENT.

2-22. DC Power Connector

2-23. Use the dc power connector (supplied), which mates with the EXT DC connector on the HP 5061B rear panel, to connect dc power to the HP 5061B. Connect the + terminal of the 22-to-30 Vdc external power to connector pin A. Connect the negative terminal of the external dc power to connector pin C (chassis ground). The remaining three pins are not used.

2-24. Mating Connectors

2-25. *Table 2-2* lists the HP 5061B front and rear panel connectors and their respective mating connectors. Not all connectors listed are shipped with the HP 5061B but are listed in the table for installer reference.

2-26. OPERATION AS BENCH OR RACK INSTRUMENT

2-27. The HP 5061B is shipped from the factory ready for operation as a bench instrument. Parts necessary to convert the HP 5061B for rack mounting are available as a kit. To convert for rack installation, refer to *Figure 2-2* and proceed as follows:

a. Remove cabinet bottom feet by pressing release button on foot, slide foot forward toward cabinet center, and lift foot off.

b. Remove adhesive-backed trim strips on sides, just behind front handles.

c. Attach filler strip along bottom edge of front panel.

d. Attach mounting brackets to sides with larger corner notch toward bottom of cabinet. See *Figure 2-2*. The HP 5061B is ready to mount in a standard 19-inch rack.

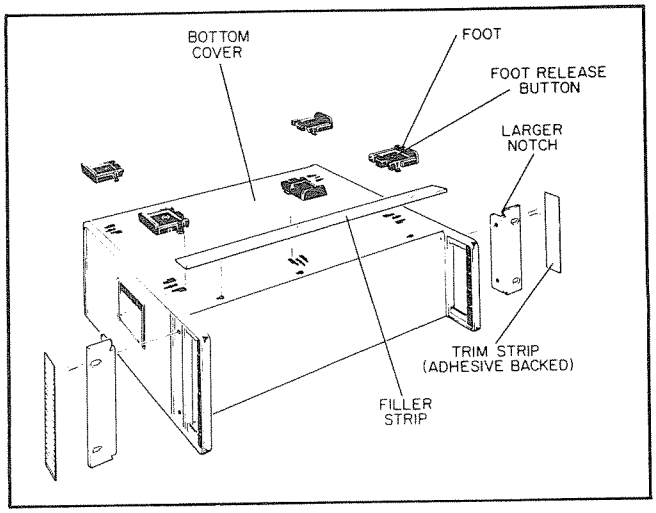


Figure 2-2. Conversion for Rack Mounting

Table 2-2. Mating Connectors

Connector Description	Connector HP Part No.	Mating Connector HP Part No.	Mating Connector Description
BNC female jacks (J2, 6, 8, 10-12, 14, & 15)	1250-0140	1250-0061*	BNC male plug, UG88/U
ZEEMAN MOD INPUT, female jack (J1)	1250-0252	1250-0061*	BNC male plug, UG88/U
EXT DC, 5-pin male jack (J19)	1251-0111	1251-0126	5-pin female plug, Cannon MS3106E-14S (Series ME)
AC LINE, 3-pin male jack (J20)	1251-2458	1251-2457	3-pin female plug, Cannon MS3106A-18-22SW
OUTPUT Signal, jacks (J5, 7, 9, and 16)	1250-0252	1250-0061*	BNC male plug, UG88/U
1PPS, BNC jack (J13) Option 003 Only	1250-0102	1250-0061*	BNC male plug, UG88/U
-2500V, 1-pin female jack (J3)	1251-1977 1251-1979 1251-1981	1251-1977 1251-1978 1251-1980	Hood Connector Receptacle Lock Spring
+3500V 1-pin male jack (J4)	1251-1977 1251-1979 1251-1981	1251-1977 1251-1978 1251-1980	Hood Connector Receptacle Lock Spring
Degausser	1251-2796	1251-2797*	Bendix PT06A-14-18P1005

**These connectors are not shipped with the instrument.*

2-28. INSTALLATION LOCATION

2-29. The cesium beam tube installed in the HP 5061B is slightly sensitive to external magnetic fields. Avoid installing the HP 5061B near large motors, generators, transformers, or other equipment which radiates strong magnetic fields of two Gauss or more. Also avoid placing a strong permanent magnet near the beam tube. A strong magnetic field can permanently affect the magnetic shielding in the beam tube. The front panel C-FIELD control can compensate for small magnetic field effects such as the magnetic field of the earth. Check the C-FIELD adjustment when the HP 5061B is relocated. Refer to C-FIELD adjustment in Section III.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section explains the functions of the operating controls and indicators of the HP 5061B Cesium Beam Frequency Standard. Operating modes (including options) are described, and turn-on procedures are given. Also included are in-cabinet performance tests to verify the HP 5061B's specifications.

NOTE

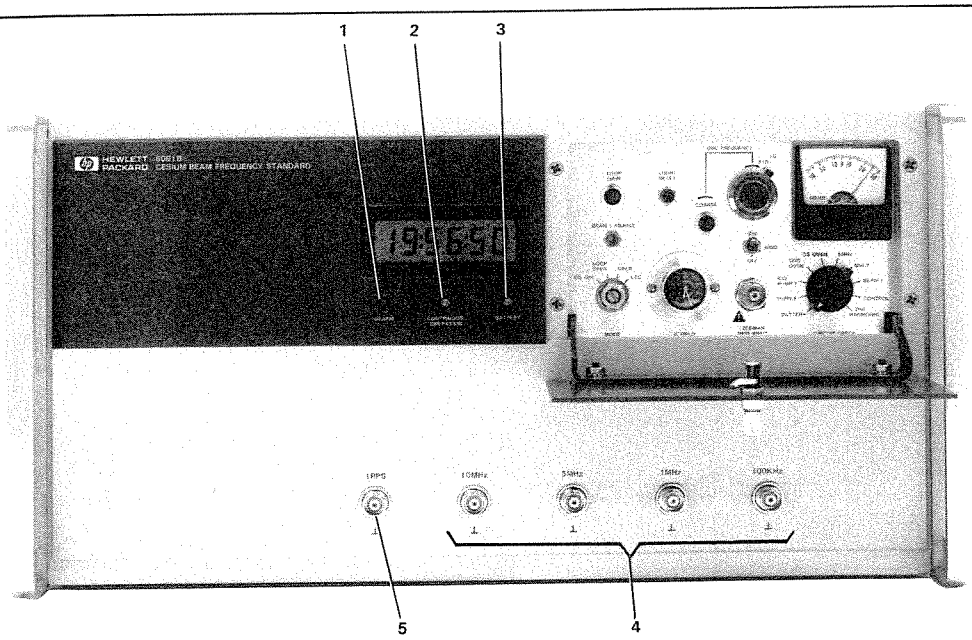
Option 003 is the Time Standard and Standby Power Supply available with the HP 5061B.

3-3. CONTROLS AND INDICATORS ON FRONT, TOP, AND REAR PANELS

3-4. Controls and indicators on the front, top, and rear panels are described in *Figures 3-1, 3-2,* and *3-3.*

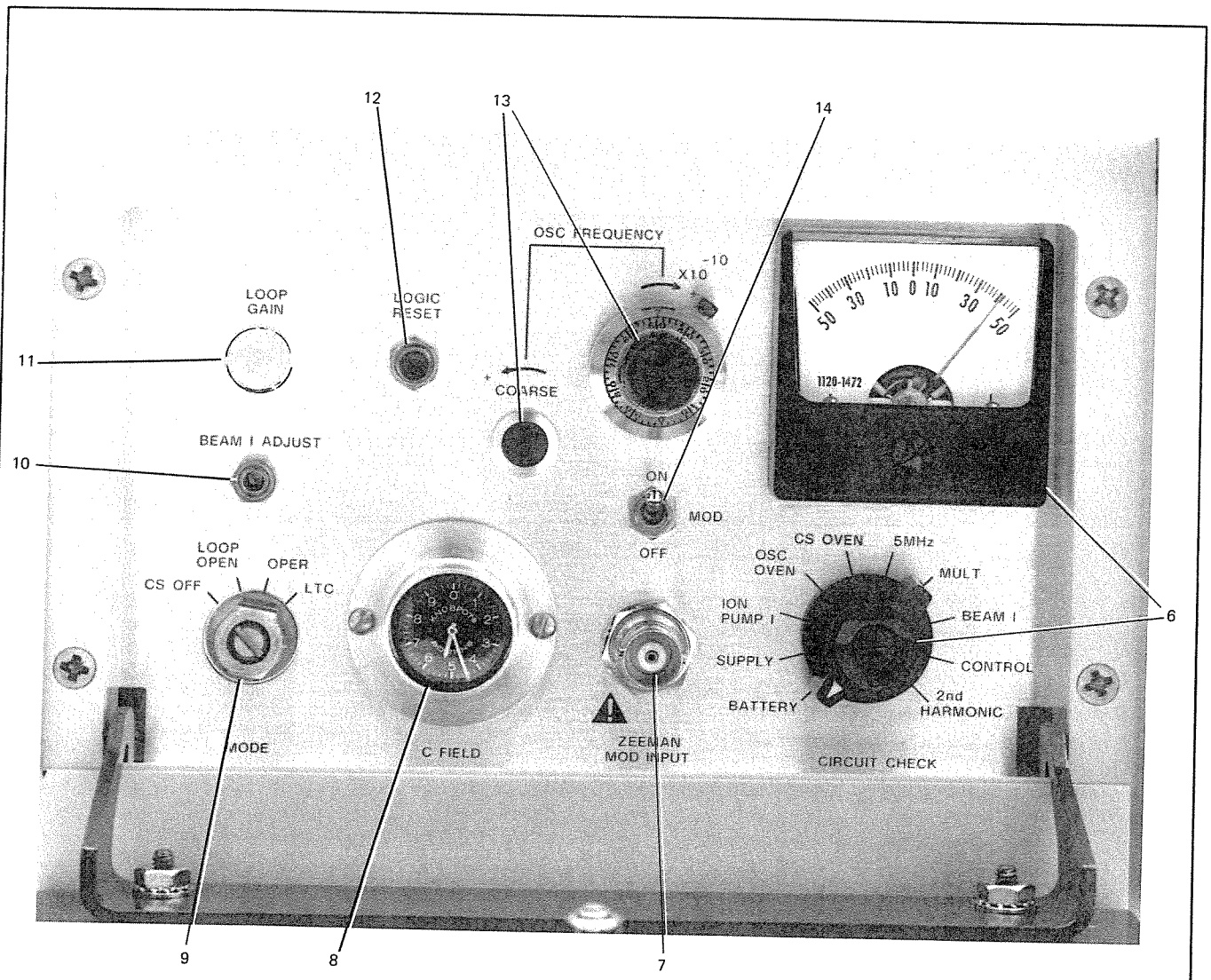
NOTE

LED is the acronym used for Light Emitting Diode.



1. ALARM LED (Amber): Normally off to indicate:
   a. The HP 5061B is correctly frequency-locked and the beam tube current is satisfactory.
   b. The quartz crystal oscillator dc correction voltage is less than ±5 Vdc.
   c. See *Table 3-1* for further explanation of LED functions.
2. CONTINUOUS OPERATION LED (Green): Normally on to indicate that circuits are functioning properly and the HP 5061B is operating as a primary frequency standard. See *Table 3-1* for further explanation of LED functions.
3. BATTERY LED (Amber): Normally off. Flashes when HP 5061B is drawing power from internal battery. (Part of the Option 003.)
4. 10 MHz, 5 MHz, 1 MHz, and 100 kHz Output Connectors: Provide output signals at these standard frequencies. See *Table 1-1* for specifications.
5. 1PPS Jack (Option 003): Provides 10-volt, 20 μs, 1 pulse-per-second signal into 50 Ohms, and originates in the Digital Clock Assembly. (Part of Option 003.)
6. CIRCUIT CHECK Switch and Meter: Provides monitoring of various circuits for operation checks and trouble indication. See *Table 3-3* for further explanation of switch functions.
7. ⚠ ZEEMAN MOD INPUT Connector: Zeeman frequency signal applied to this connector during C-FIELD adjustment. See Section III, paragraph 3-17.

Figure 3-1. Front Panel Controls



8. C-FIELD Control Knob: Provides minor frequency adjustment by changing the magnetic field inside the cesium beam tube. Frequency resolution is 8×10^{-14}/minor division.

9. MODE Switch: Controls the HP 5061B mode of operation. See *Table 3-2* for details.

10. BEAM I ADJUST Control: Adjusts Beam Current and 2nd Harmonic signal levels. See paragraph 3-28 (Routine Operating Procedures).

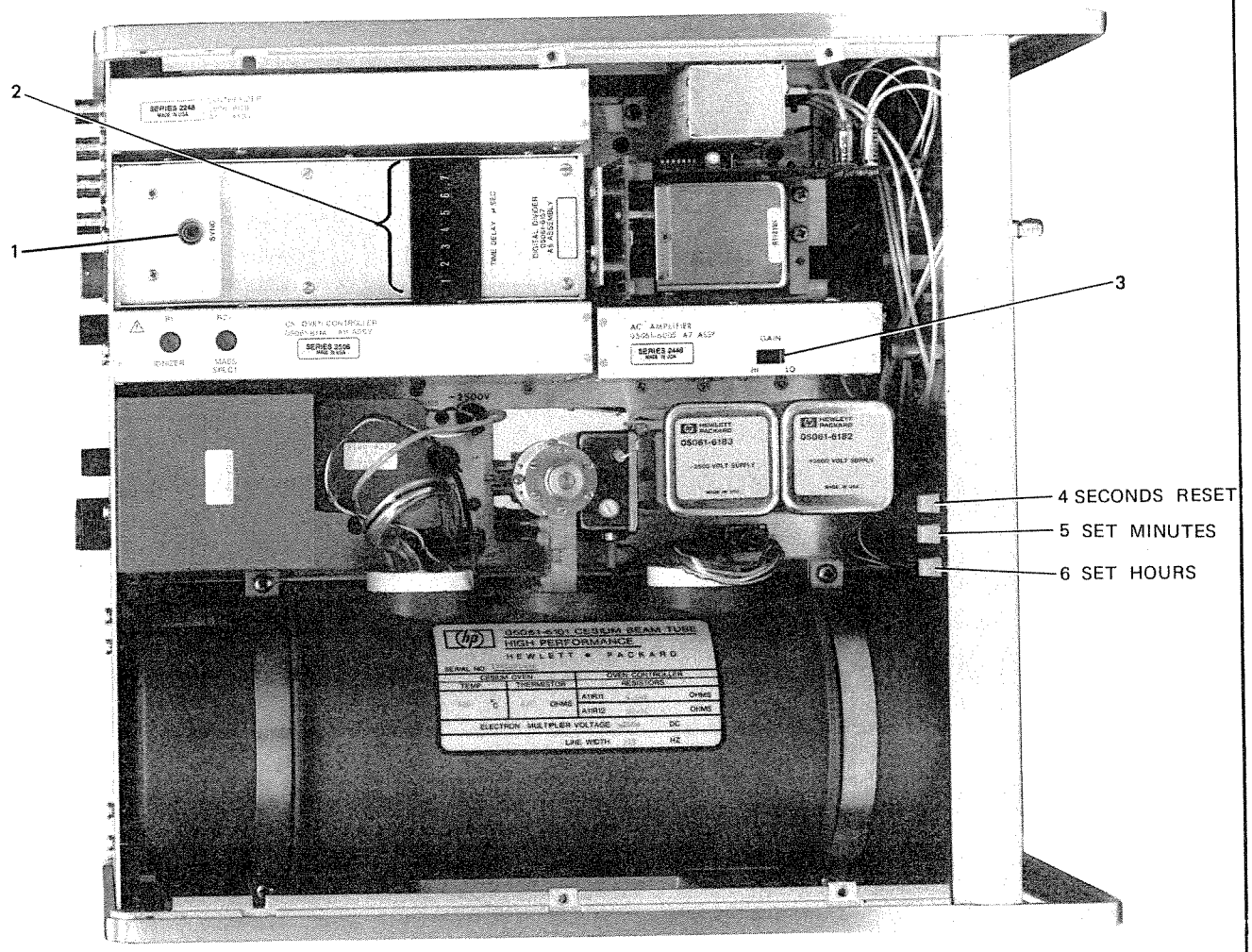
11. LOOP GAIN Control: Adjusts ac amplifier gain. See paragraph 3-28 (Routine Operating Procedures).

12. LOGIC RESET Switch: Push to reset CONTINUOUS OPERATION LED after power interruption, repair, or adjustment.

13. OSC FREQUENCY Controls: COARSE control provides crystal oscillator frequency adjustment of 1 part in 10^6. The method for adjustment is with a screwdriver via the front panel. The COARSE control is used to maintain the quartz oscillator within the control range of the HP 5061B circuits. The X10^{-10} ("Fine") control provides adjustment range of 500 parts in 10^{10} (with dial reading parts in 10^{10} nominal). **The fine control should be used for internal adjustments only.** X10^{-10} should remain set at 250 during normal operation. See paragraphs 3-15(f) and 3-28 for adjustment procedures of COARSE control.

14. MOD ON-OFF switch: Turns 137 Hz modulation of microwave frequency applied to beam tube ON or OFF. Normally set to ON.

Figure 3-1. Front Panel Controls (Continued)



1. Clock SYNC Switch (Option 003 only): Synchronizes the HP 5061B Digital Clock with an external clock when pressed; clock remains synchronized when released. See paragraph 3-34 for applicable procedures.

2. Clock TIME DELAY Switch (Option 003 only): Selects time delay of 1 pulse-per-second output. Adjustable in decade steps from 0.1 microsecond to 1 second. See paragraph 3-37 for applicable procedures.

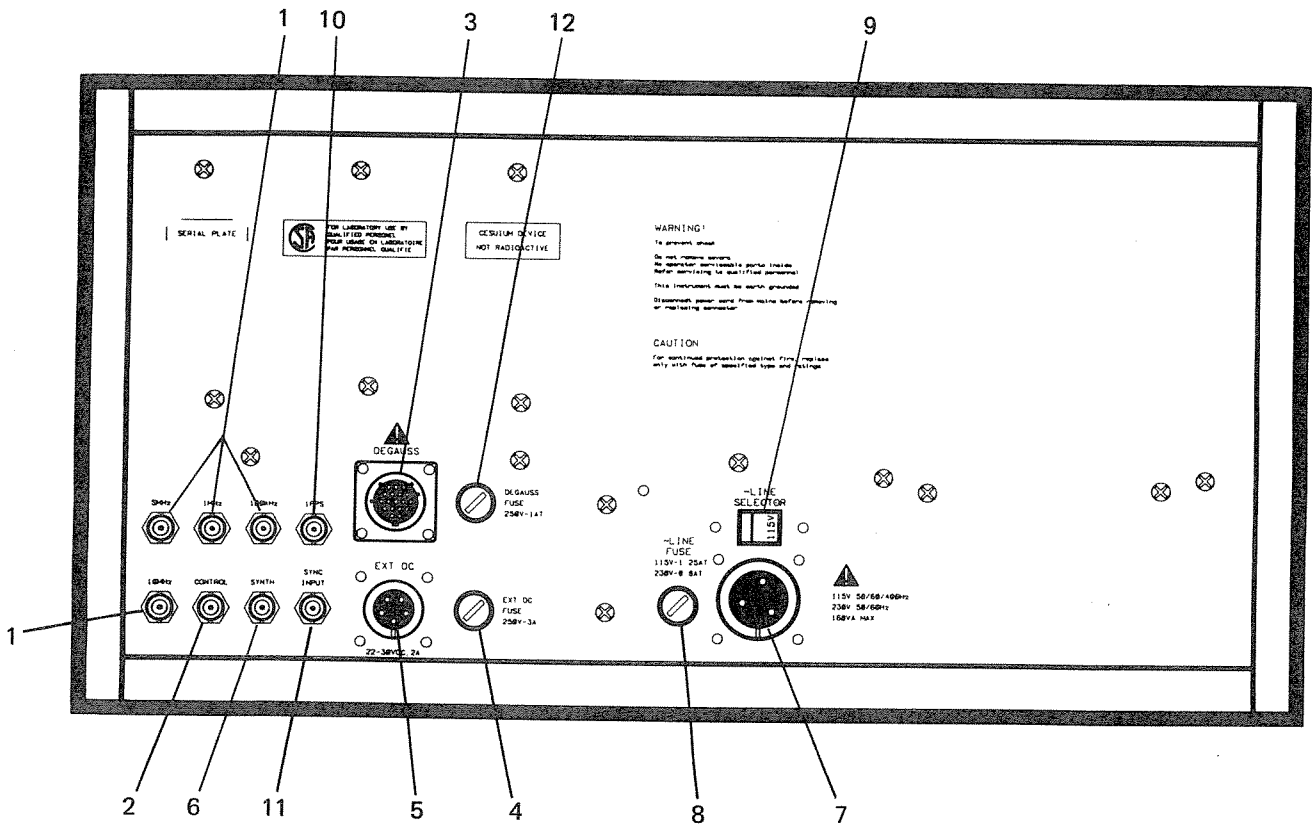
3. AC Amplifier GAIN Switch: Selects HI or LO gain of amplifier. See "AC AMPLIFIER MAINTENANCE" in Section V for more details.

4. "Seconds Reset" Switch (Option 003 only): Seconds digits are set to zero. See paragraph 3-40 for more details.

5. "Set Minutes" Switch (Option 003 only): Minutes digits are advanced at a fast rate (approximately 5 Hz). See paragraph 3-40 for more details.

6. "Set Hours" Switch (Option 003 only): Hours digits are advanced at a fast rate (approximately 5 Hz). See paragraph 3-40 for more details.

Figure 3-2. Top Operating Controls



1. OUTPUTS 10 MHz, 5 MHz, 1 MHz, 100 kHz: BNC jacks paralleled with front-panel outputs to provide these standard frequency signals.

2. CONTROL Jack: Normally used for maintenance. Connected to frequency control voltage applied to crystal oscillator.

⚠ 3. DEGAUSS Connector: Used with Option 004 only. Provides connections for external degaussing equipment used with Option 004 High Performance Beam Tube.

4. EXT DC Fuse: 3-ampere fuse (HP Part No. 2110-0003) in external dc power line.

5. EXT DC Connector: Five-pin male connector used to apply external dc power to HP 5061B. See *Table 1-1*.

6. SYNTH Test Jack: Synthesizer output frequency of 12,631,772.5 Hz is available at this jack. Signal amplitude is about 150 mV into 50 Ohms.

⚠ 7. AC LINE Jack: Accepts round female connector on ac power cable supplied with HP 5061B.

8. AC LINE Fuse: 1.25-ampere fuse (HP Part No. 2110-0305) for 115-volt power line operation or 0.8-ampere fuse (HP Part No. 2110-0020) for 230-volt power line operation.

9. SELECTOR Switch: 115/230 Volt ac power line selector switch. Must be set to correct ac line voltage.

10. 1PPS Jack (Option 003): Provides pulse from Digital Clock circuitry. See *Table 1-1* for specifications.

11. SYNC INPUT Jack (Option 003): Input to digital divider circuits for external synchronizing pulse. External synchronizing pulse must be +5V or more with rise time of less than 50 nanoseconds.

12. DEGAUSS 1 AMP Fuse (HP Part No. 2110-0007): Provides protection for a +25 to +33V line from A15 Power Regulator to the J18(A) DEGAUSS connector.

Figure 3-3. Rear-Panel Controls

3-5. Front Panel LED Indications

3-6. Conditions indicated by the front-panel LEDs are given in *Table 3-1.*

Table 3-1. Front-Panel LED Indications (Standard HP 5061B)

Front-Panel LEDs		Description
ALARM	CONTINUOUS OPERATION	
Amber	Green	
Off	On	Indicates normal operation.
On	Off	Indicates one or more of the following troubles: 1. Quartz crystal oscillator not locked to cesium resonance peak. 2. Quartz oscillator locked to secondary peak of cesium resonance. 3. Second Harmonic signal is low. Refer to paragraph 3-28 for adjustments. To correct the above faults, see Troubleshooting Tables (Section V).
Off	Off	Press LOGIC RESET switch. If CONTINUOUS OPERATION LED remains off, one or more of the following troubles are indicated: 1. CONTINUOUS OPERATION and/or ALARM LED failure. 2. Synthesizer (A1 Assembly) circuits. 3. AC power fuse is open or loss of ac power.
On	On	Indicates the following situation: Unit is operating properly but the oscillator isabout to exceed its control range. See *Table 3-4* for CONTROL adjustments.
Internal Standby Battery LED (Amber) (Option 003 only)		
BATTERY LED		**Description**
Off		Indicates normal operation. (Battery is being charged).
Flashing		Indicates instrument is powered from internal battery supply.

3-7. Front Panel MODE Switch Functions

3-8. The front panel MODE switch functions are described in *Table 3-2.*

Table 3-2. MODE Switch Functions

MODE Switch Position	MODE Description
CS OFF	Only Quartz crystal oscillator circuits (Cesium Off) energized. Power removed from cesium beam tube except ion pump (+3500 Vdc). **NOTE** **When storing the HP 5061B, connect the unit to ac power and set MODE switch to CS OFF position. This ensures a high vacuum is maintained within the cesium beam tube and could extend its life. See Section II for information on storage of the HP 5061B.**
LOOP OPEN	All circuits operating but output frequency is not locked to the cesium reference.
OPER (Normal)	Instrument operating with output frequency locked to the hyperfine transition frequency of the cesium beam tube (Cesium reference).
LTC (Long Time Constant)	Instrument operation is the same as in OPER except that servo loop time constant is approximately 60 seconds. This mode should be used only when the HP 5061B is operated in a benign laboratory environment. See *Table 1-1* for the HP 5061B specifications when it is in LTC mode. Do not operate HP 5061B in LTC mode when adjusting OSC FREQUENCY COARSE control.

3-9. Front Panel CIRCUIT CHECK Switch and Meter

3-10. Functions and use of the front panel CIRCUIT CHECK switch are listed in *Table 3-3.*

Table 3-3. Operating Checks (With CIRCUIT CHECK Switch)

CIRCUIT CHECK Switch Position	Correct Meter Indications	Description
BATTERY	0 (35 to 45 with Option 003)	Indicates battery voltage.
SUPPLY	35-45	Indicates +18.7 Volts regulated voltage.
ION PUMP I	0-15	Indicates pressure in cesium beam tube by monitoring ion pump current. Fail-safe circuit removes power from the cesium beam tube if current exceeds 30-40 μA.
OSC OVEN	*20-45 (changes with ambient temperature)	Indicates power to crystal oscillator oven heater.
CS OVEN	*5-35 (changes with ambient temperature)	Indicates power to the cesium oven in the cesium beam tube.
5 MHz	35-45 (no load)	Indicates level of 5 MHz output.
MULT	35-45	Indicates bias to step-recovery diode located in the A4 Harmonic Generator Assembly.
BEAM I	*20 (Nominal)	Indicates dc beam current (in nanoamps) from the cesium beam tube. Varies with cesium beam tube life and loop gain adjustment.
CONTROL	0 (may be as much as ±50)	Indicates dc control voltage to the quartz crystal oscillator.
2ND HARMONIC**	*30-50	Indicates 2nd harmonic amplitude (may have small fluctuations).

**During the first several hours of operation, these CIRCUIT CHECK meter indications may not fall within the limits shown in this table. This is a normal indication if the CONTINUOUS OPERATION LED remains on.*

***See "Routine Operating Procedures", paragraph 3-28.*

NOTE

For every 100 Hz error in the Zeeman frequency, a shift of 1 part in 10^{12} is introduced into the HP 5061B output frequency.

g. Set Audio Oscillator to 53.53 kHz ±50 Hz.

NOTE

If counter reads erratically, disconnect cable from HP 5061B. Set oscillator, then reconnect cable to HP 5061B and disconnect the counter.

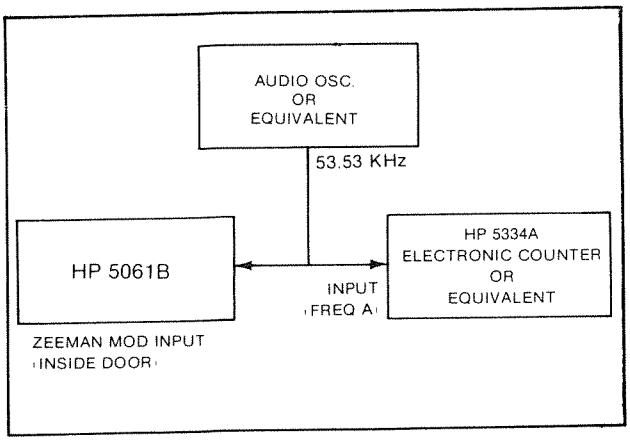


Figure 3-5. Test Setup for C-Field Adjustment

h. Adjust audio oscillator output amplitude to zero, then slowly adjust it for a maximum BEAM I reading on CIRCUIT CHECK meter. (Audio oscillator output amplitude will approximate +0.5 Vrms into 50 Ohms.)

i. Adjust C-FIELD control to top of maximum peak as indicated on BEAM I meter. See *Figure 3-4* and NOTE below.

NOTE

When making this adjustment, at least three peaks can be seen. The three largest peaks consist of two peaks of lower amplitude on either side of a higher amplitude peak. The C-FIELD control should be adjusted through sufficient range to reproduce three peaks. It then must be set to the exact top of the center (highest amplitude) peak.

j. On units which have the Option 004 High Performance Cesium Beam Tube, perform the LO CURRENT degauss procedure. Applicable procedures can be found in paragraph 3-26. If your unit is not an Option 004, repeat step f.

k. Disconnect HP 10638A Degausser from HP 506B rear-panel connector.

l. Disconnect audio oscillator and frequency counter from HP 5061B. Set MOD switch to ON and MODE switch to OPER. Wait for ALARM LED to go off. Push LOGIC RESET button. CONTINUOUS OPERATION LED should light and stay lighted. The HP 5061B is now frequency-locked to the cesium resonance (hyperfine transition frequency of the cesium atom) and is ready for use.

3-18. CIRCUIT CHECK Meter Indications

3-19. Set the CIRCUIT CHECK switch to each position and record each reading in the "HP 5061B Operating Record". This form can provide a permanent record of each HP 5061B's meter readings. The record is located at the end of Section III.

3-20. Degaussing — General Information

3-21. HP 10638A Degausser is designed to help the Option 004 High Performance Cesium Beam Tube meet its settability and reproducibility specifications outlined in *Table 1-1*. When activated, the Degausser passes an exponentially decreasing current of alternating polarity through an auxiliary degaussing coil around the beam tube magnetic shields. This action removes the residual magnetism, which could cause small frequency offsets, from the inner magnetic shields.

3-22. An HP 5061B equipped with an Option 004 High Performance Cesium Beam Tube will need HI or LO CURRENT degaussing under the following circumstances:

- HI CURRENT Degaussing

  If the HP 5061B has been subjected to a severe change in magnetic environment, or if while in transit (and in the non-operating mode), the unit is subjected to shock and/or vibration.

- LO CURRENT Degaussing

  HP 5061B power is cycled on and off.

  Whenever small C-field adjustments are made.

  HP 5061B has been physically moved.

  Whenever HI CURRENT Degaussing procedure has been performed.

3-23. HI CURRENT Degaussing Procedure

3-24. When the Cesium Standard has been turned on and has has warmed up(30 minutes), use the degausser as follows:

a. Connect the Degausser to the HP 5061B rear-panel DEGAUSS connector (J18) using the cable supplied. The 5061B CONTINUOUS OPERATION LED will turn off.

b. Set the Degausser CURRENT switch to HI.

c. Set Degausser POWER switch to ON.

d. Press START. Degausser OPERATING lamp will flash on and off.

e. Allow the Degausser to complete one cycle (20 minutes). Leave POWER switch ON.

f. When the OPERATING lamp stops flashing, the HI CURRENT degauss procedure is complete. If any interruption occurs during the HI CURRENT degauss cycle, repeat the complete HI CURRENT degauss cycle.

g. Leave HP 10638A Degausser connected to the HP 5061B. Return to paragraph 3-17 and continue C-Field adjustment procedure.

3-25. LO CURRENT Degaussing Procedure

3-26. The setup procedure for the LO CURRENT Degaussing procedure is similar to that of the HI CURRENT Degaussing procedure. Step "a" of this procedure may be omitted if the HP 10638A is already connected to the HP 5061B.

a. Connect the Degausser to the HP 5061B rear-panel DEGAUSS connector (J18) using the cable supplied. The 5061B CONTINUOUS OPERATION LED will turn off.

b. Set the Degausser CURRENT switch to LO.

c. Set Degausser POWER switch to ON.

d. Press START. Degausser OPERATING lamp will flash on and off.

e. Allow the Degausser to complete one cycle (20 minutes). Leave POWER switch ON.

f. When the OPERATING lamp stops flashing, the LO CURRENT degauss procedure is complete. If any interruption occurs during the LO CURRENT degauss cycle, repeat the complete LO CURRENT degauss cycle.

g. Return to step 3-17(f) and check the C-Field setting.

3-27. Routine Operating Procedures

3-28. During the first few days of operation, the CIRCUIT CHECK Meter readings will change somewhat. They will stabilize within a few days of initial turn-on. After this initial stabilization period, the readings will remain relatively constant. The following paragraphs describe the recommended operating procedures for the HP 5061B. *Table 3-4* lists what operator adjustments need to be made and when to make them.

a. During the first few days of operation, check all CIRCUIT CHECK Meter readings daily. Pay particular attention to the CONTROL, 2ND HARMONIC, and BEAM I readings. The CONTROL reading will change as the quartz crystal stabilizes. The CONTROL meter reading is the voltage required to keep the oscillator exactly on frequency. The BEAM I and the 2ND HARMONIC readings are dependent on the cesium beam current inside the cesium tube itself. Often this current will take some time to stabilize. Read the CIRCUIT CHECK Meter daily and make the operator adjustments if needed (as described in *Table 3-4*).

Table 3-4. Operator Adjustments

Circuit Check Meter Position	Make Adjustment When Meter Reads	Adjustment Procedure
2ND HARMONIC	<30 or >50	Adjust BEAM I Control for reading of 40 in 2ND HARMONIC meter position. See Note 1.
CONTROL	<-30 or >+30	Slowly adjust OSC FREQUENCY COARSE control for reading of 0 in CONTROL meter position. See Note 2.
BEAM I	20 (Nominal)	Refer to 2ND HARMONIC adjustment above and "Note 1" below. Normal BEAM I meter indication of 20 nA (Nominal) is read with MOD switch in ON position.

Note 1: If BEAM I ADJUST control cannot achieve 2ND HARMONIC meter reading of 40, adjust front-panel LOOP GAIN control for a reading of 40 while keeping the CIRCUIT CHECK switch in the 2ND HARMONIC position.

Note 2: CONTINUOUS OPERATION LED may go out when this adjustment is made. This is normal. When adjustment is complete, press LOGIC RESET button to enable CONTINUOUS OPERATION LED.

3-11. TURN-ON PROCEDURES

3-12. Introduction to Turn-On

3-13. The following procedures should be followed when power is first applied to the HP 5061B. When the HP 5061B has not had power applied and the unit is cold, a warmup period is required (3/4 hour for a Standard unit and 1/2 hour for an Option 004). *Table 3-1* lists normal and abnormal front-panel LED indications. *Table 3-3* lists normal meter indications. *Table 3-2* lists MODE switch functions. Use these tables as a guide for circuit checks during the turn-on procedure or during operation.

CAUTION

Before plugging in the 5061B, ensure the following:

1. **The HP 5061B rear-panel SELECTOR switch has been set to available line voltage. (See paragraph 2-14 for details.)**
2. **The correct ac line fuse (F1) is installed.**
3. **All safety precautions have been observed.**

3-14. Initial Turn-On Procedure

3-15. Use the following steps to apply power to the HP 5061B for the first time:

a. Set the HP 5061B controls as follows:

1. ENSURE 115/230 Volt rear-panel SELECTOR switch matches ac line voltage available.
2. MOD switch — OFF
3. MODE switch — LOOP OPEN
4. CIRCUIT CHECK switch — ION PUMP I
5. OSC FREQUENCY X10^{-10} control — adjust dial to read 250.

b. Connect power cable to ac power source. Instrument is on as soon as power is connected.

WARNING

THE HP 5061B CESIUM BEAM FREQUENCY STANDARD DOES NOT HAVE A LINE SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND DC OUTPUT VOLTAGES (+3500 AND -2500 VDC) ARE PRESENT WHEN THE HP 5061B IS CONNECTED TO AN EXTERNAL AC OR DC POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE EQUIPMENT. UNITS EQUIPPED WITH OPTION 003 (TIME STANDARD AND STANDBY POWER SUPPLY) WILL HAVE THE SAME DC VOLTAGES PRESENT EVEN WITH THE AC POWER CORD REMOVED FROM THE HP 5061B. PROCEDURES CALLING FOR THE REMOVAL OF INSTRUMENT COVERS SHOULD BE ACCOMPLISHED ONLY BY QUALIFIED TECHNICAL PERSONNEL.

NOTE

When the HP 5061B is shipped equipped with Option 003, the battery is discharged. Approximately fifteen hours after connecting the HP 5061B to an ac power source, the automatic (internal) charging circuits will have fully charged the battery.

c. Observe the ION PUMP I (current) indication. The meter indication may fluctuate and then decrease. After the indication decreases below about 20, the cesium beam power supplies (i.e., cesium oven, hot wire ionizer, and electron multiplier circuits) will be enabled. If the ION PUMP I indication does not decrease within 24 hours, disconnect ALL power from HP 5061B and contact your nearest Hewlett-Packard Sales and Service Office for assistance.

d. For Standard instruments, allow 45 minutes for the cesium oven and quartz oscillator to warm up. For Option 004 units, allow 30 minutes.

e. Set CIRCUIT CHECK switch to BEAM I.

f. Slowly adjust OSC FREQUENCY COARSE for the maximum BEAM I (primary peak) on CIRCUIT CHECK meter. (See *Figure 3-4.*) It is possible to peak the BEAM I on a secondary peak. Check the maximum by adjusting OSC FREQUENCY COARSE for a secondary peak on each side of the primary peak (see *Figure 3-4*). These secondary peaks will be smaller than the primary peak. (Note: Do not use OSC FREQUENCY X10^{-10} control for this adjustment.)

g. Set MOD switch to ON.

h. Set MODE switch to OPER. After a few seconds, press LOGIC RESET button. The CONTINUOUS OPERATION LED should light and stay lighted. The quartz crystal oscillator is now locked to the resonant frequency of the cesium beam tube.

i. For instruments equipped with Option 004 High Performance Cesium Beam Tubes, perform the HI CURRENT degauss procedure. This procedure uses the HP 10638A Degausser. Refer to paragraph 3-24 for the "HI CURRENT Degauss Procedure".

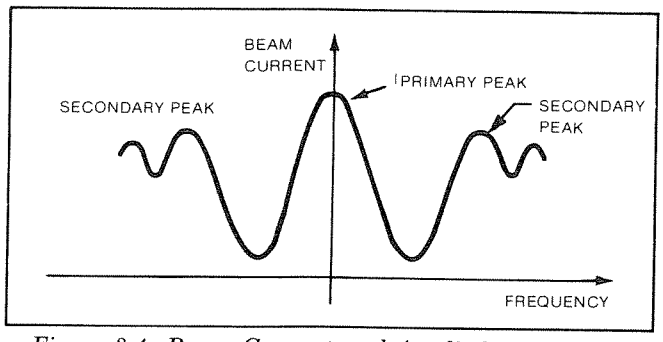


Figure 3-4. Beam Current and Applied Frequency

3-16. C-Field Adjustment Procedures

3-17. The cesium beam tube is sensitive to slight variations in both the earth's and local magnetic fields. The "C" field within the cesium beam tube compensates for these minor variations. The C-Field adjustment should be performed when:

- HP 5061B is first placed in operation, and
- whenever the HP 5061B is physically relocated.

a. With HP 5061B operating normally [CONTINUOUS OPERATION LED (green) is on and ALARM LED (amber) is off], set CIRCUIT CHECK switch to CONTROL and carefully adjust OSC FREQUENCY COARSE for zero on CIRCUIT CHECK meter.

NOTE

The MODE switch must not be set to LTC when adjusting the quartz crystal oscillator frequency. When set to LTC, the HP 5061B takes a long time to respond and adjustment is difficult.

b. Set HP 5061B controls as follows:

MOD switch — OFF
MODE switch — LOOP OPEN
CIRCUIT CHECK switch — BEAM I

c. If the HP 5061B is equipped with an Option 004 cesium beam tube, perform the LO CURRENT degauss procedure. This procedure uses the HP 10638A Degausser. Refer to paragraph 3-26 for the "LO CURRENT Degauss Procedure".

CAUTION

Always be aware of the output voltage capabilities of the audio oscillator and the dynamic range specification of the counter used in this test. Use appropriate attenuation to protect the input circuitry of the counter.

d. Connect the HP 5061B and other units as shown in *Figure 3-5.*

e. Set the frequency counter controls for the best resolution to measure the desired frequency of 53.53 kHz. If the counter used is the HP 5334A Universal Counter, perform the following setup procedure:

1. Press POWER switch to ON position.
   FREQ A and AUTO TRIG LEDs will be on.
2. Press AUTO TRIG key (LED OFF).
3. Press COM A key to (SEPARATE) position (LED OFF) for separate inputs.
4. Press AC key for ac coupling (LED ON).
5. Press X10 ATTN key for X10 attenuation (LED ON).
6. Press 50Ω Z key to 1MΩ (LED OFF).
7. Press SENS key to SENSITIVITY position (LED ON); rotate TRIGGER LEVEL/SENS control fully ccw. This sets the trigger level at 0 Volts (nominally) and sensitivity to minimum.
8. Connect audio oscillator signal to INPUT A.
9. Adjust TRIGGER LEVEL/SENS control in a clockwise direction until a stable measurement is displayed.
10. Adjust GATE TIME setting for preferred resolution.

f. Check the C-Field as follows:

1. Observing BEAM I on the CIRCUIT CHECK meter, adjust the audio oscillator about 1 kHz off frequency then slowly adjust it through the cesium resonance, reproducing the three resonance peaks described in the previous note. Set the oscillator to the exact top of the center (highest amplitude) peak.
2. Measure the audio oscillator frequency with the counter. It must be 53.53 kHz ±100 Hz for both Standard and Option 004 High Performance Cesium Beam Tubes. If the measured frequency is within limits, the "C" field is set. Proceed to step 3-17(k). If the frequency is not within the above limits, continue with step 3-17(g).

b. When the CIRCUIT CHECK Meter readings have stabilized, the time duration between readings can be lengthened. We recommend that the meter readings be taken at least once per month. Record the readings on the 5061B Operating Record (see paragraph 3-56). If the readings change make the appropriate operator adjustments if needed, as described in *Table 3-4*.

3-29. OPERATION WITH TIME STANDARD (PART OF OPTION 003)

3-30. Option 003 provides the HP 5061B with both a one pulse-per-second (1 PPS) clock output signal available at both front-and rear-panel BNC connectors and a 45-minute internal standby battery. The TIME DELAY, seven-thumbwheel decade switch (A5S1A through S1G) controls the delay of the clock pulse from 0.1 microsecond to 1 second with respect to an external reference. The TIME DELAY switches are located under the access door in the HP 5061B top cover.

3-31. The Time Standard option includes a 24-hour digital clock that displays time in hours, minutes, and seconds. The SYNC button on the A5 Assembly enables the HP 5061B to synchronize to an external reference standard. The digital clock display can be set by pressing the "Set Minutes", "Set Hours", and "Seconds Reset" switches (located behind the front-panel LCD and accessible by removing the instrument's top cover).

CAUTION

The clock must be synchronized each time the MODE switch is switched from OPER or LTC.

3-32. Setting the Clock Pulse to an External Clock

3-33. The time difference between the HP 5061B 1PPS output and an external reference clock may be set between coincidence and 1 second (with a resolution of 0.1 μs) by using the following procedure. The technique used will depend upon the HP 5061B application and individual user requirements.

3-34. Automatic Synchronization

NOTE

Refer to Figure 3-2 to physically locate the switches used in this test.

3-35. To have the HP 5061B automatically synchronized and delayed from the reference by 0 to 200 nanoseconds, proceed as follows:

a. Open the access door in the HP 5061B top cover.

b. Set the seven-thumbwheel switch to:

"0000000.0".

c. Connect a reference pulse to the HP 5061B rear-panel SYNC INPUT connector. The reference input pulse must be greater than +5V, with a rise time less than 50 nanoseconds. (The 1PPS signal from another HP 5061B may be used as a reference input pulse.)

d. Press the SYNC button on the A5 Digital Clock Assembly and hold it down for at least one second. The next 1 pps pulse from of the HP 5061B will be synchronized to the input reference pulse and delayed in time by 0 to 200 nanoseconds. Any additional offset may be selected with the seven thumbwheel switches as described in paragraph 3-37.

e. Close the access door in the HP 5061B top cover.

3-36. Manual Synchronization

3-37. After automatic synchronization has been completed (as described in paragraph 3-35, steps a through e) the delay can be set to less than 100 nanoseconds (±100 ns). Use the following procedure to set desired delay:

a. Open the access door in the HP 5061B top cover.

b. Set the seven thumbwheel switches to 000000.0.

c. Connect the HP 5061B and other equipment as shown in *Figure 3-6*.

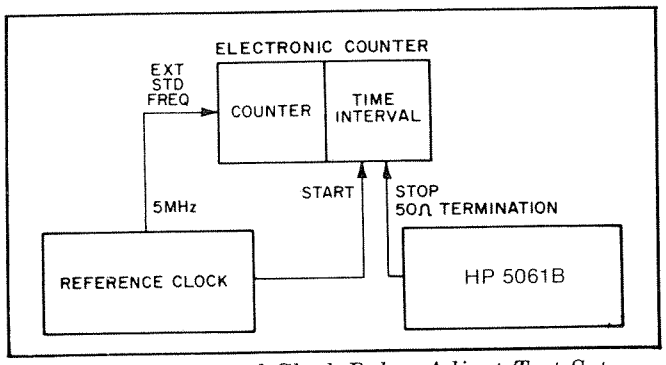


Figure 3-6. Manual Clock Delay Adjust Test Setup

NOTE

A 50-ohm resistive feedthrough "termination" should be connected at the time interval counter STOP input if the counter is not equipped with a 50Ω input impedance. This will prevent ringing in the pulse. (See Figure 3-6.)

d. Set the counter controls for the best resolution to measure the desired delay.

e. Set the counter for time interval measurement and to trigger on the leading edge (positive-going) of the two input pulses.

f. Measure the time interval between the pulses from the HP 5061B and the reference source.

g. If the HP 5334A Universal Counter is used to manually synchronize and delay the HP 5061B from an external reference pulse, use the following setup for the counter:

1. Press POWER switch to ON position.

2. Connect: Reference 1PPS to counter INPUT A (Start signal).

   HP 5061B 1PPS to counter INPUT B (Stop signal).

3. Press COM A key to (SEPARATE) position (LED OFF).

4. Press T.I. A→B function key (LED ON), and press AUTO TRIG off (LED OFF).

NOTE

Counter settings referred to in steps 5 thru 8 are for both A and B channel inputs.

5. Press AC keys for dc coupling (LED OFF).

6. Press X10 ATTN keys for X10 attenuation (LED ON).

7. Press SLOPE keys for positive slope (LED OFF).

8. Press 50Ω keys for 50Ω (LED ON).

9. Press SENS key to (TRIGGER LEVEL) off (LED OFF). This sets the sensitivity to maximum, and allows variable selection of trigger levels.

10. Press READ key once (LED ON) so that trigger levels are displayed.

11. Adjust TRIGGER LEVEL/SENS controls for +4.8 to +5.2 Volts.

12. Adjust GATE TIME setting for preferred sample rate.

NOTE

With the seven 10-position thumbwheel switches set to 000000.0, the counter should read less than or equal to 200 nanoseconds.

3-38. Two different examples using the synchronization feature are described here:

a. Example 1.

Figure 3-7 shows a delay after synchronization of 150 nanoseconds. As shown in the lower part of *Figure 3-7*, the operator may set the A5 thumbwheel switches to 999999.9 and the delay will be 50 nanoseconds. Since the right-hand thumbwheel switch can delay the pulse in 100 ns (0.1 μs) increments, 50 nanoseconds is the minimum delay that can be achieved.

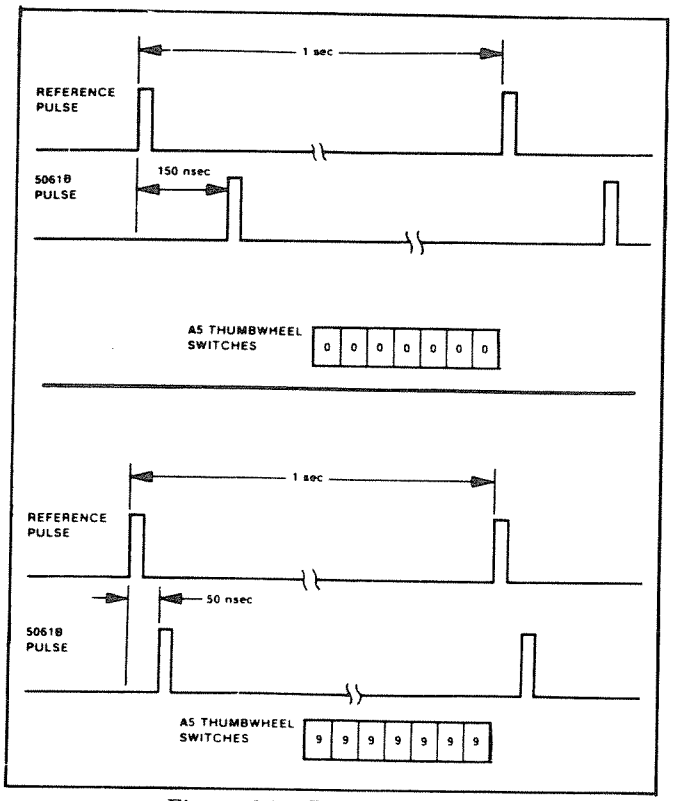


Figure 3-7. Example One

b. Example 2.

Figure 3-8 shows 190 nanoseconds delay measured after synchronization. As shown in the lower part of *Figure 3-7*, the operator has set the A5 thumbwheel switches to 999999.9 and the delay will be 90 nanoseconds. If the right-hand thumbwheel is changed to 8, as shown in the lower part of *Figure 3-8*, the delay will be 10 nanoseconds. In this example the minimum possible delay (offset) is 10 nanoseconds.

NOTE

Since the right-hand thumbwheel switch has the minimum 100 nanosecond steps, the minimum delay possible depends on the cumulative delays in the circuits of each HP 5061B Cesium Standard. The settability of the delay is dependent on the resulting delay after synchronization.

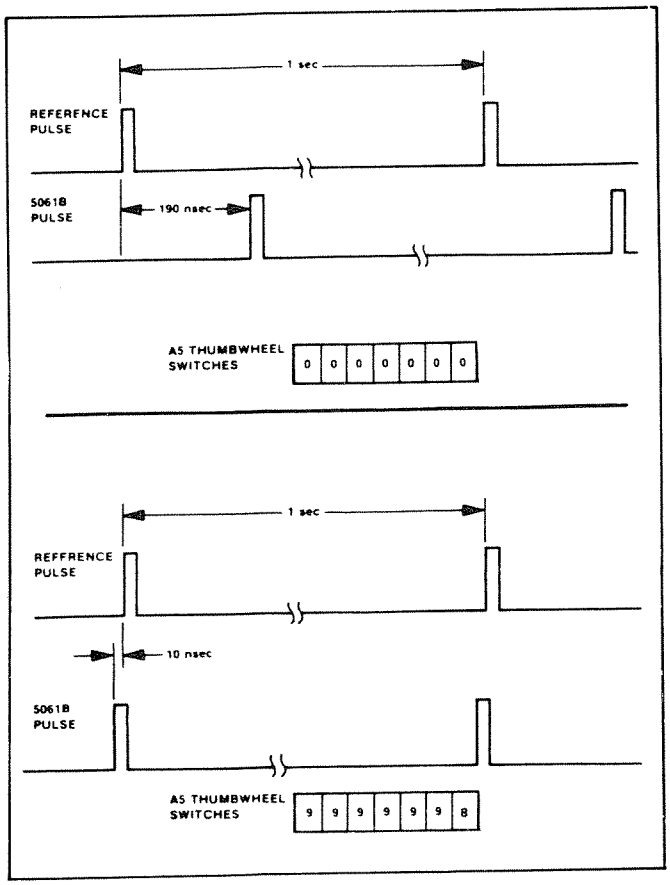


Figure 3-8. Example Two

3-39. Setting the LCD Clock Display

3-40. The front-panel clock display is set by comparing its reading to that of a reference clock (like another HP 5061B). Setting the display in this manner does not affect the synchronization of the unit's 1 PPS to that of a reference clock.

a. Using "Set Hours" and "Set Minutes" switches, set the hours and minutes digits of the clock display one minute ahead of reference clock display. Both hours and minutes digits advance at a 5 Hz rate when "Set Hours" or "Set Minutes" are depressed. Refer to *Figure 3-2* for switch locations.

b. Depress and hold "Seconds Reset" switch. While the switch is depressed, the seconds digits remain set at zero.

c. Release the "Seconds Reset" switch as the reference clock display changes from "59" to "00" seconds reading.

d. The clock display is now set.

3-41. OPERATION WITH INTERNAL STANDBY BATTERY (PART OF OPTION 003)

3-42. Option 003 also provides the HP 5061B with 45 minutes of standby power if ac line power should fail. The front-panel BATTERY warning LED will indicate the two following conditions:

a. BATTERY LED (Amber) Flashing — when HP 5061B is powered from internal battery supply.

b. BATTERY LED Off — when normal charging is taking place.

3-43. Initial Charging of Battery

3-44. When the HP 5061B is shipped with Option 003, the battery is discharged. When ac power is first applied to the HP 5061B rear-panel AC line jack (J20), the internal battery charging circuitry will charge the battery to full capacity in approximately 15 hours.

3-45. Recharge Time Requirements

3-46. The standby battery provides a minimum of 45 minutes dc power to the HP 5061B if normal external ac or dc supplies are interrupted. The internal charging circuitry keeps the battery charged at all times. The battery takes approximately 10 minutes to recharge for every minute that it supplies current to the HP 5061B.

3-47. Operation From an External DC Supply

3-48. When the HP 5061B is connected to an external dc power supply via rear-panel connector J19, in addition to being equipped with an internal standby battery, the HP 5061B power regulation circuitry is such that the external dc power supply would supply power to the HP 5061B should an ac power failure occur. When the external dc power supply voltage drops to approximately +22 Volts, the HP 5061B internal standby battery will begin to supply current to the HP 5061B's circuitry. The HP 5061B will indicate this by its front-panel BATTERY LED (amber) flashing. From this point on, the external dc power supply and internal standby battery will share supply duties; the load will shift to whichever dc source has the higher terminal voltage.

3-49. The internal standby battery charges only when the HP 5061B is connected to an ac source. If the HP 5061B is connected to an external dc source, ENSURE that the 5061B itself is connected to an external ac power source. This will keep the Option 003 Standby Battery fully charged.

3-50. If the HP 5061B is to be either stored or shipped to a new location (i.e., all external ac and dc power disconnected), the internal standby battery should be completely discharged (i.e., voltage is below "dropout" point of approximately +19.5 Volts). To accomplish this, remove external ac and dc power (if connected) from the HP 5061B rear panel. The discharging of the battery is indicated by the front-panel BATTERY LED (amber) flashing. The internal battery will discharge until its "dropout" voltage is reached and then automatically disconnect.

3-51. HP 5061B Power Removal

3-52. If the HP 5061B must have ALL power disconnected, proceed as follows:

WARNING

THE HP 5061B CESIUM BEAM FREQUENCY STANDARD DOES NOT HAVE A LINE SWITCH. THE AC POWER CIRCUITS TO TRANSFORMER T1 AND DC OUTPUT VOLTAGES ARE PRESENT WHEN THE 5061B IS CONNECTED TO AN EXTERNAL AC OR DC POWER SOURCE. CONTACT WITH THESE CIRCUITS CAN CAUSE INJURY TO PERSONNEL OR DAMAGE EQUIPMENT. UNITS EQUIPPED WITH OPTION 003 (TIME STANDARD AND STANDBY POWER SUPPLY) WILL HAVE DC VOLTAGES PRESENT EVEN WITH THE AC POWER CORD REMOVED FROM THE 5061B. PROCEDURES CALLING FOR THE REMOVAL OF INSTRUMENT COVERS SHOULD BE ACCOMPLISHED ONLY BY QUALIFIED TECHNICAL PERSONNEL.

a. Disconnect ac power and external dc power supply (if connected).

b. Remove HP 5061B bottom cover.

c. Momentarily short test points A2TP1 and A2TP2 with a jumper wire. Both test point are located on the A2 Battery Charger Assembly.

NOTE

Shorting test points A2TP1 and A2TP2 disconnects the internal battery power supply. The battery will be reconnected as soon as ac power is restored.

d. Replace the HP 5061B bottom cover.

3-53. OPERATION WITH HIGH PERFORMANCE TUBE (OPTION 004)

3-54. Option 004 provides the HP 5061B with improved performance as listed in *Table 1-1*. To achieve the specified accuracy and settability, the HP 10638A Degausser must be used to demagnetize the HP 5061B. Refer to paragraphs 3-21 and 3-22 for information on when to perform the HI and/or LO Degaussing procedures.

3-55. HP 5061B OPERATING RECORD

3-56. The "HP 5061B Operating Record" may be used to keep a record of the front-panel meter readings which can be used to periodically compare instrument performance. The record is located at the end of this Section III.

3-57. IN-CABINET PERFORMANCE TEST

3-58. The in-cabinet performance test given in *Table 3-5* lists tests to verify the HP 5061B specifications. The "Performance Test Record Card" can be filled out during tests to provide a permanent performance test record for each HP 5061B. The performance test is also useful for pre-installation testing. The HP 5061B under test should have the power applied and in the normal operating mode (ALARM LED off, CONTINUOUS OPERATION LED on) for at least 45 minutes before performing the following tests.

Table 3-5. In-Cabinet Performance Check

OPERATIONAL CHECK

1. CIRCUIT CHECK METER TEST

The circuit checks below require setting the front-panel CIRCUIT CHECK switch to each of its ten positions and observing the corresponding indication on the CIRCUIT CHECK meter. Switch positions and normal meter indications are listed in *Table 3-3*. If the HP 5061B has been operating correctly, the "HP 5061B Operating Record" will provide a list of front-panel meter readings characteristic of the unit being tested. Refer to paragraph 3-11 for the turn-on procedure. Perform the circuit checks as follows:

Turn the CIRCUIT CHECK switch through its 10 positions and compare meter indications with correct readings in *Table 3-3*.

2. OUTPUT SIGNALS TEST

The front- and rear-panel connectors labeled 10 MHz, 5 MHz, 1 MHz, and 100 kHz provide output signals at those frequencies for external use.

Procedure:

a. Measure the frequencies of the HP 5061B front- and rear-panel 10 MHz, 5 MHz, 1 MHz, and 100 kHz output connectors. (Use an electronic counter of known high accuracy.) The counter should display the correct frequencies associated with each HP 5061B connector.

3. OUTPUT SIGNALS VOLTAGES CHECK

The signals at the front- and rear-panel connectors (10 MHz, 5 MHz, 1 MHz, and 100 kHz) should be clean sine waves at 1 to 1.5 Vrms.

Procedure:

a. Connect an RMS voltmeter through a 50Ω feedthrough to the front- and rear-panel 10 MHz, 5 MHz, 1 MHz, and 100 kHz output connectors. The voltmeter should indicate between 1 and 1.5 Vrms.

b. Connect the same output connectors separately to the 50Ω vertical input channel of an oscilloscope. The oscilloscope should display a clean sine wave for each frequency.

Table 3-5. In-Cabinet Performance Check (Continued)

PERFORMANCE CHECK

1. OUTPUT SIGNALS HARMONIC DISTORTION CHECK

Harmonic distortion in the 10 MHz, 5 MHz, 1 MHz, and 100 kHz output signals should be 40 dB or more below the fundamental output signals. To perform this check, a Spectrum Analyzer is tuned to the fundamental frequency and an amplitude reference is established. The output frequency spectrum is then examined to determine fundamental-to-sideband amplitude relationship at harmonic points of the fundamental.

Procedure:

a. Connect equipment as shown in *Figure 3-9*.

b. Connect 10 MHz output to the Spectrum Analyzer input.

c. Check spectrum at 10 MHz center to 4th harmonic (40 MHz). Harmonics of 10 MHz should be 40 dB or more below fundamental.

d. Connect 5 MHz output to the Spectrum Analyzer input.

e. Check spectrum at 5 MHz center to 4th harmonic (20 MHz). Harmonics of 5 MHz should be 40 dB or more below fundamental.

f. Connect the 1 MHz output to the Spectrum Analyzer input.

g. Check spectrum at 1 MHz center to 5th harmonic (5 MHz). Harmonics should be 40 dB or more below fundamental.

h. Connect the 100 kHz output to the Spectrum Analyzer input.

i. Check spectrum at 100 kHz center to 50th harmonic (5 MHz). Harmonics should be 40 dB or more below the fundamental.

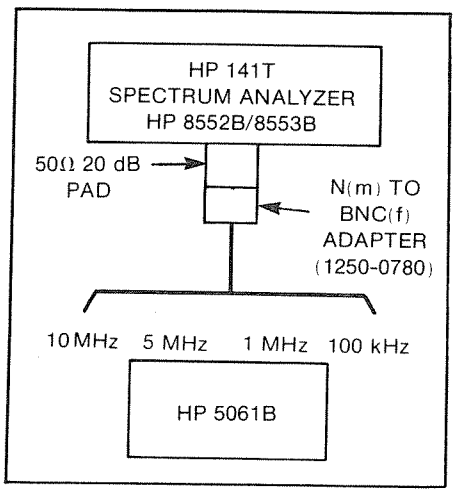


Figure 3-9. Harmonic and Non-Harmonic Distortion Test Setup

2. OUTPUT SIGNALS NON-HARMONIC DISTORTION TEST

Non-harmonic distortion in the 10 MHz, 5 MHz, 1 MHz, and 100 kHz output signals should be 80 dB or more below the output signals. To perform this test, a Spectrum Analyzer is tuned to the fundamental frequency and an amplitude reference is established. The output frequency spectrum is then examined to determine the fundamental-to-sideband amplitude relationship at non-harmonic points in the spectrum.

Procedure:

a. Connect equipment as shown in *Figure 3-9*.

b. Connect the 10 MHz output to the Spectrum Analyzer input. Check spectrum at 10 MHz ±5kHz. All non-harmonically related sidebands should be 80 dB or more below the carrier.

c. Connect the 5 MHz output to the Spectrum Analyzer input. Check spectrum at 5 MHz ±5kHz. All non-harmonically related sidebands should be 80 dB or more below the carrier.

d. Connect the 1 MHz output to the Spectrum Analyzer input. Check spectrum at 1 MHz ±5 kHz. All non-harmonically related sidebands should be 80 dB or more below the carrier.

e. Connect the 100 kHz output to the Spectrum Analyzer input. Check spectrum at 100 kHz ±5 kHz. All sidebands except harmonically related signals should be 80 dB or more below the carrier.

f. Disconnect test equipment.

Table 3-5. In-Cabinet Performance Check (Continued)

3. HP 5061B OUTPUT SIGNAL ACCURACY CHECK

The two following accuracy check techniques measure the changing phase relationship between the 5061B 5 MHz output and another primary frequency standard (HP 5061B Cesium Beam Frequency Standard or equivalent) 5 MHz output over an 8-hour period. Either procedure may be used and both are equally accurate. The procedure is divided into two parts;

a. Calibrating the measurement system, and

b. Performing the accuracy check with either;

1. the HP 8405A Vector Voltmeter, or

2. the HP K34-59991A Linear Phase Detector

NOTE

The reference standard must be of known accuracy when performing the accuracy check.

Preliminary Procedure:

a. Set the HP 5061B MODE switch to OPEN.

b. Check C-Field setting using procedure in paragraph 3-17.

Vector Voltmeter Calibration Procedure:

a. Connect the test equipment as shown in *Figure 3-10*.

b. Set up the HP 5061B as a reference for normal operation. (CONTINUOUS OPERATION LED on, ALARM LED off.)

c. Set Vector Voltmeter FREQ RANGE-MHz to correspond to input frequency (5 MHz).

d. Zero the Vector Voltmeter, Phase Meter on ±6° range with PHASE RANGE ZERO.

e. Set Strip Chart Recorder range to 0.5 Volts.

f. Set pen to chart scale center with recorder ZERO control.

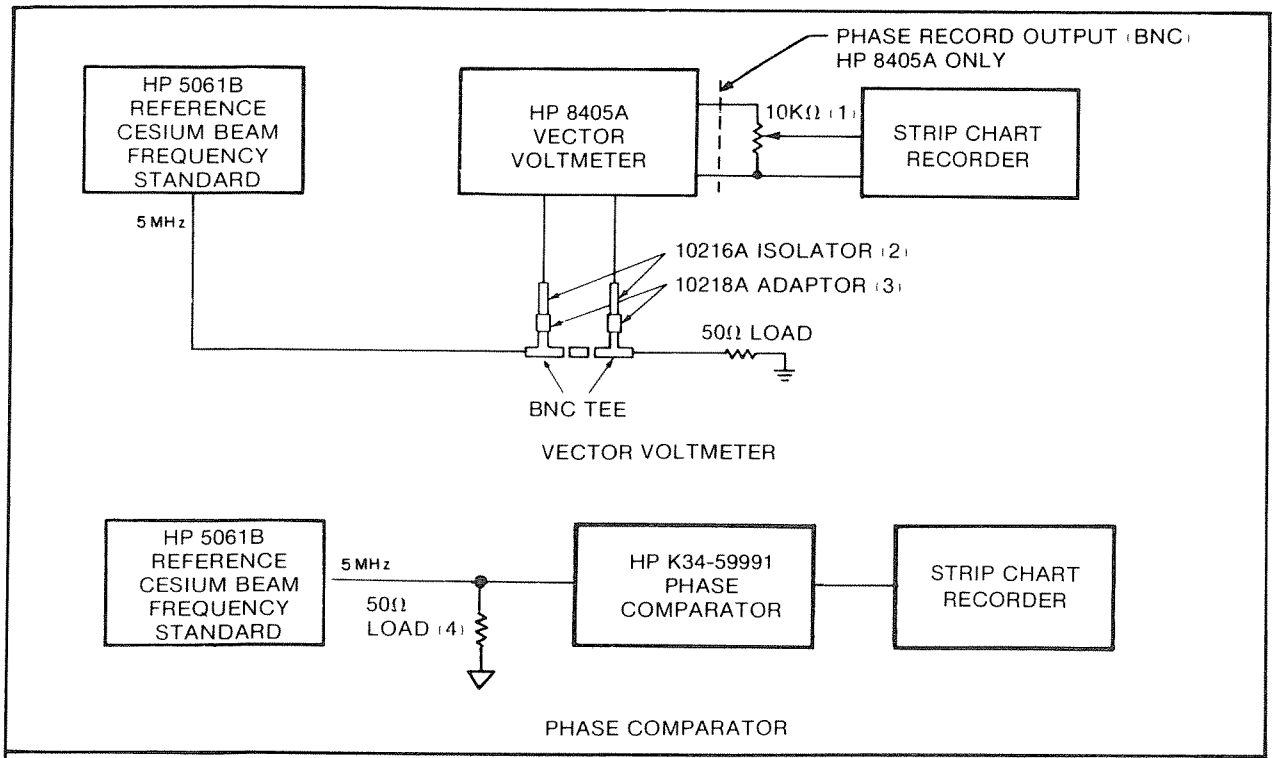
g. Set Vector Voltmeter phase range to ±180° and change METER OFFSET by ±180°.

h. Adjust 10k potentiometer for full scale pen deflection on recorder.

i. Change METER OFFSET polarity to (-). Recorder pen should move to opposite chart edge. Make required adjustments to recorder zero and 10k pot for full scale chart deflection. The recorder is now calibrated for 360° full scale or 0.2 microsecond full scale.

The Vector Voltmeter calibration procedure is completed.

Table 3-5. In-Cabinet Performance Check (Continued)



1. 10,000Ω potentiometer used with HP 8405A only.
2. Model 10216A Isolators: eliminates the effects of variations in test point impedance on measurement accuracy. An isolator adds no more than 3 pF to probe input capacitance.
3. Model 10218A Adaptors: converts probe tip to a conventional BNC male RF connector.
4. HP K34-59991A may be modified for 50Ω Input Impedance.

Figure 3-10. Vector Voltmeter/Phase Comparator Calibration Test Setup

Accuracy Measurement Procedure Using the HP 8405A Vector Voltmeter:

a. Connect equipment as shown in *Figure 3-11.*

b. Set Vector Voltmeter PHASE RANGE to 180°.

c. Start recorder at 1 inch-per-hour and record phase change for 8 hours.

d. Determine frequency error using the relationship formula,

$$\frac{\Delta t}{t} = \frac{\Delta f}{f}$$

Δt = θ change in seconds

t = total measurement time in seconds

Table 3-5. In-Cabinet Performance Check (Continued)

Accuracy Measurement Procedure Using the HP 8405A Vector Voltmeter: (Continued)

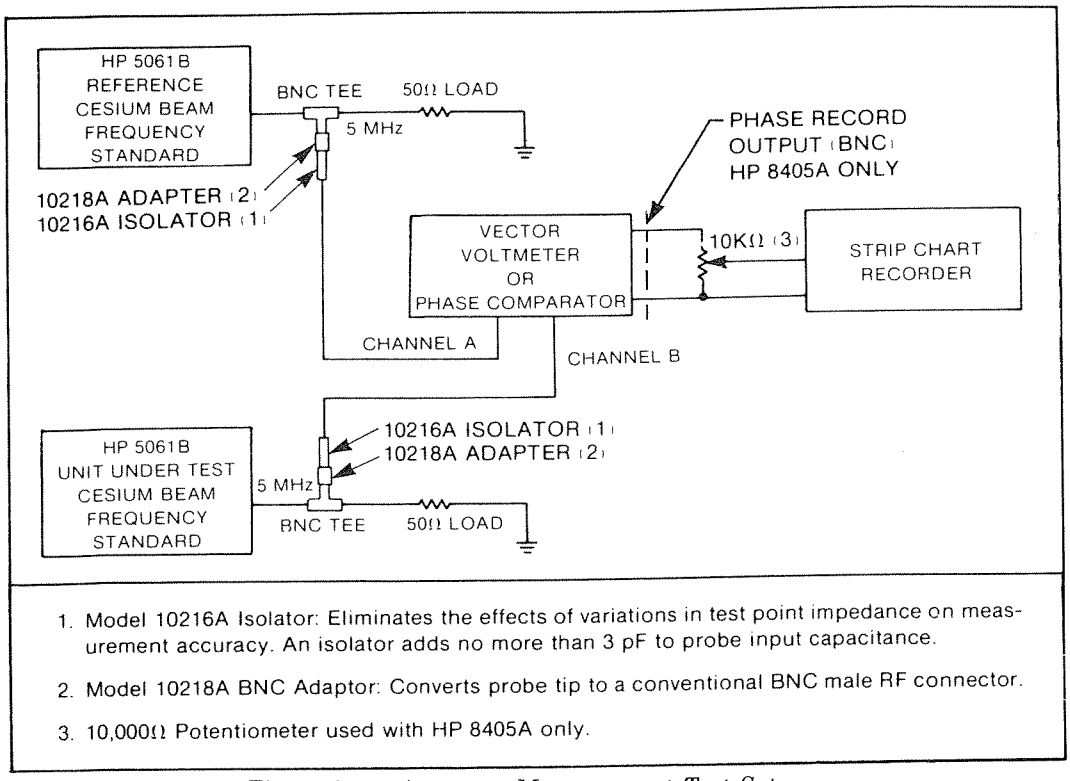
Since the formula and chart calibration is 0.2 microsecond full scale, the error in proportional parts can be calculated. Accuracy should be ±1 part in 10^{11} for a Standard Cesium Beam Tube. The Option 004, High Performance Cesium Beam Tube, accuracy should be ±7 parts in 10^{12} or better.

Example: If the phase change in the HP 5061B over an 8 hour measurement period is 0.1 microsecond, then formula

$$\frac{\Delta t}{t} = \frac{1 \times 10^{-7} \text{ sec}}{8 \text{ hrs } (60 \text{ min}/1 \text{ hr}) (60 \text{ sec}/1 \text{ min})} = 3.47 \times 10^{-2} \text{ (See } \textit{Figure 3-12}\text{)}$$

NOTE

To measure the frequency difference with respect to the accepted frequency accuracy definition, the reference standard frequency accuracy must also be known and considered in the calculation.



1. Model 10216A Isolator: Eliminates the effects of variations in test point impedance on measurement accuracy. An isolator adds no more than 3 pF to probe input capacitance.
2. Model 10218A BNC Adaptor: Converts probe tip to a conventional BNC male RF connector.
3. 10,000Ω Potentiometer used with HP 8405A only.

Figure 3-11. Accuracy Measurement Test Setup

Accuracy Measurement Check Using K34-59991A Linear Phase Detector:

a. Connect the K34-59991A OUTPUT terminals to a strip chart recorder. Set recorder for 1V full scale and 1 in./hr. and turn on recorder.

b. Connect K34-59991A to line power and turn on power switch.

c. Connect a reference 5 MHz to INPUT A and the 5061B (unit under test) 5 MHz to INPUT B.

d. Set "Zero-Oper-Full" front panel mounted toggle switch to "Zero". Adjust "Zero Scale" control for a zero scale trace on recorder.

e. Set switch to "Full" and adjust "Full Scale" control for a full scale trace on recorder.

f. Check both "Zero" and "Full Scale" outputs and readjust if necessary.

g. Set switch to "OPER" for normal operation.

Table 3-5. In-Cabinet Performance Check (Continued)

h. The recorder will now provide a continuous record of frequency comparison and will be automatically reset when the recorder pen reaches zero or full-scale position.

i. With the recorder set for 1 Volt full scale and 1 in./hr., the phase difference recorder will be 0.2 μsec full scale with 5 MHz inputs. See *Figure 3-12* for an example of a frequency difference measurement under these conditions.

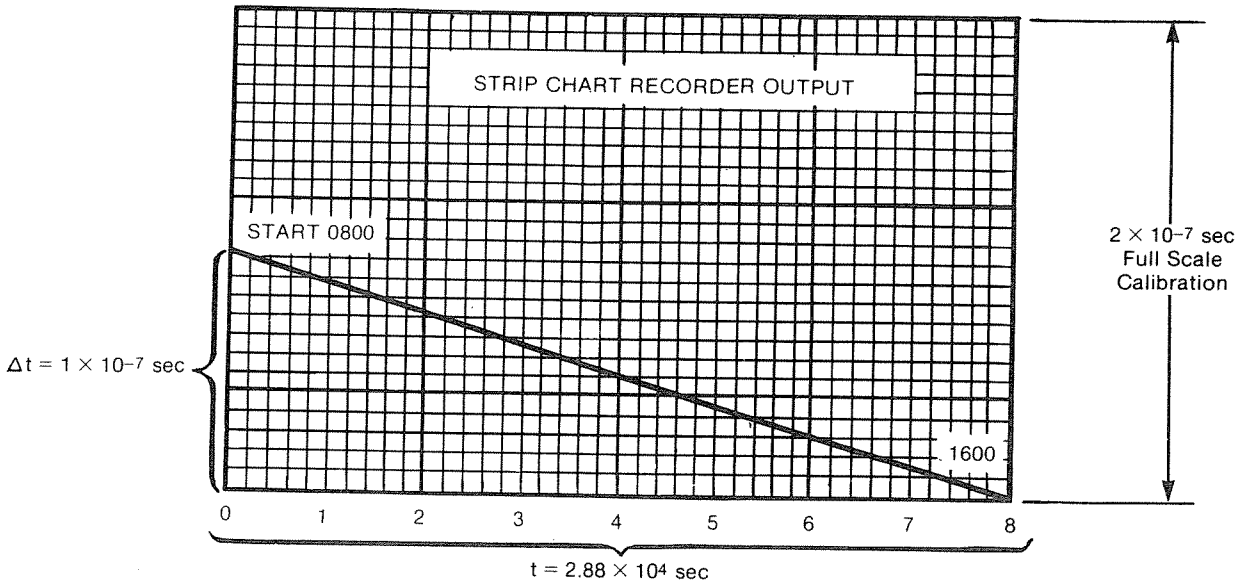


Figure 3-12. Error Measurement

4. OUTPUT CLOCK PULSE CHECK (OPTION 003)

The front panel output labeled 1PPS has the following specifications:

Rate ..... 1 pulse-per-second
Amplitude ..... +10 Volts peak, ±10%
Width ..... 20 microseconds minimum
Rise Time ..... <50 nsec
Fall Time ..... <50 nsec
Jitter ..... <1 ns rms pulse-to-pulse

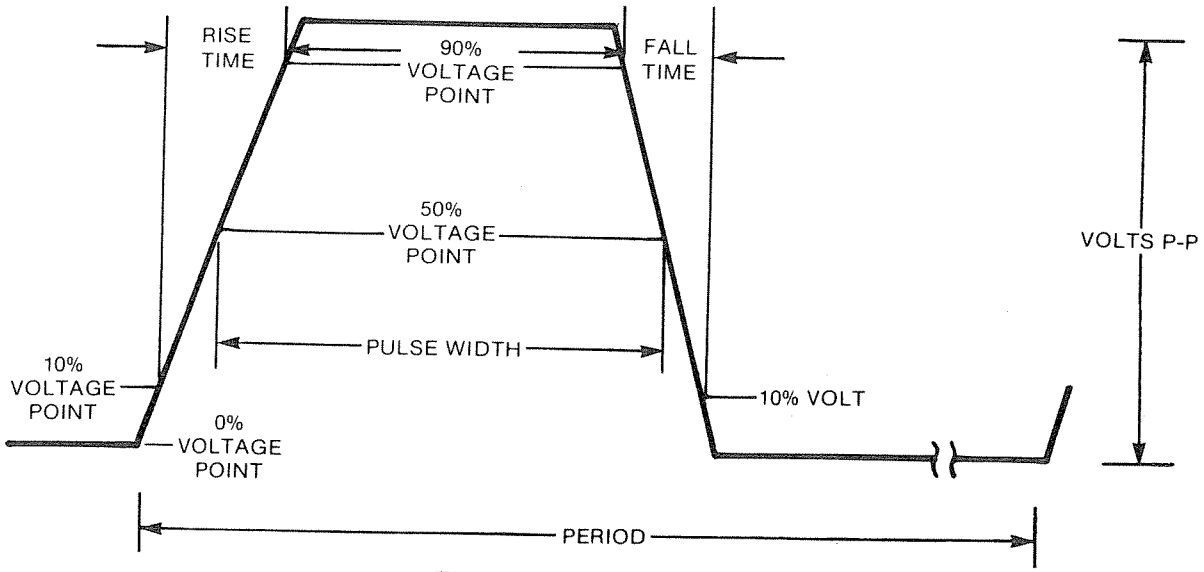


Figure 3-13. Pulse Parameters

Table 3-5. In-Cabinet Performance Check (Continued)

All pulse parameters (except jitter) are checked on an oscilloscope.

Procedure:

Pulse Parameters Test Procedure:

a. Connect the 1 PPS output of the HP 5061B to the 50Ω vertical input of an oscilloscope. Adjust the oscilloscope controls for a clear and stable display.

b. Measure rise time, fall time, and pulse width on the oscilloscope. Compare the oscilloscope display to the specifications listed above.

Pulse Jitter Test Procedure:

In this test procedure the HP 5370A/B is used to measure pulse jitter.

Procedure:

a. Connect the 5 MHz output from the HP 5061B being tested to the FREQ STD INPUT connector on the HP 5370A/B rear panel. Set the FREQ STD switch to EXT.

b. Set HP 5370A/B LINE switch to ON, and set INPUTS START and STOP controls as follows:

SLOPE ..... + ⨍
Attenuators X10
Input resistance 1MΩ
Coupling ..... DC
START COM/SEP ..... START COM

c. Press TRIG LVL key (FUNCTION group).

d. Set HP 5370A/B INPUTS START and STOP trigger LEVEL controls for a display of approximately 0.50 VOLTS.

e. From HP 5061B, connect 1PPS output through 50Ω feedthrough to START input of HP 5370A/B.

f. Press HP 5370A/B TI FUNCTION key.

Display should be approximately 1 s (second).

Display will change slightly every other second. START and STOP LEDs should be flashing at 1 Hz.

g. Press HP 5370A/B STD DEV key (STATISTICS group).

The HP 5370A/B SAMPLE SIZE will automatically be 100.

NOTE

Measurement of rms pulse jitter takes about 4 minutes. During this time the HP 5370A/B display will not change.

The rms pulse jitter must be less than 1 nanosecond.

Table 3-5. In-Cabinet Performance Check (Continued)

5. SYNCHRONIZATION AND TIME DELAY CHECK (OPTION 003)

Synchronization:

The 1PPS output of the HP 5061B Option 003 digital clock can be automatically synchronized with an external reference signal to within 100 nsec (±100 nsec).

Procedure:

NOTE

The external reference pulse must be more than +5V with a rise time of 50 nanoseconds or less.

a. Connect equipment as shown in *Figure 3-14*.

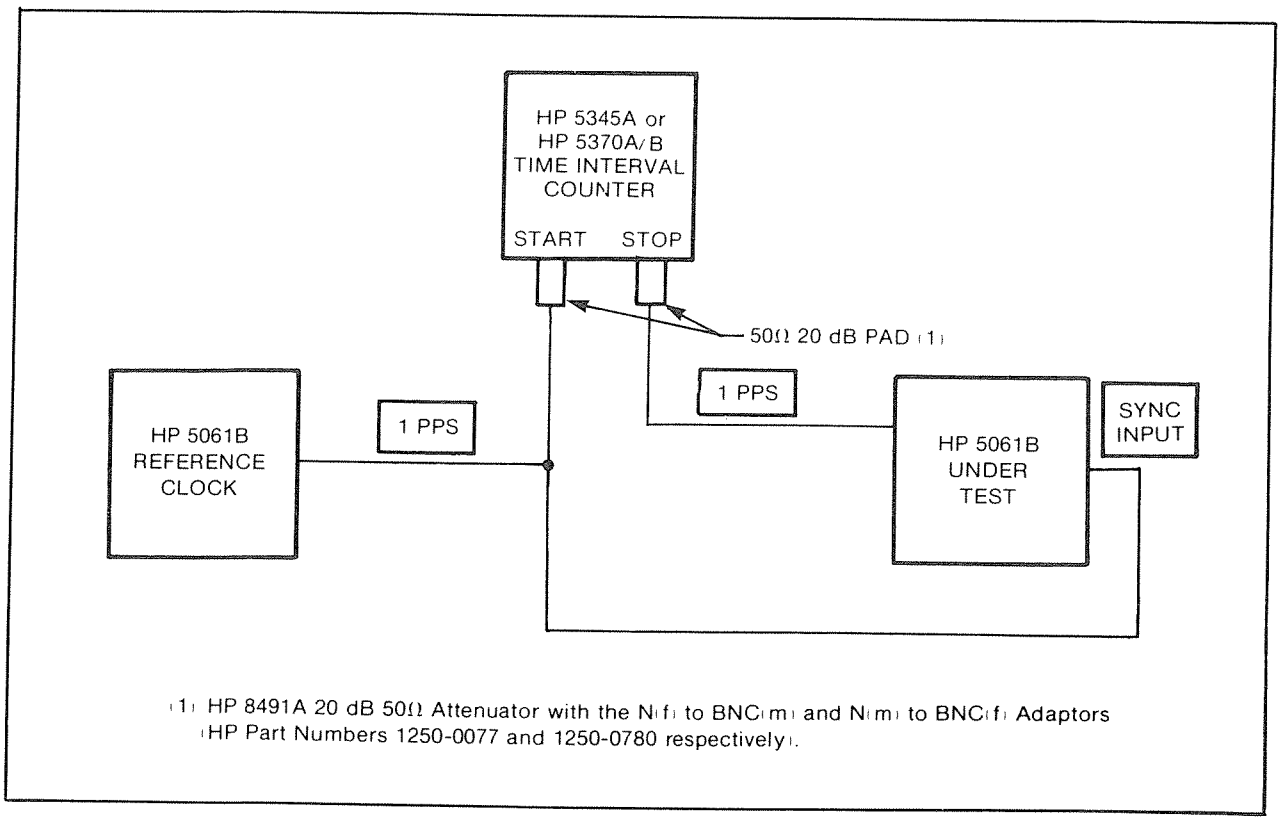
b. Set HP 5370A/B INPUTS for + $\mathcal{F}$ SLOPE.

c. Press 5370A/B FUNCTION TRIG LVL key, and adjust INPUTS START and STOP LEVEL controls for +5.00 VOLTS trigger level on the display.

d. Set the seven thumbwheel switches located on the A5 Digital Divider module to "000000.0".

e. On HP 5061B A5 divider, press and hold the SYNC switch (*Figure 3-2*) for one or two seconds. The 1PPS output will synchronize with the first pulse at the SYNC INPUT after the SYNC button is pressed. The HP 5370A/B counter should display a reading between 0 and 200 nanoseconds.

The HP 5061B A5 TIME DELAY thumbwheel switch settings can also be checked with this test setup.



(1) HP 8491A 20 dB 50Ω Attenuator with the N(f) to BNC(m) and N(m) to BNC(f) Adaptors (HP Part Numbers 1250-0077 and 1250-0780 respectively).

Figure 3-14. Equipment Setup for Synchronization and Delay Checks

Table 3-5. In-Cabinet Performance Check (Continued)

TIME DELAY Thumbwheel Switch Check Procedure:

a. Set the TIME DELAY thumbwheels to the positions in the following list and check the indication on the HP 5370A/B.

Time Interval Counter. The counter should read the time value set into the thumbwheel switches plus the delay noted in step 5 above.

1. 0.7 μsec	5. 8 μsec	9. 800 μsec	13. 80 msec
2. 0.8 μsec	6. 70 μsec	10. 7 msec	14. 700 msec
3. 1 μsec	7. 80 μsec	11. 8 msec	15. 800 msec
4. 7 μsec	8. 700 μsec	12. 70 msec	16. 900 msec

6. STANDBY POWER SUPPLY (Option 003) CAPACITY CHECK

Standby Battery Capacity Test Procedure:

a. Operate the HP 5061B for at least 15 hours. This will ensure that the battery has fully recharged prior to test initialization.

b. Disconnect the HP 5061B power cable connector from the ac power source for 45 minutes. The HP 5061B BATTERY LED should flash on and off during the entire 45 minute period.

NOTE

Disconnect external dc power source from HP 5061B if one is connected.

c. Reconnect the HP 5061B power cable to the correct ac power source. The front-panel BATTERY LED (amber) should stop flashing. During this test the CONTINUOUS OPERATION LED should stay on and the ALARM LED should stay off.

PERFORMANCE CHECK TEST CARD

HEWLETT-PACKARD MODEL 5061B
CESIUM BEAM FREQUENCY STANDARD

Tests Performed By _____

Serial No. _____ - _____

Option(s) _____ Date _____

OPERATIONAL CHECKS

Description	Check
1. Circuit Check Meter	_____ See Table 3-3
2. Output Frequencies	_____ ±1 Count (Counter Error)
3. Output Voltages	_____ 1 to 1.5V rms
4. Output Waveforms	_____ Clean Sine Waves

PERFORMANCE CHECKS

Description	Check
1. Harmonic Distortion; greater than 40 dB from rated output	_____ Greater than 40 dB
2. Non-Harmonic Distortion; greater than 80 dB from rated output	_____ Greater than 80 dB
3. Accuracy; Standard Tube $\pm 1 \times 10^{-11}$	_____ $\pm 1 \times 10^{-11}$
Option 004 $\pm 7 \times 10^{-12}$	_____ $\pm 7 \times 10^{-12}$
4. Clock Pulse; (Option 003)	_____ Rate: 1 PPS
	_____ Amplitude: 10 V p-p ±10%
	_____ Width: 20 μsec minimum
	_____ Rise Time: less than 50 nsec
	_____ Fall Time: less than 50 nsec
	_____ Jitter: less than 1 nsec rms
	_____ Time Delay: 0.1 μsec to 1 sec (depending on thumbwheel settings)
5. Clock Pulse Synchronization (Option 003) and Delay	_____ 100 nsec ±100 nsec
6. Standby Power Capacity (Option 003)	_____ 45 minutes minimum

PERFORMANCE CHECK TEST CARD

HEWLETT-PACKARD MODEL 5061B
CESIUM BEAM FREQUENCY STANDARD

Tests Performed By _____

Serial No. _____ - _____

Option(s) _____ Date _____

OPERATIONAL CHECKS

Description	Check
1. Circuit Check Meter	_____ See Table 3-3
2. Output Frequencies	_____ ±1 Count (Counter Error)
3. Output Voltages	_____ 1 to 1.5V rms
4. Output Waveforms	_____ Clean Sine Waves

PERFORMANCE CHECKS

Description	Check
1. Harmonic Distortion; greater than 40 dB from rated output	_____ Greater than 40 dB
2. Non-Harmonic Distortion; greater than 80 dB from rated output	_____ Greater than 80 dB
3. Accuracy; Standard Tube ±1 × 10^{-11}	_____ ±1 × 10^{-11}
Option 004 ±7 × 10^{-12}	_____ ±7 × 10^{-12}
4. Clock Pulse; (Option 003)	_____ Rate: 1 PPS
	_____ Amplitude: 10 V p-p ±10%
	_____ Width: 20 μsec minimum
	_____ Rise Time: less than 50 nsec
	_____ Fall Time: less than 50 nsec
	_____ Jitter: less than 1 nsec rms
	_____ Time Delay: 0.1 μsec to 1 sec (depending on thumbwheel settings)
5. Clock Pulse Synchronization (Option 003) and Delay	_____ 100 nsec ±100 nsec
6. Standby Power Capacity (Option 003)	_____ 45 minutes minimum

HP 5061B OPERATING RECORD (Meter Readings)

Page ______ of ______

INSTRUMENT SERIAL NO. ____________ C-FIELD DIAL ____________

TUBE SERIAL NO. ____________ ZEEMAN FREQUENCY: 53.53 kHz

FRONT PANEL CIRCUIT CHECK SWITCH POSITIONS AND METER READINGS

DATE	BATTERY	SUPPLY	ION PUMP I	OSC OVEN	CS OVEN	5 MHz	MULT.	BEAM I	CONTROL	2nd HARM.
	0 (35 to 45 with) Option 003)	35-45	0-15	*20-45	*5-35	35-45 (no load)	35-45	20 (Nominal)	0 (may be as much as ±50)	30-50

*Changes with ambient temperature.

HP 5061B OPERATING RECORD (Meter Readings)

Page ______ of ______

INSTRUMENT SERIAL NO. ______________ C-FIELD DIAL ______________

TUBE SERIAL NO. ______________ ZEEMAN FREQUENCY: 53.53 kHz

FRONT PANEL CIRCUIT CHECK SWITCH POSITIONS AND METER READINGS

DATE	BATTERY	SUPPLY	ION PUMP I	OSC OVEN	CS OVEN	5 MHz	MULT.	BEAM I	CONTROL	2nd HARM.
	0 (35 to 45 with) Option 003)	35-45	0-15	*20-45	*5-35	35-45 (no load)	35-45	20 (Nominal)	0 (may be as much as ±50)	30-50

*Changes with ambient temperature.