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Service

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## Introduction

This chapter provides service information for your 5071A and is divided into three major sections:

- **Returning the Instrument to Agilent for Service.** This section provides you with step-by-step instructions on how to return the instrument for service.
- **Pre-Troubleshooting Information.** This section provides you with pertinent information such as safety considerations, recommended test equipment, repair and after service considerations, service accessories, and assembly identification and location.
- **Diagnostic Trees and Procedures.** This section provides you with diagnostic trees and procedures to isolate faulty assemblies or modules. (Once you find a faulty assembly or module, use Chapter 4, “Replacing Assemblies,” to remove the defective assembly and replace it with a functioning unit.)

If the instrument is under warranty, return the instrument to Agilent for service. Refer to the first section of this chapter titled “Returning the Instrument to Agilent.” If you decide to troubleshoot the instrument yourself, refer to the section titled “Diagnostic Trees and Procedures.”

## **Returning the Instrument to Agilent for Service**

### **To Provide Repair Information**

If you are shipping the instrument to an Agilent office for service or repair, call your nearest Agilent Sales Office to make arrangements. Then tag and package the 5071A for shipment.

- 1 Write the following information on a tag:
  - Owners name and address
  - Instrument model number
  - Complete serial number
  - Description of service required or failure indications
- 2 Attach the tag to the instrument.
- 3 Pack the instrument.

If you have the original packaging materials, refer to the following section titled "Pack in Original Package Materials." If the original packaging material are not available, you can order new materials through an Agilent Sales Office. The new materials are identical to those used by the factory when packaging the instrument. If you want to use commercially available materials, refer to the section titled "To Pack in Commercially Available Materials."

### **To Pack in the Original Packaging Materials**

Whenever possible, repack the instrument in its original packaging for shipment. In any correspondence, refer to the instrument by the model number and complete serial number.

- 1 Disconnect the power cord, probes, cables, or other accessories attached to the instrument.
- 2 Make sure the folded corrugated spacer (which normally contains the manuals) is in the box to ensure proper fitting.
- 3 Make sure the four polystyrene corner blocks are in their proper positions in the box.

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### Returning the Instrument to Agilent for Service

- 4 Place the instrument on the four polystyrene corner blocks with the 3-ply pad at the rear panel end of the instrument.
- 5 Place four more polystyrene corner blocks on top of the instrument to secure it.
- 6 Do not return the manuals with the instrument. Return an accessory only when it is a part of the failure symptoms.
- 7 Seal the shipping container securely.
- 8 Place the sealed shipping container inside the wooden shipping box.
- 9 Carefully nail the box lid onto the box and apply the appropriate shipping labels.

### To Pack in the Commercially Available Materials

If the factory packaging materials are not available, you can use commercially available materials for shipping.

- 1 Wrap the instrument in heavy paper or plastic.
- 2 Place the instrument in a strong shipping container.  
A double-wall carton made of 350-lb. test material is adequate.
- 3 Protect the control panel with cardboard.
- 4 Add a layer of shock-absorbing material.  
The shock-absorbing material should be 70 to 100 mm (3 to 4 inches) thick around all sides of the instrument to prevent movement inside the container.
- 5 Seal the shipping container securely.
- 6 Mark the shipping container FRAGILE.

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## Pre-Troubleshooting Information

This section contains the following pertinent troubleshooting information:

- Safety Considerations
- Recommended Test Equipment
- Repair Considerations
- After Service Considerations
- Service Accessories
- Assembly Identification and Location

### Safety Considerations

Although this instrument has been designed in accordance with international safety standards, this manual contains information, cautions, and warnings which must be followed to ensure safe operation and to retain the instrument in a safe condition. Service instructions, and adjustment procedures requiring removal of the instrument cover, are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any servicing or make any adjustments with the cover removed, unless qualified to do so.

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#### **WARNING**

**BEFORE APPLYING AC POWER, THE INSTRUMENT AND ALL PROTECTIVE EARTH TERMINALS, EXTENSION CORDS, AUTO TRANSFORMERS, AND DEVICES CONNECTED TO THE INSTRUMENT SHOULD BE CONNECTED TO A PROTECTIVE EARTH GROUNDED SOCKET.**

**ANY INTERRUPTION OF THE PROTECTIVE GROUNDING CONDUCTOR INSIDE OR OUTSIDE THE INSTRUMENT OR DISCONNECTION OF THE PROTECTIVE EARTH TERMINAL WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. INTENTIONAL INTERRUPTION IS PROHIBITED.**

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Any adjustment, maintenance, and repair of the opened instrument under voltage should be avoided as much as possible and, if necessary, should be carried out only by a skilled person who is aware of the hazards involved (for example, fire and electric shock).

## **Recommended Test Equipment**

Test equipment recommended for testing and troubleshooting the 5071A is listed in Chapter 1, "Performance Tests."

Substitute equipment may be used if it meets or exceeds the required characteristics listed in Table 1-1.

## **Repair Considerations**

### **Electrostatic Discharge**

Electronic components and assemblies in the 5071A can be permanently degraded or damaged by electrostatic discharge. Use the following precautions when servicing the instrument:

- 1 **ENSURE that static sensitive devices or assemblies are serviced at static safe work stations providing proper grounding for service personnel.**
- 2 **ENSURE that static sensitive devices or assemblies are stored in static shielding bags or containers.**
- 3 **DO NOT wear clothing subject to static charge buildup, such as wool or synthetic materials.**
- 4 **DO NOT handle components or assemblies in carpeted areas.**
- 5 **DO NOT remove an assembly or component from its static shielding protection until you are ready to install it.**
- 6 **AVOID touching component leads. (Handle by packaging only.)**

### **Disassembly and Reassembly Specifics**

Refer to the Chapter 4, "Replacing Assemblies," in this manual for complete disassembly and reassemble details, and Chapter 5, "Replaceable Parts" for an exploded view of the instrument parts.

## **After Service Considerations**

### **Product Safety Checks**

The following safety checks must be performed after any troubleshooting and repair procedures have been completed to ensure the safe operation of the instrument.

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**WARNING**

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**RESISTANCE CHECKS DESCRIBED IN THE FOLLOWING TEXT REQUIRE THAT THE POWER CORD BE CONNECTED TO THE INSTRUMENT AND THAT AC POWER BE DISCONNECTED. BE SURE THAT THE POWER CORD IS NOT CONNECTED TO POWER BEFORE PERFORMING ANY SAFETY CHECKS.**

## Service

### Pre-Troubleshooting Information

- 1 **VISUAL INSPECTION.** Visually inspect the interior of the instrument for any signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.
- 2 **GROUND CONTINUITY TEST.** Plug the power cord into the rear-panel power receptacle. (DO NOT connect the instrument to ac power at this time.) Using a suitable ohmmeter, check resistance from the instrument's metallic connection (such as the rear panel or BNC ground collar) to the ground pin on the power cord plug. The reading must be less than  $1\Omega$ . Flex the power cord while making this measurement to determine whether intermittent discontinuities exist.
- 3 Check any indicated front or rear panel ground terminals marked, using the above procedure.
- 4 **INSULATION RESISTANCE TEST.** Tie the line and neutral pins of the power cord plug together. Measure the resistance from the instrument enclosure (chassis) to the line and neutral pins of the power cord plug. The minimum acceptable resistance is  $2\text{ M}\Omega$ . Replace any component which results in a failure.
- 5 **LINE FILTER/CABLE ASSEMBLY CHECK.** Check the line fuse and voltage selector card in the rear panel line filter/cable assembly to verify that the instrument is properly set for the ac-power source to be applied.

## **Service**

### **Pre-Troubleshooting Information**

#### **Product Performance Checks**

After replacement of any assembly or module, perform the Operational Verification Test in Chapter 1, "Performance Test," of this manual.

#### **Service Accessories**

Service accessories for troubleshooting the 5071A are available from Agilent. Table 2-1 lists the items in the 5071A Service Accessories Kit. The list includes the name, the part number, and a brief description and use of each item.

Service

**Pre-Troubleshooting Information**

**Table 2-1. Service Accessories Kit (05071-67003) Contents**

<b>Accessory</b>	<b>Part Number</b>	<b>Use</b>
Service Manual (includes profiling SW 05071-13501)	05071-90003	Corrective maintenance
Extender board for short PCAs	05071-60051	A4, 6, 7, 8 diagnosis
Extender board for long PCAs	05071-60052	A2,3 diagnosis
100 nA Current Source (powered by A6)	05071-60274	A14 diagnosis
SO-8 SMT Dip clip (#5250 ITT Pomona)	1400-1708	SMT signal access
SO-14 SMT Dip clip (#5251)	1400-1705	SMT signal access
SO-16 SMT Dip clip (#5252)	1400-1706	SMT signal access
SO-20 SMT Dip clip (#5253)	1400-1707	SMT signal access

## Pre-Troubleshooting Information

### Assembly Identification and Location

The assembly number, name and part number of the 5071A assemblies are listed in Table 2-2. Figures 2-1 and 5-2, illustrate the replaceable assemblies and cables in the 5071A.

**Table 2-2. 5071A Assembly Identification**

Assembly	Name	Part No.	Exchange Part No.*
A1	Motherboard Assembly	05071-60001	—
A2	CBT Controller Assembly	05071-60202	05071-69202
A3	Microprocessor ASsembly	05071-60003	05071-69003
A4	Digital Synthesizer Assembly	05071-60004	—
A5	87 MHz PLL Module	05071-60272	05071-69272
A6	Servo ASsembly	05071-60006	05071-69006
A7	Interface Assembly	05071-60007	—
A8	1 PPS Assembly	05071-60008	—
A9	Frequency Multiplier Module	05071-60292	05071-69292
A10	Output Frequency Distribution Amplifier Module	05071-60210	05071-69210
A11	Power Steering Logic Assembly, Std	05071-60029	—
A11	Power Steering Logic Assembly, Opt. 048	05071-60033	—
A12	Dc-Dc Power Converter Supply Module	05071-60212	05071-69212
A13	Front-Panel PC Assembly	05071-60013	—
A14	Signal Amplifier Module	05071-60214	—
A15	9.2 GHz Microwave Generator Module	05071-60215	—
A16	High Voltage Supply Module	05071-60216	—
A17	CBT (Cesium Beam Tube) Assembly	10890A	—
	or		
	Option 001 High Performance CBT Assembly	10891A	—
A18	9.2 GHz PLL Module	05071-60218	05071-69218
A19	Reference Oscillator (Quartz) Module	05071-60219	05071-69219
LF1	Line Filter/Cable Assembly	05071-60259	—
T1	Toroidal Power Transformer Assembly	9100-4962	—

\* Exchange part availability subject to change without notice. Contact your local Agilent Sales Office for current information.

Pre-Troubleshooting Information

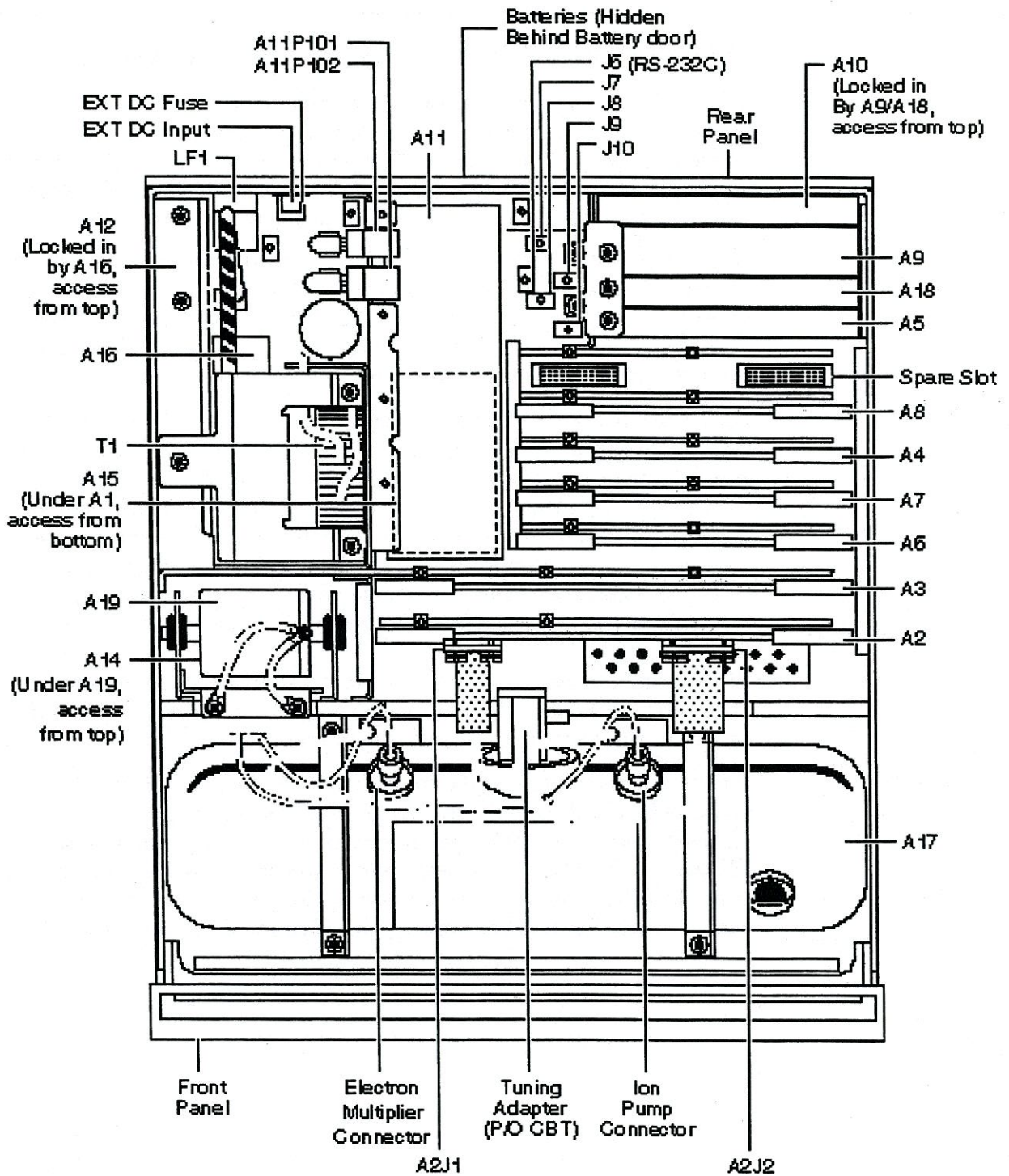


Figure 2-1. Instrument Top View

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## Diagnostic Trees and Procedures

The following sections contain diagnostic-troubleshooting trees (diagnostic trees) in the form of stepwise procedures and Yes/No decision points. The intent of this process is to isolate a faulty printed circuit assembly (PCA) or module. Component-level troubleshooting is NOT supported in this manual, except for the A1 motherboard.

Troubleshooting on the 5071A requires disassembly for access. Refer to the “Disassembly and Reassembly” procedures in chapter 4 for that information. Assembly specific tests and probing frequently requires the use of either a long or short PCA extender board. The extender boards and their part numbers are listed in Table 2-1.

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**NOTE**

Following the diagnostic-tree procedures is essential to isolating the faulty assembly or module. *If the internal self test diagnostics are used without reference to this process, misleading results may be obtained, leading to improper and unproductive repair actions.* Besides the diagnostics, other means are required to localize and isolate the problem PCA or module. These include visual checks of LEDs, and LCD display messages along with test equipment checks such as scope, multimeter, or spectrum analyzer tests.

The diagnostic self tests may be executed via SCPI commands, or from the 5071A front-panel software interface. All the information is given in the description of the diagnostic trees.

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**NOTE**

Ensure that all internal modules and assemblies are correctly installed and all interconnect cables are present and properly routed. (Refer to the functional-block interconnect tables in chapter 3, “Theory of Operation” for cable interconnect information.) Each PCA must be fully seated in its correct bus slot position on the A1 motherboard. (A9J101 if present, is capped with no connection.)

### **5071A Diagnostic Tree Organization**

- **Diagnostic-Tree Section 1 - Top-level Diagnostics Trees:**  
provides the beginning entry point for the troubleshooting process; organized around start-up events, front-panel operation/messages, and rear-panel output/input signals.
- **Diagnostic-Tree Section 2 - Functional-Group Diagnostic Trees:**  
provides diagnostic trees for any two or more assemblies or modules that interact with each other in the normal performance of instrument operation.
- **Diagnostic-Tree Section 3 - Assembly/Module Diagnostic Trees:**  
provides diagnostic trees for individual assemblies and modules when indicated by either Top-level tree pointers or Functional-Group tree pointers.

### **Navigating the Diagnostic Trouble-Tree Sections**

- 1 Go to the beginning of the Top-level diagnostic tree:
  - a If you already know the symptom/operating problem - go to the subsection in section 1 that provides its fault isolation.
  - b If you do not know what's wrong with a failed instrument, start at the beginning of the Top-level tree checking all items sequentially until you find a specific isolated fault or find a pointer to further details in sections 2 or 3.
- 2 If you know *for certain* the general hardware area where the fault exists, go to the applicable Functional-Group diagnostic tree in section 2. (If replacement of an obviously defective component does not restore normal operation, then you must start at step 1b above.)
- 3 If you know *for certain* that a particular assembly/module is at fault, go to section 3, Assembly/Module diagnostic trees to locate the applicable diagnostic tree. (If replacement of an obviously defective component does not restore normal operation, then you must start at step 1b above.)

## **Top-Level Diagnostic Tree Organization**

The following list of titles outlines the organization of the Top-Level Diagnostic tree and its seven subsections:

### **Top-Level Diagnostic Tree (Diagnostic Section 1)**

- 1.0.0 First Power On**
  - 1.0.1.1 Digital Supply Voltage Check
  - 1.0.1.2 A3 Microprocessor Fault
- 1.0.2 Dc-Supply Test/Log-Record Examination
- 1.0.3 Power On Fatal Error Check
- 1.0.4 Instrument Self Tests
- 1.0.5 CBT Warm Up
- 1.0.6 Servo-Lock Warning State
- 1.0.7 User-Input/Output Checks
- 1.0.8 5071A Profiling
  - 1.0.8.1 Profiling Results Interpretation
  - 1.0.8.2 Conclusion of Diagnostic Procedure
- 1.0.9 Delayed Failures, Warnings, and Messages
  - 1.0.9.1 Delayed Fatal Errors
  - 1.0.9.2 Delayed Warnings
  - 1.0.9.3 Delayed Advisory Messages

### **Power-On Fatal-Error Diagnostic Tree (Diagnostic Subsection 1)**

- 1.1.1 Fatal Error Interpretation
- 1.1.2 Sequencer Error Test
  - 1.1.2.1 1 PPS Assembly 80 MHz Input Test
- 1.1.3 Tube PROM Test

### **Self Test Diagnostic Tree (Diagnostic Subsection 2)**

- 1.2.1 Self Test Failure Interpretation
- 1.2.2 Pps Interrupt Error Test

**Diagnostic Trees and Procedures**

**Warmup and Operating Fatal Error Diagnostic Tree  
(Diagnostic Subsection 3)**

- 1.3.1 Warm-Up/Operating Error
  - 1.3.1.1 Operating Error-Code Interpretation
- 1.3.2 Interpreting Warm-Up Errors
  - 1.3.2.1 Cs Oven Failed: Ion-Pump Overcurrent Warm-up Error
  - 1.3.2.2 A16/CBT Excess Ion-Pump Current Test
- 1.3.3 CBT Signal Fatal Errors
- 1.3.4 CBT Shutdown Message
- 1.3.5 Cs Oven Timeout Test
- 1.3.6 CBT Background Signal Warm-Up Errors
- 1.3.7 CBT Depth of Modulation Warm-Up Errors
  - 1.3.7.1 CBT Support Circuits Test
- 1.3.8 RF Level Control-Current Test

**Warning Message Diagnostic Tree (Diagnostic Subsection 4)**

- 1.4.1 Warning Message Interpretation
- 1.4.2 Signal Gain at Range Limit/CBT Signal Low
- 1.4.3 5071A Profiling (CBT Performance Evaluation)
- 1.4.4 Power Source is Batt
  - 1.4.4.1 Ac Line Operation - Battery Indicator On
  - 1.4.4.2 Instrument Ac Power Absent
    - 1.4.4.2.1 A1C4 Voltage Test
  - 1.4.4.3 LF1/T1 Transformer Fault Verification

**I/O Diagnostic Tree (Diagnostic Subsection 5)**

- 1.5.1 Input/Output Faults

**CBT Performance Evaluation (Diagnostic Subsection 6)**

- 1.6.0 Running the 5071A Profiling Software
- 1.6.1 5071A Profiling Results Evaluation

**Advisory Messages (Diagnostic Subsection 7)**

- 1.7.1 Advisory Message Interpretation

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## Top-Level Diagnostic Tree (Diagnostic Section 1)

This section describes the top-level diagnostic procedures for the 5071A Primary Frequency Standard and provides pointers to lower-level procedures. It is complete and must be performed sequentially. The procedures are designed to troubleshoot an instrument that has failed in normal operation, and is no longer able to lock-up correctly at power on.

When the complete procedure is performed on a functional 5071A, it will end at section 1.0.8.2 with no errors or failures. The operational verification and Performance Test procedures described in Chapter 1 of this manual must be performed successfully on a repaired instrument before it is placed back in service.

A transient error condition is evident when an instrument generates an error or warning but subsequently passes the operational verification procedure without any repair. This could for example occur when the cesium beam tube (CBT) nears the end of its life.

In case of difficulty, contact your nearest Agilent Sales office for assistance.

### 1.0.0 First Power On

- 1 Remove the instrument from service.
- 2 Remove all external power.
- 3 Disconnect the internal-standby battery. (See Operating and Programming manual, pg 2-15).
- 4 Ensure that rear-panel ac-line filter/cable assembly has a good fuse.
- 5 Remove 5071A top/bottom covers and top inner shield (see pg 4-3).
- 6 Power on the 5071A by applying ac power.
- 7 Verify that all front-panel LEDs, the LCD, beeper, and keypad work:
  - a Observe the large red seven-segment and small amber LEDs momentarily illuminate.
  - b Observe the LCD illuminate its top row of pixels followed by normal two-row-display operation.
  - c Check each key by pressing it and either hear or observe a confirming response.

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**NOTE**

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a & b above should occur within first few seconds of operation.

QUESTION: Is the front-panel functional (beeper, LEDs, keyboard operational)?

**Top-Level Diagnostic Tree (Diagnostic Section 1)**

If Yes: Go to, 1.0.2.

If No: Disconnect power immediately and check the ac fuse.

If fuse is intact, Go to, 1.0.1.1.

If fuse is blown, Go to, 2.1.1.1.0 (Power supply diagnostic tree).

**1.0.1.1 Digital Supply Voltage Check**

- 1 Install the short extender board (part number 05071-60051) into the spare slot on the A1 motherboard.
- 2 Use a DMM with a point-tipped probe to verify +5V supply on the extender board test points.

QUESTION: Is +5V between 5.28 to 5.50 volts?

If Yes: Go to, 1.0.1.2

If No: Go to, 2.1.1.1.0 (Power-Supply diagnostic tree).

**1.0.1.2 A3 Microprocessor Fault**

- 1 Observe upper edge row of LEDs on A3 microprocessor assembly.

QUESTION: Are LED DS6 lit and LEDs DS1 - DS4 extinguished?

If Yes: Remove power, replace A13 (see page 4-7.), and retest.

If No: Remove power, replace A3, and retest.

**1.0.2 DC-Supply Test/Log-Record Examination**

- 1 If the INFO/STATUS menu selections display Warming up, use the CONFIG, MODE, and STANDBY menu selections to place the 5071A into STANDBY mode. (This will put the instrument into a stable state if it has not gone to Fatal Error mode.)
- 2 Record all information in the log (LOG/BROWSE menu selections).
- 3 Clear the log (use LOG/CLEAR).
- 4 Install the short extender board (part number 05071-60051) into the spare slot on the A1 motherboard.

## Service

### Top-Level Diagnostic Tree (Diagnostic Section 1)

5 Use a DMM (with point-tipped probes) set for dc volts to measure the +5, +12, and -12 volt supplies on the extender-board test-voltage points to chassis ground. They should all be within the following ranges:

+5V = 5.28 to 5.50 volts

+12V = 12.08 to 12.40 volts

-12V = -12.08 to -12.40 volts

QUESTION: Are the measured voltages within the given ranges?

If Yes: Go to, 1.0.3

If No: Go to, 2.1.1.1.0 (Power-supply diagnostic tree).

#### 1.0.3 Power On Fatal Error Check

- 1 Cycle power to the instrument, wait fifteen seconds.
- 2 Go to the INFO/STATUS section of the front-panel menu.

QUESTION: What state is the 5071A in?

If Warming Up, Go to, 1.0.2, perform step 1, then go to 1.0.4.,

If in Fatal Error, Go to, 1.1.1 (Power-On Fatal-Error diagnostic tree).

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#### NOTE

For some test purposes it is useful to force the instrument into the fatal error state. This can be done by applying power with A2P3 disconnected from A2J2.

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#### 1.0.4 Instrument Self Tests

- 1 Execute all Self tests from front panel in Standby mode as follows:
  - a Go to the UTIL menu, select TEST option, and press Enter.
  - b Press INC to initiate the Self test cycle.
  - c Observe the front-panel display CYCLES = 0: when 0 changes to 1 or greater, all Self tests have passed.
  - d If a Self test routine fails, record the displayed message and attempt to continue the tests by pressing INC again.
  - e Press DEC to halt Self test execution.

QUESTION: Did the 5071A pass all the Self tests?

If Yes: Go to, 1.0.5

If No: Go to, 1.2.1 (Self-test diagnostic tree).

### **1.0.5 CBT Warm Up**

- 1 Change operating mode to NORMAL (press CONFIG, MODE, and NORMAL), the instrument state changes to Warming up.
- 2 Wait until the green LED is flashing, or 45 minutes have passed.

QUESTION: Does the green LED continue to flash for at least 60 seconds?

If Yes: Go to, 1.0.6.

If No: Go to, 1.3.1, Warmup and Operating Error diagnostic tree.  
(For delayed error conditions, go to 1.0.9.)

### **1.0.6 Servo-Lock Warning State**

QUESTION: Is the amber LED flashing?

If Yes: Go to, 1.4.1, Warning-Message diagnostic tree.  
(For delayed error/warnings go to 1.0.9.)

If No: Go to, 1.0.7.

### **1.0.7 User-Input/Output Checks**

- 1 Check the performance of the following outputs/inputs:  
(Refer to chapter 1, page 1-8 to verify operation and page 1-7 in the Operating and Programming manual for checking the Sync inputs with a pulse source.)
  - a. Both 5/10MHz outputs,
  - b. 1 MHz output,
  - c. 100 kHz output,
  - d. RS232 port,
  - e. All 1pps outputs,
  - f. Both Sync inputs
  - g. Status Output
    - 1) Use an oscilloscope to verify TTL-high state.
    - 2) Put the instrument into Standby.
    - 3) Verify transition to TTL-low state.
    - 4) Return the instrument to Normal.

QUESTION: Did all Input/Output checks pass?

If Yes: Go to, 1.0.8.

If No: Go to, 1.5.1 (I/O diagnostic tree).

## **1.0.8 5071A Profiling**

Successful completion of the preceding tests indicate that all functional blocks of the 5071A under test are operational.

This is confirmed by the instruments' ability to lock-up its servo loops successfully with no errors. These tests are however, not sufficiently detailed to predict the accuracy or stability of the instrument, which could be degraded by noise or instability in the CBT and the electronic circuits.

Because the operating accuracy and stability of the 5071A can only be confirmed by long observations, it is useful to assess the noise contribution of the CBT at the completion of the top-level test procedure. The CBT has a finite lifetime, and measurements of its operating parameters may be used to give advanced warning of required service.

- 1 Perform the 5071A profiling procedure provided at 1.6.0. The procedure has no effect on the timekeeping performance of the instrument, and may be conducted on an 5071A currently in use. The procedure requires only that the instrument will run in Normal Operation mode.
- 2 When the profiling software has generated its report, use the following information to evaluate the results.

### **1.0.8.1 Profiling Results Interpretation**

#### **Signal to Noise**

#### **Ratio**

The Signal to Noise Ratio is an estimate of the current overall operating condition of both the CBT and instrument electronics.

- If the result is Band 1, the instrument's stability should meet specification. CBT problem is unlikely.
- If the result is Band 2, the test is indeterminate. High Probability that CBT is performing to specifications.
- If the result is Band 3, instrument stability will probably not meet specification. CBT problem is likely. Consult Chapter 1 on Performance Tests to confirm poor performance.

## Top-Level Diagnostic Tree (Diagnostic Section 1)

### Depth of Modulation

The Depth of Modulation can help isolate faults to either the CBT or instrument electronics.

A Band 3 modulation depth combined with a peak-output current below 100 nA indicates deteriorating CBT performance. Be sure to thoroughly diagnose the entire instrument before considering the A17 CBT to be at fault. Contact your nearest service facility for further assistance.

### VCXO Control

#### Value

The frequency of the VCXO is continually adjusted by the frequency servo to correct for noise and aging. The present state of the adjustment is provided by the VCXO control value. This value has no discernible effect on instrument operation as long as it remains within a  $\pm 100\%$  range. It is desirable to schedule readjustment of the A19 frequency if the control value reaches  $\pm 90\%$ . The adjustment procedure is provided at 3.9.1.7 and 3.9.1.8.

### 1.0.8.2 Conclusion of Diagnostic Procedure

If the results of the profiling procedure do not suggest CBT replacement, the instrument can be returned to service. If repairs have been made, full performance testing or operational verification must be performed as described in chapter 1.

If an 5071A has been successfully tested as described above and fails to meet specifications, you may need to return the instrument to the nearest qualified repair facility. Contact your nearest Agilent Sales office for further assistance.

### 1.0.9 Delayed Failures, Warnings, and Messages

The error messages covered in sections 1.1.1, 1.2.1, 1.3.1, and 1.4.1 describe the error conditions which can occur respectively at power-up, during self-test, during servo lock-up, and immediately following servo lock-up. Error conditions can occur later than this, for example due to component failure, aging, or progressive loss of CBT performance. These will be described as *delayed* error conditions.

Delayed error conditions include "Fatal Errors" which result in the instrument going off-line, "Warnings" of unsatisfactory internal conditions which do not necessarily cause operation to fail completely, and "Messages" which are advisory.

## Service

### Top-Level Diagnostic Tree (Diagnostic Section 1)

Use the following information to investigate possible malfunctions. Examine the instrument's log and record any error conditions which have occurred before beginning troubleshooting.

#### 1.0.9.1 Delayed Fatal Errors

Operational fatal errors are usually caused by a significant malfunction of one of the instrument's functional blocks. These errors will usually prevent subsequent operation and can be diagnosed in the usual way using the top level diagnostic procedure.

#### 1.0.9.2 Delayed Warnings

Warnings which occur in normal operation may not always require the instrument to be removed from service, especially when some loss of performance is tolerable. For example declining CBT performance will result in a "CBT signal low" warning. This warning is only issued once, as it does not cause the instrument to stop operating.

Some errors may occur due to transient conditions, or perhaps be caused by unusually strong external EMI (Electro-Magnetic Interference). Such error conditions can be cleared using the front-panel **Shift**, **5**, **Enter** sequence. When ever possible, however, the instrument should be run through Operational Verification procedure as a precaution. The procedure in section 1.4.1 can be used to investigate the cause of warnings.

#### 1.0.9.3 Delayed Advisory Messages

Advisory messages have several degrees of importance, and may occur together with fatal errors. Messages are discussed in section 1.7.1.

## **Power-on Fatal-Error Diagnostic Tree (Subsection 1)**

This subsection describes the power-on fatal-error diagnostic tree. It assumes that the internal +5, +12, and -12 dc-supply voltages are all present and within specifications.

### **1.1.1 Fatal-Error Interpretation**

- 1 Observe the log contents for any of the following error messages.

QUESTION: What is the error?

If Error = Sequencer interrupt error <number>, Go to, 1.1.2

If Error = Config load err <number>, page <number>, Go to, 1.1.3

If Error = Config write error <number>, Go to, 1.1.3

If Error = Bad CBT EEPROM format, Go to, 1.1.3

If Error = CBT load error <number> page <number>, Go to, 1.1.3

If Error = none of the above, Go to, 1.3.1

### **1.1.2 Sequencer Error Test**

This error occurs when 1MHz is absent on A3.

- 1 Place the short extender board (part number 05071-60051) into the available spare slot on the motherboard (XOFTP1 and XOFTP2).
- 2 Use an oscilloscope to verify that a 1 MHz signal is present at the test point labeled "+1 MHz" with an amplitude of 4 volts, 50% duty cycle, and a nominal 20 ns rise time.

QUESTION: Is the 1 MHz signal present as specified?

If Yes: Remove power, replace A3, and retest.

If No: Go to 1.1.2.1.

#### **1.1.2.1 1-PPS Assembly 80 MHz Input Test**

- 1 Remove ac power and disconnect the cable from A8J3.
- 2 Connect free end of the cable to the 50  $\Omega$  impedance input of an oscilloscope. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  feed-through terminator at the scope end of the cable.)
- 3 Apply ac power and verify that the signal at A8P3 is an 80 MHz sine wave with at least 0.6 Vp-p amplitude.

QUESTION: Is the 80 MHz signal as described in step 3?

If Yes: Remove power, replace A8, and retest.

If No: Go to, 3.4.1.0 (A9 diagnostic tree)

**1.1.3 Tube PROM Test**

- 1 Remove power from the instrument.
- 2 Disconnect A2P3 from A2J2.
- 3 Apply power to the instrument.
- 4 Verify presence of +5 V ( $\pm 0.5$ ) at pin 1 on A2J2 to chassis ground.
- 5 Use a digital storage scope or logic analyzer (trigger set to 2.5V, DC coupled, timebase to 50 us/div., no auto trigger) to verify the signals are toggling at A2J2 pins 2 and 3 following activation of the reset button on top of A3. The pulse levels should be approximately 4.0 V<sub>p-p</sub>. (Refer to the A2 connector pinout diagrams at the beginning of the A2 diagnostic trees opposite procedure 3.1.1.1.0.)

**QUESTION:** Is there +5 V at pin 1 and a toggling signal present on pins 2 and 3 of A2J2?

If Yes: CBT ROM may be defective: contact your nearest Agilent Sales office for assistance.

If No: Remove power, replace A2, and retest.

## Self Test Diagnostic Tree (Subsection 2)

This subsection describes what to do after a Self-test fails.

### 1.2.1 Self-Test Failure Interpretation

QUESTION: Which test(s) failed? (*If 13/14: Repair A7 and retest.*)

If TEST 13, Interface register test, Remove power, replace A7, and retest.

If TEST 14\*, Interface abus offset test,

Interface abus +5V test,

Interface abus +12V test,

Interface abus -12V test, Remove power, replace A7, and retest.

**NOTE: If test 13/14 fails, remove power, replace A7 and retest.**

If TEST 0, CBT register test: Remove power, replace A2, and go to 1.1.3.

If TEST 1, CBT window comp test (open)

CBT window comp test (short), Go to, A2 Thermistor tree  
beginning at 3.1.2.1.0.

If TEST 2, CBT therm zero test,

CBT therm ones test, Go to, A2 Thermistor tree beginning at 3.1.2.1.0.

If TEST 3, CBT Cs oven zero test (<num.> V),

CBT Cs oven ones test (<num.> V),

CBT Cs oven bit test (bit <num.>), Go to, A2 Cesium-Oven tree  
beginning at 3.1.4.1.0.

If TEST 4, CBT hw ion zero test (<num.> V),

CBT hw ion all 1's test (<num.> V),

CBT hw ion bit test (bit <num.>), Go to, A2 Hot-Wire Ionizer tree  
beginning at 3.1.1.1.0.

If TEST 5, CBT mspec zero test (<num.> V),

CBT mspec ones test (<num.> V),

CBT mspec bit test (bit <num.>), Go to, A2 Mass-Spectrometer tree  
beginning at 3.1.3.1.0.

If TEST 6, CPU RTDS test (no interrupt),

CPU RTDS test (<num.> tics),

CPU RTDS test (no 1MHz), Remove power, replace A3, and retest.

If TEST 7, CPU clock locked test, Remove power, replace A3, and retest.

If TEST 8, DDFS register test, Remove power, replace A4, and retest.

If TEST 9, 87 MHz PLL test (<num.> kHz, <num.> V), Go to, A5 87 MHz PLL tree  
(3.2.1.0).

If TEST 10, 9.2 GHz PLL test (<num.> V), Go to, Rf-chain tree (2.3.1.0).

If TEST 11, Servo register test, Remove power, replace A6, and retest.

If TEST 12, Servo converter timeout test, Remove power, replace A6, and retest.

If TEST 15, Pps register test, Remove power, replace A8, and retest.

If TEST 16, Pps interrupt test, Go to, 1.2.2.

If TEST 17, Power logic signals test, Remove power, replace A11, and retest.

\*Failure of test 14 may occur with any combination of tests 2, 3,4,5,9, and 10.

### 1.2.2 Pps Interrupt-Error Test

- 1 Install the short-extender board (part number 05071-60051) into the spare slot on the A1 motherboard.
- 2 Use an oscilloscope with trigger level set to +1.5 volts (no auto trigger) and high-impedance probe to check presence of 20  $\mu$ s pulses with an amplitude greater than 4 V at a rate of 1 pulse per second on XOPTJ1 pin 44.

QUESTION: Is the waveform correct?

If Yes: Remove power, replace A3, and retest.

(If the problem persists: remove power, replace A1, and retest; or contact your nearest Agilent Sales office for further assistance.)

If No: Remove power, replace A8, and retest.

### Warmup And Fatal Error Diagnostic Tree (Subsection 3)

This subsection describes the warmup- and fatal-error diagnostic tree.

#### 1.3.1 Warm-Up/Operating Error

- 1 Examine the log (LOG/BROWSE).

QUESTION: Is the last item in the log an error code that appears similar to this: Error code: 000000a0 20000000?

If Yes: The instrument has failed after warming up: Go to, 1.3.1.1.

If No: The instrument has failed to complete warm up: Go to, 1.3.2.

#### 1.3.1.1 Operating Error-Code Interpretation

- 1 Convert the two 8-character hexadecimal words in the error code into its two corresponding 32-bit binary words using the chart below.
- 2 Divide the right-most binary word into 16 fields each containing two adjacent bits.
- 3 Divide the 14 right-most bits of the second binary word into seven fields each containing two adjacent bits.
- 4 Each of the 23 two-bit fields corresponds to the output of an internal test at the moment the instrument entered Fatal-Error mode.

A non-zero number in any one of the fields indicates a potential cause of the shut-down as shown on the following page.

Hexa- decimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Binary	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111



## Top-Level Diagnostic Tree (Diagnostic Section 1)

QUESTION: What combination of errors are indicated by the code?  
(Assembly/module trees are listed in diagnostic-tree section 3.)

If FATAL ERROR #2, Go to, 1.3.4.  
If ONLY FATAL ERROR #9, Go to, 3.1.3.1.0, A2 Mass-spectrometer tree.  
If ONLY FATAL ERROR #11, Go to, 3.1.4.1.0, A2 Cesium-oven tree.  
If ONLY FATAL ERROR #10, Go to, 3.1.1.1.0, A2 Hot-wire ionizer tree.  
If ONLY FATAL ERROR #12, Go to, 1.3.5, Cs oven timeout test.  
If ONLY FATAL ERROR #4, Go to, 3.9.1.1, A19 Reference-oscillator tree.  
If FATAL ERROR #5, Go to, 2.4.3.0, C-field tree.  
If FATAL ERROR #19 or #22, Go to, 1.3.3.

---

**NOTE**

A non-zero total in the first field of the right-most word indicates that the 5071A was being steered at the time of shutdown: it has no diagnostic significance.

Additional diagnostic information may be obtained from any warnings or messages indicated by data in the error codes. See 1.4.1 and 1.7.1 for more details.

---

### 1.3.2 Warm-Up Error Interpretation

- 1 Locate the most recent error (should be at the end of the log).
- 2 Record this error.

QUESTION: What is the error?  
(All assembly/module trees are in diagnostic tree section 3.)  
(RF-chain and C-field trees are in diagnostic tree section 2.)

If ERROR = Cs oven failed: ion pump overcurrent, Go to, 1.3.2.1.  
If ERROR = Cs oven timeout, Go to, 1.3.5.  
If ERROR = Osc. oven timeout, Go to, 3.9.1.1, A19 diagnostic tree.  
If ERROR = Low Cs signal <#> with max Emult, Go to, 1.3.6.  
If ERROR = High Cs signal <#> with min Emult, Go to, 1.3.6.  
If ERROR = Cannot set E-mult to avoid saturation, Go to, 1.3.6.  
If ERROR = Signal saturated at min E-mult voltage, Go to, 1.3.6.  
If ERROR = Beam min/max values not 5% apart, Go to, 1.3.7.  
If ERROR = Failed attempts to set Osc. control, Go to, 1.3.7.  
If ERROR = Osc. control range error, Go to, 1.3.7.  
If ERROR = CBT signal loss Go to, 1.3.7.  
If ERROR = Line center not found, Go to, 1.3.7.  
If ERROR = VCXO at tuning limit, Go to, 1.3.7.  
If ERROR = RF Amplitude range error, Go to, 2.3.1.0.  
If ERROR = RF amplitude at range limit, Go to, 2.3.1.0.  
If ERROR = E-mult voltage has changed, Go to, 3.7.1.0.  
If ERROR = Failed attempts to set C-field, Go to, 1.3.7.

### 1.3.2.1 Cs Oven Failed: Ion Pump Overcurrent Warm-up Error

This error occurs when current drawn by the CBT Ion Pump fails to go below 40  $\mu$ A within 45 minutes after operation begins. It can be caused by either excessive current drawn by the CBT as a result of a high internal gas pressure, or by a failure in the Ion pump high-voltage supply (P/O A16), or the current-monitoring circuit (P/O A2). The following procedures check these alternatives:

- 1 Observe the measured Ion-Pump supply current on the LCD display (Use the INFO/Pump menu selection.).

QUESTION: Is the current more than 40  $\mu$ A?

If Yes: Go to, 1.3.2.2.

If No: The problem may have cleared itself, remove ac power, and retest.

### 1.3.2.2 A16/CBT Excess Ion-Pump Current Test

- 1 Remove ac power and wait at least 60 seconds for the high voltage supplies to bleed down.
- 2 Disconnect the Ion Pump high-voltage (HV) connector from the CBT (see Figure 2.1). (Ensure that the end of the high-voltage lead is clear of any conductors.)
- 3 Disconnect the flexible cable joining the CBT to A2J2.
- 4 Power up the instrument and allow a few seconds for it to enter the Fatal-Error mode.
- 5 Observe the measured Ion Pump supply current on the LCD display (Use the INFO/Pump menu selection.).
- 6 Remove power, wait 1 minute, and reconnect the Ion-pump HV lead.

QUESTION: Was the current more than 1 microamp?

If Yes: A fault is present in the Ion Pump power supply circuitry, Go to, 3.7.1.0, A16 diagnostic tree (This tree also checks part of A2.).

If No: CBT Ion-Pump current is high. When caused by poor vacuum (for example, due to prolonged storage) the condition may correct itself if the unit is placed into STANDBY mode for 24 hours. If the condition persists after this time, remove power and contact your nearest Agilent Sales office for assistance.

### **1.3.3 CBT-Signal Fatal Errors**

These errors occur when the instrument completes its lock-up procedure, and the frequency servo loop cannot operate correctly. They usually indicate the CBT output signal is unstable. This can be due to a malfunction in the CBT itself, or more frequently, in the circuits associated with it. The following procedure tests these alternatives.

- 1 Perform the Analog-Signal Chain tests (2.2.1.0) and repair as required.
- 2 Perform the RF-Chain tests (2.3.1.0) and repair as required.
- 3 Perform the A16 Electron-Multiplier Supply tests (3.7.2.1) and repair as required.
- 4 Perform the RF-Level Control-Current Check, (1.3.8), and repair as required.
- 5 Apply power to the instrument: observe the warm up and subsequent operation.

QUESTION: Did the instrument fail in the same manner?

If Yes: The CBT is possibly defective, contact your nearest Agilent Sales office for further assistance.

If No: Problem may be resolved - retest.

### **1.3.4 CBT Shutdown Message**

- 1 Read the CBT shutdown message preceding the error code.

QUESTION: What is the message?

If CBT shutdown: thermistor open, Go to, A2 thermistor  
(3.1.2.1.0) diagnostic tree.

If CBT shutdown: thermistor shorted, Go to, A2 thermistor  
(3.1.2.1.0) diagnostic tree.

If CBT shutdown: ion pump overcurrent, Go to, Excess Ion-  
pump current (1.3.2.1) test.

## Top-Level Diagnostic Tree (Diagnostic Section 1)

### 1.3.5 Cs Oven-Timeout Test

This error occurs because the indicated cesium oven temperature has not reached the correct value within 45 minutes from power on or an error has subsequently occurred. This may be due to a failure of the cesium-oven heater or thermistor, or the associated circuits on A2.

- 1 Perform the A2 Thermistor and Cesium Oven diagnostic test procedures in diagnostic section 3 (3.1.2.1.0 and 3.1.4.1.0) of this chapter.
- 2 Replace A2 and/or A7 as indicated.
- 3 Reapply power to the instrument and observe the warm up behavior.

QUESTION: Did the instrument fail in the same manner?

If Yes: The CBT may be defective, contact your nearest Agilent Sales office for assistance.

If No: Continue diagnostic testing.

### 1.3.6 CBT Background-Signal Warm-Up Errors

These errors occur when the CBT background signal is not within acceptable limits after warm up. This condition can be caused by a malfunction in the CBT itself or by various circuits that control it. This procedure checks these alternatives.

---

**NOTE**

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The instrument self-tests **must** pass successfully for the following procedure to be conclusive.

- 1 Perform the Electron-Multiplier Supply tests with procedure 3.7.2.1. Replace A16 if necessary, and re-connect all leads.
- 2 Perform the Analog-Signal Chain tests 2.2.1.0. Repair as necessary, and re-connect all cables and assemblies.
- 3 Retest the instrument by cycling ac power.

QUESTION: Does the instrument fail to lock-up, then display one of the same errors?

If Yes: A CBT fault is indicated, contact your nearest Agilent Sales office for further assistance.

If No: Continue the diagnostic procedures.

### **1.3.7 CBT Depth-of-Modulation Warm-Up Errors**

These errors usually indicate that modulation of CBT output signal that results from tuning the microwave-probe signal through cesium resonance, does not fall within minimal limits for correct operation. The errors can be caused by incorrect operation of the microwave multiplication process (RF chain), mis-tuning of the A19 VCXO (voltage-controlled crystal oscillator), failure of the A7 C-field control circuits or rarely, failure of the CBT. The following procedure checks these alternatives:

- 1 Test the RF chain by performing procedures 2.3.1.0. through 2.3.6.0.
- 2 Test the C-field circuits by performing procedures 2.4.1.0. through 2.4.3.0.

QUESTION: Did all diagnostic tests pass?

If Yes: The microwave signal is adequate for satisfactory warm-up completion, Go to, 1.3.7.1.

If No: Repair as required and retest.

#### **1.3.7.1 CBT Support-Circuit Tests**

- 1 Perform the A19 VCXO tests 3.9.1.1 through 3.9.1.8).
- 2 Check the RF-level control current as described at 1.3.8.
- 3 When all tests complete satisfactorily, cycle power to the instrument.

QUESTION: Did warm-up fail with the same error message?

If Yes: CBT is probably defective, contact your nearest Agilent Sales office for further assistance.

If No: Continue the diagnostic procedure.

### 1.3.8 RF-Level Control-Current Test

The amplitude of the microwave probe signal is controlled by an amplitude modulator in A15 driven with current generated from a DAC on A7. If control current is absent, amplitude modulation is lost.

- 1 Remove power and disconnect the cable from A1J19 to A15J1.
- 2 Using a suitable SMA adapter, connect the DMM to the cable from A1J19 and set the DMM to measure at least 16 mA dc.
- 3 Disconnect the CBT from A2 at A2J2. Cycle instrument power and wait for it to enter the Fatal Error mode.
- 4 Observe and record the current measured at A1J19.
- 5 Remove power and reconnect the CBT cable to A2J2.
- 6 Reapply power to the instrument and verify that LCD displays Warming up.
- 7 Quickly observe and record the average current at A1J19.
- 8 Remove power and reconnect the cable to A1J19.

QUESTION: Was the Fatal Error current  $15.8 \pm 0.3$  mA, and the Warming up current  $1.58 \pm 0.03$  mA?

If Yes: The control current circuit is operational.

If No: Remove power, replace A7, and retest.

**Warning Message Diagnostic Tree  
(Subsection 4)**

This subsection describes the warning-message diagnostic tree.

**1.4.1 Warning Message Interpretation**

- 1 Examine the log for any of the following entries (LOG/BROWSE menu selections) (Assembly/Module trees are located in diagnostic tree section 3.)

QUESTION: What is the warning message?

If WARNING is: VCXO near tuning limit, Go to, 3.9.1.1.

If WARNING is: Signal gain at range limit, Go to, 1.4.2.

If WARNING is: Internal DC supply out of range, Remove power, replace A7, and retest.

If WARNING is: Microprocessor PLL unlocked, Remove power, replace A3, and retest.

If WARNING is: CBT signal low, Go to, 1.4.3.

If WARNING is: Power source is Batt, Go to, 1.4.4.

If WARNING is: RF amplitude at range limit, Go to, 1.3.7.

(Warning 21 relates to factory testing and will typically not occur during actual use.)

**1.4.2 Signal Gain at Range Limit/CBT Signal Low**

- 1 Perform A16 Electron-multiplier tests (3.7.2.1).
- 2 Perform analog-signal-chain tests (2.2.1.0).
- 3 Replace assemblies/modules as indicated.

QUESTION: Did all tests/evaluation pass?

If Yes: Ignore Warning, a transient error may have occurred:  
Go to 1.4.3.

If No: Remove power, repair as indicated, and retest:  
Go to 1.4.3.

**Top-Level Diagnostic Tree (Diagnostic Section 1)**

**1.4.3 5071A Profiling (CBT Performance Evaluation)**

The errors observed suggest deteriorating CBT performance.

- 1 Use the 5071A Profiling software as described at 1.6.0 to evaluate CBT performance.

**QUESTION:** Did the CBT pass the profiling performance evaluation.

If Yes: CBT is operational.

If No: Remove instrument power, replace A17, and retest.

If the error persists contact your nearest Agilent Sales office for further assistance.

**1.4.4 Power Source is Batt**

If ac power is applied and this message appears, you must determine whether the instrument is operating from the ac line or from the battery.

- 1 Disconnect both batteries from the 5071A by:
  - a. opening the rear battery compartment door, then
  - b. disconnect the two connectors to the batteries.

**QUESTION:** Does the instrument continue to operate or has all power been lost?

If still operating, Go to, 1.4.4.1.

If power has been lost, Go to, 1.4.4.2.

**Top-Level Diagnostic Tree (Diagnostic Section 1)**

**1.4.4.1 AC-Line Operation - Battery Indicator On**

(Fault is most likely in A11 power-steering-logic assembly).

- 1 Disconnect A11P102 from A11.
- 2 Verify that power-source indicator returns to normal with no indication of battery operation.

QUESTION: Do the indicators return to normal (no indication of battery operation)?

If Yes: A11 assembly is at fault, remove power, replace A11, and retest.

If No: Fault is in one or more of the following: swap-out in this order and retest.

- a. cable assembly (05071-60257),
- b. A1 motherboard (circuit traces or connectors), or
- c. A3 assembly.

**1.4.4.2 Instrument AC Power Absent**

- 1 Reconnect the internal standby batteries and reapply ac power.
- 2 Measure the dc voltage between TP5 on A11 and a common test point (not chassis ground), such as TP6,9, or 12 on A11.
- 3 Verify that the voltage is between 32 and 38 Vdc and record results.

QUESTION: Is the voltage 32 - 38 Vdc?

If Yes: Remove power, replace A11 (probable CR14 fault), and retest.

If No: Go to, 1.4.4.2.1

**1.4.4.2.1 A1C4 Voltage Test Procedure**

- 1 Measure the dc voltage across A1C4 (large-can filter capacitor).

QUESTION: Is the voltage between 32 and 38 Vdc?

If Yes: Remove power, replace faulty 05071-60253 cable, and retest.

If No: Go to, 1.4.4.3.

**1.4.4.3 LF1/T1 Transformer Fault Verification**

- 1 Measure the 60 Hz ac voltage between CR3 pins 2 and 3 on the A1 (motherboard) assembly.
- 2 Verify presence of 25-35 Vrms.

QUESTION: Is the voltage between 25-35 Vrms?

If Yes: Remove power, replace A1, (or A1CR3), and retest.

If No: The LF1 line filter/cable assembly (05071-60259) or toroidal power transformer T1 (9100-4962), may be each or both at fault. Ensure that F1 line fuse is not open, then replace LF1/T1 and retest.

**I/O Diagnostic Tree  
(Subsection 5)**

This subsection describes the Input/Output (I/O) diagnostic tree.

**1.5.1 Input/Output Faults**

- 1 Use the following list to find a fault-isolation procedure associated with the observed I/O problem. (Assembly/Module diagnostic trees are located in diagnostic tree section 3.)

**QUESTION:** Which I/O was found at fault?

If 5/10 MHz: Go to, 3.5.1.0 (A10 diagnostic tree).

If 1 MHz: Go to, 3.5.1.0 (A10 diagnostic tree).

If 100 kHz: Go to, 3.5.1.0 (A10 diagnostic tree)

If 1 PPS: Go to, 3.3.0 (A8 diagnostic tree).

If 1 PPS Sync: Go to, 3.3.0 (A8 diagnostic tree).

If RS-232: Confirm fault, (check datacomm config., internal cables) remove power, replace A3, and retest.

If Status Output: Confirm fault, (check internal cables), replace A7, and retest.

## CBT Performance Evaluation (Subsection 6)

This subsection describes how to use the 5071A Profiling software.

### 1.6.0 Running the 5071A Profiling Software

You can evaluate suspect CBT performance with the 5071A Profiling program running on a PC compatible computer (DOS® 3.3 or higher) that has at least one RS-232 serial port. Use the instructions below to run this software (the disk is located at back of this manual):

- 1 Set up serial data communications link hardware between the 5071A and the computer.  
(Refer to chapter 4 of the 5071A Operating and Programming manual to connect the 5071A to the computer's COM1 or COM2 serial port.)
- 2 Ensure that the 5071A's Baud rate is set to 2400 or greater.
- 3 Insert the disc containing the 5071A Instrument Profiling program into the computer.
- 4 Copy the program file CK5071A.EXE to a suitable directory.
- 5 Switch to that directory and run the program by typing CK5071A at the DOS prompt. The program will prompt you to enter the number of the COM port in use (1 or 2) and the Baud rate in use.
- 6 Enter these values into the computer.  
Soft-key labels will appear at the bottom of the display when the program establishes communication with the 5071A operating system.
- 7 Press Terminal emulator to start a terminal emulator program that can be used for SCPI instructions. (Exit with Alt Q.)
- 8 Verify the serial link by pressing Return and observe the SCPI prompt on the computers' display as follows: `scpi >`

*Allow the instrument to stabilize for about 30 minutes before running the Profile program.*

- 9 Press 5071A Profile to start the instrument profiling program.

The program takes about 10 minutes to evaluate the internal operating conditions of the instrument.

## Top-Level Diagnostic Tree (Diagnostic Section 1)

While the program runs, data appears on the screen and a text file is created. When the measurements are complete, leave the program by pressing the appropriate soft-key.

---

**NOTE**

If the 5071A should return a prompt other than "scpi >" or "E-xxx>", it will not be possible to monitor and control the instrument with SCPI commands as documented in the manual.

This could occur in a terminal emulator after using the Profiling Software if the program was not exited properly, or suffered a system crash during execution.

1 If the prompt is "p4th A>>" (note the double ">>" in this prompt) type h and press the Enter or Return key.

This should result in an error message and bring up a second prompt "p4th A>". Proceed to step 2 below.

2 If the prompt is "p4thA >" type (all lower case) halt and press the Enter or Return key.

This should return you to the SCPI system with either the "scpi >" or "E-xxx>" prompt.

---

The output file is in the current directory with the name PROFILE.TXT. The file can be viewed using the usual DOS utilities, or printed.

### 1.6.1 5071A Profiling Results Evaluation

An 5071A Profiling report example appears on the next page. You can use the example along with the explanations below to interpret your instrument's profiling results.

#### VCXO Control

##### Value

The present A19 VCXO adjustment state is shown by the vcxo Control value. This value normally changes with time as a result of aging in A19. There is no resulting loss of performance.

If the value is outside the -90% to +90% range, then the A19 VCXO Set-Point Adjustment (3.9.1.7 and 3.9.1.8) should be performed as soon as is convenient.

The instrument will experience a Fatal Error if the value reaches  $\pm 100\%$ .

## Top-Level Diagnostic Tree (Diagnostic Section 1)

### **Depth of Modulation**

The Depth of Modulation can help isolate faults to either the CBT or the instrument electronics.

A “Band 3” modulation depth combined with a peak-output current below 100 nA indicates deteriorating CBT performance. Be sure to thoroughly diagnose the entire instrument before considering the A17 CBT to be at fault. Contact your nearest Agilent service facility for further assistance.

### **Signal to Noise Ratio**

The Signal to Noise Ratio is an estimate of the current overall operating condition of both the CBT and instrument electronics.

- If the result is Band 1, the instrument’s stability should meet specification. CBT problem is unlikely.
- If the result is Band 2, the test is indeterminate. High probability that CBT is performing to specifications.
- If the result is Band 3, instrument stability will probably not meet specification. CBT problem is likely. Consult Chapter 1 on Performance Tests to confirm poor performance.

Service

Top-Level Diagnostic Tree (Diagnostic Section 1)

=====  
Output file from program CK5071A (rev. A.00.01)  
=====

DOS System time: 1994-01-25 16:25:07

5071A Status:  
=====

Instrument time: 1994-01-25 16:25:07 (49377)  
CBT Serial number: 3112A00102 (H)  
Tube Type: 10891A  
Instrument Status summary: Operating normally, Steered  
Power source: ac  
Log status: 101 entries  
Last Message in Log: "Lock completed"  
Fractional frequency offset: 314e-15  
VCXO control value: -13.72 %  
Internal temperature: 42.6 C

Cesium Beam Tube measured data:  
=====

Ion Pump current: 0.2 uA  
Peak output current: 101 nA  
Electron multiplier voltage: 1234 V  
Depth of Modulation: Band 1 (see note)  
Signal to noise ratio: Band 1 (see note)

Note: Result may be "Band 1", "Band 2", or "Band 3".

## Advisory Messages (Subsection 7)

Advisory Messages are found in the log. If they are associated with fatal errors or warnings, they may be useful in fault isolation.

### 1.7.1 Advisory Message Interpretation

Message: E-multiplier at voltage range limit. This message may occur with CBT aging. The condition does not by itself imply any loss of performance.

No action required.

Message: 87 MHz PLL unlocked. This message indicates an RF-chain problem leading to an erroneous voltage level in the A5 module. This message may be associated with a fatal error.

Go to, 1.3.7.

Message: Go to, 1.3.7.

Message: DRO unlocked. This message indicates an RF-chain problem leading to an erroneous voltage level in the A15 module. This message may be associated with a fatal error.

Go to, 1.3.7.

Message: VCXO Oven error. This message indicates a problem with the A19 module or its monitoring circuit. A malfunction in the A19 module will usually cause degraded performance or a fatal error.

Go to, 3.9.1.1.

Message: Center peak saturated. This message indicates that the amplified CBT output signal is unstable. If the condition persists, a CBT signal loss fatal error may result.

Check the analog signal chain (2.2.1.0), and the Electron Multiplier supply (3.7.2.1).

If no problems are found with A6, A14, or A16 with the above procedures, the CBT may be faulty. Contact your nearest Agilent field service center for further assistance.

## Functional-Group-Diagnostic Trees (Diagnostic Section 2)

This section provides functional-group-level diagnostic trees for the 5071A Primary Frequency Standard.

Functional-group diagnostic trees necessarily evaluate two or more assemblies/modules when such operation is interactive. The cumulative operation of the constituent parts is analyzed as a whole.

When possible, an assembly or module is isolated to fault-status within the functional-group diagnostic tree. At other times, the functional-group tree points to individual assembly/module diagnostic trees located in section 3.

The names of the functional-groups are listed below in order with the assemblies and modules that comprise them:

### **1 Power-supply diagnostic tree: 2.1.1.0**

- A1 motherboard assembly
- A11 Power steering logic assembly
- A12 Dc-to-Dc Converter module
- LF1 Line filter module/cable assembly
- T1 Toroidal power transformer
- B1 24V Internal-Standby Battery

### **2 Analog-signal chain diagnostic tree: 2.2.1.0**

- A6 Servo assembly
- A14 Signal amplifier module

### **3 RF-chain diagnostic tree: 2.3.1.0**

- A4 Digital Synthesizer assembly
- A5 87 MHz PLL module
- A9 Frequency multiplier module
- A10 Output frequency distribution amplifier module
- A15 9.2 GHz microwave module
- A18 9.2 GHz PLL module
- A19 Reference oscillator module

### **4 C-field diagnostic tree: 2.4.1.0**

- A7 Interface assembly
- A17 Cesium-beam tube assembly

**Power-Supply Diagnostic Tree  
(Functional Group Subsection 1)**

This subsection describes the Power-supply diagnostic tree and provides information for fault isolation to:

- A1 Motherboard,
- T1 Toroidal power transformer,
- A11 Steering-logic assembly,
- A12 Dc-to-Dc Converter module,
- LF1 Line filter module/cable assembly, and
- B1 24V Internal-Standby Battery.

**2.1.1.1.0 AC Line-Fuse Test**

QUESTION: Does the ac-line fuse blow at power-up?

If Yes: Go to 2.1.1.2.0.

If No: Go to 2.1.1.1.1.

**2.1.1.1.1 A12 Power Input Test**

- 1 Remove the instrument top/bottom covers and inner shield.
- 2 Apply ac power to the instrument.
- 3 Use a DMM to measure the input voltage ( $V_{in}$ ) at the A12 module (across the  $V_{in}$  and  $V_{in}$  return power input lugs on the module)
- 4 Verify that the voltage present is between 32 and 38 Vdc with no more than 1 Vrms ripple.

QUESTION: Does the measured voltage meet specifications?

If Yes: Go to, 2.1.3.0.0.

If No: a) Measure the dc voltage across capacitor C4 (large can attached to A1 with screws)

b) Verify that the voltage present is between 32 and 38 Vdc with no more than 1 Vrms ripple.

QUESTION: Does the measured voltage meet specifications?

If Yes: Go to, 2.1.1.1.2.

If No: Go to, 2.1.1.1.4

**2.1.1.1.2 A11/A11 Cable Test**

- 1 Use a DMM to measure the voltage from A11TP5 to A11TPs 6, 9, or 12.
- 2 Verify that the voltage is between 32 and 38 Vdc with no more than 1 Vrms ripple.

QUESTION: Does the measured voltage meet specifications?

If Yes: Go to, 2.1.1.1.3.

If No: The fault is at either A11 or assembly 05071-60253 or both. Remove power, replace A11, assembly 05071-60253 or both, and retest.

**2.1.1.1.3 A11/A11-A1 Cables Test**

The fault here is probably within A11 (CR14), or the A11-to-A1 cable (05071-60253), or the A12 module cable.

- 1 Use a DMM to measure the voltage across A1C3.
- 2 Verify that the voltage present is between 32 and 38 Vdc with no more than 1 Vrms ripple.

QUESTION: Does the measured voltage meet specifications?

If Yes: Remove power, replace A12, and retest.

If No: Remove power, replace A11 or cable 05071-60253, or both and retest.

**2.1.1.1.4 A1CR3 Bridge Rectifier Test**

- 1 Use a DMM to measure the ac voltage across the ac input at A1CR3.
- 2 Verify that the voltage is at least 25 Vrms.

QUESTION: Does the measured voltage meet specifications?

If Yes: Remove power, replace CR3 (or A1), and retest.

If No: Remove power, ensure that F1 line fuse is not open then, replace T1 or LF1, or both, and retest.

**2.1.1.2.0 AC-Line Fuse Fault Isolation, Rule Out A11**

- 1 Ensure that proper line fuse and line-switch setting (for the available ac-input voltage) are used. (See operating manual for details.)
- 2 Replace ac-line fuse.
- 3 Disconnect A11P101 to isolate the problem.
- 4 Apply ac-line voltage again.
- 5 Check the ac-line fuse immediately for possible open condition.

QUESTION: Did the line fuse blow?

If Yes: Go to 2.1.1.2.1.

If No: Go to 2.1.2.4.0.

**2.1.1.2.1 AC-Line Fuse Fault Isolation: Rule Out A1**

- 1 Replace ac-line fuse.
- 2 Disconnect the ac-line toroidal transformer connector going to A1J5.
- 3 Apply ac-line voltage again.
- 4 Check the ac-line fuse immediately for possible open condition.

QUESTION: Did the line fuse blow?

If Yes: Go to, 2.1.2.2.0.

If No: Go to, 2.1.2.3.0.

**2.1.2.2.0 AC-Line Fuse Fault Isolation: Rule Out LF1/T1**

Fault is between the ac-line connector on the back panel, the ac-line toroidal transformer, or the cable connecting the two.

- 1 Disconnect LF1 (line filter/cable assembly 05071-60259) at the bulkhead by the toroidal power transformer T1.
- 2 Replace the line fuse.
- 3 Re-apply power to the unit.
- 4 Check the ac-line fuse immediately for possible open condition.

QUESTION: Did the fuse blow?

If Yes: Remove power, replace LF1 (05071-60259), and retest.

If No: Remove power, replace T1 (9100-4962), and retest.

**2.1.2.3.0 A1 Fault**

- 1 Remove power, ensure interconnecting cables are not shorted, then either troubleshoot or replace A1, and retest.

The problem is on the motherboard (A1), in one or more of the following:

- CR3 full-wave bridge rectifier circuit,
- C4 and R4 filter capacitor and bleeder resistor , or
- Over voltage protection circuitry (around CR1).

You may elect to use the A1 Theory of Operation information in chapter 3 to effect component-level repair

**2.1.2.4.0 AC-Line Fuse Fault Isolation: A11/A12 Inputs**

If the ac-line fuse doesn't blow after disconnecting A11P101, then the fault can be further isolated:

- 1 Reconnect all connectors. (Install a new fuse if necessary.)
- 2 Disconnect A1P2 from A1J2 on A1 motherboard. (This breaks the circuit at the dc-dc power converter module, A12.)
- 3 Apply ac-line voltage again.
- 4 Check the ac-line fuse immediately for possible open condition.

QUESTION: Did the ac-line fuse blow?

If Yes: Go to, 2.1.2.5.0.

If No: Go to, 2.1.3.0.0 (Fault is in the A12 power supply module or the circuits loading the supply.

**2.1.2.5.0 A11P101 Connection Test**

- 1 Disconnect A11P101.
- 2 Check for a short circuit between pins 1 or 4 (positive side) and pin 2 (gnd) of the cable using an ohmmeter or equivalent.
- 3 Verify that the pins are not shorted: flex the cable several times to ensure there are no intermittent connections

QUESTION: Is the cable faulty?

If Yes: Replace A11P101 cable, and retest: go to 2.1.1.1.0.

If No: Remove power, replace A11, and retest.

**2.1.3.0.0 A12 Module Test**

- 1 Power on the instrument.
- 2 Use a DMM to measure the A12 output voltages at the module solder-lug connections.
- 3 Verify that they are within the ranges shown below:
  - +5V supply: at least +5.28 Vdc
  - +12V supply: at least +12.08 Vdc
  - 12V supply: at least -12.08 Vdc

QUESTION: Are all voltages approximately zero?

If Yes: Remove power, replace A12, and retest.

---

**NOTE**

A situation could occur during troubleshooting to cause similar symptoms. If, for example, one of the output voltages were accidentally shorted to another power supply output voltage, the protection circuits within the A12 module will shut down all the output voltages. In order to recover from this protection mode, the ac power must be removed from the instrument for at least 30 seconds. Then reapply ac power and all output voltages should return to normal. If they do not, replace A12 and retest.

If No: One or two are less than specified, Go to, 2.1.3.1.0.

**2.1.3.1.0 Rule Out A1 or Module Fault**

- 1 Remove all power from the instrument.
- 2 Measure the resistance (to the chassis) of each supply voltage on the A1 motherboard.
- 3 Verify that they conform to the following ranges:
  - +5V resistance: > 2.0  $\Omega$
  - +12V resistance: > 10.0  $\Omega$
  - 12V resistance: > 10.0  $\Omega$

QUESTION: Do the resistances meet or exceed the values shown above?

If Yes: Remove power, replace A12, and retest.

If No: Go to, 2.1.3.2.0.

**2.1.3.2.0 Rule Out Shorted Assemblies/Modules**

- 1 Remove each printed circuit board assembly from A1 in a stepwise manner and observe whether the resistance value for the faulty supply voltage returns to normal.
- 2 Disconnect all module connectors to A1 in a stepwise manner and observe whether the resistance value for the faulty supply voltage returns to normal.
- 3 Verify the Assembly/Module that causes the faulty supply voltage resistance to return to normal.

QUESTION: Which assembly/module appears at fault?

If a specific assembly/module is isolated, replace, and retest.

If, after removing all loads from the motherboard, the resistance is still below specification, replace A1, and retest.

**2.1.4.0.0 Ext. DC Input Fuse Fault**

The Ext. DC Input fuse blows when powering-on or running the 5071A. The assumption here is that ONLY the dc fuse blows, with the instrument operating normally from the ac line or internal standby battery.

- 1 Remove all power and disconnect A11P101.
- 2 Replace the blown fuse.
- 3 Reapply dc instrument power.
- 4 Check the dc fuse immediately for possible open condition.

QUESTION: Did the fuse blow?

If Yes: The problem is either on A1 or in the wiring of the Ext. DC connector which can be visually inspected for faults, or in cable assembly 05071-60253

If No: Remove power, replace A11, and retest.

**2.1.5.0.0 No Operation From Internal Standby Battery**

QUESTION: Does the 5071A operate at all from the internal battery?

If Yes: Go to, 2.1.5.1.0.

If No: Go to, 2.1.5.2.0.

### 2.1.5.1.0 Internal-Battery Charger Test

If the 5071A operates for less time than specified, the fault is either the battery or that it is not being charged properly. Verify charger operation as follows:

- 1 Apply ac power and observe the instrument complete warm-up.
- 2 Remove ac power and do not disconnect or turn-off internal-standby batteries.
- 3 Allow the instrument to run on the internal-standby batteries for at least one minute.
- 4 Reapply ac power to the instrument. (This causes the boost-charge mode entry: the current to the batteries should be between 140 mA and 180 mA., if the charger is operating correctly.
- 5 Verify that the boost-charge current is between 140 and 180 mA using a clip-on ammeter at any battery lead.

QUESTION: Is the boost-charge current within specification?

If No: Remove power, replace A11, and retest charging current.

If Yes: Replace both battery packs and retest operating time.

### 2.1.5.2.0 A11 F1 Fuse Fault

If the instrument will not operate from the internal batteries at all, the fault could be fuse F1 on the A11 board. Fuse F1 is in series with the batteries to protect them from catastrophic discharge if a short circuit occurs.

- 1 Ensure that both batteries are connected in the normal configuration and all external instrument power is removed,
- 2 Measure the voltage at TP1 on A11 with respect to a common point (not chassis ground) such as TP's 6,9, and 12.
- 3 Verify a battery voltage of approximately 24 volts.

QUESTION: Is 24 volts present?

If Yes: The battery packs may be at fault or are not being properly charged. Go to, 2.1.5.1.0.

If No: Disconnect the two internal-standby battery connections and replace F1 on A11 (or A11 entirely). Reconnect the internal-standby battery connections and retest. If only F1 is replaced and it blows again at retest, replace A11 entirely, then retest.

**Analog-Signal Chain Diagnostic Tree  
(Functional-Group Subsection 2)**

This subsection describes the analog-signal chain diagnostic tree. The tree provides information to check both A14 Signal-Amplifier module and A6 Servo assembly.

**2.2.1.0 A6 TP 5 and 6 Voltage Test 1**

- 1 Remove instrument power.
- 2 Mount A6 on the short extender board (05071-60051).
- 3 Disconnect the CBT wiring harness from A2J2.
- 4 Connect the output of the resistive current source (05071-60274) to the input connector of A14, instead of the cable from the CBT. (Do not connect the ET-current-source input lead at this time.)
- 5 Ensure that the power and signal cable from A14 is seated in A6J3.
- 6 Reapply power and wait until the LCD displays Fatal Error.
- 7 Verify that the gain value displayed via the INFO/GAIN menu selections is 14.4%.
- 8 Measure the following voltages:  
Gnd to A6-TP5; voltage should be between 10.3 and 11.3 volts.  
Gnd to A6-TP6; voltage should be between -11.3 and -10.3 volts.  
QUESTION: Are the voltages within the above specification?  
If Yes: Go to, 2.2.2.0.  
If No: Go to, 2.2.1.1.

**2.2.1.1 A6 TP 5 and 6 Voltage Test 2**

- 1 Disconnect the Signal Amplifier power/signal cable from A6J3.
- 2 Repeat the previous voltage measurements at A6-TP5 and A6-TP6 with the same voltage limits.  
QUESTION: Are the voltages within correct tolerances?  
If Yes: Remove power, replace A14, and retest.  
If No: Remove power, replace A6\*, and retest.

---

**\*NOTE**

Ensure that the jumper position of the new A6 is in the same position as the one being replaced.

---

**2.2.2.0 A6J7 Voltage Test**

- 1 Use the DMM or oscilloscope to measure the voltage at A6J7 and record the result.

QUESTION: Is the voltage between 0.00 and 0.05 volts?

If Yes: Go to, 2.2.3.0.

If No: Go to, 2.2.2.1.

**2.2.2.1 A6U10 10.2 and 10.3 Voltage-Difference Test**

- 1 Use the DMM or scope to measure the voltage difference between A6-U10.2 and A6-U10.3 with the test clip.

QUESTION: Is the voltage difference between -0.03 and 0.03 volts.

If Yes: Remove power, replace A6\*, and retest.

If No: Remove power, replace A14, and retest.

**2.2.3.0 VFC Output Test 1**

- 1 Use the oscilloscope and the universal counter to measure the amplitude and frequency of the logic signal at A6J2, pin 44 (This is the twelfth pin from the right on the row of pins furthest away from the PCA board surface.).

---

**NOTE**

Use the 10:1 high-impedance probe at the measurements, with the input impedance of the oscilloscope and counter set to 1 M $\Omega$ . Use dc coupling and set the trigger levels to 0.15 volts at the probe output.

The waveform should consist of TTL-level pulses with a frequency between zero and  $(100 + 3.2 \times 10^4 \times V)$  Hz, where V is the voltage measured at 2.2.2.0 above.

QUESTION: Is the TTL waveform and level within tolerance?

If Yes: Go to, 2.2.4.0.

If No: Remove power, replace A6\*, and retest.

**2.2.4.0 Reference Voltage Test 1**

- 1 Measure the voltage from A6, J4, pin 9 to ground with a DMM. (Refer to 3.9.1.1.4 for pin assignment.)

QUESTION: Is the voltage between -4.995 and -5.005?

If Yes: Go to, 2.2.5.0.

If No: Remove power, replace A6\*, and retest.

\*See note at 2.2.1.1.

**2.2.5.0 Analog-Signal Chain Transimpedance Test**

- 1 Connect the 100-nA current source input lead to A6, J4, pin 9 (closest to J5 and J6). (This applies a -100 nA input signal to A14.)
- 2 Measure the voltage at A6J7.

QUESTION: Is the voltage difference between +6.9 and +7.5?

If Yes: Go to, 2.2.6.0.

If No: Go to, 2.2.5.1.

**2.2.5.1 A6U10 10.2 and 10.3 Voltage Test**

- 1 Use the DMM to measure the voltage difference between A6-U10.2 and A6-U10.3 with the dip clip.

QUESTION: Is the voltage between +4.75 and +5.25?

If Yes: Remove power, replace A6\*, and retest.

If No: Remove power, replace A14, and retest.

**2.2.6.0 VFC Output Test 2**

- 1 Use the high-impedance probe, frequency counter, and oscilloscope to check frequency and amplitude of the logic signal at A6 U33-3.
- 2 Verify that the waveform is TTL-level pulse with a frequency between 219 and 231 kHz.

QUESTION: Does the waveform consist of TTL-level pulses between 219 and 231 kHz?

If Yes: A14 and the input section of A6 are operating correctly.  
Carefully re-connect the CBT output cable to the input of A14-J1 and resume testing.

If No: Remove power, replace A6\*, and retest.

\*See note at 2.2.1.1.

**RF-Chain Diagnostic Tree  
(Functional-Group Subsection 3)**

This subsection describes the RF-chain diagnostic tree for the 5071A Primary Frequency Standard and provides fault isolation of, or pointers to diagnostic trees for, constituent RF-chain assemblies or modules.

**2.3.1.0 RF-Chain Test Start Up**

- 1 Remove power by disconnecting external ac and dc power.
- 2 Ensure that the internal-standby battery packs are disconnected.
- 3 Wait at least one minute for A16 high voltage supply to bleed down.
- 4 Disconnect semi-rigid coax from cesium-beam tube.
- 5 Connect this free end to the spectrum analyzer with an SMA female-female barrel and the Microwave Test cable for use at 9 GHz.
- 6 Disconnect right-hand CBT cable (viewed from front) from A2J2.
- 7 Go to, 2.3.2.0.

**2.3.2.0 9192 MHz Signal-Spectrum Test**

- 1 Set input attenuator on HP/Agilent 8566 microwave spectrum analyzer for a maximum input level of +10 dBm (Must be done before #2).
- 2 Reconnect external ac (or dc) power.
- 3 Verify that instrument powers up and goes into Fatal Error mode.
- 4 Set spectrum analyzer for a center frequency of 9192.0 MHz and a span of 5 MHz/division.
- 5 Verify presence of a single carrier signal with amplitude at least -3 dBm. (Include the microwave test cable loss in your calculations.).

QUESTION: Is a single carrier signal present with an amplitude of at least -3 dBm?

If Yes: Go to, 2.3.3.0.

If No: Go to, 3.6.1.0 (A15 Diagnostic tree).

**2.3.3.0 A19 Output Amplitude and Frequency Test**

- 1 Program frequency counter to use internal timebase. (The frequency counter timebase must be calibrated to ensure an accuracy of  $1 \times 10^{-7}$  or better.)
- 2 Disconnect the semi-rigid cable from A9J5.
- 3 Use the adapter cable to connect it to the input of the oscilloscope with a  $50 \Omega$  terminator.
- 4 Verify that the amplitude of the signal, is greater than 1.0 Vp-p.
- 5 Disconnect semi-rigid cable from the oscilloscope.
- 6 Connect frequency counter input to A19 output, and measure frequency.
- 7 Reconnect A19 output to A9J5.

QUESTION: Is frequency 10 MHz,  $\pm 5$  Hz?

If Yes: Go to, 2.3.4.0.

If No: Go to, 3.9.1.1 (A19 diagnostic tree).

**2.3.4.0 A10 Port 1 and 2 Amplitude Test**

- 1 Program the rear-panel output ports for 10 MHz.
- 2 Use an oscilloscope to verify that both output provide a sine wave with an amplitude of at least  $\geq 2.8$  Vp-p into  $50 \Omega$ . Record results.

QUESTION: Are both port amplitudes  $\geq 2.8$  Vp-p?

If Yes: Go to, 2.3.5.0.

If No: Go to, 3.5.1.0 (A10 diagnostic tree).

**2.3.5.0 A10 Output Frequency Test**

- 1 Program frequency counter to use its internal timebase. (The frequency counter timebase must be calibrated to ensure an accuracy of  $1 \times 10^{-7}$  or better.)
- 2 Connect the rear-panel port 1 output to the frequency counter input.
- 3 Measure the frequency.

QUESTION: Is frequency 10 MHz,  $\pm 5$  Hz?

If Yes: Go to, 2.3.6.0.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**2.3.6.0 9192 MHz Frequency Test**

- 1 Disconnect the Microwave Test cable from the spectrum analyzer.
- 2 Connect to the input of a microwave-frequency counter.
- 3 Program the rear-panel output ports for 10 MHz.
- 4 Connect one output to the external reference input of the microwave frequency counter.
- 5 Program the microwave frequency counter to use a 10 MHz external reference instead of its internal timebase.
- 6 Measure the frequency of the microwave signal.

QUESTION: Is the indicated frequency 9192.631770 MHz  $\pm$ 2 Hz?

If Yes: RF chain is operational.

If No: Go to, 2.3.7.0.

**2.3.7.0 320 MHz Frequency and Amplitude Tolerance Test**

- 1 Disconnect A9P1 from A9J1.
- 2 Connect A9J1 to the 50  $\Omega$  input of an oscilloscope (Use a 50  $\Omega$  feedthrough at scope end of the cable if necessary.).
- 3 Verify presence of a sine-wave with at least 6.0 Vp-p amplitude.
- 4 Disconnect A9J1 from the oscilloscope.
- 5 Reprogram frequency counter to use 10 MHz external reference from 5071A output.
- 6 Use the frequency counter to verify presence of a 320 MHz  $\pm$ 0.1 Hz signal at A9J1.

QUESTION: Did the measured signal comply with the required characteristics?

If Yes: Go to, 2.3.8.0.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**2.3.8.0 87.36823 MHz Frequency and amplitude Test**

- 1 Measure amplitude and frequency at A5J101 with an oscilloscope.

QUESTION: Is frequency 87.368230 MHz  $\pm$ 0.1 Hz with an amplitude of at least 0.4 Vp-p?

If Yes: Go to, 3.8.1.0 (A18 diagnostic tree).

If No: Go to, 2.3.8.1.

**2.3.8.1 131.771 kHz. Frequency Test**

- 1 Disconnect coax from A5J2.
- 2 Connect a spectrum analyzer (HP/Agilent 8566) to the free end of the coax (not to A5J2).
- 3 Adjust the spectrum analyzer to a center frequency of 131.7 kHz and a 10 kHz span.
- 4 Verify the presence of a 131.770 kHz signal with amplitude of at least -13.5 dBm.
- 5 Reconnect coax to A5J2.

QUESTION: Did the signal meet the characteristics in step 5?

If Yes: Go to, 2.3.8.2.

If No: Go to, 3.5.3.0 (A4 diagnostic tree).

**2.3.8.2 80 MHz Frequency Test**

- 1 Disconnect coax from A5J1.
- 2 Connect frequency counter to the free end of the coax (not to A5J1).
- 3 Verify the frequency as 80 MHz  $\pm$ 0.1 Hz.
- 4 Use an oscilloscope to verify that the sine-wave voltage is at least 0.6 Vp-p.
- 5 Reconnect coax to A5J1.

QUESTION: Did the measured signal comply with the characteristics

in steps 3 and 4?

If Yes: Go to, 3.5.3.0 (A5 diagnostic tree).

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**C-Field Diagnostic Tree  
(Functional-Group Subsection 4)**

This subsection describes the C-field diagnostic tree for the 5071A Primary Frequency Standard. (Refer to the A2 connector pinout diagram ahead of procedure 3.1.1.1.0 for pin number and location.)

**2.4.1.0 C-Field Current Test**

- 1 Remove all power from the 5071A.
- 2 Remove the jumper on the right-hand side of A2J2 labeled CFC (C-Field Current jumper.).
- 3 Connect the Multimeter to the pins which were occupied by the jumper using small clip-leads.
- 4 Set the DMM to read dc current.
- 5 Reapply instrument power and wait about 15 seconds. Use the CONFIG/MODES menu to put the instrument in STANDBY.
- 6 Compare the current shown on the DMM with the nominal current displayed on the instrument LCD using the INFO/C\_field Menu. (The display units are Milliampères. The current value is set by the instrument to match the parameters of the CBT.)
- 7 Remove instrument power and replace the CFC jumper.

QUESTION: Are the measured and indicated current magnitudes in agreement to within 0.2 mA?

If Yes: The C-Field system is working correctly.

If No: Go to 2.4.2.0.

**2.4.2.0 C-Field Current Source Test**

- 1 Remove all power from the 5071A.
2. Disconnect CBT wiring harness from A2J2.
3. Replace the jumper on the right-hand side of A2J2 labeled CFC (C-Field Current jumper.).
4. Connect the DMM between pins 4 and 14 of A2J2.

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5. Set the DMM to measure dc current in the 10 to 100 mA range.
6. Reapply instrument power and wait about 15 seconds.
7. Measure the C-field current supplied.
8. Remove power and reconnect CBT wiring harness to A2J2.

QUESTION: Is the C-field current the same as measured in 2.4.1.0 above, within  $\pm 0.2$  mA?

If Yes: Re-check results before replacing A17 CBT.

If No: Remove power, replace A7, and retest. Sustained failure indicates that either A2 or traces on the A1 Motherboard are at fault.

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## Assembly/Module Diagnostic Trees (Diagnostic Section 3)

This section provides diagnostic trees for individual assemblies and modules. Assembly and tree numbers in bold designate the trees that are actually present in this section. The following assemblies and modules are covered or are referenced to other sections/diagnostic trees:

- A1 Motherboard (See section 2, Power-supply diagnostic tree.)
- A2 CBT Controller assembly, tree 1: 3.1.1.1.0**
- A3 Microprocessor assembly (See section 1, Top-level diagnostic tree.)
- A4 Digital Synthesizer (See A5 or section 2, RF-chain diagnostic tree.)
- A5 87 MHz PLL module, tree 2: 3.2.1.0**
- A6 Servo (See section 2, Analog signal-chain diagnostic tree.)
- A7 Interface assembly (See A2 diagnostic tree.)
- A8 1 PPS module, tree 3: 3.3.0**
- A9 Frequency Multiplier module, tree 4: 3.4.1.0**
- A10 Output Frequency Distribution Amplifier module, tree 5: 3.5.1.0**
- A11 Power-steering logic (See section 2, Power-supply diagnostic tree.)
- A12 Dc-Dc Converter module (See section 2, Power-supply tree.)
- A13 Front-panel assembly (See section 1, Top-level diagnostic tree.)
- A14 Signal Amplifier module (See section 2, RF-chain diagnostic tree.)
- A15 9.2 GHz Microwave Generator module, tree 6: 3.6.1.0**
- A16 High-Voltage Supply module, tree 7: 3.7.1.0**
- A17 Cesium-beam tube (See section 1, Top-level tree.)
- A18 9.2 GHz PLL module, tree 8: 3.8.1.0**
- A19 Reference Oscillator (Quartz) module, tree 9: 3.9.1.1**

### *Assembly/Module (A/M) Procedure Numbering System*

The assembly/module diagnostic tree step numbers identify the assembly or module tree under consideration (within this section, 3) by the second digit from the left of a particular procedural step, for instance: step 3.4.1.1 is the second procedure for A9.

## A2 CBT Controller Diagnostic Tree (A/M Subsection 1)

This subsection describes the A2 Assembly diagnostic tree. The tree is divided into four functional subsections as follows:

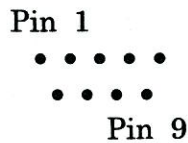
1. A2 Hot-Wire Ionizer tree
2. A2 Thermistor tree
3. A2 Mass-Spectrometer tree
4. A2 Cesium-Oven tree

Each of the functional subsections is designed to isolate a fault to one of the following assemblies:

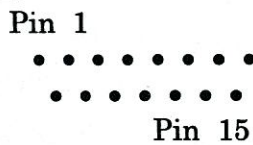
- A2 CBT Controller
- A7 Interface
- A17 Cesium-Beam Tube (CBT)

Refer to the A2 CBT Controller Assembly pinouts shown below for A2J1 and A2J2 when any A2 tests require connection to either CBT or A2 J1 or J2 pins.

For A2J1:



For A2J2:



## A2 Hot-Wire Ionizer Diagnostic Tree

This functional subsection describes the A2 hot-wire ionizer diagnostic tree for the 5071A Primary Frequency Standard. Performance of these tests is indicated by the presence of either a self-test or fatal error that reports a hot-wire ionizer fault.

### 3.1.1.1.0 CBT Hot-Wire Resistance Test

- 1 Power off the 5071A.
- 2 Unplug cable from A2J1 and A2J2.
- 3 Using a 4-wire Ohm Meter, measure the resistance across pins 1 and 6 on the CBT cable.

QUESTION: Is the resistance between 0.1 and 0.25  $\Omega$ ?

If Yes: Go to, 3.1.1.1.1.

If No: Recheck results and Ohmmeter, then replace CBT.

### 3.1.1.1.1 CBT Hot-wire Resistance-to-Ground Test

- 1 Measure the resistance across pins 1 and 4 on the CBT cable.

QUESTION: Is the resistance greater than 200 k $\Omega$ ?

If Yes: Go to, 3.1.1.1.2.

If No: Recheck results and DMM, then replace CBT.

### 3.1.1.1.2 Hot-Wire Monitor Test (No Current)

- 1 Remove instrument power.
- 2 Remove A2 CBT Controller.
- 3 Install the long extender board (05071-60052) into A2 slot.
- 4 Turn on the 5071A.
- 5 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is HW Ionizer: between -0.5 and +0.5 V?

If Yes: Go to, 3.1.1.1.3.

If No: Remove power, replace A7, and retest.

**3.1.1.1.3 Hot-Wire Monitor Test (Current On)**

- 1 Place a 10 k $\Omega$  resistor between the pins listed below before each of the voltage measurements in steps 3 through 6.
- 2 Use the SCPI command `syst:print?` to read the HW-Ionizer voltage. (Terminal-to-instrument via RS-232C data communication required.)
- 3 Measure pins 1 and 37: reading should be between 20.0 and 21.0V
- 4 Measure pins 1 and 38: reading should be between -20.0 and -21.0V
- 5 Measure pins 3 and 37: reading should be between -20.0 and -21.0V
- 6 Measure pins 3 and 38: reading should be between 20.0 and 21.0V

QUESTION: Are all the readings within specified limits?

If Yes: Remove power, replace A2, and retest.

If No: Remove power, replace A7, and retest.

## A2 Thermistor Diagnostic Tree

This functional subsection describes the A2 thermistor diagnostic tree for the 5071A Primary Frequency Standard. Performance of these tests is indicated by the presence of either a self-test or fatal error that reports a thermistor fault.

### 3.1.2.1.0 CBT Thermistor Resistance Test

- 1 Power off the 5071A.
- 2 Unplug cable from A2J2.
- 3 Use a DMM to measure the resistance between pins 6 and 7 on cable.  
QUESTION: Is the resistance measured between 200 and 250 k $\Omega$ ?  
If No: Recheck results and DMM, then replace CBT.  
If Yes: Go to, 3.1.2.1.1.

### 3.1.2.1.1 CBT Thermistor Ground Test

- 1 Use a DMM to measure the resistance between cable pins 7 and 11.  
QUESTION: Is the resistance less than 1  $\Omega$ ?  
If No: Recheck results and DMM, then replace CBT.  
If Yes: Go to, 3.1.2.1.2.

### 3.1.2.1.2 Thermistor Monitor Test (No Current)

- 1 Remove instrument power.
- 2 Remove A2 CBT Controller.
- 3 Install long extender board (05071-60052) into A2 slot.
- 4 Turn on the 5071A.
- 5 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)  
QUESTION: Is thermistor between -0.05 and +0.05 C°  
If Yes: Go to, 3.1.2.1.3.  
If No: Remove power, replace A7, and retest.

**3.1.2.1.3 Thermistor Monitor Test 1 (Current On)**

- 1 Place a 10 k $\Omega$  resistor between pins 1 and 7 on connector XA2P2 (48-pin connector on extender card).
- 2 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is thermistor between 9.35 and 9.75 C°?

If Yes: Go to, 3.1.2.1.4.

If No: Remove power, replace A7, and retest.

**3.1.2.1.4 Thermistor Monitor Test 2 (Current On)**

- 1 Place a 10 k $\Omega$  resistor between pins 3 and 7 on connector XA2P2.
- 2 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is thermistor between -9.35 and -9.75 C°?

If Yes: Remove power, replace A2, and retest.

If No: Remove power, replace A7, and retest.

## A2-Mass-Spectrometer Diagnostic Tree

This functional subsection describes the A2 mass-spectrometer diagnostic tree for the 5071A Primary Frequency Standard. Performance of these tests is indicated by the presence of either a self-test or fatal error that reports a mass-spectrometer fault.

### 3.1.3.1.0 Mass-Spectrometer Resistance Test

- 1 Remove instrument power.
- 2 Unplug CBT cables from A2J1 and A2J2.
- 3 Use a DMM to measure the resistance across A2P4 CBT cable pins 1 and 4.

QUESTION: Is the resistance greater than 200 k $\Omega$ ?

If Yes: Go to, 3.1.3.1.1.

If No: Recheck results and DMM, then replace CBT.

### 3.1.3.1.1 Mass-Spectrometer Test (Current Off)

- 1 Remove instrument power.
- 2 Replace A2 CBT Controller with long extender board (05071-60052). (Do not insert A2 at this time.)
- 3 Reapply instrument power: instrument will go to Fatal Error.
- 4 Use SCPI command `syst:print?`. (Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is `Mass spec:` between -0.5 and +0.5V?

If Yes: Go to, 3.1.3.1.2.

If No: Remove power, replace A7, and retest.

### 3.1.3.1.2 Mass-Spectrometer Monitor Test (+ Current On)

- 1 Place a 10 k $\Omega$  resistor between pins 1 and 37 on connector XA2P2 (48-pin connector on extender card).
- 2 Use SCPI command `syst:print?`. (Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is `Mass spec:` between 9.5 and 11V?

If Yes: Go to, 3.1.3.1.3.

If No: Remove power, replace A7, and retest.

**3.1.3.1.4 Mass-Spectrometer Monitor Test (- Current On)**

- 1 Place a 10 k $\Omega$  resistor between pins 3 and 37 on connector XA2P2.
- 2 Use SCPI command `syst:print?`  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is Mass spec: between -9.5 and -11V?

If Yes: Remove power, replace A2, and retest.

If No: Remove power, replace A7, and retest.

## A2 Cesium-Oven Diagnostic Tree

This functional subsection describes the A2 cesium-oven diagnostic tree for the 5071A Primary Frequency Standard. Performance of these tests is indicated by the presence of either a self-test or fatal error that reports a cesium-oven fault.

### 3.1.4.1.0 Cesium-Oven Resistance Test

- 1 Remove instrument power.
- 2 Unplug cable from A2J2.
- 3 Use a DMM to measure the resistance between cable pins 8 and 15.  
QUESTION: Is the resistance between 200  $\Omega$  and 250 k  $\Omega$ ?  
If No: Recheck results and DMM, then replace CBT.  
If Yes: Go to, 3.1.4.1.1.

### 3.1.4.1.1 Cesium Oven-to-Ground Test

- 1 Use a DMM to measure the leakage resistance between cable pins 15 and 11.  
QUESTION: Is the leakage resistance at least 10 k  $\Omega$ ?  
If No: Recheck results and DMM, then replace CBT.  
If Yes: Go to, 3.1.4.1.2.

### 3.1.4.1.2 Cesium Oven Monitor Test (Current Off)

- 1 Remove instrument power.
- 2 Remove A2 CBT Controller.
- 3 Install long extender board (05071-60052) into A2 slot.
- 4 Reapply instrument power.
- 5 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)  
QUESTION: Is CBT Oven Err: between 0.5 and -0.5C°?  
If Yes: Go to, 3.1.4.1.3.  
If No: Remove power, replace A7, and retest.

**3.1.4.1.3 Cesium Oven Monitor Test (+ Current On)**

- 1 Place a 10 k $\Omega$  resistor between pins 1 and 36 connector XA2P2 (48-pin connector on extender card).
- 2 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is CBT Oven Err: between 20.0 and 21.0C°?

If Yes: Go to, 3.1.4.1.4.

If No: Remove power, replace A7, and retest.

**3.1.4.1.4 Cesium Oven Monitor Test (- Current On)**

- 1 Place a 10 k $\Omega$  resistor Between pins 3 and 36 connector XA2P2.
- 2 Use SCPI command `syst:print?`.  
(Terminal-to-instrument via RS-232C data communication required.)

QUESTION: Is CBT Oven Err: between -20.0 and -21.0 C°

If Yes: Remove power, replace A2, and retest.

If No: Remove power, replace A7, and retest.

### A5 Diagnostic Tree (A/M Subsection 2)

This subsection describes the A5 87 MHz PLL module diagnostic tree.

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**NOTE**

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Ensure that the instrument is in Fatal Error mode. This enables A4 to provide a 131.77 kHz output.

#### 3.2.1.0 Power-Supply Tests

- 1 Check the +5V, +12V and both -12V terminals on A5 with a DMM.
- 2 Verify +12V is between +12 and +12.5V to chassis.
- 3 Verify +5V is between 5.25 and 5.5V to chassis and -12V is between -12 and -12.5V to chassis.

QUESTION: Are power supply voltages correct?

If Yes: Go to, 3.2.2.0.

If No: Go to, 2.1.1.1.0 (Power-supply tree).

#### 3.2.2.0 80-MHz Signal Test

- 1 Disconnect coax cable from A5J1.
- 2 Connect free end of cable to 50  $\Omega$  input of an oscilloscope. (If a 50  $\Omega$  input is absent, use the high-impedance input with a 50  $\Omega$  coaxial-feedthrough terminator at the scope end of the coax).
- 3 Verify presence of an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude.
- 4 Reconnect cable to A5J1.

QUESTION: Is an ~80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude displayed on the oscilloscope?

If Yes: Go to, 3.2.3.0.

If No: Go to, 3.2.2.1.

**3.2.2.1 A9J3 80-MHz Signal Cable Test**

- 1 Disconnect cable from A9J3.
- 2 Connect A9J3 to the 50  $\Omega$  input of an oscilloscope. (If a 50  $\Omega$  input is absent, use the high-impedance input with a 50  $\Omega$  coaxial-feedthrough terminator at the scope end of the coax).
- 3 Verify presence of an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude.
- 4 Reconnect cable to A9J3.

QUESTION: Does the scope show an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude?

If Yes: Remove power, replace cable between A9J3 and A5J1, and retest.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**3.2.3.0 A4 131.770-kHz Signal Test**

- 1 Disconnect coax cable from A5J2.
- 2 Connect free end of the cable to an HP/Agilent 8566 spectrum analyzer (or equivalent).
- 3 Set the center frequency to 131.7 kHz. and the span to 10 kHz.
- 4 Verify presence of a signal at 131.770 kHz with at least -15 dBm amplitude.
- 5 Reconnect cable to A5J2.

QUESTION: Does the spectrum analyzer show a signal at the correct frequency and amplitude?

If Yes: Go to, 3.2.4.0.

If No: Remove power, replace A4, and retest.

**3.2.4.0 A5 Mon Signal Test**

- 1 Measure dc voltage on the mon terminal with a scope.
- 2 Verify that the voltage is less than +0.25 Vdc, greater than -0.25 Vdc, and contains negligible (<10 mV.) ac content?

QUESTION: Does the mon terminal signal meet the above signal specifications?

If Yes: Go to, 3.2.5.0.

If No: Remove power, replace A5, and retest.

**3.2.5.0 A5J101 87.36823-MHz Signal Test**

- 1 Connect the HP/Agilent 8566 spectrum analyzer (or equiv.) to A5J101.
- 2 Set center frequency to 87.368 MHz and span to 10 kHz.
- 3 Verify presence of an 87.368 MHz ( $\pm 1$  kHz) signal with a  $0 \pm 3$  dBm amplitude.

QUESTION: Does the spectrum analyzer show a signal at  
87.368 MHz ( $\pm 1$  kHz) with amplitude  $0 \pm 3$  dBm?

If Yes: A5 is nominally operational.

If No: Remove power, replace A5, and retest.

**A8 Diagnostic Tree  
(A/M Subsection 3)**

This subsection describes the A8 1 PPS Assembly diagnostic tree.

**3.3.0. A8 Test Setup**

- 1 Remove instrument power.
- 2 Mount A8 on the short extender board (05071-60051).
- 3 Disconnect the CBT cable from A2J2 (this ensures power up to Fatal Error mode).
- 4 Disconnect coax cable from A8J3 and reconnect to 50  $\Omega$  input of the oscilloscope (use 50  $\Omega$  feedthrough if necessary).
- 5 Apply instrument power and verify presence of an 80 MHz sine wave with at least 0.6 Vp-p amplitude.

QUESTION: Is the waveform as described in step 5?

If Yes: Go to, 3.3.1.

If No: Go to, 3.4.1.0 (A9 Diagnostic tree).

**3.3.1. A8 1 MHz Output Signal Test**

- 1 Remove instrument power.
- 2 Reconnect cable marked A8P3 to A8J3 and reapply instrument power.
- 3 Use the SO-16 dip clip and the oscilloscope with a high-impedance probe to examine the wave-form at A8-U41.2 and A8-U41.3.

The correct waveform is a 1 MHz square-wave with a logic-low level of less than 0.5 Vdc, and a logic-high level of greater than 2.5 volts. The wave-form on A8-U41.3 must be the complement of that on A8-U41.2. (Use the rear-panel 1 MHz output to conveniently trigger the oscilloscope.)

- 4 Record your results.

QUESTION: Is the waveform as described in step 8?

If Yes: Go to, 3.3.2.

If No: Go to, 3.3.1.1.

**3.3.1.1. A8 1 MHz Waveform Voltage/Frequency Test**

- 1 Replace the A8 module with a new (or known functional) A8.
- 2 Repeat procedure 3.3.1, steps 1, 2, and 3 .

QUESTION: Were the correct waveforms observed?

If Yes: A8 is defective, retain new A8 and retest.

If No: Go to, 3.3.1.2, (Another assembly may be loading down the A8 1 MHz output.)

**3.3.1.2. A8 1 MHz Output Signal Loading Test**

- 1 Repeat procedure 3.3.1 after sequentially replacing A2, A3, A4, and A7 one at a time. (Remove power when changing assemblies.)

QUESTION: Did one or more replaced assemblies correct the problem?

If Yes: Retain the replaced assembly and retest.

If No: A1 may be defective, contact your nearest Agilent Sales office for further assistance.

**3.3.2. Clock Increment Test**

- 1 Set the Instrument LCD display to the CLOCK/Set Menu.
- 2 Verify that the time (hh:mm:ss) display increments at one-second intervals.

QUESTION: Does the time display increment correctly?

If Yes: Go to, 3.3.3.

If No: Go to, 3.3.2.1.

**3.3.2.1 Clock Does Not Increment**

- 1 Remove instrument power and replace A8.
- 2 Reapply power and observe display for time increment.

QUESTION: Does the time display increment correctly?

If Yes: Retain new A8 and retest.

If No: Go to, 3.3.2.2.

**3.3.2.2 Clock Does Not Increment**

- 1 Remove instrument power and replace A3.
- 2 Reapply power and observe display for time increment.

QUESTION: Does the time display increment correctly?

If Yes: Retain new A3 and retest.

If No: A1 may be defective, contact your nearest Agilent Sales office for further assistance.

**3.3.3. 1 PPS Outputs Test**

- 1 Reapply instrument power if required.
- 2 Use the oscilloscope with 50  $\Omega$  input termination to check for 20 microsecond pulses at a rate of 1 pulse per second at each of the three external 1 PPS output connectors.
- 3 Verify that all 1 pps output levels are: pulse low level less than 0.5 volts, and pulse high level more than 3.0 volts. Use a trigger level of 1.5 volts.

QUESTION: Are all 1 pps outputs present as specified in step 2?

If Yes: Go to, 3.3.4.

If No: Go to, 3.3.3.1.

**3.3.3.1. 1 PPS Output Fault**

- 1 Remove instrument power and replace A8.
- 2 Repeat steps 1 and 2 of procedure 3.3.3.

If Yes: Retain new A8 and retest.

If No: Go to, 3.3.5.

### 3.3.4. A8 Front/Rear-Panel Sync Input Test

- 1 Connect the pulse generator output to the front panel Sync input.
- 2 Set the pulse generator to apply 0 to 3.0 volt pulses of 1 microsecond length at a rate of 10 pps.
- 3 Use the CLOCK/Sync menu to arm the front input.
- 4 Observe the LCD display and record the displayed message.
- 5 Repeat steps 1 through 4 using the rear-panel Sync input.

QUESTION: What message was displayed on the LCD?

If the LCD display shows: Caught a sync pulse for both  
Sync inputs, A8 is operational,  
continue testing

If the LCD display shows: Sync timed out for one or both Sync  
inputs, Go to, 3.3.4.1.

#### 3.3.4.1 A8 Sync Fault

- 1 Remove instrument power and replace A8.
- 2 Repeat procedure 3.3.4.

QUESTION: Does the LCD display Caught a sync pulse  
for both inputs?

If Yes: Retain new A8 and retest.

If No: Go to, 3.3.5.

**3.3.5. A8-to-Chassis Interconnect Test**

- 1 Remove instrument power.
- 2 Remove A8 from slot XA8.
- 3 Carefully remove the five SMB cable connectors (Note their locations first.) from J14, J15, J16, J17, and J18 on A1.
- 4 Verify continuity and rule-out short-to-ground for all five cables and their corresponding front- and rear-panel 1 pps output and Sync input connectors. Record results.
- 5 Reconnect the verified cables and BNC connectors.

**QUESTION:** Are any of the five SMB-to-BNC cable assemblies open or shorted?

**If Yes:** Replace the cable assembly as required, reinstall A8 and retest.

**If No:** A1 may be defective, contact your nearest Agilent Sales office for further assistance.

### **A9 Diagnostic Tree (A/M Subsection 4)**

This subsection describes the A9 Frequency Multiplier module diagnostic tree.

#### **3.4.1.0 A9 Module Power Checks**

- 1 Check the -12V and +5V terminals on A9 with a DMM and verify that:

-12V is between -12 and -12.5V to chassis

- 2 Verify +5V is between 5.25 and 5.5V to chassis.

QUESTION: Are power-supply voltages correct?

If Yes: Go to, 3.4.2.0.

If No: Remove power, replace A9, and retest.

#### **3.4.2.0 10-MHz Signal Test**

- 1 Disconnect semi-rigid cable from A9J5.
- 2 Connect free end of the cable to a scope with 50  $\Omega$  input impedance. (If the scope doesn't have a 50  $\Omega$  input, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator installed at the scope end of the coax).
- 3 Verify presence of 10-MHz undistorted sine wave with at least 1 Vp-p amplitude.
- 4 Reconnect cable to A9J5.

QUESTION: Does the scope show a 10-MHz undistorted sine wave with at least 1 Vp-p amplitude?

If Yes: Go to, 3.4.3.0.

If No: Go to, 3.4.2.1.

**3.4.2.1 A19 10-MHz Output Test**

- 1 Disconnect cable from A19 output connector.
- 2 Connect A19 output connector to a scope with 50  $\Omega$  input impedance (If the scope doesn't have a 50  $\Omega$  input, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator installed at the scope end of the coax).
- 3 Verify presence of a 10-MHz undistorted sine wave with at least 1 Vp-p amplitude.

QUESTION: Does the scope show a 10-MHz undistorted sine wave with at least 1 Vp-p amplitude?

If Yes: Remove power, replace cable between A9J2 and A10J5, and retest.

If No: Go to, 3.9.1.1 (A19 trouble tree).

**3.4.3.0 A9 80-MHz Signal Test**

- 1 Connect A9J2 to the 50  $\Omega$  input of a scope using coax. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax).
- 2 Verify presence of an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude.
- 3 Repeat steps 1 and 2 for A9J3 and A9J4

QUESTION: Does the scope show an 80-MHz. undistorted sine wave with at least 0.6 Vp-p amplitude present at all three test connections?

If Yes: Go to, 3.4.4.0.

If No: Remove power, replace A9, and retest.

**3.4.4.0 A9 J1 320-MHz Signal Test**

- 1 Adjust input attenuation on spectrum analyzer for a +30 dBm maximum signal.
- 2 Connect A9J1 to the spectrum analyzer using coax.
- 3 Verify presence of a 320-MHz signal of at least +18 dBm amplitude.

QUESTION: Does the analyzer show a 320-MHz signal of at least +18 dBm amplitude?

If Yes: Go to, 3.4.5.0.

If No: Remove power, replace A9, and retest.

### **A10 Diagnostic Tree (A/M Subsection 5)**

This subsection describes the A10 Output Frequency Distribution Amplifier Module diagnostic tree.

#### **3.5.1.0 A10 Module Power Checks**

- 1 Check the +12V and +5V terminals on A10 with a DMM and verify +12V is between +12 and +12.5V to chassis.
- 2 Verify +5V is between 5.25 and 5.5V to chassis.

QUESTION: Are power-supply voltages correct?

If Yes: Go to, 3.5.2.0.

If No: Remove power, replace A10, and retest.

#### **3.5.2.0 A10 Module J5 80-MHz Input Test**

- 1 Disconnect cable from A10J5.
- 2 Connect free end of the cable to a scope with 50  $\Omega$  input impedance (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax.).
- 3 Verify presence of an 80-MHz undistorted sine wave with at least 0.6 V<sub>p-p</sub> amplitude.
- 4 Reconnect cable to A10J5.

QUESTION: Does the scope show an 80-MHz undistorted sine wave with at least 0.6 V<sub>p-p</sub> amplitude?

If Yes: Go to, 3.5.3.0.

If No: Go to, 3.5.2.1.

**3.5.2.1 A9J2-to-A10J5 Cable Test**

- 1 Disconnect cable from A9J2.
- 2 Connect A9J2 to a scope with 50  $\Omega$  input impedance (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax).
- 3 Verify presence of an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude?

QUESTION: Does the scope show an 80-MHz undistorted sine wave with at least 0.6 Vp-p amplitude?

If Yes: Remove power, replace cable between A9J2 and A10J5, and retest.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**3.5.3.0 A10 Module Output Port-1 Test**

- 1 Connect port 1 on the rear panel to the 50  $\Omega$  input of a scope using coax. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax).
- 2 Verify the presence of a sine wave with an amplitude of at least 2.8 Vp-p and a frequency of 5 or 10 MHz (whichever has been selected, see Config/Output menu).

QUESTION: Does the scope show an undistorted sine wave with amplitude of at least 2.8 Vp-p and a frequency of 5 or 10 MHz (whichever has been selected, see Config/Output menu).

If Yes: Go to, 3.5.4.0

If No: Go to, 3.5.3.1.

**3.5.3.1 A10 Port-1 Frequency Error (10, not 5 MHz)**

QUESTION: Is the output 10 MHz when it should be 5 MHz?

If Yes: Go to, 3.5.3.1.1.

If No: Go to, 3.5.3.2.

**3.5.3.1.1 A10 Port-1 Frequency-Selection Error Test**

- 1 Jumper the SEL-A terminal on A10 to chassis ground.
- 2 Recheck port 1 with scope.
- 3 Verify presence of 5-MHz signal.
- 4 Remove clip lead.

QUESTION: Is a 5-MHz signal present?

If Yes: Remove power, replace A7, and retest.

If No: Remove power, replace A10, and retest.

**3.5.3.2 A10 Port-1 Frequency Error (5, not 10 MHz)**

QUESTION: Is the port 1 output 5 MHz when it should be 10 MHz?

If Yes: Go to, 3.5.3.2.1.

If No: Go to, 3.5.4.0.

**3.5.3.2.1 A10 Port-1 Frequency Selection Error Test**

- 1 Check SEL A on A10 with a DMM.
- 2 Verify that it is no greater than 2 volts.

QUESTION: Is the SEL A voltage 2 or less?

If Yes: Go to, 3.5.3.2.2.

If No: Remove power, replace A10, and retest.

**3.5.3.2.2 A10 SEL-A Line Test**

- 1 Remove instrument power.
- 2 Unsolder white wire from SEL-A terminal and re-check with DMM.
- 3 Reapply instrument power.
- 4 Verify that voltage on wire is greater than 2 volts.

QUESTION: Is voltage greater than 2 volts?

If Yes: Remove power, replace A7, and retest.

If No: Remove power, replace A10, and retest.

**3.5.4.0 A10 Port-2 Test**

- 1 Connect port 2 on the rear panel to the 50  $\Omega$  input of a scope using coax. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax).
- 2 Verify presence of a sine wave..

QUESTION: Does the scope show a sine wave with amplitude of at least 5.6 Vp-p and a frequency of 5 or 10 MHz (selected, from front-panel Config/Output menu).

If Yes: Go to, 3.5.5.0.

If No: Go to, 3.5.4.1.

**3.5.4.1 A10 Port-2 Frequency Error (10, not 5 MHz)**

QUESTION: Is the Port-2 output 10 MHz when it should be 5 MHz?

If Yes: Go to, 3.5.4.1.1.

If No: Go to, 3.5.4.2.

**3.5.4.1.1 A10 Port-2 Frequency Selection Error Test**

- 1 Connect a clip lead from SEL B on A10 to chassis ground.
- 2 Recheck port 2 with scope.
- 3 Verify presence of 5-MHz output.
- 4 Remove clip lead.

QUESTION: Does the frequency remain at 5 MHz?

If Yes: Remove power, replace A7, and retest

If No: Remove power, replace A10, and retest.

**3.5.4.2 A10 Port-2 Frequency Error (5, not 10 MHz)**

QUESTION: Is the Port-2 output 5 MHz when it should be 10 MHz?

If Yes: Go to, 3.5.4.2.1.

If No: Go to, 3.5.5.0.

**3.5.4.2.1 A10 Port-2 Frequency Selection Error Test**

- 1 Check SEL A on A10 with a DMM.
- 2 Verify that it is no greater than 2 volts.  
QUESTION: Is the SEL A voltage 2 or less?  
If Yes: Go to, 3.5.4.2.2.  
If No: Remove power, replace A10, and retest.

**3.5.4.2.2. A10 SEL-B Line Test**

- 1 Remove instrument power.
- 2 Unsolder gray wire from SEL B terminal.
- 3 Reapply instrument power.
- 4 Check voltage on gray with DMM.
- 5 Verify that voltage is greater than 2 volts.  
QUESTION: Is voltage greater than 2 volts?  
If Yes: Remove power, replace A7, and retest.  
If No: Remove power, replace A10, and retest.

**3.5.5.0 A10 1 MHz Output Test**

- 1 Connect the 1 MHz output connector on the rear panel to the 50  $\Omega$  input of a scope using coax. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial feedthrough terminator at the scope end of the coax).
- 2 Verify presence of a 1-MHz undistorted sine wave with at least 2.8 Vp-p amplitude.  
QUESTION: Does the scope show a 1-MHz undistorted sine wave with at least 2.8 Vp-p amplitude?  
If Yes: Go to, 3.5.6.0  
If No: Remove power, replace A10, and retest.

**3.5.6.0 A10 100-kHz Output Test**

- 1 Connect the 100-kHz output connector on the rear panel to the 50  $\Omega$  input of a scope using coax. (If a 50  $\Omega$  input is absent, use the high impedance input with a 50  $\Omega$  coaxial-feedthrough terminator at the scope end of the coax).
- 2 Verify presence of a 100-kHz undistorted sine wave with at least 2.8 Vp-p amplitude.

QUESTION: Does the scope show a 100-kHz undistorted sine wave with at least 2.8 Vp-p amplitude?

If Yes: A10 is nominally operational.

If No: Remove power, replace A10, and retest.

### **A15 Diagnostic Tree (A/M Subsection 6)**

This subsection describes the A15 9.2 GHz Microwave Generator Module diagnostic tree.

#### **3.6.1.0 A15 Module Power Check**

- 1 Check the +4.5V terminal on A15 with a DMM.
- 2 Verify +4.5V is between +4.4 and +4.6V to chassis.

QUESTION: Is the power-supply voltage correct?

If Yes: Go to, 3.6.2.0.

If No: Go to, 3.6.1.1.

#### **3.6.1.1 A18J3 Voltage Test**

- 1 Disconnect cable from A18J3.
- 2 Connect a DMM set for dc volts to A18J3.
- 3 Verify the voltage present between +4.4 and +4.6V.

QUESTION: Is the voltage between +4.4 and +4.6V?

If Yes: Go to, 3.6.1.2.

If No: Go to, 3.8.1.0 (A18 diagnostic tree).

#### **3.6.1.2 +4.5V Cable Test**

- 1 Remove instrument power.
- 2 Unsolder wire from A15 +4.5V terminal.
- 3 Reapply instrument power.
- 4 Check voltage on the wire with a DMM.
- 5 Verify that the voltage is between +4.4V and +4.6V.

QUESTION: Is the voltage between +4.4V and +4.6V?

If Yes: Remove power, replace A15, and retest.

If No: Remove power, replace cable, and retest.

**3.6.2.0 320-MHz Signal Test**

- 1 Adjust spectrum analyzer input attenuation for a +30 dBm. maximum signal.
- 2 Disconnect cable from A15J4.
- 3 Connect the free end of the cable to the spectrum analyzer.
- 4 Verify the presence of a 320-MHz signal with at least +18 dBm amplitude.
- 5 Reconnect cable to A15J4.

QUESTION: Does the analyzer show a 320-MHz signal with at least +18 dBm amplitude?

If Yes: Go to, 3.6.3.0.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**3.6.3.0 A15J3 Signal Test**

- 1 Disconnect coax cable from A18J4.
- 2 Connect free end of the cable to a spectrum analyzer with 50  $\Omega$  input impedance.
- 3 Verify the presence of a signal with frequency between 70 and 110 MHz and amplitude between -25 and -10 dBm.
- 4 Reconnect cable to A18J4.

QUESTION: Does the analyzer show a signal with frequency between 70 and 110 MHz and amplitude between -25 and -10 dBm.?

If Yes: Go to, 3.6.4.0.

If No: Remove power, replace A15, and retest.

### 3.6.4.0 A15J5 Signal Test

- 1 Disconnect semi-rigid coax cable from CBT.
- 2 Disconnect cable from A15J1.
- 3 Connect semi-rigid coax cable to an HP/Agilent 8566B microwave spectrum analyzer using appropriate microwave coaxial test cable (GoreTex 32R01R01048.0).
- 4 Verify the presence of a signal with no sidebands between 9180 and 9205 MHz, having an amplitude between -10 and -30 dBm. (Account for the microwave test-cable signal loss in your calculations.)

QUESTION: Is signal frequency between 9180 and 9205 MHz with an amplitude between -10 and -30 dBm with no sidebands present?

If Yes: Go to, 3.6.5.0.

If No: Go to, 3.6.4.1.

### 3.6.4.1. A15J5-CBT Cable Test

- 1 Remove four mounting nuts for A15.
- 2 Slide A15 out far enough to create the clearance required to remove the semi-rigid coax from A15J5.
- 3 Remove the semi-rigid coax from A15J5.
- 4 Connect A15J5 to an HP/Agilent 8566B microwave spectrum analyzer (or equiv.) using an appropriate microwave coaxial-test cable (e.g.: GoreTex)
- 5 Verify presence of a signal between 9180 and 9205 MHz, with an amplitude of at least 0 dBm, and no discernible sidebands. (Account for microwave-test cable loss.)

QUESTION: Does the spectrum analyzer show a signal between 9180 and 9205 MHz, with an amplitude of at least 0 dBm, and no discernible sidebands?

If Yes: Remove power, replace A15J5-CBT cable, and retest.

If No: Remove power, replace A15, and retest.

**3.6.5.0 A15J1 Power-Level Check**

- 1 Connect A15J1 to a +2.5 Vdc power supply.
- 2 Check spectrum analyzer again and verify that amplitude has increased to at least 0 dBm.
- 3 Disconnect power supply from A15J1 and reconnect internal cable to A15J1.

QUESTION: Did the amplitude on the spectrum analyzer increase to at least 0 dBm?

If Yes: Go to, 3.6.6.0.

If No: Remove power, replace A15, and retest.

**3.6.6.0 A15J2 Frequency-Range Test**

- 1 Disconnect cable from A15J2.
- 2 Connect a 0 to +10 volt power supply to A15J2.
- 3 Vary voltage from 0 to +10V while watching signal on spectrum analyzer connected to A15J5.
- 4 Verify that a frequency of 9192.6 MHz can be obtained with a voltage between +2 and +8 Vdc.

QUESTION: Can frequency of 9192.6 MHz be obtained with a voltage between +2 and +8 Vdc?

If Yes: Go to, A18 diagnostic tree in this section.

If No: Remove power, replace A15, and retest.

### A16 Diagnostic Tree (A/M Section 7)

This subsection describes the A16 High-voltage supply module diagnostic tree. The tree provides information to check both A16 and circuits on A2 CBT controller assembly that drive A16.

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**WARNING**

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Tests are performed with High Voltage present and *must* be used with appropriate safeguards by qualified personnel.

#### 3.7.1.0 A16 Preliminary Set-Up

- 1 Remove instrument power
- 2 Mount the A2 CBT Controller on the long extender
- 3 Disconnect A19 from A1 at A1J11, this will prevent the 5071A from leaving the warming up mode for 45 minutes after turn-on.
- 4 Disconnect semi-rigid cable at A9J5.
- 5 Use a coaxial-adapter cable to connect the signal-generator output (set for 10 MHz at +7 dBm) to A9J5 replacing the 10 MHz input from A19.
- 6 Power up and check that the instrument enters the warming up mode in about 10 seconds.

#### 3.7.1.1 Ion Pump High-Voltage Supply Test

- 1 Power-down the instrument.
- 2 Wait at least one minute for A16 high voltage to bleed down.
- 3 Disconnect the high voltage (HV) connector (thick flexible wire on the right-hand side of the Cesium Beam Tube when viewed from the front of the instrument). (See Figure 2-1.)
- 4 Use a short piece of insulated wire to jumper the inside of the HV connector on the cable to the tip of the high voltage probe.
- 5 Ground the high voltage probe return to the 5071A chassis, and plug the probe output into the DMM. Select dc. voltage mode and at least 100.0 Volts range. The input impedance of the DMM must be equal to that specified for the high-voltage probe.
- 6 Power-up the instrument and observe the voltage displayed by the DVM.

**QUESTION:** Is the measured voltage when multiplied by the high voltage probe calibration factor between 3.3 kV and 4.3 kV?

If Yes: Go to, 3.7.1.2

If No: Remove power, replace A16 and retest.

**3.7.1.2 Ion Pump Return Current Test**

- 1 Use the INFO/PUMP menu selection to display the output of the Ion Pump current monitor circuit.

**QUESTION:** Was the current displayed between 3 and 5 microamps? (The high-voltage probe must have an input resistance of 1 Giga $\Omega$ .)

If Yes: Go to 3.7.1.3.

If No: Go to 3.7.1.3.1.

**3.7.1.3 Ion Pump Return Current Zero Test**

- 1 Power down the instrument, and wait one minute for the A16 module voltages to bleed down.
- 2 Disconnect the Ion Pump supply cable from the high-voltage probe and locate the plug well clear of other conductors.
- 3 Re-power the instrument, wait 15 seconds, and use the INFO/PUMP menu selection to display the Output of the Ion Pump current monitor circuit on the LCD display.

**QUESTION:** Is the displayed current between 0.0 and 1.0 microamps?

If Yes: Ion Pump high-voltage supply is correct, Go to, 3.7.2.1.

If No: Go to 3.7.1.3.1.

**3.7.1.3.1 Ion Pump Current Monitor Diagnosis**

- 1 Power down the instrument, and wait one minute for the A16 module voltages to bleed down.
- 2 Disconnect the A16 module from A1 at A1J12.
- 3 Re-power the instrument, wait 15 seconds, and use the INFO/PUMP menu selection to display the Output of the Ion Pump current monitor circuit on the LCD display.
- 4 Re-connect the A16 module to A1 at A1J12.

QUESTION: Was the displayed current between 0.0 and 1.0 microamps?

If Yes: Remove power, replace A16, and retest.

If No: Go to, 3.7.1.3.2.

**3.7.1.3.2 Ion Pump Current Monitor Diagnosis (cont)**

- 1 Power-down the instrument and remove the A2 module from the extender.
- 2 Re-power the instrument, wait 15 seconds, and use the INFO/PUMP menu selection to display the Output of the Ion Pump current monitor circuit on the LCD display.

QUESTION: Is the displayed current between 0.0 and 1.0 microamps?

If Yes: Remove power, replace A2, and re-test.

If No: Remove power, replace A7, and re-test.

**3.7.2.1 Electron Multiplier High-Voltage Supply Test**

- 1 Remove instrument power, and wait one minute for the A16 module voltages to bleed down.
- 2 Re-connect the Ion Pump high-voltage supply cable to A17.
- 3 Disconnect the left-hand high-voltage lead and reconnect it to the tip of the high-voltage probe using a short piece of insulated wire between the inside of the high-voltage lead connector and the high-voltage probe.
- 4 Ground the high voltage probe return to the 5071A chassis, and plug the probe output into the DMM. Set voltage mode and at least 10.0 Volts range. The input impedance of the DMM must equal that specified for the high-voltage probe.
- 5 Apply instrument power, wait for the instrument to begin warming up, and observe the voltage displayed by the DMM. Multiply this voltage by the voltage-division ratio of the probe and record results.
- 6 Observe the voltage displayed on the LCD using the INFO/EMULT menu selection. Note that the LCD does not display the sign of the voltage.

QUESTION: Do the voltage readings agree to within 5%?

If Yes: The A16 High-Voltage Supply Module is functional. Remove the extender, replace A2. Re-connect A19 to A1 at A1J11, and reconnect the semi-rigid cable from the SMA connector on A19 to A9J5. Continue testing.

If No: Go to, 3.7.2.2.

**3.7.2.2 Electron Multiplier Supply Control Current Test**

- 1 Remove instrument power, and wait one minute for the A16 module voltages to bleed down.
- 2 Power up and check that the instrument enters the warming up mode in about 10 seconds.
- 3 Verify that the green LED A2DS1 is lit.
- 4 Use the DMM to measure the current from A2U7-pin-3 to ground.
- 5 Use the INFO/E\_mult Menu to display the program voltage of the Electron-multiplier supply.
- 6 Verify the ratio of displayed voltage to measured current as between 950 to 1050 volts per mA.

(Ratio = displayed voltage ÷ measured current)

QUESTION: Is the ratio of displayed volts to measured mA correct?

If Yes: A2 is delivering the correct control current. Remove power, replace A16, and re-test.

If No: Remove power, replace A2, and re-test.

**A18 Diagnostic Tree  
(A/M Subsection 8)**

This subsection describes the A18 9.2 GHz PLL Module diagnostic tree.

**3.8.1.0 A18 Module Power Check**

- 1 Check the +12V, -12V, and +5V terminals on A18 with a DMM.
- 2 Verify +12V is between +12 and +12.5V to chassis.
- 3 Verify +5V is between 5.25 and 5.5V to chassis.
- 4 Verify -12V is between -12V and -12.5V to chassis.

QUESTION: Are power supply voltages correct?

If Yes: Go to, 3.8.2.0.

If No: Go to, 2.1.1.1.0 (Power-supply diagnostic tree).

**3.8.2.0 A5 87.368230 MHz Input Signal Test**

- 1 Disconnect coax cable from A18J1.
- 2 Connect free end of coax to the 50  $\Omega$  input of an oscilloscope.  
(If a 50  $\Omega$  input is absent, use the high-impedance input with a 50  $\Omega$  coaxial-feedthrough terminator at the scope end of the coax).
- 3 Verify the presence of an ~87 MHz sine wave with at least 0.4 Vp-p amplitude.
- 4 Reconnect free end of coax to frequency counter input and verify that signal frequency is 87.368  $\pm$ 1 kHz.
- 5 Reconnect cable to A18J1.

QUESTION: Does the signal comply with the characteristics described in step 3 and 4?

If Yes: Go to, 3.8.3.0.

If No: Go to, 3.8.2.1.

**3.8.2.1 A5 87.368230-MHz Input Cable Test**

- 1 Disconnect cable from A5 output connector.
- 2 Connect A5 output connector to a scope 50  $\Omega$  input (If a 50  $\Omega$  input is absent, use the high-impedance input with a 50  $\Omega$  coaxial-feedthrough terminator at the scope end of the coax).
- 3 Verify presence of an 87.368230 MHz ( $\pm 100$  kHz.) sine wave with at least 0.4 Vp-p amplitude.

QUESTION: Does the scope show an 87.368230 MHz ( $\pm 100$  kHz.) sine wave with at least 0.4 Vp-p amplitude?

If Yes: Remove power, replace the cable between A5 and A18J1, and retest.

If No: Go to, A5 diagnostic tree.

**3.8.3.0 A15 70-110 MHz Input Test**

- 1 Disconnect coax cable from A18J4.
- 2 Connect free end of the cable to the 50  $\Omega$  input of a spectrum analyzer.
- 3 Verify presence of a signal with frequency between 70 and 110 MHz and amplitude between -25 and -10 dBm.
- 4 Reconnect cable to A18J4.

QUESTION: Does the spectrum analyzer verify the signal in step 3?

If Yes: Go to, 3.8.4.0.

If No: Go to, 3.8.3.1.

**3.8.3.1 A15J3 and A18J4 Cable Test**

- 1 Disconnect cable from A15J3.
- 2 Connect A15J3 to the 50  $\Omega$  input of a spectrum analyzer.
- 3 Verify presence of a signal with frequency between 70-110 MHz and amplitude between -25 and -10 dBm.
- 4 Reconnect cable to A15J3.

QUESTION: Does the analyzer verify the signal in step 3?

If Yes: Remove power, replace the cable between A15J3 and A18J4, and retest.

If No: Go to, 3.8.3.2.

**3.8.3.2 A15 +4.5V Test**

- 1 Measure the dc voltage on the +4.5V terminal on A15 (accessible on the underside of the instrument when the bottom cover is removed).
- 2 Verify voltage between +4.4V and +4.6V.

QUESTION: Is voltage correct?

If Yes: Go to, 3.8.3.2.1.

If No: Go to, 3.8.3.3.

**3.8.3.2.1 A15 320 MHz Input Test**

- 1 Disconnect cable from A15J4. Adjust input attenuation on spectrum analyzer for +30 dBm. maximum signal.
- 2 Connect free end of cable to spectrum analyzer.
- 3 Verify the presence of a signal with a frequency of 320 MHz and amplitude of at least +18 dBm.
- 4 Reconnect cable to A15J4.

QUESTION: Does the analyzer show a signal with frequency of 320 MHz and amplitude of at least +18 dBm?

If Yes: Remove power, replace A15, and retest.

If No: Go to, 3.4.1.0 (A9 diagnostic tree).

**3.8.3.3 A18J3 DC-Voltage Test**

- 1 Disconnect cable from A18J3.
- 2 Use a DMM to carefully check the dc voltage of the A18J3 center pin.
- 3 Verify that the voltage is between +4.4 and +4.6V.

QUESTION: Is the voltage between +4.4 and +4.6V?

If Yes: Go to, 3.8.3.4.

If No: Remove power, replace A18, and retest.

**3.8.3.4 A18J3 to A15/+4.5V Cable Test**

- 1 Remove instrument power.
- 2 Check continuity of A18J3 to A15/+4.5V cable with a DMM.
- 3 Check for short or open condition.

QUESTION: Is it shorted or open?

If Yes: Replace cable.

If No: Replace A15.

### 3.8.4.0 A18J4 Signal Input Test

- 1 Disconnect cable from A18J4 and reconnect that cable to the input of a 2-way 3-dB. power splitter.
- 2 Connect one of the power-splitter outputs to A18J4 and the other to a spectrum analyzer.
- 3 Verify the frequency of the signal on the spectrum analyzer to an accuracy of 100 kHz.

QUESTION: Is frequency < 87.3 MHz? Yes, Go to, 3.8.4.1.

Is frequency > 87.4 MHz? Yes, Go to, 3.8.4.2.

Is frequency between 87.3 and 87.4 MHz?

Yes, Go to, 3.8.4.3.

### 3.8.4.1 A18 Mon Voltage Test

- 1 Measure dc voltage on the A18 mon terminal with a scope.
- 2 Verify that the average voltage is less than +0.05 Vdc?

QUESTION: Is the average voltage less than +0.05 Vdc?

If Yes: Go to, A15 diagnostic tree.

If No: Remove power, replace A18, and retest.

### 3.8.4.2 A18 Average Mon Voltage Test

- 1 Measure dc voltage on the A18 mon terminal with a scope.
- 2 Verify that the average voltage is more than +0.45 Vdc.

QUESTION: Is the average voltage more than +0.45 Vdc?

If Yes: Go to, 3.6.1.0 (A15 diagnostic tree).

If No: Remove power, replace A18, and retest.

### 3.8.4.3 Mon Signal AC-Content Test

- 1 Examine voltage on the A18 mon terminal with a scope.
- 2 Observe the signal and measure its ac content.

QUESTION: Is the ac content more than 10 mV?

If Yes: A18 is probably at fault, (although A15 is suspect).

Remove power, replace A18, and retest.

If No: A18 is nominally operational.

### **A19 Diagnostic Tree (A/M Subsection 9)**

This subsection describes the diagnostic tree for the A19 module and associated circuits on A6. The A19 module is an ovenized voltage-controlled, quartz-crystal oscillator (VCXO), it receives oven and oscillator power from the A6 module. At power-up, the VCXO requires a warm-up time of at least 10 minutes before its output is stable. The 10 MHz VCXO output is tuned over a nominal range of  $\pm 3$  Hz by an electronic frequency control (EFC) voltage. The EFC signal is generated by a DAC on A6.

#### **3.9.1.1 A6 Unloaded A19-Power-Supply Voltages**

- 1 Power down the instrument and remove A6.
- 2 Check the continuity of fuses A6- F3, F4, F5, (2.5  $\Omega$  or less) and replace as required.
- 3 Mount A6 in the instrument with the short extender card (05071-60051).
- 4 Disconnect A19 from A1 at A1J11 and CBT cable from A2J2.
- 5 Disconnect the semi-rigid cable from A19 to A9J5.
- 6 Connect the signal generator output (set to provide 10 MHz at +7 dBm) to A9J5.
- 7 Apply power to the instrument. (Wait until LCD displays Fatal Error.)
- 8 Measure A19 supply voltages with a DMM at test points TP9, TP8 and TP7 on A6. Voltages should be as follows:
  - TP9, (+12 V nominal), more than 11.75 and less than 12.75 volts.
  - TP8, (-12 V nominal), more than -12.75 and less than -11.75 volts.
  - TP7, (+10.8 V nominal), more than 10.3 and less than 11.3 volts.

**QUESTION:** Are the power supply voltages correct?

If Yes: Go to, 3.9.1.2.

If No: Remove power, replace A6, and retest.

### 3.9.1.2 A19 Loaded Power-Supply Voltages

- 1 Remove power and reconnect A19 by firmly seating the plug at A1J11.
- 2 Reapply power. (Wait until LCD displays Fatal Error.)
- 3 Measure A19 supply voltages with a DMM at test points TP9, TP8 and TP7 on A6 to verify compliance as follows:
  - TP9, (+12 v nominal), more than 11.75 and less than 12.75 volts.
  - TP8, (-12 v nominal), more than -12.75 and less than -11.75 volts.
  - TP7, (+10.8 v nominal), more than 10.3 and less than 11.3 volts.

QUESTION: Are the power supply voltages correct?

If Yes: Go to, 3.9.1.3.

If No: Go to, 3.9.1.2.1.

#### 3.9.1.2.1 A19 Power Fault

- 1 Remove instrument power.
- 2 Replace A6.
- 3 Reapply power. (Wait until LCD displays Warming up.)
- 4 Use the CONFIG/Mode menu to go to STANDBY.
- 5 Measure the A19 supply voltages with a DMM at test points TP9, TP8 and TP7 on A6 to verify compliance as follows:
  - TP9, (+12 v nominal), more than 11.75 and less than 12.75 volts.
  - TP8, (-12 v nominal), more than -12.75 and less than -11.75 volts.
  - TP7, (+10.8 v nominal), more than 10.3 and less than 11.3 volts.

QUESTION: Are the power supply voltages correct?

If Yes: Go to, 3.9.1.3.

If No: Remove power, replace A19, check the fuses on A6 (replace as necessary), and re-test from 3.9.1.2.

**3.9.1.3 A6J4.1 and A6J4.9. Reference Voltage Test**

- 1 Verify reference voltages on A6J4.1/A6J4.9. with a DMM:

A6J4.1 (nominal 5.000) > 4.995 and < 5.005 volts

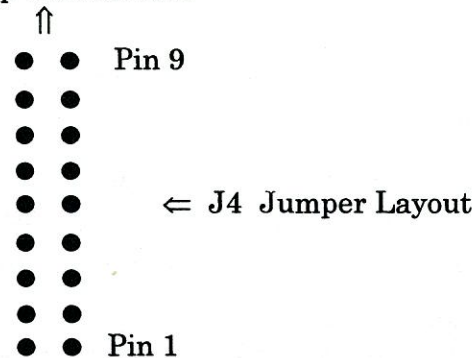
A6J4.9 (nominal -5.000) > -5.005 and < -4.995 volts

QUESTION: Are the voltages correct?

If Yes: Go to, 3.9.1.4.

If No: Remove power. Check fuses A6F1 and A6F2. If blown, replace and repeat this step. If not blown, replace A6, and retest.

Top of A6 Board



**3.9.1.4 EFC Voltage Test (1)**

- 1 Record the position of the jumper connecting the left-hand row of pins of A6-J4 with the right-hand. (The jumper positions number 1 through 9, beginning at the bottom.)
- 2 Use the INFO/Ctrl menu to determine the EFC control voltage as a percentage between -100% and +100%.
- 3 Calculate the expected EFC control voltage using the formula:  
Control voltage =  $1.25 * (5 - \text{Pos. Jmpr}) - 0.03308 * (\% \text{Ctrl})$ . For example, if the jumper is in the 6 position and the control is +8%,  
control voltage =  $1.25 * (6) - 0.03308 * (8) = 7.24$ .
- 4 Measure the EFC control voltage applied to the oscillator at A6J6.
- 5 Verify that the measured and calculated voltages agree to within 0.03 volts.

QUESTION: Do the measured and calculated EFC voltages agree to within 0.03 volts?

If Yes: Go to, 3.9.1.5.

If No: Go to, 3.9.1.4.1.

**3.9.1.4.1. EFC Voltage Test (2)**

- 1 Unplug the A19 oscillator from A1-J11 and repeat the measurement procedure described in 3.9.1.3.

QUESTION: Do the measured and calculated EFC voltages agree to within 0.03 volts?

If Yes: Remove power, replace A19, and retest.

If No: Remove power, replace A6, and retest.

**3.9.1.5 A19 Oven Warm-up Time Test**

- 1 Power-cycle the instrument.
- 2 Wait 10 minutes.
- 3 Observe the value of the A19 (VCXO) oven monitor using the INFO/Ovens menu.
- 4 Verify that the voltage is now be between -10.0 and -5.0 volts, indicating that the oscillator oven has warmed up.

QUESTION: Does the A19 oven warm up in 10 minutes or less?

If Yes: Go to, 3.9.1.6.

If No: Remove power, replace A19, and retest.

**3.9.1.6 A19 Signal-Amplitude Test**

- 1 Disconnect the semi-rigid cable from A9J5.
- 2 Use the adapter cable to connect it to the input of the oscilloscope with a 50  $\Omega$  terminator.
- 3 Verify that the amplitude of the signal, is greater than 1.0 Vp-p.

QUESTION: Is the signal amplitude greater than 1.0 Vp-p.

If Yes: Go to, 3.9.1.7.

If No: Remove power, replace A19, and retest.

**3.9.1.7 A19 Signal-Frequency Test**

- 1 Connect the output of the semi-rigid cable to the frequency counter with a 50  $\Omega$  input terminator.
- 2 Observe the A19 frequency with an accuracy of  $\pm 1$ Hz. (The counter timebase must be calibrated to an accuracy of better than  $1 \times 10^{-7}$ .)
- 3 Calculate the nominal output frequency of the A19 from the EFC control percentage using the equation:  
$$\text{Freq}_{\text{nom}} = 10.0 \text{ MHz} + 0.0331 * (\% \text{Ctrl}) \text{ Hz.}$$
- 4 Verify that the measured frequency agrees with the calculated frequency to  $\pm 2$  Hz.

QUESTION: Does the measured frequency agree with the calculated frequency to  $\pm 2$  Hz?

If Yes: The A19 reference-oscillator chain has checked-out correctly.  
If No: Go to, 3.9.1.8.

**3.9.1.8 A19 VCXO Set-Point Adjustment**

The following procedure attempts to adjust the VCXO set-point. It should be carried out if the A19 appears to have aged out of tolerance, or if a new A19 has been installed.

- 1 Remove the cover plate from the left side of the instrument as seen from the front.
- 2 Observe the frequency output of A19 as described in procedure 3.9.1.7.
- 3 Using a non-conducting screwdriver, adjust the VCXO mechanical trimmer accessible through a hole in the left-hand chassis side-rail, to bring the frequency within 1 Hz of its calculated nominal value.
- 4 Carefully withdraw the screwdriver.

QUESTION: Can the frequency be correctly adjusted?

If Yes: The procedure is complete and the A19 VCXO-chain operation has been verified.

If No: Remove power, replace A19, and retest.

