5071A Primary Frequency Standard

Assembly- Level Service Manual

Rev. B, July 3, 2007
Part Number: 05071-90040

Symmetricom®

Assembly- Level Service Manual

This manual describes how to service the Symmetricom 5071A Primary Frequency Standard. The information in this manual applies to instruments having the number prefix listed below, unless accompanied by a "Manual Updating Changes" package indicating otherwise.

SERIAL NUMBER PREFIX: US4538 AND ABOVE

Some sections of this manual refer to using the '5071A Profiling software'. This revision of the manual no longer supplies a 3.5-inch floppy disk with this software. To obtain a copy free of charge visit our web site at http://www.symmttm.com/products_pfr_5071A.asp and follow the links to "Software and Drivers". The latest revision of the Profiling Software (Symmetricom P/N 05071-13501) can then be saved to your computer hard disk. This software is only available for use with a Windows®-based PC.

There are a limited number of 5071A replaceable parts available. The 5071A Primary Frequency Standard is a very precise and complex product and Symmetricom strongly recommends that they be sent in for repairs and post-repair performance testing. However, there are some assemblies, such as the Cesium beam tube that we do sell should you wish to perform this in your own facility. We require that you have a copy of the 5071A Assembly-Level Service Manual (P/N 05071-90040) before doing any repairs or parts replacements.

Although Symmetricom Global Services (SGS) is always available to help when you have questions, they cannot be expected to provide troubleshooting assistance when you are repairing the 5071A - That is the purpose of the 5071A Service Manual.

5071A Primary Frequency Standard

Manual part number
05071-90040

Safety Considerations

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

This product is a safety Class I instrument (provided with a protective earth terminal). If this instrument is used in a manner not specified by Symmetricom, the protection provided by the equipment may be impaired.

Before Applying Power
Verify that the product is set to match the available line voltage and the correct fuse is installed. Refer to instructions in Chapter 1 of this Manual.

Before Cleaning
Disconnect the product from operating power before cleaning. Clean only with lightly damp cloth and mild detergents. Do not get unit wet.

Safety Earth Ground
An uninterruptible safety earth ground is recommended from the mains power source to the product input wiring terminals or supplied power cable. The terminal is located on the rear of the unit near the AC input receptacle.

Warning Symbols That May Be Used In This Manual

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

Indicates hazardous voltages.

Indicates earth (ground) terminal.

 OR 

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

Indicates Alternating current.

Indicates Direct current.

Rack Mounting

The Model 5071A Unit is designed for mounting in a standard 19-inch (48.26 cm) rack. Follow the rack manufacturer's instructions for mounting the Model 5071A Unit while observing the following guidelines:

- Elevated Operating Temperature: If the Model 5071A Unit is installed in a closed or multi-unit rack assembly, the ambient temperature of the rack environment may be greater than the Model 5071A Unit's Maximum Operating Temperature of 50°C/122°F. Install the Model 5071A Unit in an environment that is compatible with the Model 5071A Unit 's operating temperature range, which is 0 °C to 50 °C, or 32 °F to 122 °F
- Mechanical Loading: Mount the Model 5071A Unit so as to avoid uneven mechanical loading that could cause hazardous conditions.
- Circuit Overloading: Observe the power ratings on the Model 5071A Unit 's nameplate and the additional load the Model 5071A Unit may place on the supply circuit. Overloading the supply circuit may adversely affect the supply wiring and over-current protection.
- Reliable Earthing: Maintain reliable earthing (grounding) of rack mounted equipment. Pay particular attention to supply connections other than direct connections to the branch circuit (e.g., use of power strips).

CAUTION ________________
Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a *CAUTION* sign until the indicated conditions are fully understood and met.

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

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

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

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Safety Considerations (contd)

WARNING:

BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING SIGN UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

AVERTISSEMENT:

LA BLESSURE PHYSIQUE OU RESULTAT DE MAI DE MORT DE L'ECHEC POUR FAIRE ATTENTION A UN AVERTISSEMENT. Ne PAS PROCEDER AU DELA D'UN SIGNE ANNONCIATEUR JUSQU'A CE QUE LES CONDITIONS INDIQUEES SONT ENTIEREMENT COMPRISES ET SONT RENCONTREES.

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WARNING:

THE MODEL 5071A UNIT SHOULD ONLY BE PLUGGED INTO A GROUNDED RECEPTACLE. SYMMETRICOM RECOMMENDS THAT THE CHASSIS EXTERNAL GROUND BE CONNECTED TO A RELIABLE EARTH GROUND.

ANY INTERRUPTION OF THE PROTECTIVE GROUNDING CONDUCTOR (INSIDE OR OUTSIDE THE INSTRUMENT) OR DISCONNECTING THE PROTECTIVE EARTH TERMINAL WILL CAUSE A POTENTIAL SHOCK HAZARD THAT COULD RESULT IN PERSONAL INJURY. (GROUNDING ONE CONDUCTOR OF A TWO CONDUCTOR OUT-LET IS NOT SUFFICIENT PROTECTION.)

AVERTISSEMENT:

RELIER CET APPAREIL À UNE PRISE DE COURANT AVEC CONTACT ADEQUATE DE MISE À LA TERRE. SYMMETRICOM RECOMMANDE QUE LE CHÂSSIS SOIT RELIÉ À UNE TERRE FIABLE.

N'IMPORTE QUELLE INTERRUPTION DU CONDUCTEUR FONDANT PROTECTIF (DANS OU HORS DE L'INSTRUMENT) OU DEBRANCHER LE TERMINAL DE TERRE PROTECTIF CAUSERA UN DANGER DE CHOC POTENTIEL QUI POURRAIT AVOIR POUR RESULTAT LA BLESSURE PERSONNELLE. (FONDANT UN CONDUCTEUR D'UNE DEUX SORTIE DE CONDUCTEUR EST LA PROTECTION PAS SUFFISANTE).

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Safety Considerations (contd)

WARNING:

FOR CONTINUED PROTECTION AGAINST FIRE, REPLACE THE LINE FUSE(S) ONLY WITH 250V FUSE(S) OF THE SAME CURRENT RATING AND TYPE (FOR EXAMPLE, NORMAL BLOW, TIME DELAY). DO NOT USE REPAIRED FUSES OR SHORT CIRCUITED FUSEHOLDERS.

AVERTISSEMENT:

POUR LA PROTECTION CONTINUÉE CONTRE LE FEU, REMPLACER LE FUSIBLE DE LIGNE (LES FUSIBLES) SEULEMENT AVEC 250V FUSIBLE (LES FUSIBLES) DU MÊME COURANT ÉVALUANT ET TAPE (PAR EXEMPLE, LE COUP NORMAL, LE DÉLAI). NE PAS UTILISER DE FUSIBLES RÉPARÉS OU CIRCUITED FUSEHOLDERS COURT.

DC Power Supply (VDC Operation Model) Installation

- Use a 15 Amp DC circuit breaker in series with the DC power source.
- Do not connect the unit directly to a DC power source without the breaker.
- 14 AWG ($1.5mm^2$) gage wire is the minimum gage permitted by the NEC for DC power source hookup.
- The Unit Chassis must be grounded for proper safety.

WARNING:
ENSURE THAT A DISCONNECT DEVICE, SUCH AS A SWITCH, WITH THE APPROPRIATE VOLTAGE/CURRENT RATING IS PROVIDED WHEN CONNECTING A DC POWER SOURCE TO THE VDC OPERATION MODEL.

AVERTISSEMENT:
S'ASSURER QU'UN DÉBRANCHER L'APPAREIL, TEL QU'UN COMMUTATEUR, AVEC LE CLASSEMENT DE TENSION/COURANT APPROPRIÉ EST FOURNI EN CONNECTANT UNE SOURCE DE POUVOIR DE DC AU MODÈLE DE CONFIGURATION DE VDC.

Acoustic Noise Emissions
LpA<47 dB at operator position, at normal operation, tested per EN 27779. All data are the results from type test.

Geräuschemission
LpA<47 dB am Arbeits platz, normaler Betrieb, geprüft nach EN 27779. Die Angagen beruhen auf Ergebnissen von Typenprüfungen.

Electrostatic Discharge Immunity Testing
When the product is tested with 8kV AD, 4kV CD and 4kV ID according to IEC801-2, a system error
may occur that may affect measurement data made during these disturbances. After these occurrences, the system self-recovers without user intervention.

Certification and Warranty

Certification

Symmetricom certifies that this product met its published specification at the time of shipment from the factory. Symmetricom further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

Symmetricom warrants Symmetricom hardware, accessories and supplies against defects in materials and workmanship for a period of two years from date of shipment. If Symmetricom receives notice of such defects during the warranty period, Symmetricom will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

Symmetricom warrants that Symmetricom software will not fail to execute its programming instructions, for the period specified above, due to defects in material and workmanship when properly installed and used. If Symmetricom receives notice of such defects during the warranty period, Symmetricom will replace software media which does not execute its programming instructions due to such defects.

Symmetricom does not warrant that the operation of Symmetricom products will be uninterrupted or error free. If Symmetricom is unable, within a reasonable time, to repair or replace any product to a condition as warranted, the customer will be entitled to a refund of the purchase price upon prompt return of the product.

Symmetricom products may contain remanufactured parts equivalent to new in performance or may have been subjected to incidental use.

The warranty period begins on the date of delivery or on the date of installation if installed by Symmetricom. If customer schedules or delays Symmetricom installation more than 30 days after delivery, warranty begins on the 31st day from delivery.

Warranty does not apply to defects resulting from
(a) improper or inadequate maintenance or calibration, (b) software, interfacing, parts or supplies not supplied by Symmetricom, (c) unauthorized modification or misuse, (d) operation outside of the published environmental specifications for the product, or (e) improper site preparation or maintenance.

TO THE EXTENT ALLOWED BY LOCAL LAW, THE ABOVE WARRANTIES ARE EXCLUSIVE AND NO OTHER WARRANTY OR CONDITION, WHETHER WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED AND SYMMETRICOM SPECIFICALLY DISCLAIMS ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY, SATISFACTORY QUALITY, AND FITNESS FOR A PARTICULAR PURPOSE.

Warranty (contd)

Symmetricom will be liable for damage to tangible property per incident up to the greater of $300,000 or the actual amount paid for the product that is the subject of the claim, and for damages for bodily injury or death, to the extent that all such damages are determined by a court of competent jurisdiction to have been directly caused by a defective Symmetricom product.

TO THE EXTENT ALLOWED BY LOCAL LAW, THE REMEDIES IN THIS WARRANTY STATEMENT ARE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. EXCEPT AS INDICATED ABOVE, IN NO EVENT WILL SYMMETRICOM OR ITS SUPPLIERS BE LIABLE FOR LOSS OF DATA OR FOR DIRECT, SPECIAL, INCIDENTAL, CONSEQUENTIAL (INCLUDING LOST PROFIT OR DATA), OR OTHER DAMAGE, WHETHER BASED IN CONTRACT, TORT, OR OTHERWISE.

For consumer transactions in Australia and New Zealand: the warranty terms contained in this statement, except to the extent lawfully permitted, do not exclude, restrict or modify and are in addition to the mandatory statutory rights applicable to the sale of this product to you.

Assistance
Product maintenance agreements and other customer assistance agreements are available for Symmetricom products.

For any assistance, contact your nearest Symmetricom Sales and Service Office.

CE

DECLARATION OF CONFORMITY

In accordance with ISO/IEC GUIDE 22 and EN 45014

Symmetricom

Symmetricom, Inc.
2300 Orchard Parkway
San Jose, CA 95131

Declares under our sole legal responsibility that the

PRIMARY FREQUENCY STANDARD

MODEL NO. 5071A

CONFORMS TO THE FOLLOWING EUROPEAN UNION DIRECTIVES:

Safety
73/23/EEC Low Voltage Safety as amended by 93/68/EEC
IEC 61010-1
EN 61010-1

Electromagnetic Compatibility
89/336/EEC Electromagnetic Compatibility

EN61326	EMC Requirements for Measurement, Control and Laboratory Equipment.
EN61000-3-2	Harmonic Current Emissions
EN61000-3-3	Voltage Fluctuation and Flicker Emissions

WEEE
Waste Electrical and Electronic Equipment Directive (WEEE) 2002/95/EC
For more information about Symmetricom's WEEE compliance and recycle program, please visit the Symmetricom's WEEE/RoHS website at *http://www.symmetricom.com/About_Us/WEEE_RoHS_Initiatives.htm*

RoHS
Restriction of the Use of Certain Hazardous Substances Directive 2002/95/EC
This product falls under the category of Monitoring and Control Instruments Equipment (Category 9 as defined in Annex 1A of the WEEE 2002/96/EC Directive) which is excluded from the RoHS Directive 2002/95/EC (reference Article 2, paragraph 1) requirements.

Note: The Model 5071A is compliant when supplied with or without the High Performance Option. CE Marking first affixed 2007

We declare that the equipment specified above conforms to the above Directives and Standards.

28 March 2007	**Robert Mengelberg**	**Compliance Program Manage**	Robert Mengelberg
Date	Name	Title	Signature

Contents

Preface

This manual provides assembly-level service information for the Symmetricom 5071A Primary Frequency Standard.

Repair Strategy

The Symmetricom 5071A Primary Frequency Standard can be returned to Symmetricom for all service work, including troubleshooting, and verifying specifications. Contact Symmetricom for more details.

If you decide to service the instrument yourself, use the operational verification procedure in Chapter 1, “Performance Tests,” in this manual to define the type of problem. For more complete tests, use the full performance tests in Chapter 1. After a repair, re-check the Standard's operation with the verification or full-performance test procedures.

This service manual is designed to isolate failures to the assembly or module level only. If a failure occurs, you can isolate the faulty assembly or module by using the procedures in Chapter 2 “Service.” The procedures in Chapter 4 “Replacing Assemblies” enable you to remove and replace defective assemblies or modules.

Text Conventions used in this manual

Throughout this manual there are symbols used to denote special meanings. These are explained below:

< > These separators mark where information may be any value or text (otherwise known as “wild cards”). The actual value in these cases is not critical to the process.

Instrument Identification

Instrument identification is made from the serial number located on the rear panel of the 5071A. Symmetricom uses a two-part serial number with the first part (prefix) identifying a series of instruments and the second part (suffix) identifying a particular instrument within a non-repeating series. A Symmetricom assigned alpha character within the serial number identifies the country in which the instrument was manufactured. The letters “A” or “US” denote manufacture in the United States of America.

Instruments Covered by This manual

This manual applies directly to Symmetricom 5071A Primary Frequency Standards that have the same serial number prefix(es) shown on the title page. If the serial number prefix of your Standard differs from that listed on the title page of this manual, then there may be differences between this manual and your instrument. Instruments having a higher serial prefix are covered when required by one or more manual-change sheets included with this manual. If a required change sheet is missing, contact Symmetricom by phone or email using the information provided at the back of this manual.

Manual Organization

This assembly-level service manual consists of a table of contents, preface, Six chapters and an index. The page running headers identify the chapters and sections of this manual. The chapter contents are summarized as follows:

Chapter 1, Performance Tests, provides test procedures to ensure that the Standard meets all warranted specifications.

Chapter 2, Service, is divided into five sections. Section 1 contains instructions for returning the Standard to Symmetricom for service. Section 2 contains pre-troubleshooting information and Sections 3, 4, and 5 provide the diagnostic troubleshooting-tree procedures (diagnostic trees) to isolate faulty assemblies and/or modules.

Chapter 3, Theory of Operation, provides two levels of hardware functional description based on a signal-flow block-diagram perspective.

Chapter 4, Replacing Assemblies, contains procedures for replacing defective assemblies and/or modules in the instrument.

Chapter 5, Replaceable Parts, lists the replaceable parts inside the Standard and explains how to order them from Symmetricom.

Chapter 6, Specifications, This information is duplicated in the 5071A Operating and Programming manual P/N 05071-90041, and is therefore not printed in this manual.

How to Order Manuals

A copy of this manual (part number 05071-90040) can be downloaded from the following website:
http://www.symmttm.com/products_pfr_5071A.asp

The Symmetricom 5071A Operating and Programming manual (part number 05071-90041) can be obtained from the same site as well.

1. Performance Tests – Verifying Specifications

Introduction

NOTE

In the interest of PRESERVING its usability the information in this chapter has been retained in its original form without changes. No attempt has been made to update the equipment, accessories, or parts to current availability. It is therefore necessary for the user of this manual to consider the recommendations of test equipment and accessories as suggestions. Some or all of these items may no longer be available from Symmetricom or any other vendors. An updated list of available replacement parts from Symmetricom is provided in Chapter 5.

This chapter provides procedures to test the electrical performance of the 5071A Primary Frequency Standard, using the specifications listed in Chapter 6, "Specifications." Three types of tests are provided:

- Operational Verification
- Complete Performance Tests
- RS-232 Verification

Operational Verification

The Operational Verification test is an abbreviated series of checks that may be performed to give a high degree of confidence that the instrument is operating properly without performing the complete Performance Tests. An operational verification is useful for incoming inspection, routine maintenance, and after instrument repair.

Complete Performance Tests

The complete Performance Tests verify the specifications listed in Chapter 6 of this manual. All tests can be performed without access to the inside of the instrument.

RS-232 Verification

The RS-232 Serial Port verification checks the serial port for successful data communication with a terminal or PC.

Test Record

The results of the Operational Verification, complete Performance Tests, and RS-232 Verification can be recorded on a copy of the Performance Test Record, located at the end of this chapter.

Equipment Required

Equipment required for the performance tests in this chapter is listed in the following table. Any equipment that satisfies the critical specification listed in the table may be substituted for the recommended model(s). (The performance test and diagnostic procedures assume the use of the listed equipment.)

If operational verification or full-performance tests are being performed, use the test equipment called out on this page and the appropriate test cables/adapters listed on page 6.

If diagnostic troubleshooting is required, use the test equipment called out on this page, page 5, and the appropriate test cables/adapters listed on page 6.

Table 1-1. Recommended Test Equipment

Instrument	**Required Characteristics**	**Use**	**Model**
General-Purpose Oscilloscope	At least 100 MHz bandwidth Input: 1 MΩ	OV, T	HP/Agilent 54600A
Spectrum Analyzer	Frequency Range Span: 0 to 40 MHz Measurement Resolution 1 kHz/Div. Center Frequency Accuracy: 1 PPM	P, T	HP/Agilent 3585A/B
Linear Phase Comparator	Input Frequency Range: 5 to 10 MHz Input Level (50Ω): 1 Vrms Output: 0 to +1 Vdc Output Linearity: Proportional from 0 to 360 degrees phase	P	HP/Agilent K34-59991A
Strip Chart Recorder	Paper Movement: 1 inch/hour Input Range: 0 to +1 Vdc Full Scale Range: +1 Vdc Full Scale Resolution: 50 minor divisions	P	No Recommendation

Table 1-1. Recommended Test Equipment (Continued)

Digital Multimeter	Input Resistance: 10 MΩ Accuracy: 0.04% at 1 Vdc	T	HP/Agilent 34401A
40kV ac/dc High Voltage Probe	Range: >= 5KV dc, input Z= 1 GΩ, Accuracy: 2%, 10 MΩ load	T	HP/Agilent 34300A
Clip-on Current Probe	Range: >= 1 Amp dc Output: 1 Vdc at 10 Amp dc	T	HP/Agilent 34302A
Universal Counter	Range: >= 500 MHz Accuracy: 0.1 PPM	T	HP/Agilent 53131A, Opt 010, 030
CW Microwave Counter	Range: >= 10 GHz Accuracy: >= 0.1 ppm	T	HP/Agilent 5350B, Option 010
Spectrum Analyzer	Frequency Range: >= 9.5 GHz Resolution: 100 kHz / Division Center Frequency Accuracy: 1 PPM Input: Up to 1 watt input capability Dynamic Range: 100 dB	T	HP/Agilent 8566A/B
Input Probe	10:1 Divider (included with 54600A oscilloscope)	T	HP/Agilent 10071A
Input Probe	1:1 1 MΩ (for 50 Ω measurements)	T	HP/Agilent 10070A
RF Signal Generator	Frequency Range: > 80 MHz Power: >= +7 dBm	T	HP/Agilent 8656B
Pulse Generator	Repetition Rate: 10 Hz Pulse Width: <= 10 usec Output Voltage: >= +3V	T	HP/Agilent 8111A
General-purpose DC Power Supply, Adjustable	0 - 10V, >= 25 ma	T	HP/Agilent E3610A
IBM-Compatible PC	MS-DOS® 3.3 or later, 640 kB RAM, 1 serial (COM:) Port	T	Any Vendor
Service Accessories Kit	Special Test Tools, Devices, and Fixtures	T	05071-67003
Profiling Software	For Online CBT Performance Testing (See Title Page for download instructions)	T	05071-13501

Table 1-1. Recommended Test Equipment (Continued)

BNC, and Data-communication cables	BNC Cables, 50 Ω, 1 M long, quantity 4 RS-232 Cable, 9-pin (jack) to 9-pin (jack)	T	HP/Agilent 10503A 24542U
Adapters	50 Ω BNC In-line Feed through 2-Way 3dB Power Splitter BNC (jack) to BNC (jack), quantity 4 BNC (jack) to SMC (plug), quantity 2 BNC (plug) to SMC (jack) BNC (jack) to SMB (plug) BNC (plug) to SMB (jack) N (plug) to BNC (jack) N (plug) to SMA (jack) SMA (jack) to SMA (plug) Right-Angle SMA (plug) to SMA (plug) SMA (jack) to SMA (jack) SMB (jack) to SMB (jack) SMB (plug) to SMB (plug) SMC (jack) to SMC (jack) SMC (plug) to SMC (plug)	T	HP/Agilent 10100C 0960-0496 1250-0080 1250-0832 1250-0831 1250-1236 1250-1857 1250-0780 1250-1250 1250-1249 1250-1159 1250-1158 1250-0672 1250-0669 1250-0827 1250-1113
Microwave Test Cable	SMA (male) at both ends, <10dB loss at 10 GHz	T	GoreTex 32R01R01048.0
Special Tools	Narrow bladed non-conducting screwdriver TORX® T-8 Driver TORX® T-10 Driver TORX® T-15 Driver TORX® T-25 Driver	T	Jacobsen #8777 8710-1614 8710-1623 8710-1622 8710-1617
OV = Operational Verification P = Complete Performance Tests T = Troubleshooting			

5071A Operational Verification

Power-On Self-Tests and Servo Lock

1 Inspect the 5071A for any damage (see the section titled "Initial Inspection" in Chapter 7 of the 5071A Operating and Programming Manual for detailed inspection information).

2 Ensure that the ac-power setting, ac-line fuse (rear panel), and supplied power cord are appropriate for your ac-power source. (Refer to Chapter 7, "Installation," for detailed information.)

3 Now, apply power to the instrument by connecting ac-power source to the instrument via the ac power cord. The amber **Attention** light is lit indicating normal power-up sequence and the following messages are displayed on the LCD in sequence:

a. The message "waiting for ion pump start" may appear. If so it could stay on for up to 20 minutes before the following messages appear.
b. Warming up (**this indicates self-test passed successfully**)
c. Lowering E_mult voltage
d. Setting Osc. Control
e. Setting RF amplitude
f. Setting E_mult voltage
g. Logging signal levels
h. Setting C-field
i. Locking servo loops
j. Operating normally

4 After about 15 minutes (typically), the **Attention** (amber) light goes out and the **Continuous Operation** (green) light flashes. This indicates that all servo loops have locked and the instrument is operating normally.

5 Press **Shift**, then **5** (Utilities).

LCD display shows `RESET`.

6 Press **Enter**.

This resets the continuous operation circuit, causing the light to be on steadily. Any subsequent fault will cause the **Continuous Operation** light to go out or flash.

7 Mark Pass or Fail on the Performance Test Record, line 1.

NOTE

The 5071A powers up at shipment receipt with the following configuration:

Output Ports:

Port 1	5 MHz output
Port 2	10 MHz output

RS-232C:

Baud rate	2400
Data bits	8
Parity	none
Stop bits	1

System Logs:

Printer log	disabled
Error log	lock completed

These first-time power-up configurations can be changed by using the front panel controls. See the section titled “Setting the Output Port Frequency” in the 5071A Operating and Programming Manual for instructions on how to do this.

Rear-Panel Output Signal Checks

Check the rear-panel outputs for appropriate signal waveform, frequency and voltage.

Required Equipment

- BNC-to-BNC 1-meter cable (male connectors), model number HP/Agilent 10503A
- Type N (male)-to-BNC (female) adapter, HP/Agilent part number 1250-0780
- 50-Ω feedthrough BNC (male) and (female) adapter, model number HP/Agilent 10100C
- HP/Agilent 54600A General-Purpose 100 MHz Oscilloscope (or equivalent)

To check the rear-panel output connectors quickly for the presence of valid output signals, perform the following steps:

NOTE The LCD display backplane light will turn off after approximately 4 minutes to conserve energy if no front-panel key is pressed. Press any key to turn the backplane light back on.

1 Connect one of the 5071A outputs to an input channel of the HP/Agilent 54600A with a 50-Ω feed through termination and BNC cable as shown in Figure 1-1.

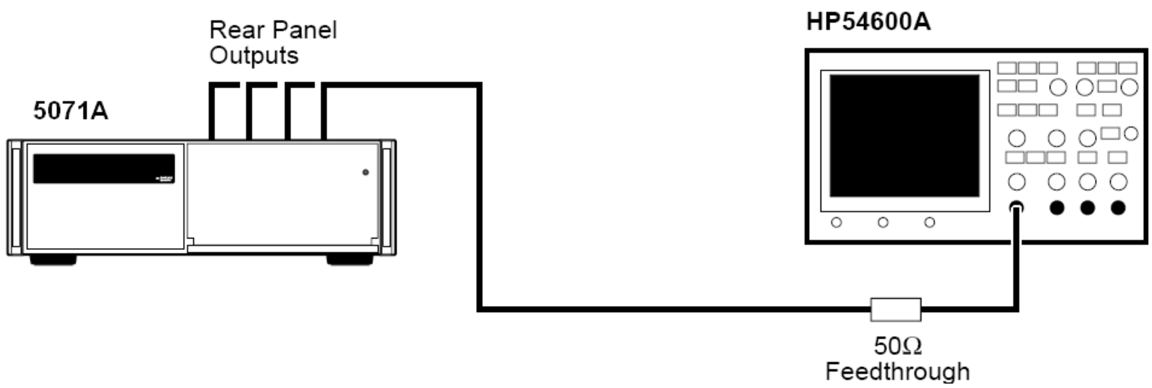

Figure 1-1. Rear-Panel Outputs Verification Setup

2 On the HP/Agilent 54600A Oscilloscope, press “Autoscale.” (Use manual settings if needed to check the 1pps Outputs.)

3 Verify that the output signal waveform, frequency, and nominal voltage correspond to the values listed in Chapter 6, “Specifications,” for the signal under test.

4 Repeat steps 1 through 4 for all outputs.

5 Mark Pass or Fail on the Performance Test Record, line 2.

RS-232 Serial Port Verification

1 Ensure that the correct hardware connections exist between the 5071A and your terminal, personal computer, or workstation for your remote operation needs as shown in Figure 1-2.

2 Ensure that the 5071A and your data communications equipment (terminal) are powered-up and have passed their own self-tests.

3 On your terminal, press the “Enter” or “Return” key several times.

4 Observe the returned **scpi>** or **E-xxx>** prompt on the terminal screen.

if the above prompt appears, the RS-232 Verification check passed.

If the prompt does not appear:

- Check and verify all serial port parameters: baud rate, data bits, stop bits, and parity.
- Check and verify the hardware connections and cabling for correct DTE-DCE signal paths. (Serial-port pin assignments are shown on page 4-2 of the Operating and Programming manual.)
- Check and verify all cables and connections for open or shorted lines.

5 Mark Pass or Fail on the Performance Test Record, line 3.

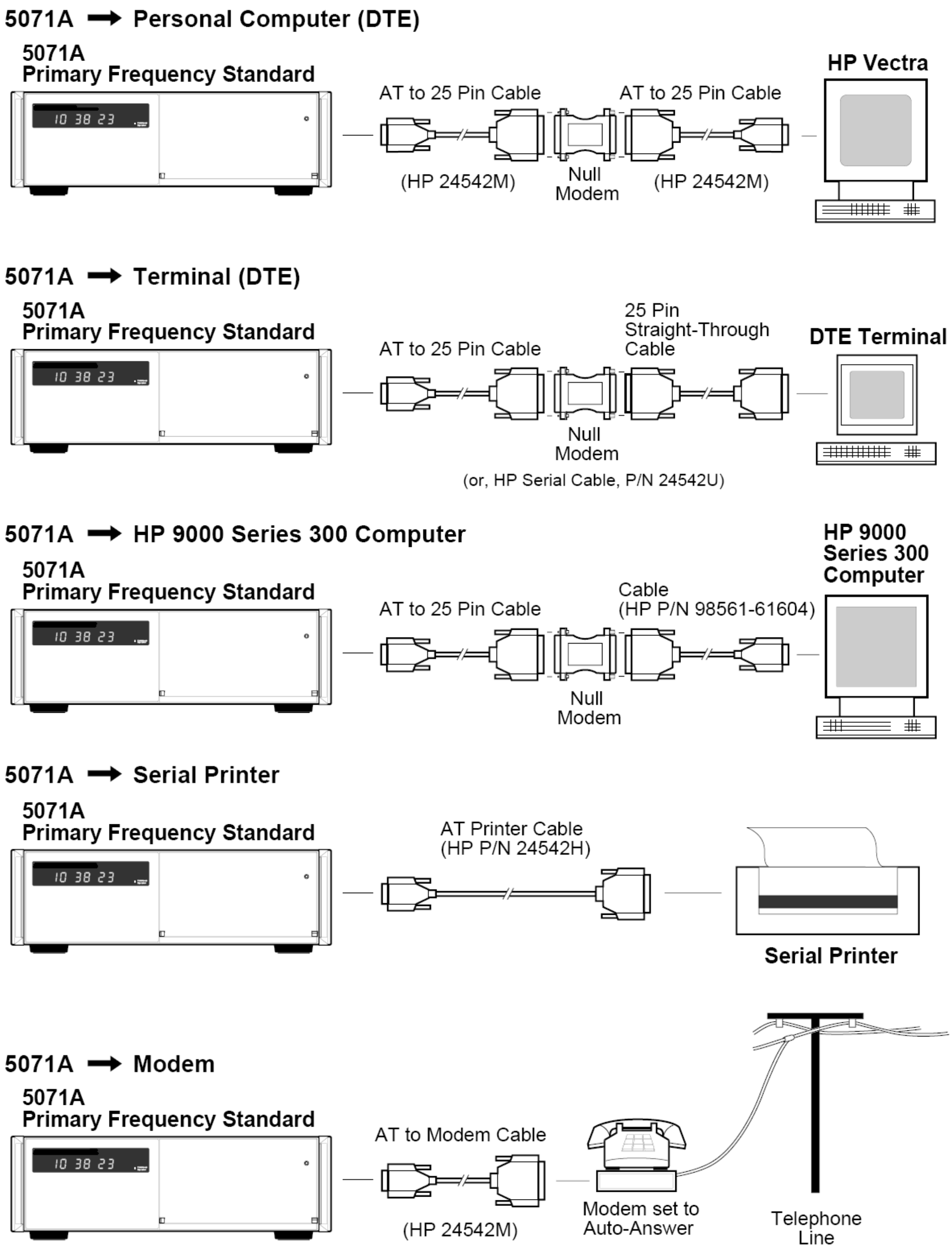

Figure 1-2. RS-232C Cabling Setups

5071A Complete Performance Tests

Before performing the following tests, the 5071A under test must have been in operation for at least 30 minutes. If you are initially starting the 5071A, follow the instructions in the “Power-On Self Tests” procedure under the Operational Verification Test on page 7.

Test 1 — Output Signals: Harmonic Distortion and Spurious Signals Check

A. Harmonic Distortion Check for the 5 and 10 MHz Outputs

Harmonics on the 10 MHz and 5 MHz output signals must be more than 40 dBc below the fundamental. To perform this check, a spectrum analyzer is tuned to the fundamental frequency and an amplitude reference is established. The output frequency spectrum is then examined to determine fundamental-to-sideband amplitude relationship at harmonic points of the fundamental.

Equipment

HP/Agilent 3585B Spectrum Analyzer

Setup

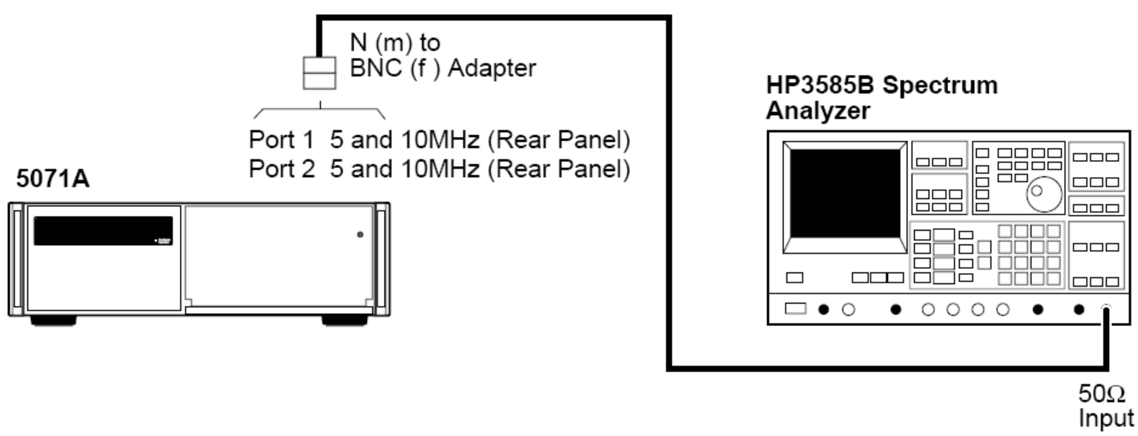

Figure 1-3. Harmonic Distortion Test Setup

Specifications

Verify all harmonics are < –40 dBc with respect to the fundamental frequency.

Procedure

If you are using the HP/Agilent 3585B Spectrum Analyzer, follow the steps below to test for harmonic signals on the 5 and 10 MHz outputs. If you are using a different spectrum analyzer, use these steps as a guide for operation of that analyzer.

1 Connect the 5071A Port 1 to the HP/Agilent 3585B analyzer as shown in Figure 1-3. Set the 3585B for 50Ω input impedance.

2 On the 5071A, set output ports 1 and 2 to 10 MHz using the front panel controls. See the section titled “Setting the Output Port Frequency” in the 5071A Operating and Programming Manual for instructions on how to do this.

3 On the HP/Agilent 3585B, perform the following steps:

a) Press the green “INSTR PRESET” button and allow the analyzer to go through its auto range algorithm (this takes about 5 seconds).

b) Press the “DISP LINE” (display line) button in the marker menu and adjust the line to –40.0 dBc.

c) Press the “PEAK SEARCH” button and then the “MKR->REF LVL” button (both are in the marker menu area).

d) Set both the resolution bandwidth (RES BW) and the video bandwidth (VIDEO BW) to 1 kHz. Enter the 1 kHz values using the numeric and unit keys. The RES BW and VIDEO BW values are displayed at the bottom of the screen.

NOTE The sweep time is 125 seconds. DO NOT adjust the sweep time manually.

e) Press the “CONT” button in the sweep menu area to begin a new sweep.

f) When the new sweep has passed through the fundamental frequency, press the “PEAK SEARCH” button again. Then press the “OFFSET” and the “ENTER OFFSET” buttons in the marker menu area. Verify that both the offset frequency (Hz) and the offset level (dB) go to zero (0 Hz and 0 dB should be displayed at the top of the screen). If necessary, press and hold the “ENTER OFFSET” button to zero-out the marker offsets.

g) When at least one sweep has completed, verify that there are no harmonic signals on or above the –40dBc display line. Use the knob in the marker area to move the offset marker to any harmonic signal that you want to measure or record. The marker shows the offset frequency and level in dBc from the output signal at 5 or 10 MHz. Verify that there are no harmonically related signals on or above –40dBc within 5 harmonics of the fundamental.

4 On the 5071A, set output ports 1 and 2 to 5 MHz using the front panel controls.

5 Repeat step 3.

6 Connect 5071A Port 2 to the HP/Agilent 3585B Spectrum Analyzer and repeat steps 2 through 5 to test Port 2.

7 Record the actual reading in the appropriate place in the Performance Test Record.

B. Non-Harmonic (Spurious) Signal Check for the 5 and 10 MHz Outputs

Non-harmonically related (spurious) signals on the 5 and 10 MHz outputs must be more than 80 dBc below the output signal levels. To perform this test, a spectrum analyzer is tuned to the 5 or 10 MHz signal and an amplitude reference is established. The output frequency spectrum is then examined at 1 MHz on either side of the center frequency to determine the fundamental-to-sideband amplitude relationship for any signals occurring within this range.

Equipment

HP/Agilent 3585B Spectrum Analyzer

Setup

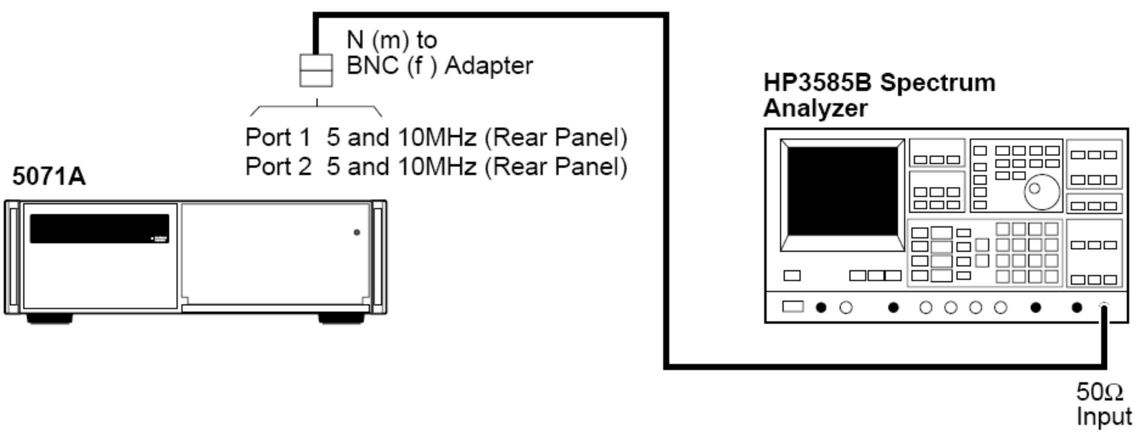

Figure 1-4. Non-Harmonic Distortion Test Setup

Specifications

All spurious nonharmonic signals must be < –80 dBc with respect to the fundamental frequency.

Procedure

If you are using the HP/Agilent 3585B Spectrum Analyzer, follow the steps below to test for spurious signals on the 5 and 10 MHz outputs. If you are using a different spectrum analyzer, use these steps as a guide for operation of that analyzer.

1 Connect the 5071A Port 1 to the 3585B analyzer as shown in Figure 1-4. Set the 3585B for 50Ω input impedance.

2 On the 5071A, set output ports 1 and 2 to 10 MHz using the front panel controls. See the section titled “Setting the Output Port Frequency” in the 5071A Operating and Programming Manual for instructions on how to do this.

3 On the 3585B, perform the following steps:

a) Press the green “INSTR PRESET” button and allow the analyzer to go through its auto range algorithm (this will take about 5 seconds).

b) Press the “DISP LINE” (display line) button in the marker menu and adjust the line to –80.0 dBc.

c) Press the “PEAK SEARCH” button and then the “MKR->REF LVL” button (both are in the marker menu area).

d) Set both the resolution bandwidth (RES BW) and the video bandwidth (VIDEO BW) to 1 kHz. Enter the 1 kHz values using the numeric and unit keys. The RES BW and VIDEO BW values are displayed at the bottom of the screen.

NOTE The sweep time is 125 seconds. DO NOT adjust the sweep time manually.

e) Press the “CONT” button in the sweep menu area to begin a new sweep.

f) When the new sweep has passed through the fundamental frequency, press the “PEAK SEARCH” button again. Then press the “OFFSET” and the “ENTER OFFSET” buttons in the marker menu area. Verify that both the offset frequency (Hz) and the offset level (dB) go to zero (0 Hz and 0 dB should be displayed at the top of the screen). If necessary, press and hold the “ENTER OFFSET” button to zero-out the marker offsets.

g) When at least one sweep has completed, verify that there are no spurious signals on or above the –80 dBc display line. Use the knob in the marker area to move the offset marker to any spurious signal that you want to measure or record. The marker shows the offset frequency and level in dBc from the output signal at 5 or 10 MHz.

h) Verify that one of the following conditions is true:

No spurious signals are on or above the –80 dBc display line between 4 MHz and 6 MHz for the 5 MHz output, or

No spurious signals are on or above the –80 dBc display line between 9 MHz and 11 MHz for the 10 MHz output.

4 On the 5071A, set output ports 1 and 2 to 5 MHz using the front panel controls.

5 Repeat step 3.

6 Connect 5071A Port 2 to the 3585B Spectrum Analyzer and repeat steps 2 through 5 to test Port 2.

7 Record the actual reading in the appropriate place in the Performance Test Record.

C. Harmonic Distortion Check for the 1 MHz Output

Harmonics on the 1 MHz output signal must be more than 40 dBc below the fundamental. To perform this check, a spectrum analyzer is tuned to the fundamental frequency and an amplitude reference is established. The output frequency spectrum is then examined to determine the fundamental-to-sideband amplitude relationship at harmonic points of the fundamental.

Equipment

HP/Agilent 3585B Spectrum Analyzer

Setup

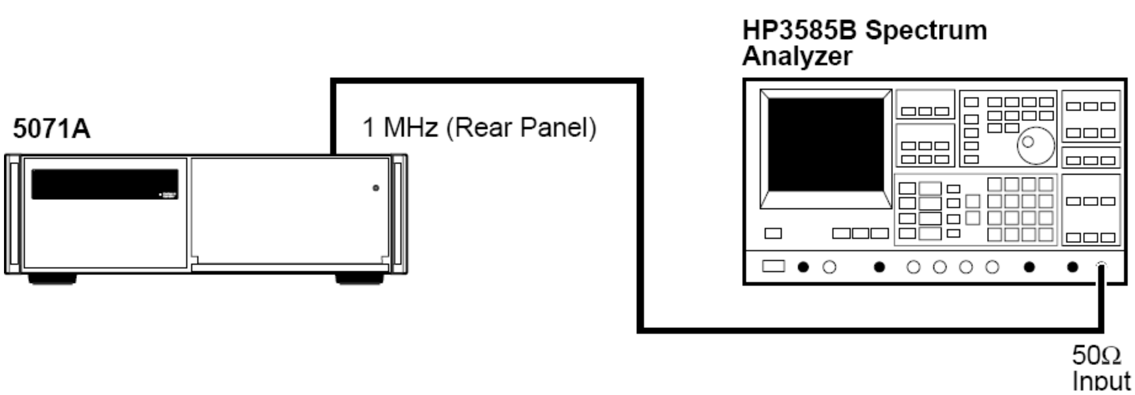

Figure 1-5. 1MHz Output Harmonic Distortion Test Setup

Specifications

All harmonics must be < –40 dBc with respect to the fundamental frequency.

Procedure

If you are using the HP/Agilent 3585B Spectrum Analyzer, follow the steps below to test for harmonic signals on the 1 MHz output. If you are using a different spectrum analyzer, use these steps as a guide for operation of that analyzer.

1. Connect the 5071A 1 MHz output to the 3585B Spectrum Analyzer as shown in Figure 1-5. Set the 3585B for 50Ω input impedance.

2. On the 3585B, perform the following steps:

   a. Press the green “INSTR PRESET” button and allow the analyzerto go through its auto range algorithm (this will take about 5 seconds).

   b. Press the “STOP FREQ” button. Then set the stop frequency to 20 MHz using the numeric and unit keys in the entry menu.

   c. Press the “DSP LINE” button and move the display line to–40.0 dBc.

   d. Press the “PEAK SEARCH” button, then the “MKR->REF LVL” button.

   e. When the new sweep has passed through the fundamental frequency, press the “OFFSET” and the “ENTER OFFSET” buttons in the marker menu area. Verify that both the offsetfrequency (Hz) and the offset level (dB) go to zero (0 Hz and 0 dBshould be displayed at the top of the screen). If necessary, pressand hold the “ENTER OFFSET” button to zero-out the markeroffsets.

   f. When at least one sweep has completed, verify that there are no signals on or above the –40 dBc display line at multiples of 1 MHz up to 4 MHz. Use the knob in the marker area to move the offsetmarker to any signals within this range if you want to measure or record these signals. The marker shows the offset frequency and level in dBc from the 1 MHz signal.

3. Record the actual reading in the appropriate place in the Performance Test Record.

D. Harmonic Distortion Check for the 100 kHz Output

Harmonics on the 100 kHz output signal must be more than 40 dBc below the fundamental. To perform this check, a spectrum analyzer is tuned to the fundamental frequency and an amplitude reference is established. The output frequency spectrum is then examined to determine fundamental-to-sideband amplitude relationship at harmonic points of the fundamental.

Equipment

HP/Agilent 3585B Spectrum Analyzer

Setup

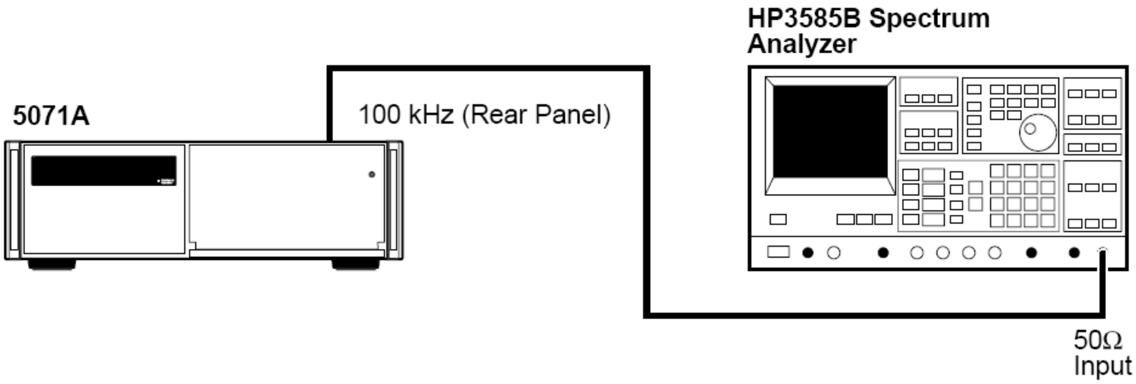

Figure 1-6. 100 kHz Harmonic Distortion Test Setup

Specifications

All harmonics must be < –40 dBc with respect to the fundamental frequency.

Procedure

If you are using the HP/Agilent 3585B Spectrum Analyzer, follow the steps below to test for harmonic signals on the 100 kHz output. If you are using a different spectrum analyzer, use these steps as a guide for operation of that analyzer.

1 Connect the 5071A 100 kHz output to the 3585B Spectrum Analyzer as shown in Figure 1-6. Set the 3585B for 50Ω input impedance.

2 On the 3585B, perform the following steps:

a. Press the green “INSTR PRESET” button and allow the analyzer to go through its auto range algorithm (this will take about 5 seconds).

b. Press the “STOP FREQ” button. Then set the stop frequency to 3 MHz using the numeric and unit keys in the entry menu.

c. Press the “DSP LINE” button and move the display line to –40.0 dBc.

d. Press the “PEAK SEARCH” button, then the “MKR->REF LVL” button.

e. Set the resolution bandwidth (RES BW) to 300 Hz and the video bandwidth (VIDEO BW) to 1 kHz.

NOTE The sweep time is 66.8 seconds. DO NOT adjust the sweep time manually.

f. Press the “CONT” button in the sweep menu area to begin a new sweep.

g. When the new sweep has passed through the fundamental frequency, press the “OFFSET” and the “ENTER OFFSET” buttons in the marker menu area. Verify that both the offset frequency (Hz) and the offset level (dB) go to zero (0 Hz and 0 dB should be displayed at the top of the screen). If necessary, press and hold the “ENTER OFFSET” button to zero-out the marker offsets.

h. When at least one sweep has completed, look for any signals that appear on or above the –40 dBc display line at multiples of 100 kHz up to 500 kHz. Use the knob in the marker area to move the offset marker to any signals within this range if you want to measure or record these signals. The marker shows the offset frequency and level in dBc from the 100 kHz signal.

3 Record the actual reading in the appropriate place in the Performance Test Record.

Test 2 — Frequency Accuracy

The following accuracy check measures the changing phase relationship between the 5071A 10 MHz output and another primary frequency standard (5071A Primary Frequency Standard or better). An HP/Agilent K34-59991A Linear Phase Comparator is used to measure the phase between the 5071A under test and the reference standard.

NOTE

In this test, the reference standard must be of known accuracy. The measurement time must be of sufficient length so the accuracy of the measurement is not impaired by the stability of either the reference standard or the unit under test. If the reference standard is a 5071A with the High-Performance CBT, the accuracy measurement must be made for 24 hours if the unit under test is a Long-Life (Standard) CBT. The test can be made in 2 1/2 hours if the unit under test has the High-Performance CBT.

Equipment

HP/Agilent K34-59991A Linear Phase Comparator
Strip Chart Recorder

Setup

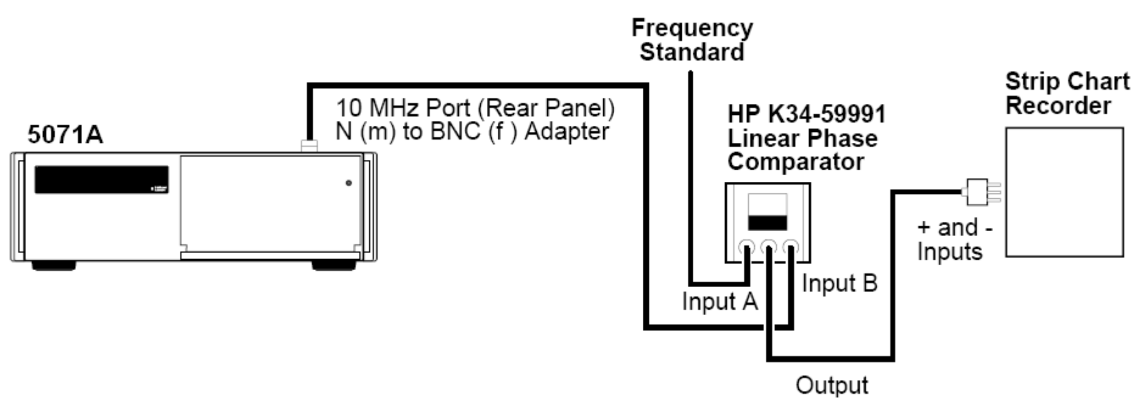

Figure 1-7. Frequency Accuracy Test Setup

Specifications

Long-Life (Standard): ± $1x10^{-12}$

High-Performance: ± $2x10^{-13}$

NOTE

The accuracy of the 5071A is better than $2x10^{-13}$ (High-Performance) or $1x10^{-12}$ (Long-Life). Be sure the accuracy of the reference standard is known with sufficient precision to make this measurement accurately.

Procedure

1. The 5071A must be on for at least 30 minutes and the green continuous operation LED must be on.
2. Connect the HP/Agilent K34-59991A Phase Comparator OUTPUT terminals to the strip chart recorder as shown in Figure 1-7. Set the recorder for 1V full scale and 1 inch/hour. Turn on the recorder.
3. Turn on the K34-59991A power.
4. Connect the 10 MHz reference to INPUT A and the 5071A (unit under test) 10 MHz to INPUT B as shown in Figure 1-7.
5. Set K34-59991A "ZERO-OPER-FULL" front panel mounted toggle switch to "ZERO." Adjust the "ZERO SCALE" control for a zero reading on the meter. Then adjust the recorder for a zero indication.
6. Set K34-59991A switch to "FULL" and adjust "FULL SCALE" control for a full scale reading on the recorder.
7. Check both "ZERO" and "FULL SCALE" settings on the recorder and readjust if necessary.
8. Set K34-59991A switch to "OPER" for normal operation.
9. The recorder now provides a continuous record of the phase difference between the reference standard and the 5071A unit under test. When its output reaches full scale (360 degrees), the K34-59991A will automatically reset to 0 (0 degrees).
10. With the recorder set as described, the phase record is 100 ns full scale (with 10 MHz inputs). The figure below shows an example of a frequency difference measurement under these conditions.
11. The frequency difference between the unit under test and the reference is given by the following equation:

$$\Delta f/F = \Delta t/T$$

Where: $\Delta f/F$ is the desired frequency difference, and Δt is the phase change (in seconds) over the measurement time, T.

The Figure 1-8 shows a typical plot using the strip chart recorder.

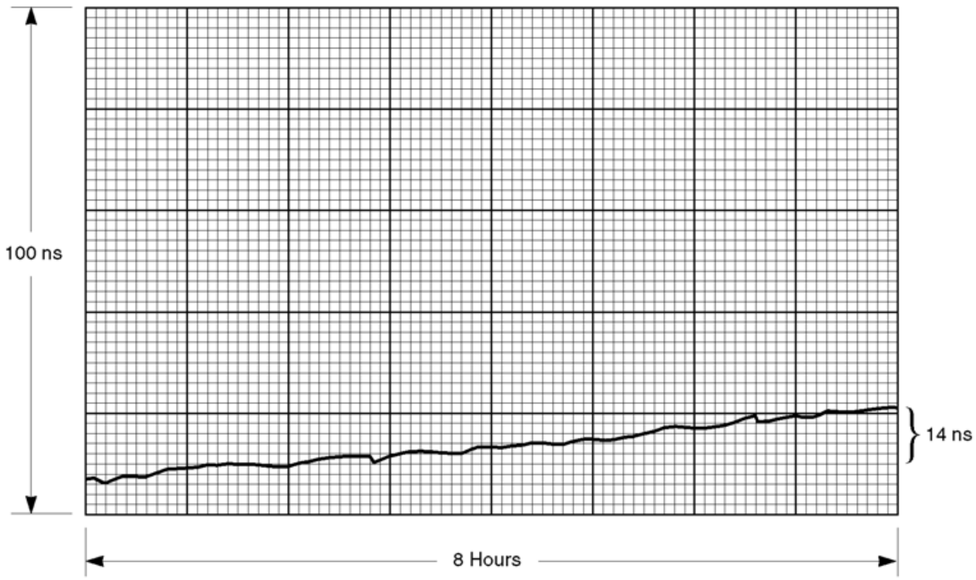

Figure 1-8. Error Measurement

In the example, the frequency difference, $\Delta f/F$, is computed as follows:

$\Delta f/F = \Delta t/T$

Δt = (7 minor divisions × $2x10^{-9}$ seconds/minor divisions)
= $14x10^{-9}$ seconds

T = 8 hours or 2.88×10^4 seconds

$\Delta f/F = \Delta t/T = 14 \times 10^{-9}/2.88 \times 10^4$

$= 4.9 \times 10^{-13}$ or 4.9 parts in 10^{13}

This shows that frequency difference between the unit under test and the reference is 4.9 parts in ten to the 13th. This is only an example. The measured frequency accuracy of a 5071A should be 1 x 10^{-12} or better for a Long-Life (Standard), or 2 x 10^{-13} or better for a high performance unit

NOTE

The final computation should include the accuracy of the reference source.

12 Record the actual reading in the appropriate place in the Performance Test Record.

Test 3 — Stability

NOTE

High accuracy precision measurements of time stability are available through the National Institute of Standards and Technology (NIST) in the USA. NIST can completely characterize and verify all major specifications of the 5071A. For information regarding the various tests available, contact:

M.C. 847.4
National Institute of Standards and Technology
325 Broadway
Boulder CO 80303-3328
USA
Telephone: (303) 497-3753

A. Time Domain

This is an engineering-level measurement requiring a special test setup. The test setup must be carefully designed to eliminate all sources of noise. For more information on how to make this measurement, see NIST Technical Note 1337 (available from US Government Printing Office, Washington DC., USA). This is an excellent theoretical as well as technical reference for this measurement.

Record the actual reading in the appropriate place in the Performance Test Record. This completes the performance test.

B. Frequency Domain

This measurement requires the HP/Agilent 3048A or equivalent Phase Noise Measurement System, a highly specialized test system. In order to perform properly, this system must contain a reference oscillator with phase noise characteristics that are equal to or better than the 5071A. Instructions for performing frequency domain stability tests can be found in the HP/Agilent 3048A system documentation.

Record the actual reading in the appropriate place in the Performance Test Record.

Performance Test Record

Model 5071A Primary Frequency Standard

Serial Number: ____________________ **Repair/Work Order No.** ____________________

Test Performed By: ________________ **Temperature:** ____________________

Date: ____________________________ **Relative Humidity:** ____________________

Notes: ____

Test Number	Operational Verification	Test Results Pass	Fail
1	Power-On Self-Tests/Servo Lock	_______	_______
2	Rear-Panel Output Signal Checks	_______	_______
3	RS-232 Serial Port Verification	_______	_______

Complete Performance Tests

Test Number	Description	Actual Reading	Limits
1	Output Signals: Harmonic Distortion and Spurious Signals Check		
	A. Harmonic Distortion Check for the 5 and 10 MHz Outputs	____________	Greater than 40 dBc
	B. Non-harmonic (Spurious) Signal Check for the 5 and 10 MHz Outputs	____________	Greater than 80 dBc
	C. Harmonic Distortion Check for the 1 MHz Output	____________	Greater than 40 dBc
	D. Harmonic Distortion Check for the 100 kHz Output	____________	Greater than 40 dBc

Test Number	Description	Actual Reading	Limits
2	Frequency Accuracy	____________	Long-Life: $\pm 1x10^{-12}$ High-Performance: $\pm 2x10^{-13}$
3	Stability **A.** Time Domain **B.** Frequency Domain	 ____________ ____________	See Specifications table in Chapter 6 of this manual.

2. Service

Introduction

NOTE

In the interest of PRESERVING its usability most of the information in this chapter has been retained in its original form. No attempt has been made to update the equipment, accessories, or parts to reflect current availability. It is therefore necessary for the user of this manual to consider the recommendations of test equipment and accessories as suggestions. Some or all of these items may no longer be available from Symmetricom or any other vendors. An updated list of available replacement parts from Symmetricom is provided in Chapter 5.

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

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

Returning the Instrument to Symmetricom for Service

To Provide Repair Information

If you are shipping the instrument to Symmetricom for service or repair, call your nearest Symmetricom sales representative or distributor to make arrangements. Alternatively you can visit our web site at http://www.symmetricom.com/support/warrantyandrepair and fill out the form to receive an RMA and return address information.

IMPORTANT NOTE

If you do not have the original shipping container for the 5071A it is STRONGLY recommended that you first order the packaging kit part number 59991-91105 from Symmetricom before returning for repair. This kit provides all the necessary packaging material to give the greatest amount of protection against shipping damage. Any 5071A received for repair in any other packaging and found damaged will not be covered under any Symmetricom warranty program. Such damage will be evaluated and you will be provided with a quotation to repair such damage before regular repair or calibration can be performed.

It is also advised that all hazardous materials regulations for labeling be followed for your local and country laws. The following web site will provide you with up-to-date instructions: http://www.symmttm.com/5071A/Shipping/

Be sure to include the RMA with the shipment.

To Pack in the Original Packaging Materials

To protect your 5071A against shipping damage repack the instrument in its original packaging for shipment. Shipping kit Part Number 59991-91105 is available through Symmetricom. 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.
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 Apply the appropriate shipping labels.

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.

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.

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 workstations 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 trouble-shooting and repair procedures have been completed to ensure the safe operation of the instrument.

WARNING

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.

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 1Ω. 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 MΩ. Replace any component that 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.

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 Symmetricom. 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.

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

Accessory	**Part Number**	**Use**
Service Manual	05071-90040	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

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.
A1	Motherboard Assembly	05071-68001
A1	Motherboard Assembly, Opt.048 only	05071-68028
A2	CBT Controller Assembly	05071-60202
A3	Microprocessor Assembly	05071-68003
A4	Digital Synthesizer Assembly	05071-68004
A5	87 MHz PLL Module	05071-60272
A6	Servo Assembly	05071-68006
A7	Interface Assembly	05071-68007
A8	1 PPS Assembly	05071-68008
A9	Frequency Multiplier Module	05071-60292
A10	Output Frequency Distribution Amplifier Module	05071-60210
A11	Power Steering Logic Assembly, Std	05071-68029
A11	Power Steering Logic Assembly, Opt. 048 only	05071-68033
A12	Dc-Dc Power Converter Module	05071-60212
A12	DC-DC Power Converter Module. Opt. 048 only	05071-60279
A13	Front-Panel PC Assembly	05071-60213
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 or Option 001 High Performance CBT Assembly	10890A 10891A
A18	9.2 GHz PLL Module	05071-60218
A19	Reference Oscillator (Quartz) Module	05071-60294
LF1	Line Filter/Cable Assembly	05071-60259
T1	Toroidal Power Transformer	9100-4962
T1	Toroidal Power Transformer, Opt. 048 only	9100-5134

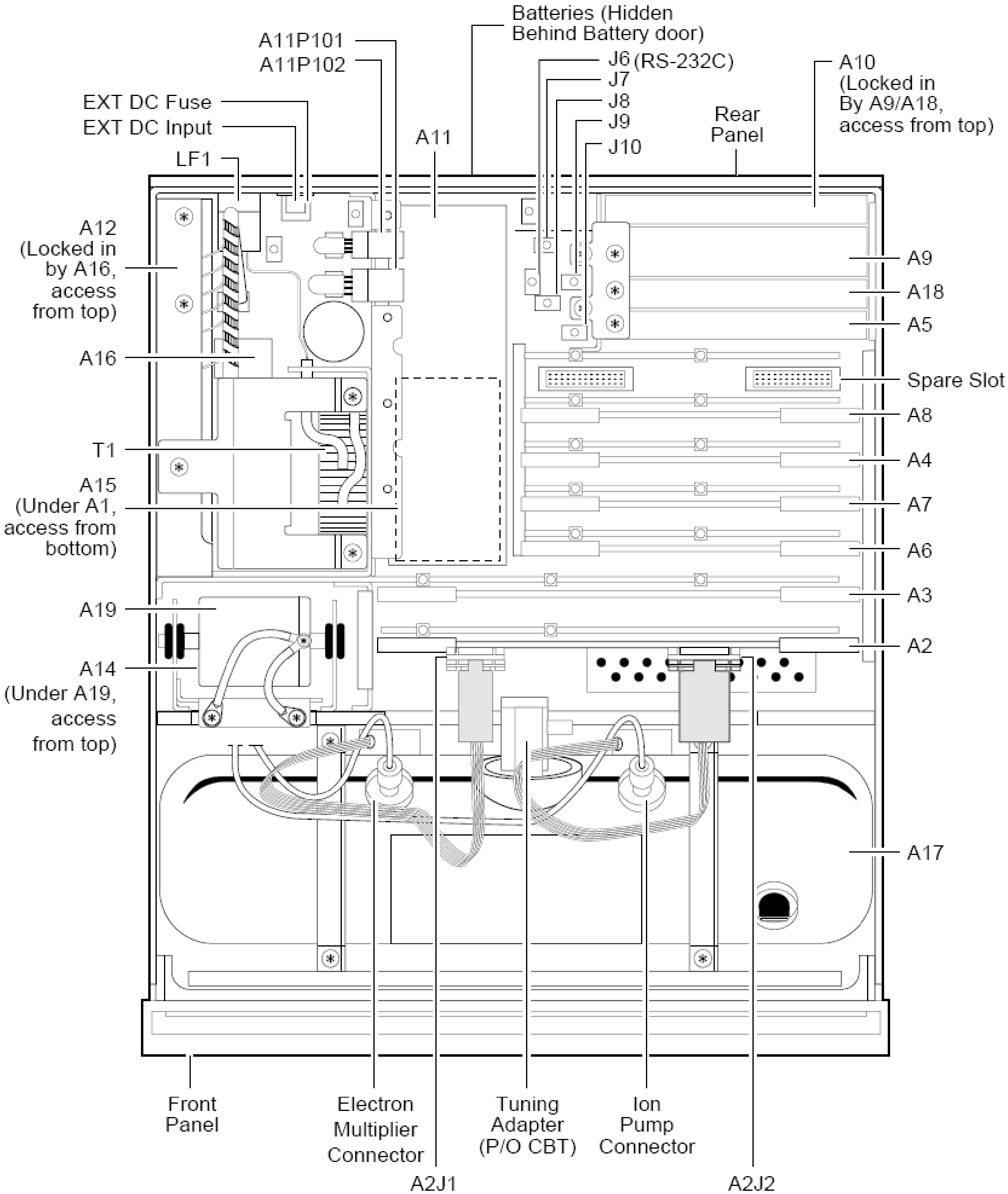

Figure 2-1. Instrument Top View

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.

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.

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 <u>for certain</u> 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 <u>for certain</u> 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

Warm-up and Operating Fatal Error Diagnostic Tree (Diagnostic Subsection 3)

Warning Message Diagnostic Tree (Diagnostic Subsection 4)

I/O Diagnostic Tree (Diagnostic Subsection 5)

CBT Performance Evaluation (Diagnostic Subsection 6)

Advisory Messages (Diagnostic Subsection 7)

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 Symmetricom 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). (For Opt. 048, ensure that the rear-panel dc-line fuse holder has a good fuse of the correct rating).
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 dc or 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.

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

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

If Yes: Go to, 1.0.2.

If No: Disconnect power immediately and check the appropriate rear panel power fuse.

If fuse is intact, Go to, 1.0.1.1. (For Opt. 048 Go to 1.0.1.1.0.)

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

1.0.1.1.0 DC Input 1 and 2 Power Steering Circuit Check

1 Use the DC Input 1 and 2 Power Steering Schematic (Figure 2-1.) located on page 32 of this chapter to troubleshoot the dc power input steering function.

QUESTION: Is the DC input power steering circuit functional?

If Yes: Go to, 1.0.1.1.

If No: Replace the 48V Sub-panel Assembly (P/N 05071-60277) and retest.

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 159.), 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 05071-68051) into the spare slot on the A1 motherboard.

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).

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.

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, Warm-up 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.

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 ±100% range. It is desirable to schedule readjustment of the A19 frequency if the control value reaches ± 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 a 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 Symmetricom 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.

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 (XOPTP1 and XOPTP2).

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 Ω impedance input of an oscilloscope. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 (± 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 Vp-p. (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 Symmetricom 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 µs 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 Symmetricom for further assistance.)
If No: Remove power, replace A8, and retest.

Warm-up 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

FIRST WORD (Rightmost word):

```
-      0    0    0    0    0    0    0    0  ⇐Hex digit
      /\  /\  /\  /\  /\  /\  /\  /\
     00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ⇐Binary digit
     | | | | | | | | | | | | | | |  \_1. Servo offset - No Message
     | | | | | | | | | | | | | |  \_2. CBT shutdown: <#> - Fatal Error
     | | | | | | | | | | | | |  \_3. VCXO near tuning limit - Warning
     | | | | | | | | | | | |  \_4. VCXO at tuning limit - Fatal Error
     | | | | | | | | | | |  \_5. C-field current at range limit - Fatal Error
     | | | | | | | | | |  \_6. E-multiplier voltage at range limit - Message
     | | | | | | | | |  \_7. Signal gain at range limit - Warning
     | | | | | | | |  \_8. Internal DC supply out of range - Warning
     | | | | | | |  \_9. Mass spec supply regulation failure - Fatal Error
     | | | | | |  \_10. Hotwire supply regulation failure - Fatal Error
     | | | | |  \_11. CBT oven supply regulation failure - Fatal Error
     | | | |  \_12. CBT oven voltage at range limit - Fatal Error
     | | |  \_13. RF amplitude at range limit - Warning
     | |  \_14. Microprocessor PLL unlocked - Warning
     |  \_15. 87 MHz PLL unlocked - Message
      \_16. Unused bit - always zero.
```

SECOND WORD:

```
  0     0     0     0     0     0     0     0   ⇐ Hex digit
 / \   / \   / \   / \   / \   / \   / \   / \
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ⇐ Binary digit
|                        |  |  |  |  |  |  |    \_17. DRO unlocked - Message
|                        |  |  |  |  |  |    \_18. VCXO oven error - Message
|                        |  |  |  |  |    \_19. CBT signal loss - Fatal Error
|                        |  |  |  |    \_20. CBT signal low - Warning
|                        |  |  |    \_21. Servo system is in manual mode - Warning
|                        |  |    \_22. Attempted lock on wrong peak - Fatal Error
|                        |    \_23. Center peak saturated - Message
 \-----reserved--------/
```

Example Error-Code Interpretation

- You can create a fatal error by disconnecting A5P2 from A5 after the instrument has powered-up and is running (wait up to 35 seconds for the software to confirm this failure). When the attention LED begins flashing, you're ready to read the error code from the log.

- Typical log display: Error code: 000000a0 20000000

- By using the above error-message map, the following information may be decoded:
  - 15. 87 MHz PLL unlocked - Message
  - 19. CBT signal loss - Fatal Error (This is the event that initiated the shut-down.)
  - 20. CBT signal low – Warning

NOTE **You must power-off, reconnect A5P2, and then power-on again to clear this error**.

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 μA 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 μA?

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 instrument 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 Symmetricom 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 Symmetricom 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.

If CBT shutdown: E-mult adjust failed – This indicates that although larger e-mult movements were attempted the internal CBT parameters could not be compensated sufficiently to allow continued operation. Repair is likely necessary, however a re-start of the 5071A should first be attempted as a possible remedy. If the failure re-occurs with the same message, contact Symmetricom to arrange repair/replacement of the CBT. If the error is not repeated but another error occurs, follow the procedures for that error.

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 Symmetricom 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 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 Symmetricom 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 procedure 2.3.1.0. through 2.3.6.0.

2 Test the C-field circuit by performing procedure 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 Symmetricom 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 ± 0.3 mA, and the `Warming up` current 1.58 ± 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.

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 Symmetricom for further assistance.

1.4.4 Power Source is Batt

(Note: Step 1.4.4 does not apply for Opt. 048)

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.

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. (For Opt. 048 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

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Verify that the voltage is between 45 and 51 Vdc and record results.

QUESTION: Is the voltage 45 - 51 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.

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QUESTION: Is the voltage between 45 and 51 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. (33-47 Vrms for Opt. 048)

QUESTION: Is the voltage between 25-35 Vrms?
(33-47 Vrms for Opt. 048)
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, (9100-5134 for Opt. 048)), 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 (See the title page for information on how to download a copy)

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 Locate the folder with the ‘ck5071a.exe’ file and execute it 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.

4 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.

5 Press `Terminal emulator` to start a terminal emulator program that can be used for SCPI instructions. (Exit with `Alt Q`.)

6 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.

7 Press `5071A Profile` to start the instrument profiling program.

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

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

A 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 ±100%.

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 Symmetricom 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.

-

```
================================================
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-mult adjusted - this appears to notify that due to internal CBT parameters the E-mult voltage was adjusted by a larger amount than usually required during steady-state operation. The appearance of this message on the display will be accompanied by a visible "wink" of the green Continuous Operation LED which is normal. No action required.

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: `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 Symmetricom 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: 2.1.1.1.0
- 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. (Does not apply for Opt. 048).

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. (Does not apply for Opt. 048).

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 (Vin) at the A12 module (across the Vin and Vin return power input lugs on the module)

4 Verify that the voltage present is between 32 and 38 Vdc (45 and 51 Vdc for Opt. 048) 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 (45 and 51 Vdc for Opt. 048) 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 (45 and 51 Vdc for Opt. 048) 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 (45 and 51 Vdc for Opt. 048) 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 (33 Vrms for Opt. 048).

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), (9100-5134 for Opt. 048) 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.
If No: One or two are less than specified, Go to, 2.1.3.1.0.

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.

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 for non-Opt. 048.

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

(Note: Sections 2.1.5.0.0 through 2.1.5.2.0 do not apply for Opt. 048 instruments)

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 <u>do not disconnect or turn-off</u> 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 MΩ. 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 ($100+ 3.2\times10^4 \times V$)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 1×10^{-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 Ω 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, ±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 ≥2.8 Vp-p into 50 Ω. Record results.

QUESTION: Are both port amplitudes ≥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 1×10^{-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, ±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 ±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 Ω input of an oscilloscope (Use a 50 Ω 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 ±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 ±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 ±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 Milliamperes. 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.
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 ±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.

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:

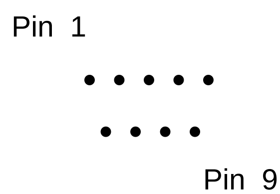
1. A2 Hot-Wire Ionizer tree
2. A2 Thermistor tree
3. A2 Mass-Spectrometer tree
4. A2 Cesium-Oven tree

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

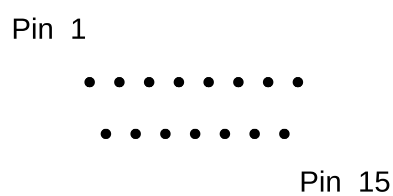
- A2 CBT Controller
- A7 Interface
- A17 Cesium-Beam Tube (CBT)

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 Ω?

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 kΩ?

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 kΩ 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 kΩ?

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 Ω?

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 kΩ 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 kΩ 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 kΩ?

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 kΩ 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 kΩ 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 Ω and 250 k Ω?

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 Ω?

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 kΩ 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 kΩ 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.

NOTE 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 Ω input of an oscilloscope. (If a 50 Ω input is absent, use the high-impedance input with a 50 Ω 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 Ω input of an oscilloscope. (If a 50 Ω input is absent, use the high-impedance input with a 50 Ω 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 (±1 kHz) signal with a 0 ±3 dBm amplitude.

QUESTION: Does the spectrum analyzer show a signal at 87.368 MHz (±1 kHz) with amplitude 0 ±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 Ω input of the oscilloscope (use 50 Ω 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 Symmetricom 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 Symmetricom for further assistance.

3.3.3. 1 PPS Outputs Test

1 Reapply instrument power if required.

2 Use the oscilloscope with 50 Ω 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 Symmetricom 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 Ω input impedance. (If the scope doesn't have a 50 Ω input, use the high impedance input with a 50 Ω 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 Ω input impedance (If the scope doesn't have a 50 Ω input, use the high impedance input with a 50 Ω 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 Ω input of a scope using coax. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω input impedance (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 A10J5.

QUESTION: Does the scope show an 80-MHz undistorted sine wave with at least 0.6 Vp-p 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 Ω input impedance (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω input of a scope using coax. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω input of a scope using coax. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω input of a scope using coax. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω input of a scope using coax. (If a 50 Ω input is absent, use the high impedance input with a 50 Ω 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 Ω 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.

WARNING 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 GigaΩ.)

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 Ω input of an oscilloscope. (If a 50 Ω input is absent, use the high-impedance input with a 50 Ω 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 ±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 Ω input (If a 50 Ω input is absent, use the high-impedance input with a 50 Ω coaxial-feedthrough terminator at the scope end of the coax).

3 Verify presence of an 87.368230 MHz (±100 kHz.) sine wave with at least 0.4 Vp-p amplitude.

QUESTION: Does the scope show an 87.368230 MHz (±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 Ω 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 Ω 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 ±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 Ω 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

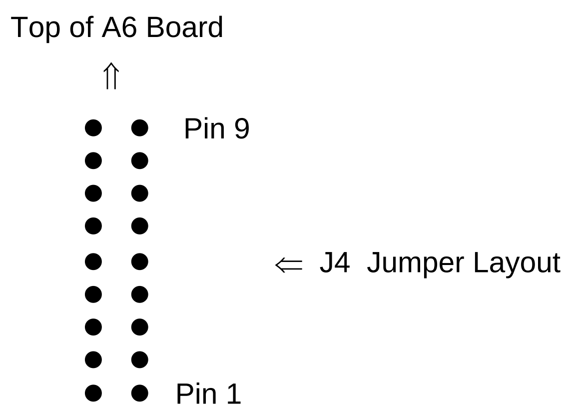
1 Verify reference voltages on A6J4.1/A6J4.9. with a DMM:

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.



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-Pos.Jmpr)-0.03308*(%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 Ω 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 Ω input terminator.

2 Observe the A19 frequency with an accuracy of ±1Hz. (The counter timebase must be calibrated to an accuracy of better than 1×10^{-7}.)

3 Calculate the nominal output frequency of the A19 from the EFC control percentage using the equation:
Freq_nom = 10.0 MHz + 0.0331*(%Ctrl) Hz.

4 Verify that the measured frequency agrees with the calculated frequency to ±2 Hz.

QUESTION: Does the measured frequency agree with the calculated frequency to ±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.

3. Theory of Operation

Introduction

This chapter describes assembly-level operating principles for the 5071A Primary Frequency Standard and is divided into three sections. All three sections of this chapter are organized around functional concepts and the direction of signal flow into, within,
and out-of the instrument/assemblies/modules. Because of this, the presentation of assemblies and modules may not occur in ascending order of reference designation number.

Note

All references to internal-battery power, battery status or battery operation, do not apply for 5071A Option 048. Option 048 does not have an internal standby battery.

Basic Operating Principles

The operation of the 5071A Primary Frequency Standard is based on matching the frequency of a synthesized microwave probe signal to the hyperfine resonance in the ground state of the cesium atom. This resonance is the basis for the internationally accepted unit of time.

In operation, the frequency of a nominal 10 MHz crystal oscillator is multiplied by the correct fixed rational number (frequency synthesis process) to achieve the cesium resonance frequency at 9.192... GHz. This synthesized frequency is compared (as described later), in a cesium atomic beam tube to the actual cesium resonance, creating
an error signal proportional to its difference from the true resonance frequency.

This error signal is processed and fed back to control the 10 MHz crystal oscillator's actual frequency reducing the error to zero. Thus, if the rational number is properly chosen and there are no distortions of the cesium resonance, the crystal oscillator is directed to run at exactly 10 MHz. All outputs from the 5071A are derived from this controlled 10 MHz crystal oscillator.

Simplified Functional Description

This section provides a simplified overview of the instrument's operation along with the function of each block (listed below) as shown in Figure 3-1.

1. Front panel and remote instrument control,
2. 10 MHz reference-source/microwave probe signal synthesis,
3. Cesium frequency definition and error-signal genesis,
4. Analog error-signal amplification, processing, and 10-MHz reference-signal feedback signal generation,
5. Sync-input signal interface/user-output signal selection, generation, and
6. AC/DC power supply and distribution.

Functional Block Descriptions

This section explains how assemblies and modules work together in groups (see Figure 3-2.) to provide the functions and signals described in the simplified-functional description. Additionally, signal path tables are included to provide specific signal path and cabling information useful for ensuring, or re-establishing correct assembly, module, A1 motherboard, and chassis interconnections.

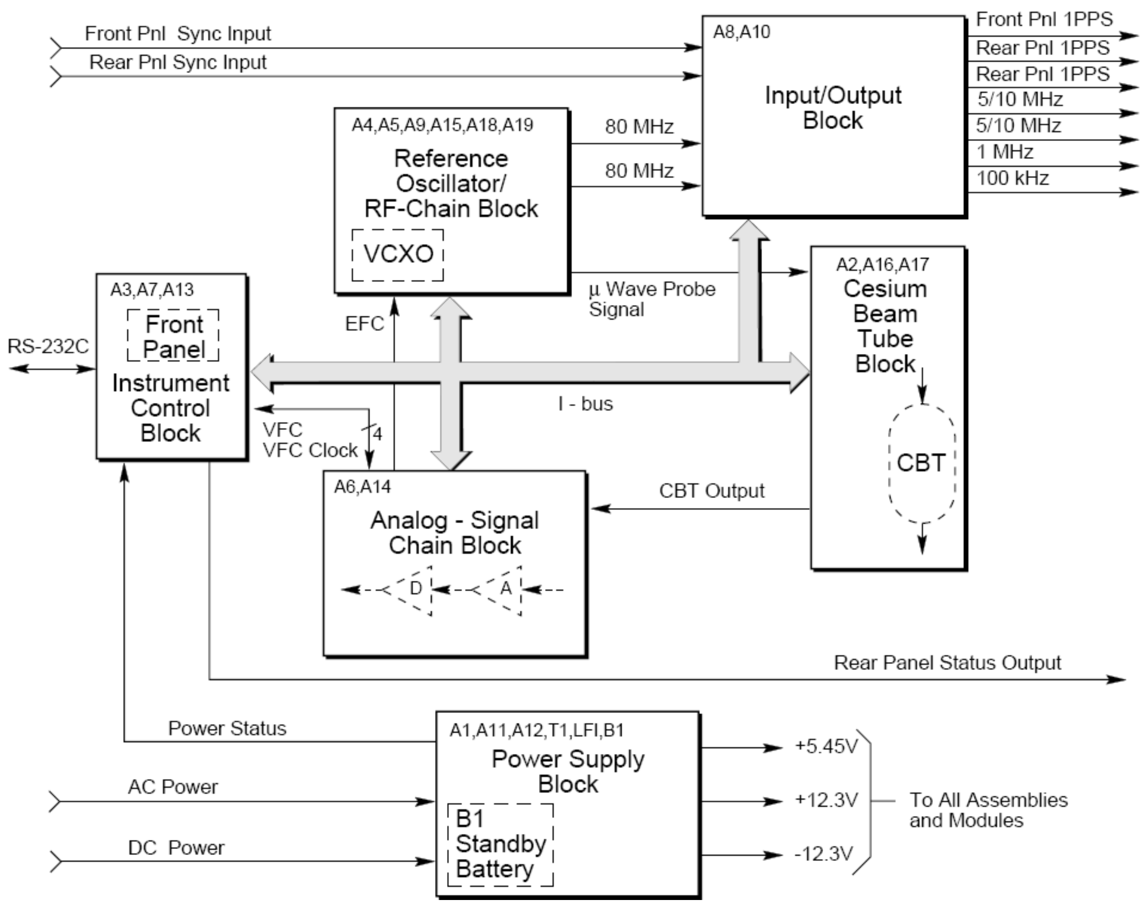
A1 Motherboard Circuit Description

This section provides component-level theory of operation for A1. It gives you information about how individual components on A1 and component groups (including A11, A12, T1, and B1) perform their functions and provide dc power to the instrument.

Simplified Functional Description

This section provides the simplified functional description of the 5071A Primary Frequency Standard. The 5071A provides extremely accurate and stable sine-wave outputs that are within five to ten parts in 10^{13} of the internationally accepted definition of frequency. The organization of the six blocks within the instrument
is shown in Figure 3-1. They are:

1. Instrument control; A3, A7, A13, and Instrument bus (I-bus)
2. Reference oscillator/RF chain; A4, A5, A9, A15, A18, and A19
3. Cesium Beam tube; A2, A16, and A17
4. Analog-signal chain; A6, and A14
5. Input/output; A8, and A10
6. Power distribution; A1, A11, A12, LF1, T1, and B1(non-Opt. 048)



* Opt. 048 do not have Standby Battery

Figure 3-1. 5071A Simplified Block Diagram

Instrument Control Block

This block provides front panel and remote instrument management with a keypad-LCD/menu interface or via SCPI (Standard Commands for Programmable Instruments) commands transferred through the RS-232C serial port.

The block consists of microprocessor, front panel, and interface assemblies, and the I-bus that, together facilitate control of all internal housekeeping, servo loop, diagnostic, and system status instrument functions. All instrument functions are controlled and/or monitored by this block.

Reference Oscillator/RF chain Block

The reference oscillator/RF chain block generates a microwave probe signal centered around 9.19263177138 GHz. It also provides a high-quality 10 MHz sine wave signal (ovenized-quartz VCXO-generated) that is used as a basis to synthesize the microwave probe signal. The synthesis is phase-coherent so that the frequency of the probe signal
is arithmetically related to that of the reference oscillator.

Accordingly, the block also provides amplitude- and phase-coherent frequency modulation applied to the microwave probe signal which is then fed to the Cesium Beam Tube (CBT).

Cesium Beam Tube Block

The Cesium Beam tube block operates by matching the frequency of the microwave probe signal with the hyperfine resonance of cesium atoms. The comparison occurs in the CBT. This resonance constitutes the international definition of the second, defining frequency and time.

In the CBT, the actual frequency of the resonance differs slightly from the nominal value of 9.192631770 GHz because of the applied magnetic field present, and the second-order Doppler shift resulting from the finite velocity of the atoms in the beam. Both of these effects are calculable and have been corrected for within the instrument. The correction yields an overall accuracy of better than five parts in 10^{-13} for the high-performance tube option.

The entire matching process creates a time-dependent CBT output error signal. The error signal contains information used to determine frequency and amplitude errors of the microwave probe signal. This error signal is routed to the analog signal chain block.

Analog Signal Chain Block

The CBT output signal is amplified by the analog signal chain and converted into digital samples that are fed to the microprocessor (via VFC/VFC clock lines) in the instrument control block. The microprocessor uses the samples to calculate corrections to the microwave probe signal frequency and amplitude.

The main frequency servo loop is completed by changing the frequency of the reference oscillator in the reference oscillator/RF chain block as required. The analog signal chain block consequently generates an Electronic Frequency Control (EFC) signal routed back to the reference oscillator/RF chain block.

Input/Output Block

The input/output (I/O) block generates the instrument's rear panel RF output signals which are phase-coherent with signals in the RF chain. The I/O block receives two low-noise 80 MHz signals from the reference oscillator/RF chain block. These 80 MHz signals are used to create the instrument's 1PPS and sine-wave outputs. When the microwave probe signal is at correct frequency and amplitude, the I/O block will synthesize the exact nominal output frequencies.

The block also receives a front or rear panel Sync-input signal to synchronize the 1 pps outputs with an external system or event. The 1PPS output pulse signals are derived by division. The phase of the 1PPS output pulses may be adjusted in 50 ns units.

Power Supply Block

The power supply block provides the instrument with required internal dc power from either ac power, an internal standby battery (Opt. 048 does not have an internal standby battery) , or an external dc power source. It monitors the presence of these power sources, switching from one to another as required. In addition, this block (except in Opt. 048) maintains the internal standby battery charge when ac power is present.

Functional Block Descriptions

This section provides you with information about how assemblies and modules work together in groups to provide the functions and signals described in the simplified functional description.

Figure 3-2 is an overall block diagram of the 5071A that shows all assemblies and modules within the six functional blocks. The blocks and their assembly/module components and connections are discussed and tabulated in approximate order of signal flow within each block.

Instrument Control Block:

- A3 Microprocessor
- A7 Interface
- A13 Front Panel
- Instrument bus (I-bus)

Reference Oscillator/RF chain Block:

- A19 Reference Oscillator (VCXO)
- A9 Frequency Multiplier
- A5 87 MHz PLL
- A4 Digital Synthesizer
- A18 9.2 GHz PLL
- A15 9.2 GHz Microwave Generator Module

Cesium Beam Tube Block:

- A2 CBT Controller
- A16 High Voltage Supply Module
- A17 CBT (Cesium Beam Tube)

Analog Signal Chain Block:

- A14 Signal Amplifier Module
- A6 Servo

Input/Output Block:

- A10 Output Frequency Distribution Amplifier Module
- A8 1 PPS

Power Supply Block:

- LF1 Line Filter/Cable Assembly
- T1 Toroidal Power Transformer
- A1 Rectifier/Crowbar/Ext Dc Input Filter circuits
- A11 Power Steering Logic
- A12 Dc-Dc Power Converter Module
- B1 24-V Internal Standby Batteries (Does not apply for Opt. 048).

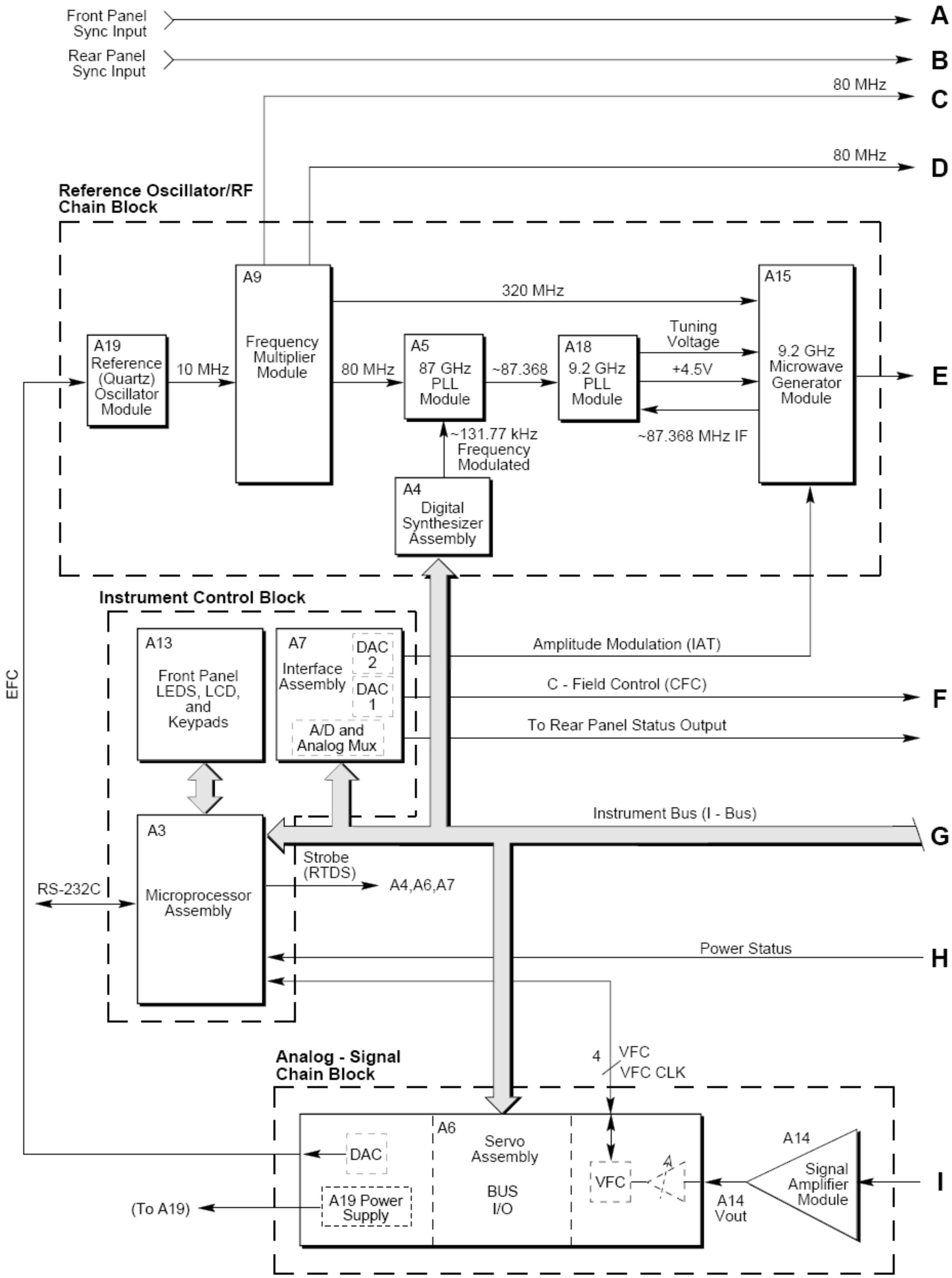


Figure 3-2. 5071A Overall Block Diagram

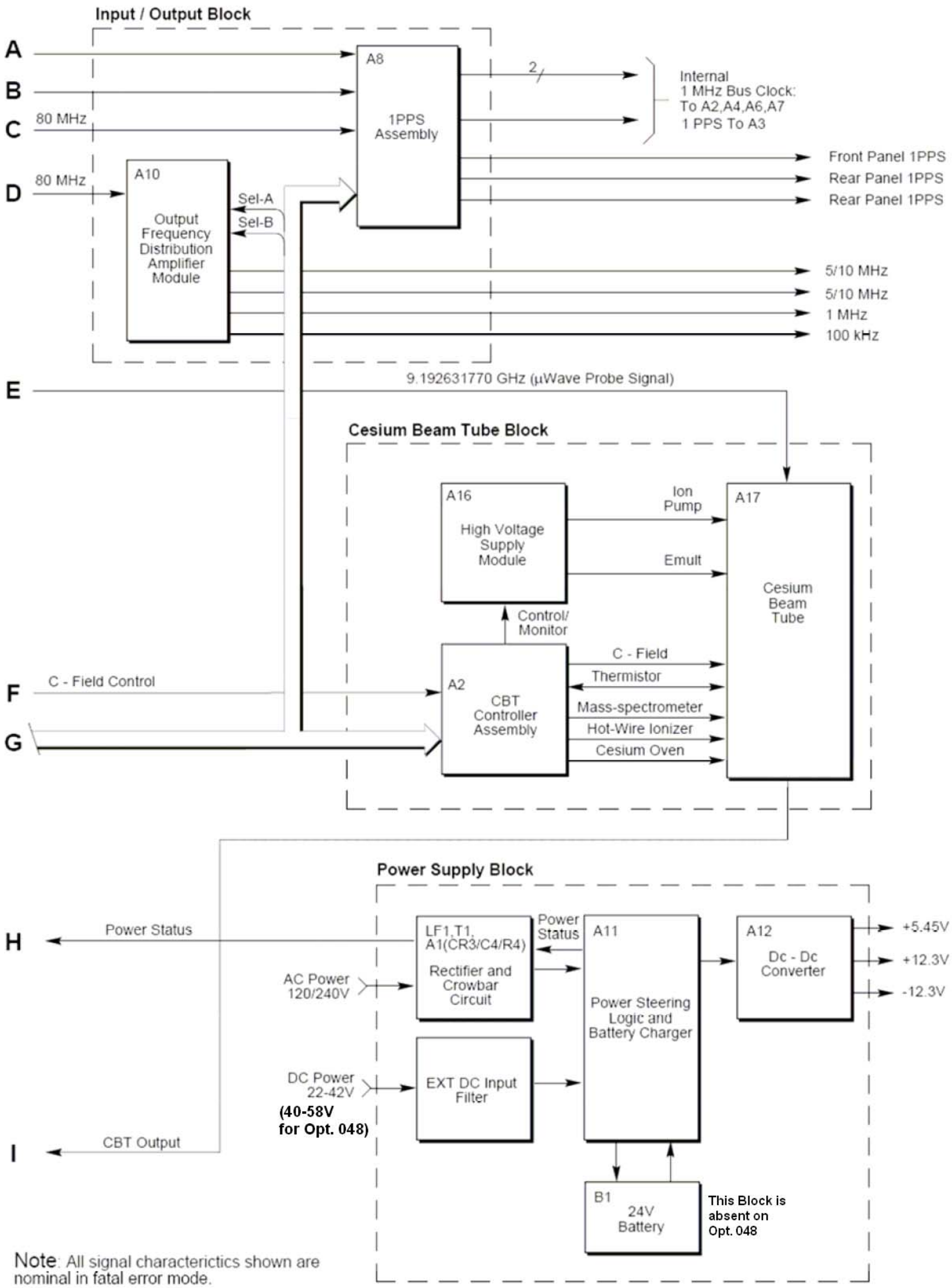


Figure 3-2. 5071A Overall Block Diagram (Continued)

Instrument Control Block

The instrument control block consists of the A3 microprocessor, A7 Interface, A13 front panel assemblies, I-bus, and operating firmware. It has five inputs:

a. front panel keypad entry,
b. RS-232C,
c. VFC,
d. power status,
e. I-bus,

and seven outputs:

a. front panel LEDs/LCD displays,
b. RS-232C,
c. VFCclk,
d. Strobe (to A4, A6, A7),
e. SEL A/SEL B (to A10),
f. Status Output, and
g. I-bus.

Hardware

A3 receives data inputs that, via processing create outputs to control all internal housekeeping, servo-loop, diagnostic, and system status functions. All instrument blocks are controlled or monitored by this block. The outputs can also provide information about the instrument's current operational status.

A13 keypads and LEDs/LCD displays provide the hardware user interface to facilitate test-bench and rack-mount front-panel user-interface operation while the rear-panel RS-232C port and status output provide the interface hardware for remote operation with the on-board SCPI command set.

The VFC and VFC clock lines go to A6, providing a path for specific frequency count data that arrives from the analog-signal chain block. The Strobe output is routed to A4/A6/A7 and is used synchronize data transfer between A3 and the reference oscillator/RF chain, analog-signal chain, and cesium-beam tube blocks respectively.

A7 receives command input from the I-bus to generate four functional outputs:

a. amplitude modulation signal (DAC 2) sent to A15,
b. C-field control signal (DAC 1) routed to A17 CBT,
c. two isolated digital outputs (SEL A/SEL B) sent to A10, and
d. one isolated digital output sent to the rear panel Status Output BNC connector.

Another area on A7 (A/D and Analog MUX) samples the tuning voltages of A5, A9, A18, the +5V, +12V, -12V dc supply voltages, and several CBT supply voltages, sending this information to A3 via the I-bus.

The rear-panel Status Output provides a way to monitor instrument operation. In default mode it tells when the front-panel continuous-operation LED turns off. This output is SCPI command programmable via RS-232C port to go active with other combinations of internal instrument events.

The I-bus consists of data, address, synchronization, power, and dedicated hardware signal lines that together provide the main control and information pathway within the instrument.

Table 3-1. Instrument Control Block Interconnections

Source Module or Assembly	From Path Connectors Pin # in italics	Signal Name	To Path Connectors Pin # in italics	Destination Module or Assembly
A3	XA3J1 *60/61/62*	RS-232C (3)	A1J6	Rear Panel
A3	XA3J2 *14/46*	Strobe (2, ±RTDS)	XA4J2 *14/46* XA6J2 *14/46* XA7J2 *14/46*	A4 A6 A7
A11	A11P102	Power Status (4, via A1J3)	XA3J1 *26/27/28/58*	A3
A6	XA6J2 *14/44*	VFC (2, ±VFCP)	XA3J2 *12/44*	A3
A3	XA3J2 *13/45*	VFCclock (2, 0.5 MHz)	XA6J2 *13/45*	A6
A7	XA7J2 *11*	Amplitude Modulation (IAT)	A15J1 to A1J19	A15
A7	XA7J2 *10*	C-Field Control (CFC)	XA2J2 *10*	A17 (via A2)
A7	XA7J2 *43*	Status Output (~PD5)	A1J6 *2*	Rear Panel
A3	A3J1 *79-95*	A3 - A13 bus cable	A13J1 to A1J13	A13
A3	XA3J1&2	I-bus (Instrument Bus)	A1 Global, All Slots	All Bussed Assemblies and Modules

Operating Firmware

The firmware is stored in two ROMs on the A3 board. It provides six operating modes for the instrument: Power On, Warm Up, Normal Operation, Warning, Standby, and Fatal Error. This subsection describes the instrument's behavior in each of these modes.

Power On Mode: When power is applied, the 5071A starts operation in the Power On mode. The firmware checks the functions of the A3 board and determines if all other assemblies and modules are present (Power-on Self-tests). If all tests at power-on pass, the instrument changes automatically to the Warm Up mode. If one or more of the power-on A3 self tests fail, the instrument will not be able to function, and the mode changes automatically to Fatal Error. An error message will be logged and can be used, with observations of LEDs on the top of the A3 board, to diagnose the fault.

Warm Up Mode: At power-on, power is applied to A19 (VCXO oven) and A17 (CBT Ion Pump). If the Ion pump current is correct at the beginning of Warm-up mode, then the CBT Cesium oven and Electron Multiplier voltages are turned on to their set-points. After the CBT and VCXO ovens have reached the correct temperatures, the firmware adjusts the electron multiplier so that a threshold CBT output is achieved. The tuning voltage of the VCXO is then swept to find the peak of the Cesium resonance pattern.

The firmware then steps through various levels of RF attenuation to obtain optimum power for the microwave probe signal. Next, the electron multiplier is adjusted to obtain the desired CBT output current. After these settings have been logged in memory, the C-field is set to the proper value. When these adjustments are complete the operating mode changes automatically to Normal Operation (the green continuous operation light blinks), and the message “`Lock Completed`” is logged.

If CBT ion-pump current is excessive after 45 minutes, an error will be logged and the instrument goes to Fatal Error mode. If the instrument is unable to find a setpoint during the warm-up sequence, the mode will go to Fatal Error, and an error message will be logged. If something is wrong with the instrument, it is usually detected during the lock-up procedure.

Normal Operation Mode: In the Normal Operation mode, five separate servo loops operate continuously, regulating the CBT Oven temperature, the CBT peak output current, the VCXO frequency value, the microwave power level, and the CBT C-Field value. The microwave probe signal fed to the CBT is frequency and amplitude modulated to produce appropriate error signals (feedback) when convolved with the transfer function of the Cesium resonance.

The Cesium oven servo operates independently. Oven temperature is read about four times a second and the oven heater voltage is adjusted to achieve the desired set-point.

The four remaining servo loops operate synchronously with the microwave-probe-signal modulation sequence. The CBT output signal current is digitized by a voltage-to-frequency converter and counter (VFC on A6). The resulting sampled data is processed by the servo algorithm to generate correction signals for the D-to-A converters that generate the VCXO EFC signal (DAC on A6), the microwave probe signal amplitude modulation, the C-Field current, the analog signal gain, and the CBT Electron Multiplier voltage.

Because the microwave probe signal undergoes frequency and amplitude modulation during normal operation, frequency and power measurements are difficult to obtain. This is why most of the testing must be done in Fatal Error mode.

During normal operation, a diagnostic program (known as the “Health Monitor”) operates continuously. This program checks operating parameters and digital-state variables to detect anomalies or errors.

If an error condition is detected that is not fatal, a warning is logged, and the operating mode goes to “Warning”.

If a persistent error condition prevents the feedback loops from operating normally, the operating mode goes to Fatal Error, and an error code is sent to the log. The error code will contain information about which health monitor errors were associated with the actual failure (see chapter 2, sections 1.1.1, 1.2.1, 1.3.1, and 1.4.1. for decoding information.).

Warning Mode: The warning mode occurs when the health monitor detects a possible problem or internal standby-battery operation. The instrument can still run as a frequency standard, but the user is warned of a possible problem or future problem. The Continuous Operation LED flashes, and the Warning LED is lit. After a transient warning, the instrument can return to normal operation by entering “UTIL, Reset” from the front panel, or by via SCPI commands.

Fatal Error Mode: The Fatal Error mode occurs when the 5071A encounters an unrecoverable error condition. An error message is logged, and the CBT is shut down except for the ion-pump supply. It is not possible to exit Fatal Error mode without cycling instrument power or pressing the reset button on the A3 board.

It is useful to diagnose instrument problems in the Fatal Error mode because all servo loop activity and microwave probe signal modulation is halted. In the Fatal Error mode the RF power input to the CBT is maximized and the synthesizer is set to give an unmodulated frequency of 9192.631770 MHz.

Standby Mode: The Standby mode is a user-selected mode which can be selected during the Warm Up or Normal Operation modes. This mode can be used to run diagnostic self tests or to store the 5071A while maintaining the CBT for ready use. The ion pump remains on, preserving the CBT vacuum. The instrument can be addressed using SCPI commands in all operating modes, although some instructions are mode-specific.

Reference Oscillator/RF chain Block

The Reference Oscillator/RF chain Block consists of the A19 reference oscillator module, A9 frequency multiplier, A5 87 MHz PLL module, A4 digital synthesizer, A18 9.2 GHz PLL module, and A15 9.2 GHz Microwave Generator module. It has three inputs:

a. EFC control,
b. I-bus,
c. amplitude modulation program,
and three outputs:
a. 80 MHz × 2,
b. Frequency modulated 9.19263177138 GHz microwave probe signal.

A19 is the frequency reference for the RF chain, the output of which drives A9. A19 is a stable, low-phase noise, ovenized quartz-crystal oscillator with a nominal output frequency of 10 MHz. An External Frequency Control (EFC) input allows frequency adjustments over a range of ±0.3 ppm, providing servo loop correction for noise, drift, and aging over several years. A mechanical trimmer allows larger adjustments. A19 takes about 10 minutes to reach operating temperature after power on.

A9 multiplies the 10 MHz input to generate four low-noise outputs:

a. an 80 MHz signal sent to A8 1 PPS assembly,
b. an 80 MHz signal sent to A10 output frequency distribution amplifier module,
c. an 80 MHz signal sent to A5 87 MHz PLL module, and
d. a 320 MHz signal sent to A15 9.2 GHz microwave generator module.

A4 receives command input via its I-bus connection, directing its internal circuits to generate the appropriate agile sine-wave output centered around 131.77138 kHz. The output is sent to one input of A5.

A5 has two inputs:

a. an 80 MHz signal from A9, and
b. a frequency modulated 131.77138 kHz signal from A4.

These signals are used to create a frequency modulated 87.36822862 MHz signal sent to one input of the A18 9.2 GHz PLL module.

A18 has two inputs and two outputs. The 87.36822862 MHz signal received from A5 is phase compared with an 87.36822862 MHz feedback signal from A15 to generate a tuning-voltage signal routed to one input of A15. Another output is routed from A18 to A15 that provides +4.5 Vdc power for A15.

A15 has four inputs and two outputs. It uses the 320 MHz signal from A9, the tuning voltage from A18, the amplitude-modulation program signal from A7, and +4.5 Vdc power from A18 to create a frequency and amplitude modulated 9.19263177138 GHz output routed to the cesium beam tube block.

Table 3-2. Reference Oscillator/RF Chain Block Interconnections

Source Module or Assembly	From Path Connectors	Signal Name	To Path Connectors	Destination Module or Assembly
A6	A6J5	EFC Control	A19J108xx	A19
A19	A19J1	10 MHz Reference	A9J5	A9
A9	A9J4	80 MHz	A8J3	A8
A9	A9J2	80 MHz	A10J5	A10
A9	A9J1	320 MHz	A15J4	A15
A9	A9J3	80 MHz	A5J1	A5
A4	A4J3	~131.77 kHz Frequency modulated	A5J2	A5
A5	A5J101	~87.3668 MHz	A18J1	A18
A18	A18J2	Tuning Voltage	A15J2	A15
A18	A18J3	+4.5 V	A15+4.5	A15
A15	A15J3	~87.3668 MHz PLL Feedback	A18J4	A18
A7	A1J19	Amplitude Modulation (IAT)	A15J1	A15
A15	A15J5	μWave Probe Signal, ~9 GHz	A17 Adapter	A17
A3	XA3J1&2	I-bus (Instrument Bus)	XA4J1&2	A4

Cesium Beam Tube Block

The Cesium Beam Tube block consists of the A2 CBT Controller, A16 High Voltage Supply module, and A17 CBT. It has three inputs and one output.

A2 receives command input from the I-bus to generate five functional signals:

a. control/monitor lines routed to the A16 high voltage supply module,
b. Thermistor signal lines routed to A17 CBT,
c. mass-spectrometer control signal routed to A17,
d. hot-wire ionizer control signal routed to A17, and
e. cesium-oven control lines also sent to A17. A2 also transfers the C-field control signal generated on A7 to the C-field winding inside A17.

A16 generates supply voltages for the ion pump and electron multiplier in A17. A16 receives power and control signals from A2. The Ion pump supply delivers an open-circuit voltage of +3500V, nominal. It is unregulated and supplies a limited amount of power to A17 under load. The current drawn is monitored by A2 and A7 and is readable via the front panel interface. If the ion-pump current exceeds 50 microamps, the instrument cannot warm-up.

The CBT Electron multiplier requires a low-noise supply at a voltage of -900 to -2500 volts dc. The set-point of this supply is determined by a control current generated by a D to A converter on A2. The Electron-Multiplier supply is disabled whenever the instrument is the “Fatal Error” or “Standby” modes.

A17 has eight inputs and one primary output. The ion-pump, electron-multiplier, C-field control, Thermistor-signal lines, mass-spectrometer control, hot-wire ionizer supply, cesium-oven supply are used to maintain proper CBT operating conditions, while the 9.19263177138 GHz microwave probe signal input is used to create a CBT error output signal. The CBT error signal is routed to one input of the analog signal chain block.

Electronically, A17 is a non-linear resonator that uses the microwave hyperfine resonance of Cesium-133 atoms in an atomic beam. Close to the resonance frequency of 9192.63177 MHz, CBT output current changes rapidly in a predictable manner with the frequency of the applied microwave probe signal.

Physically, A17 is a sealed, evacuated assembly containing its own vacuum pump. To operate, A17 requires a number of external power supplies and signals provided by A2, A7 and A16. A17 contains a read-only memory (ROM) that stores its operating parameters. The ROM is read at power-up by A3 using circuits on A2. Up to 30 minutes may be required for A17 to reach operating temperature.

Table 3-3. Cesium Beam Tube Block Interconnections

Source Module or Assembly	**From Path Connectors** Pin # in italics	**Signal Name**	**To Path Connectors** Pin # in italics	**Destination Module or Assembly**
A2	XA2J1 *28/29/30*	Control/Monitor (3)	A1J12	A16
A16	Long White HV lead	Ion Pump	Right-hand CBT HV socket	A17
A16	Short-White HV lead	Electron Multiplier	Left-hand CBT HV socket	A17
A7	XA7J2 *10*	C-Field Control (CFC)	XA2J2 *10*	A2
A2	A2J2	C-Field Control	A17P3	A17
A2	A2J2	Thermistor	A17P3	A17
A2	A2J2	Mass-Spectrometer	A17P3	A17
A2	A2J1	Hot-Wire Ionizer	A17P4	A17
A2	A2J2	Cesium Oven	A17P3	A17
A15	A15J5	μ Wave Probe Signal ~9 GHz	A17 Adapter	A17
A17	A17P1	CBT Output	A14J1	A14
A3	XA3J1&2	I-bus (Instrument Bus)	XA2J1&2	A2

Analog Signal Chain Block

The analog signal chain block consists of the A14 signal-amplifier module and A6 servo assembly. This block has three inputs and three outputs providing a means of converting the CBT error-signal output into the EFC voltage signal required by the A19 module EFC input.

This block amplifies low-level current output from the CBT, conditions the signal, and converts it to a digital count which can be processed by the feedback algorithm that runs on A3. The algorithm output is then transferred back to the block to generate the EFC signal fed to A19.

The CBT output signal is a current with a peak value of about 100 nA. The current carries low-frequency signals caused by the frequency and amplitude modulation of the microwave probe signal processed by the CBT's transfer function. Useful information is contained in the frequency range from dc-900 Hz.

The CBT output is fed to A14, a low-noise transimpedance amplifier with a frequency response of dc-900 Hz. The push-pull output (A14 Vout) of the amplifier is coupled to the differential signal-channel input of A6 which also supplies it with power. The single-ended-to-differential transimpedance of A14 is 50 MΩ.

The input stage of A6 feeds a programmable amplifier (gain set by A3 via I-bus). The amplified CBT signal is then converted to a chain of pulses by a linear voltage-to-frequency converter (VFC). The VFC output pulses are fed to A3, and the number occurring during a predetermined gate time counted. The number of pulses corresponds to the integral of the CBT output during the gate time, and is the input to the servo algorithm.

The servo algorithm (P/O operating firmware) processes the signal counts during successive gate times using the predetermined microwave probe signal modulation sequence to generate estimates of the frequency, C-field, and microwave probe signal amplitude errors.

The updated servo loop output is fed via the I-bus to a 16-bit DAC on A6. The output of the DAC is low-pass filtered and fed by a special amplifier to the EFC input of A19, closing the main servo loop. The A6 assembly also contains power conditioning circuitry for A19.

Table 3-4. Analog Signal Chain Block Interconnections

Source Module or Assembly	**From Path Connectors** Pin # in italics	**Signal Name**	**To Path Connectors** Pin # in italics	**Destination Module or Assembly**
A17	A17P1	CBT Output	A14J1	A14
A14	A14J2	A14 Vout	A6J3	A6
A6	XA6J2 *12/44*	VFC (2, ±VFCP)	XA3J2 *12/44*	A3
A3	XA3J2 *13/45*	VFCclock (2, ±0.5 MHz)	XA6J2 *13/45*	A6
A6	A6J5	EFC (2, EFC/REFC)	A19J11 *39/40*	A19
A6	XA6J2 *39/40*	A19 Power (2, ±VCXO)	A1J11	A19
A3	XA3J1&2	I-bus (Instrument Bus)	XA6J1&2	A6

Input/Output Block

The input/output block consists of the A8 1PPS assembly and A10 Output Frequency Distribution Amplifier module. This block has five inputs and nine outputs.

A10 receives an 80-MHz sine-wave signal from A9, SEL-A, and SEL-B select inputs from A7 via the I-bus which are used to create the 5/10-MHz programmable outputs for ports 1 and 2 along with fixed 1-MHz, and 100-kHz outputs routed to the appropriate rear panel connectors.

A8 has four inputs and five outputs. An 80-MHz input from A9 is used with I-bus command I/O to generate:

a. 1-MHz system clock signal sent to A2, 4, 6, and 7, and
b. two rear panel/one front panel 1PPS outputs.

Also, front- and rear panel Sync input signal connectors are used with I-bus command signals to synchronize the instrument's 1 pps outputs to external events and systems

Table 3-5. Input/Output Block Interconnections

Source Mdl or Assy	**From Path Connectors**	**Signal Name** (Connector Pin # in italics)	**To Path Connectors**	**Destination Mdl or Assy**
Sync Input, Front Panel	A1J17	Sync Input	XA8J2 *10/11/12*	A8
Sync Input, Rear Panel	A1J15	Sync Input	XA8J2 *42/43/44*	A8
A9	A9J4	80 MHz Input	A8J3	A8
A8	XA8J2 *16/48*	1 MHz Internal Bus Clock	XAnJ2 *16/48*	A2, 4, 6, 7
A8	XA8J1 *44*	1 PPS Output	XA3J1 *44*	A3
A8	XA8J2 *36/37/38*	1 PPS Output (3)	A1J14	1PPS Output, Front Panel
A8	XA8J2 *7/8/9*	1 PPS Output (3)	A1J16	1PPS Output, Rear Panel
A8	XA8J2 *4/5/6*	1 PPS Output (3)	A1J18	1PPS Output, Rear Panel
A9	A9J2	80 MHz Input	A10J5	A10
A7	XA7J2 *8*	SEL-A (~PD0)	A1J7	A10
A7	XA7J2 *9*	SEL-B (~PD1)	A1J7	A10
A10	N/A	5/10 MHz Programmable Output	Module Internal	Port 1, Rear Panel
A10	N/A	5/10 MHz Programmable Output	Module Internal	Port 2, Rear Panel
A10	N/A	1 MHz Output	Module Internal	1 MHz, Rear Panel
A10	N/A	100 kHz Output	Module Internal	100 kHz, Rear Panel
A3	XA3J1&2	I-bus (Instrument Bus)	XA8J1&2	A8

Power Supply Block

Note

All references to internal-battery power, battery status or battery operation, do not apply for 5071A Option 048. Option 048 does not have an internal standby battery.

The Power Supply Block consists of LF1 line filter/cable assembly, T1 toroidal power transformer, A1 rectifier/crowbar/Ext dc input filter circuits, A11 power steering logic assembly, A12 Dc-Dc power-converter module, and B1 24V internal standby batteries (Opt. 048 does not have batteries). This block has three inputs and five outputs. Figure 3-3 is a power supply block diagram that shows specific power paths to and from all power supply blocks with jack and connector labels.

The power supply block provides the instrument with internal dc power from either an ac power, internal standby battery (none for Opt. 048), or an external dc power source. It monitors the presence of these power sources, switching from ac-line, to external-dc, and then to internal standby batteries respectively, (In opt. 048 switching is from external dc-line, to ac-line). In addition, this block maintains the internal standby battery charge and protects the batteries from catastrophic discharge, (none for Opt. 048).

AC power enters the instrument at LF1 line filter/cable assembly, providing initial filtering, fuse protection, and line-voltage selection. The LF1 cable assembly connects directly to the primary windings of T1 toroidal power transformer stepping down the selected line voltage to an approximate 28 Vrms (37 Vrms for opt. 048) ac voltage. The T1 secondary output is rectified, filtered, and crowbar protected by circuits on A1 producing a 32-38 Vdc (45-51 Vdc for Opt. 048) voltage which is then routed to A11.

DC power enters the instrument at the rear panel EXT DC Input connector (fuse protected by F2), is routed through low-pass filter components on A1, and then sent to A11.

B1 provides 24 Vdc to A11 and receives an appropriate trickle or boost charge input from A11 as required when ac power is applied only. (Does not apply for Opt. 048).

A11 implements the power-source steering hierarchy, provides power-status signals to A3, maintains the internal standby battery charge when ac power is applied, and provides internal standby battery fuse protection (non-Opt. 048 instruments) . A11 receives the ac, dc, internal standby power sources, selects one of them and routes it to the A12 Dc-Dc power converter module.

A12 converts the 22-42 Vdc (40-58Vdc for Opt. 048) steered power to nominal +5V, +12V, and -12V dc and routes these three voltages to A1 at A1J2.

Table 3-6 . Power Supply Block Interconnections

Source Module or Assembly	From Path Connectors	Signal Name	To Path Connectors	Destination Module or Assembly
LF1	LF1 Cable	100-240 Volts AC Power, (voltage selected on LF1)	T1 Cable-In	T1 Xfmr
T1 Xfmr	T1 Cable-Out	~28 Vrms, (secondary output of T1) (~ 37Vrms for Opt. 048	A1J5	A1
Ext. DC Input	A1J1 - A1J4	22-42 Volts DC Power (40-58 Vdc on Opt. 048), (filtered on A1)	A1J4 - A11J101	A11
A1	A1J4	32-38 Volts DC (45-51 Vdc for Opt. 048) (rectified and filtered on A1)	A1P4 - A11P101	A11
A11	A11P101 -	Steered DC Power, 22-42 V (40-58 Vdc on Opt. 048)	A1J4	A1
A1	A1J4	Steered DC Power, 22-42 V (40-58 Vdc on Opt. 048) (low-pass filtered on A1)	A1J2 - A12P2	A12
A12	A12P2	+12.3 VOut, +12.3 VReturn, - 12.3 VOut, - 12.3 VReturn, +5.45 VOut, +5.45 VReturn	A1J2	A1
P/O B1	Red/Blk Plug	+ 12 Vdc	Red/Blk Jack	A11
P/O B1	Red/Blk Plug	+ 12 Vdc	Red/Blk Jack	A11
A11	A11J2	DC Valid, DC Valid Return, AC Valid, AC Valid Return, Vcc, Spare, Pwr Fail, Pwr Fail Return Batt Valid, Batt Valid Return	A1J3	A1

A1 Motherboard Circuit Description

A1 routes signals and power within the instrument via interconnect lines and buses. A1 has seven slots for plug-in boards (each plug-in board has two connections to A1), and a power supply section. A1 also has jacks for power/control/monitor functions for all the modules in the instrument. Refer to Figures 3-3 through 3-6 for A1 schematic, interconnect, block-diagram, and component-location information.

The power supply section consists of the ac line voltage input, overvoltage protection, and external dc input circuits as shown in Figure 3-3 and 3-5, A1 Power Supply Schematic and Block Diagrams.

AC-Line Voltage Input Circuit

A1J5 receives the output of the toroidal power transformer (T1) and delivers it to full wave bridge rectifier A1CR3 for rectification. The rectified voltage is then filtered by filter capacitor A1C4 and routed to A11 Power Steering Logic Assembly via connector A1J4.

Overvoltage Protection Circuit

The Overvoltage Protection circuit across the ac input lines is a crowbar circuit comprised of silicon controlled rectifier (SCR) A1CR1, zener diode A1VR1, resistors A1R1 through A1R3, A1R5, A1R6, and capacitor A1C1. This circuit not only protects the components within the Overvoltage Protection circuit but also the dc-dc converter integrated circuits (ICs), A12U1 through A12U3, on A12 Dc-Dc Power Converter Module rated at a maximum input voltage of 56 Vdc, (72 Vdc for Opt. 048).

When the input ac-line selector switch is set to the 120 Vac position, A1CR1 is active if the input voltage is roughly 165 Vac. At this level, the secondary side of the circuit (across A1C4 or the output of the full wave bridge rectifier A1CR3) exceeds 50 Vdc, (65 Vdc for Opt. 048).

This causes zener diode A1VR1 to breakdown and supply current to the gate of A1CR1. A1CR1 conducts and temporarily shorts the ac voltage to ground blowing the main fuse inside LF1 line filter/cable assembly. When A1 CR1 is conducting, the current in the secondary circuit flows through A1R1, R2, R3 and A1CR1 to PS_COMMON
(non-chassis ground return).

NOTE

Figure 3-4 uses a dual-row 1-48 or 1-96 pin format to show A1 slot signal-pin designations. The actual A1 connectors are three-row DIN connectors (A, B, C, 1-16 pins). Pin A-1 on any DIN slot connector corresponds to pin 1 of the slot connectors shown in Figure 3-4.

This current opens the ac-line fuse before the energy flowing through the above mentioned components can damage them. Resistor A1R6 pulls the gate of the SCR (A1CR1) to ground so it cannot float - causing a false crowbar trip. A1R5 and A1C1 provide some filtering in case there are any spikes on this line (again, to prevent false tripping).

A1R4 bleeds the voltage down on A1C4, as a safety feature, when power is removed from the instrument. Together A1R13 and A1C22 are a filtering circuit that reduce conducted emissions.

A1C3 provides filtering for switching signals emanating from the A12 Dc-Dc Power Converter Module. A1R7 and A1R8 tie the otherwise floating lines going to the A12 module to analog ground. This is a preventive measure to keep these lines from floating up to above the 56V (72V for Opt. 048) limit on the input to the dc-dc converter ICs inside A12.

There are also diodes (A1CR4-A1CR6) placed on all A12 outputs to ensure the outputs never go out of range and destroy the assemblies/modules connected to them. This is in addition to the over-voltage protection already supplied by A12 itself.

External DC Input Circuit

A1J1 receives the dc input from an external dc source (22 to 42V) (40-58 Vdc on Opt. 048). The dc voltage is then routed to a filter consisting of A1L1 and A1C2 before being sent to A11 Power Steering Logic Assembly via connector A1J4. Capacitor C2, is rated at 80V (100V for Opt. 048), as the maximum allowable input voltage is 42V (58V for Opt. 048). Diode A1CR2 prevents any damage to the instrument if the external dc-input source is reversed. The current handling capability of A1CR2 is as high as that of the external input fuse (5A) (2.5AT for Opt. 048) so the fuse blows before the diode fails.

A11 Power Steering Logic Assembly

A11 directs the outputs of three power sources (two in case of Opt. 048) to the main instrument input bus in a hierarchical order. The three power sources are: 1) the dc from the ac line (through a transformer, rectifier, and filter) 2) the external dc input, and 3) the internal standby 24V battery, (this does not apply for Opt. 048). The main instrument power input goes directly to A12 Dc-Dc Power Converter Module which supplies power to all instrument components (except A11 Power Steering Logic Assembly itself, which has its own supply). A11 circuits are divided up into six functional blocks: external dc, housekeeping, dc from ac line, battery logic, battery charger, and power fail detection. (For Option 048 instruments the A11 circuits are divided up into three functional blocks only: external dc, housekeeping, and dc from ac line).

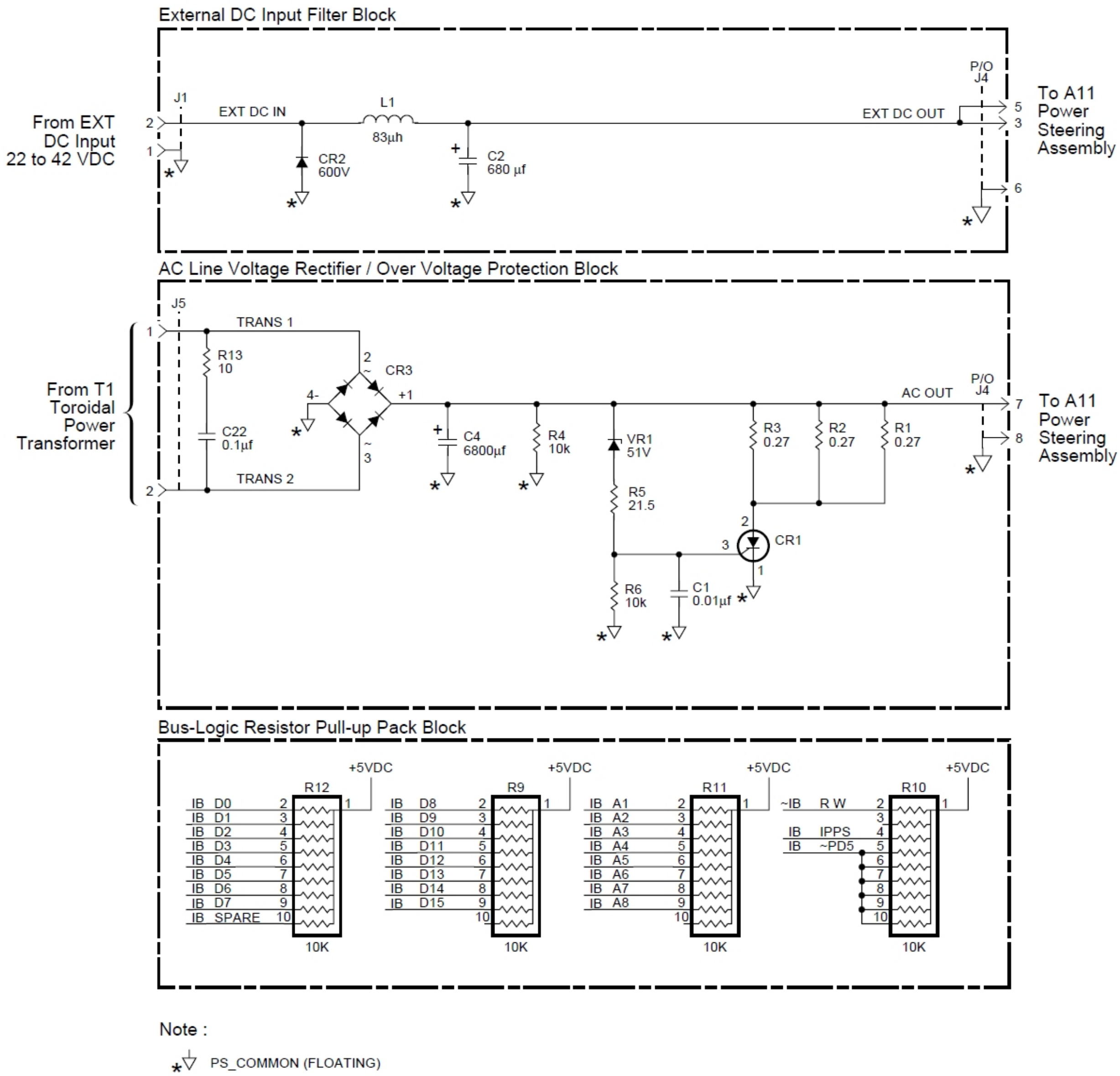


Figure 3-3. A1 Power Supply/Distribution Schematic Diagram

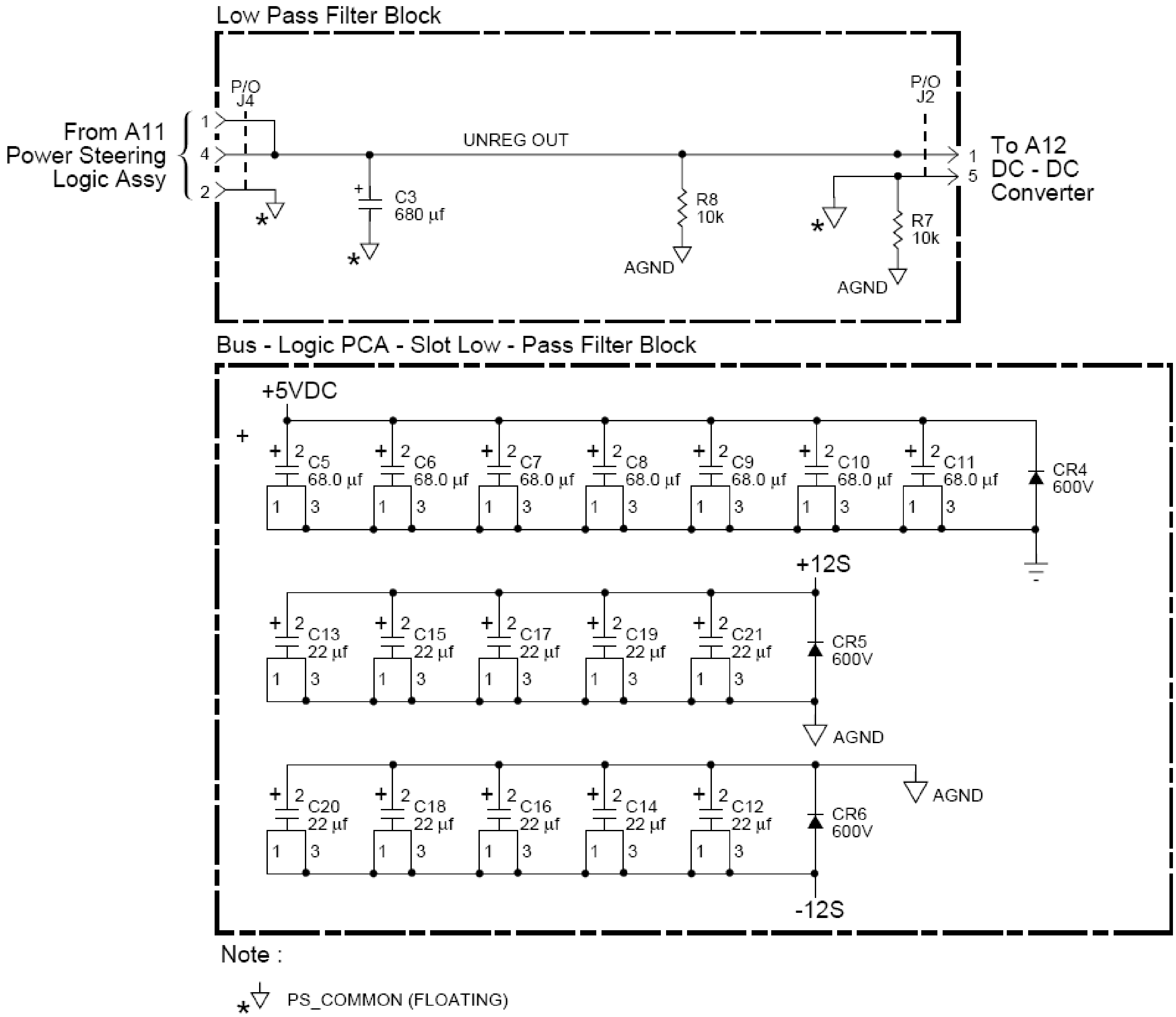


Figure 3-3. A1 Power Supply/Distribution Schematic Diagram (Continued)

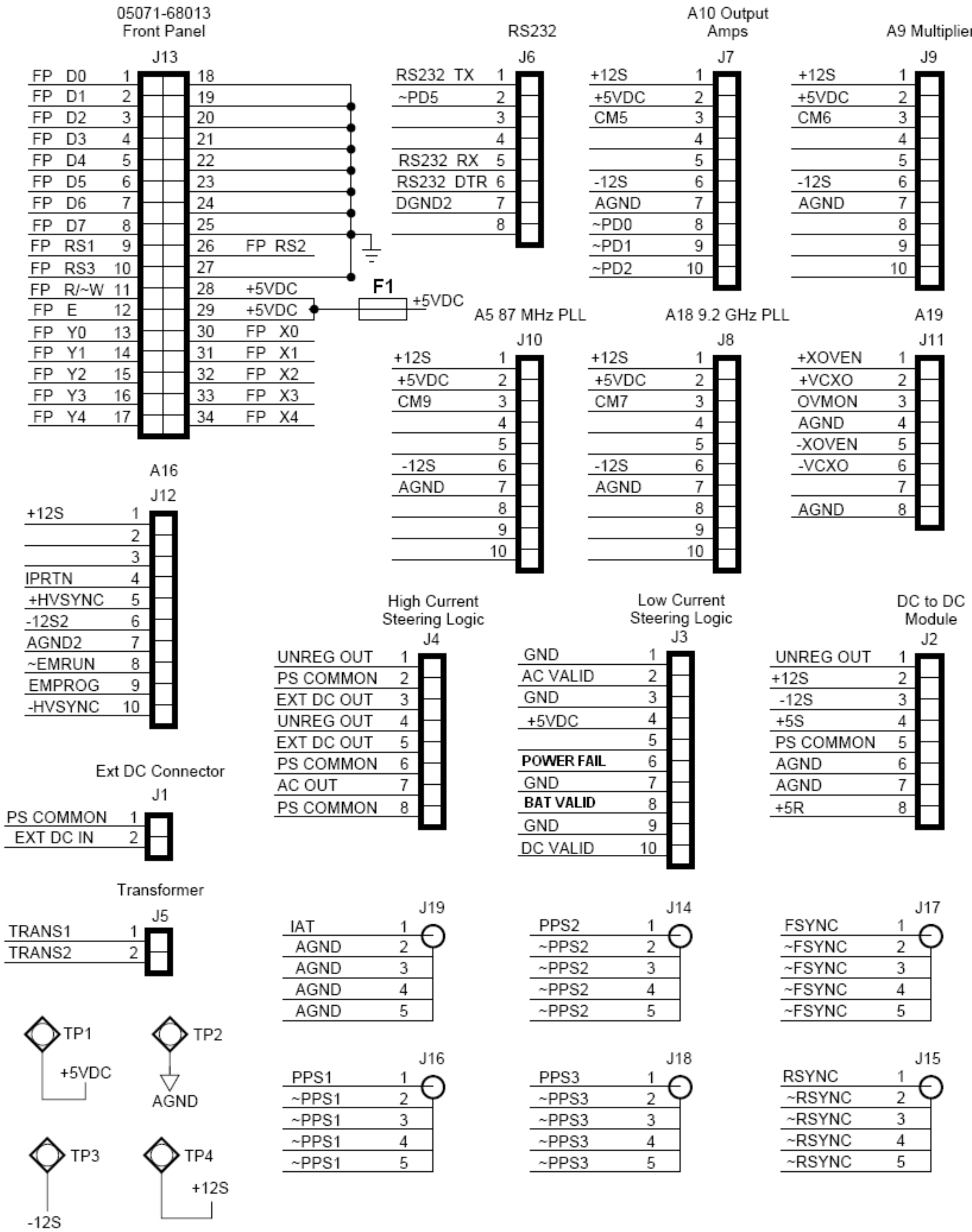


Figure 3-4. A1 Slot/Module Interconnect Diagram

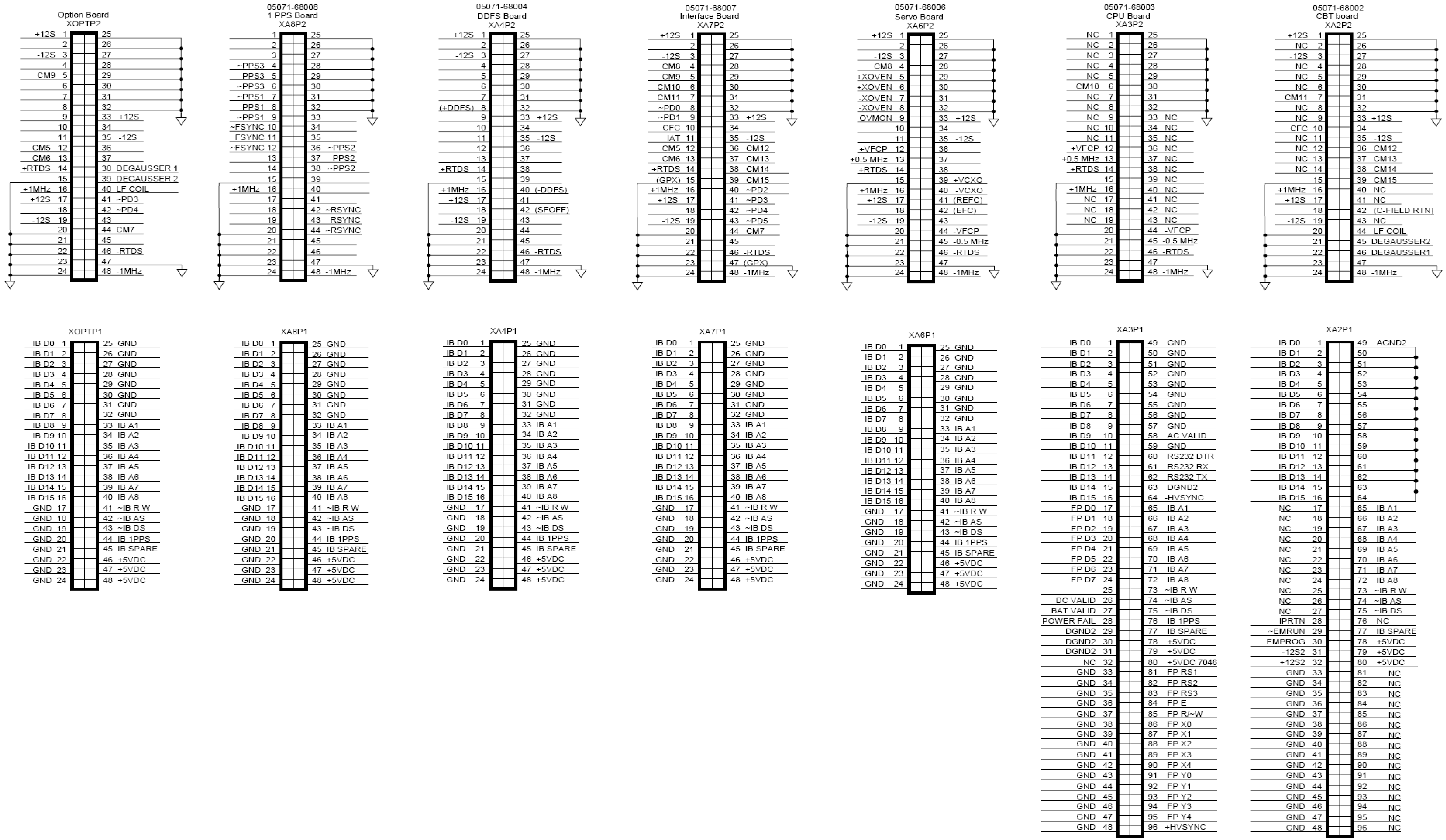
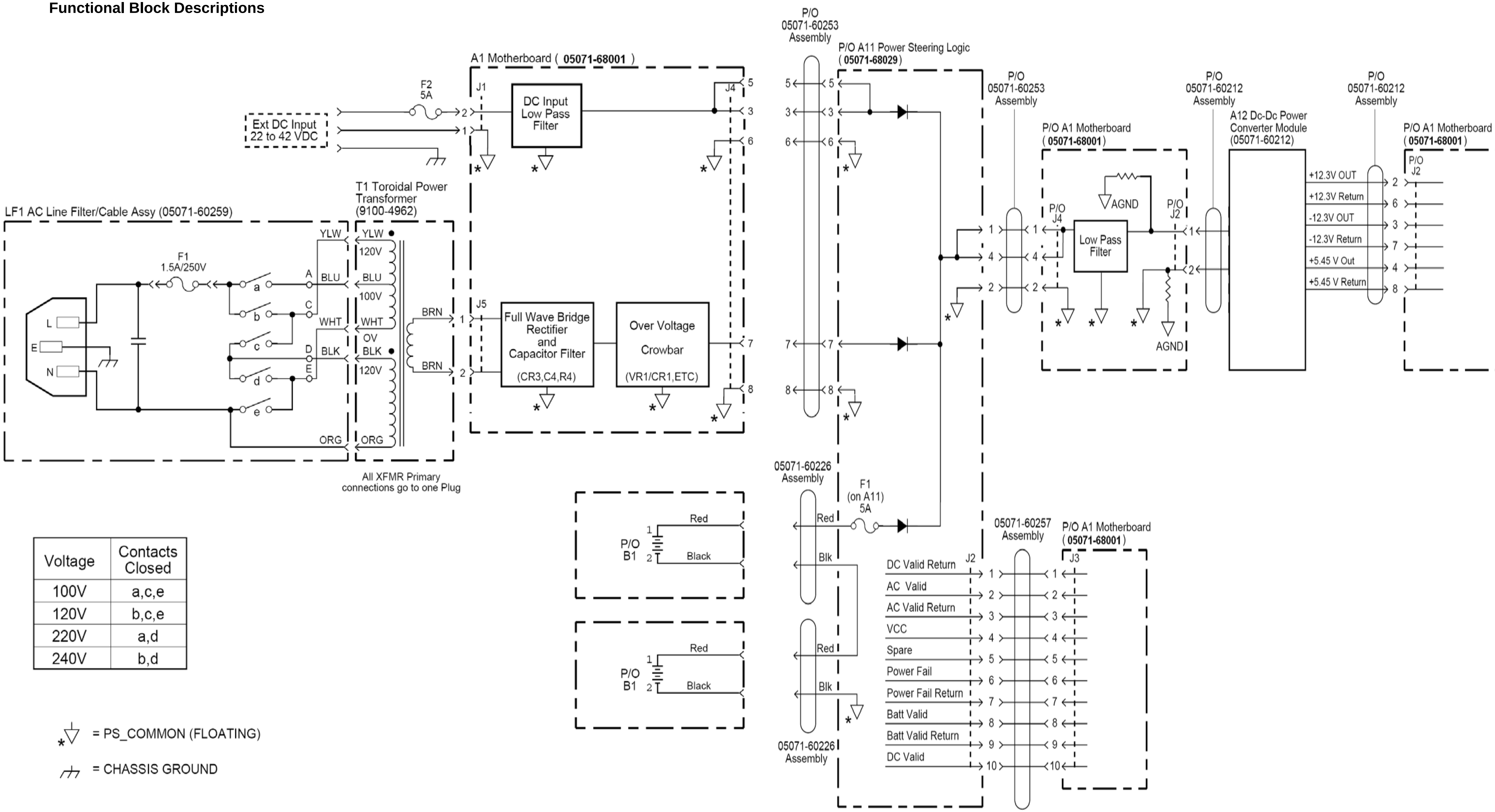


Figure 3-4. A1 Slot/Module Interconnect Diagram (continued). This schematic also applies for Opt. 048



Voltage	Contacts Closed
100V	a,c,e
120V	b,c,e
220V	a,d
240V	b,d

Figure 3-5. Power Supply Block Diagram

Option 048 Schematic Block Diagrams

The following figures 3-6 to 3-8 are the corresponding schematics for an option 048 instrument.

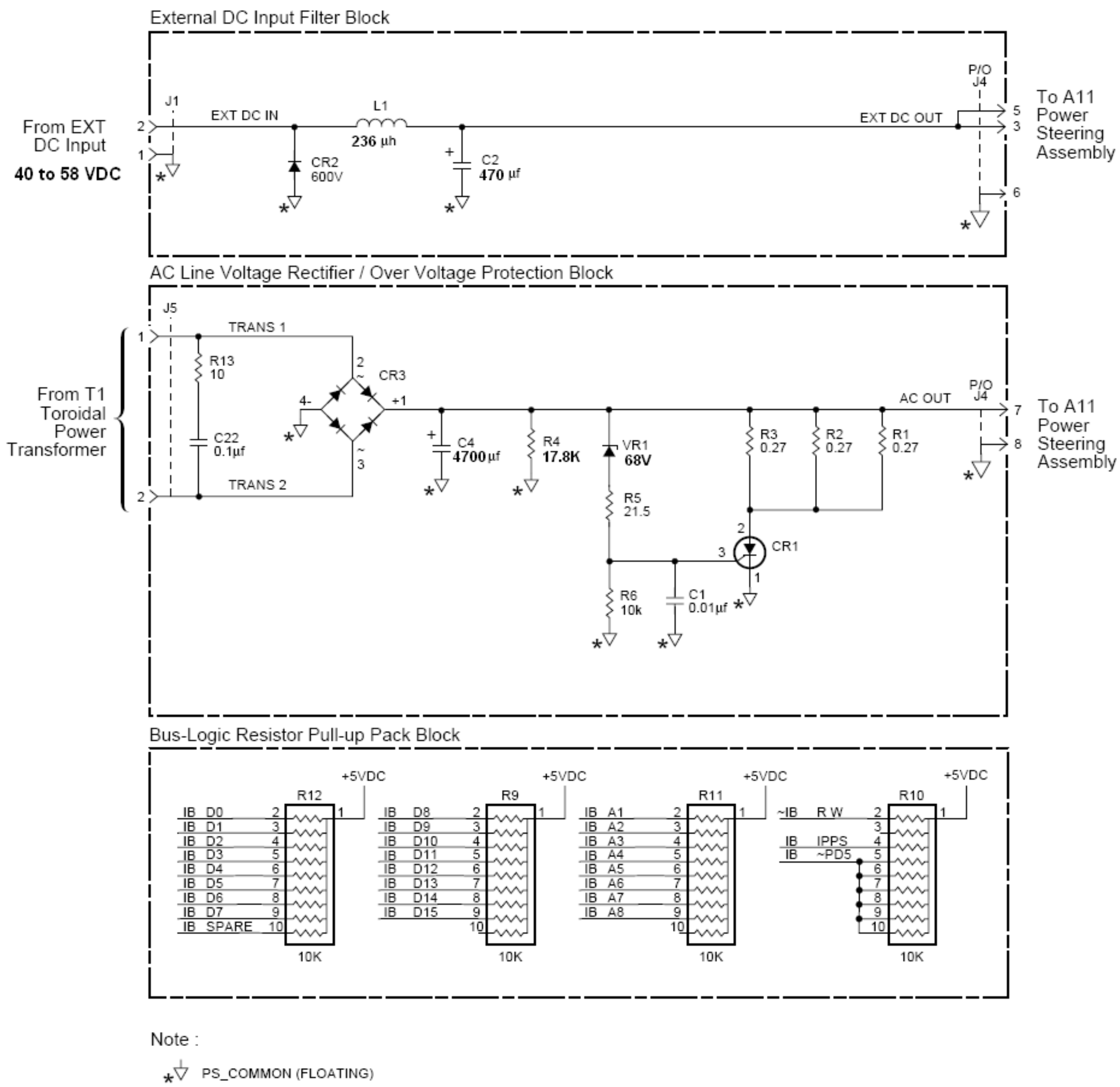


Figure 3-6. Opt. 048, A1 Power Supply/Distribution Schematic Diagram

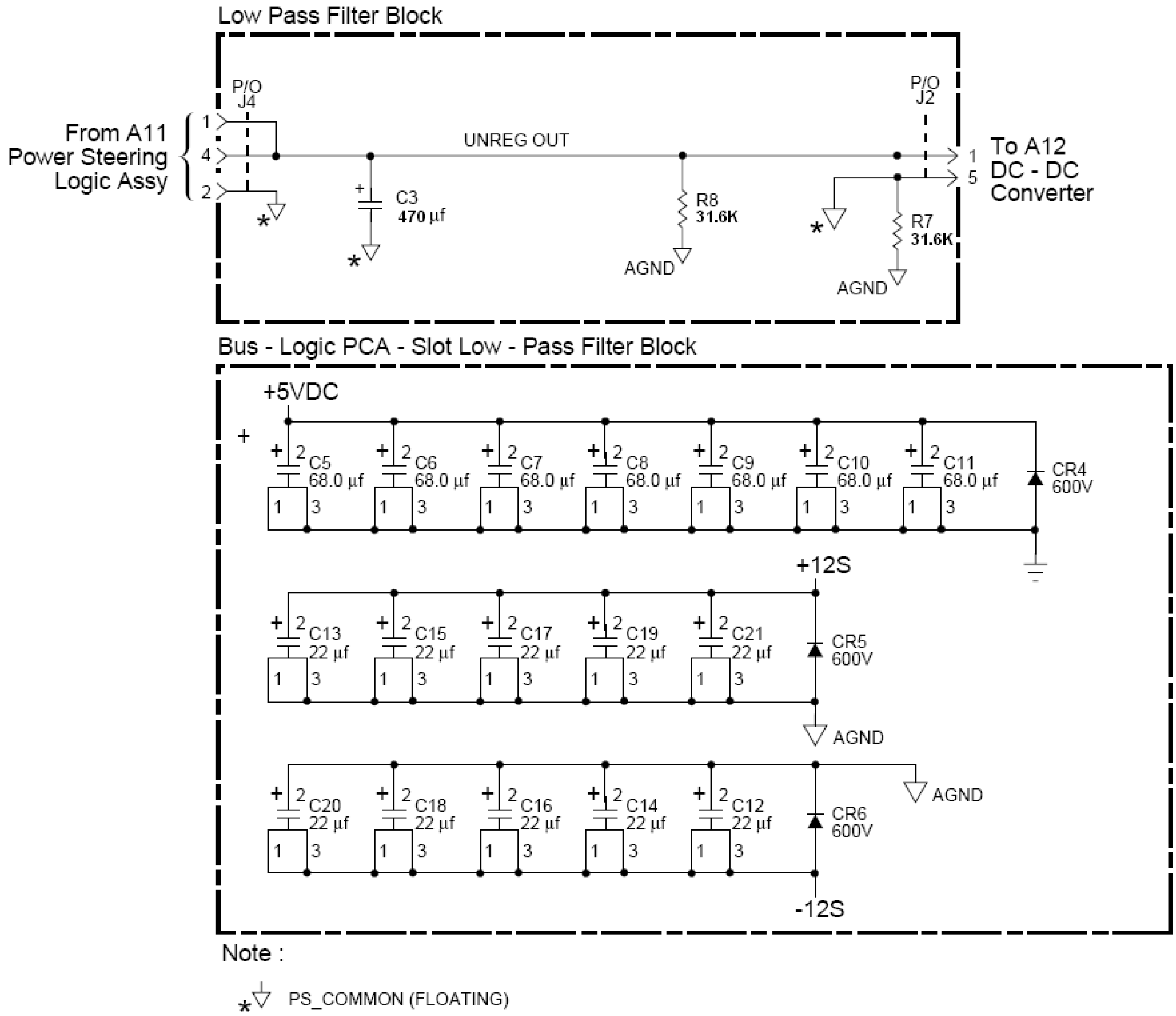


Figure 3-6. Opt. 048, A1 Power Supply/Distribution Schematic Diagram (Continued)

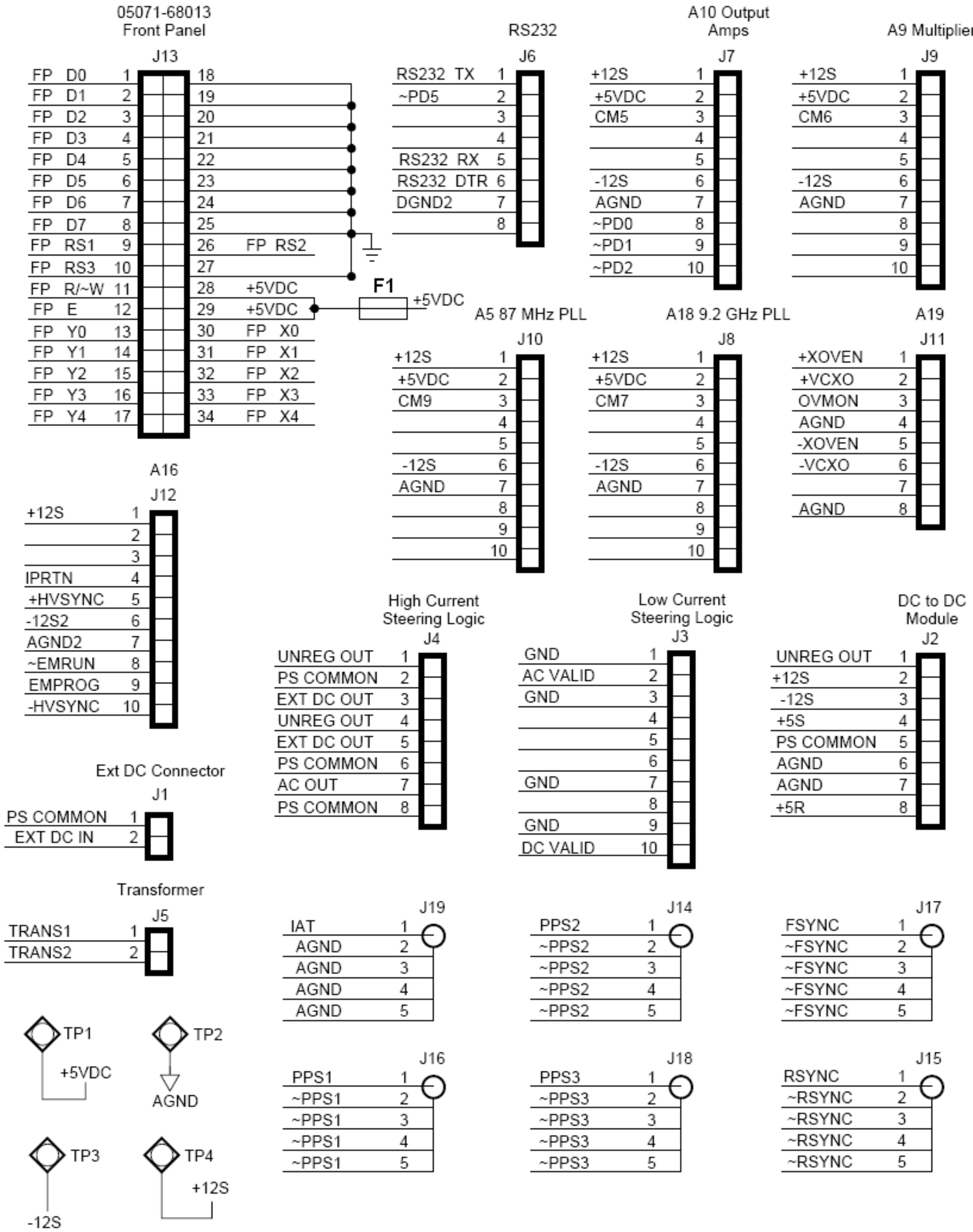
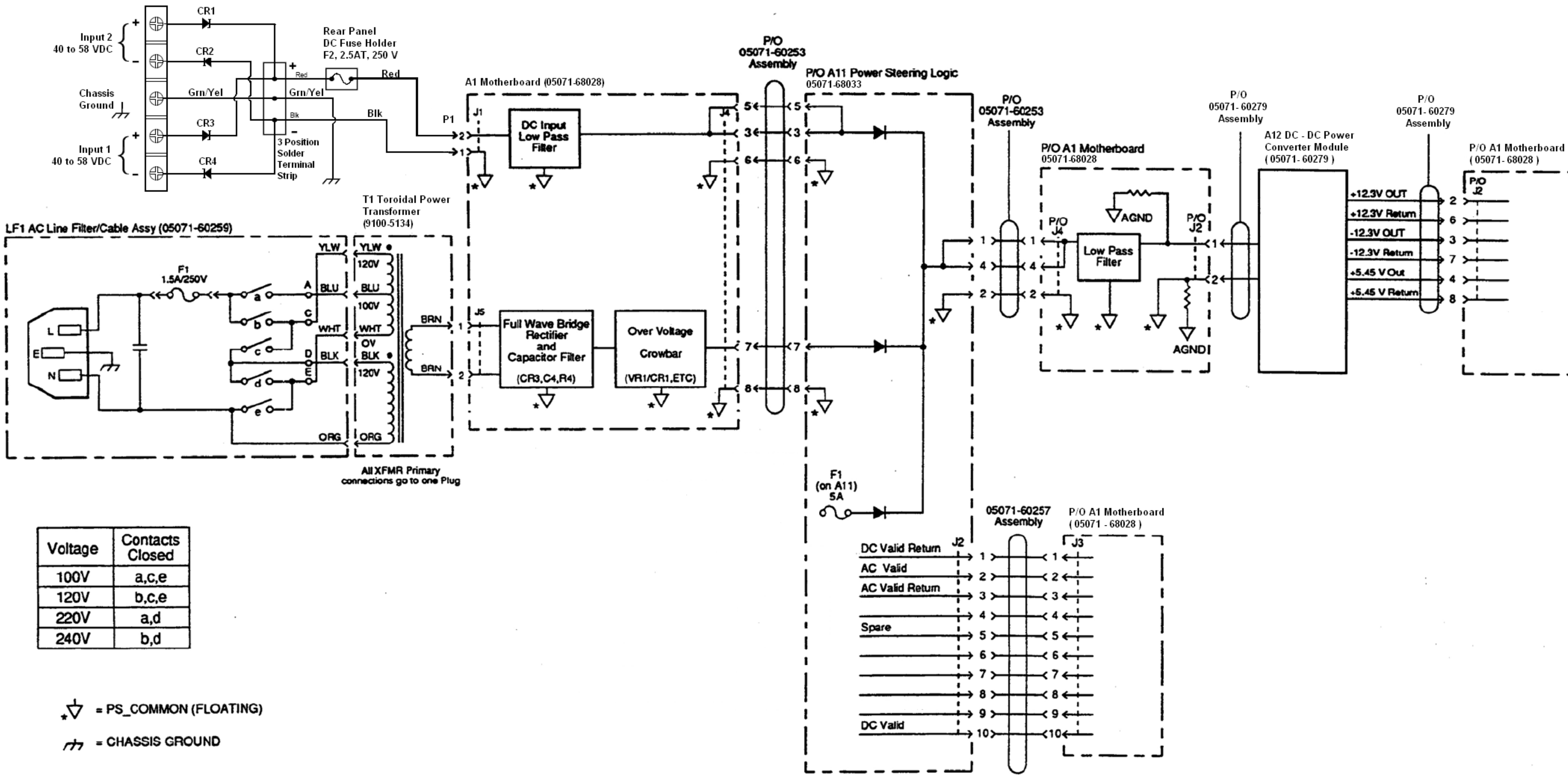


Figure 3-7. Opt. 048, A1 Slot/Module Interconnect Diagram



Voltage	Contacts Closed
100V	a,c,e
120V	b,c,e
220V	a,d
240V	b,d

Figure 3-8. Opt. 048, Power Supply Block Diagram

A12 Dc-Dc Power Converter Module

The primary components on A12 module are three resonant zero-current switching Dc-Dc converter modules (A12U1-U3). There is a converter module for each power supply voltage (+5V, +12V, and -12V). Both the input and output ports of each module are heavily filtered. Additional circuitry consists of overvoltage protection on each output port (any one voltage going too high shuts down the entire supply) and additional filtering common to all inputs.

LF1 AC-Line Filter/Cable Assembly

The LF1 Assembly provides ac-line noise and spike protection, fuse protection, and line voltage selection. The assembly mounts to the rear bulkhead of the instrument chassis and connects directly to the toroidal power transformer T1.

T1 Toroidal Power Transformer

The toroidal power transformer provides the required ac step-down capability to supply the A12 module with its specified input voltage (after appropriate rectification and filtering). The toroidal design reduces radiated magnetic fields and eddy-current-induced heat and also provides a more compact transformer component.

B1 Internal-Standby Battery

(Does not apply for Opt. 048). The B1 24-volt Battery consists of two identical sealed rechargeable 12-volt lead-acid battery packs located in the rear of the instrument underneath the A11 assembly.

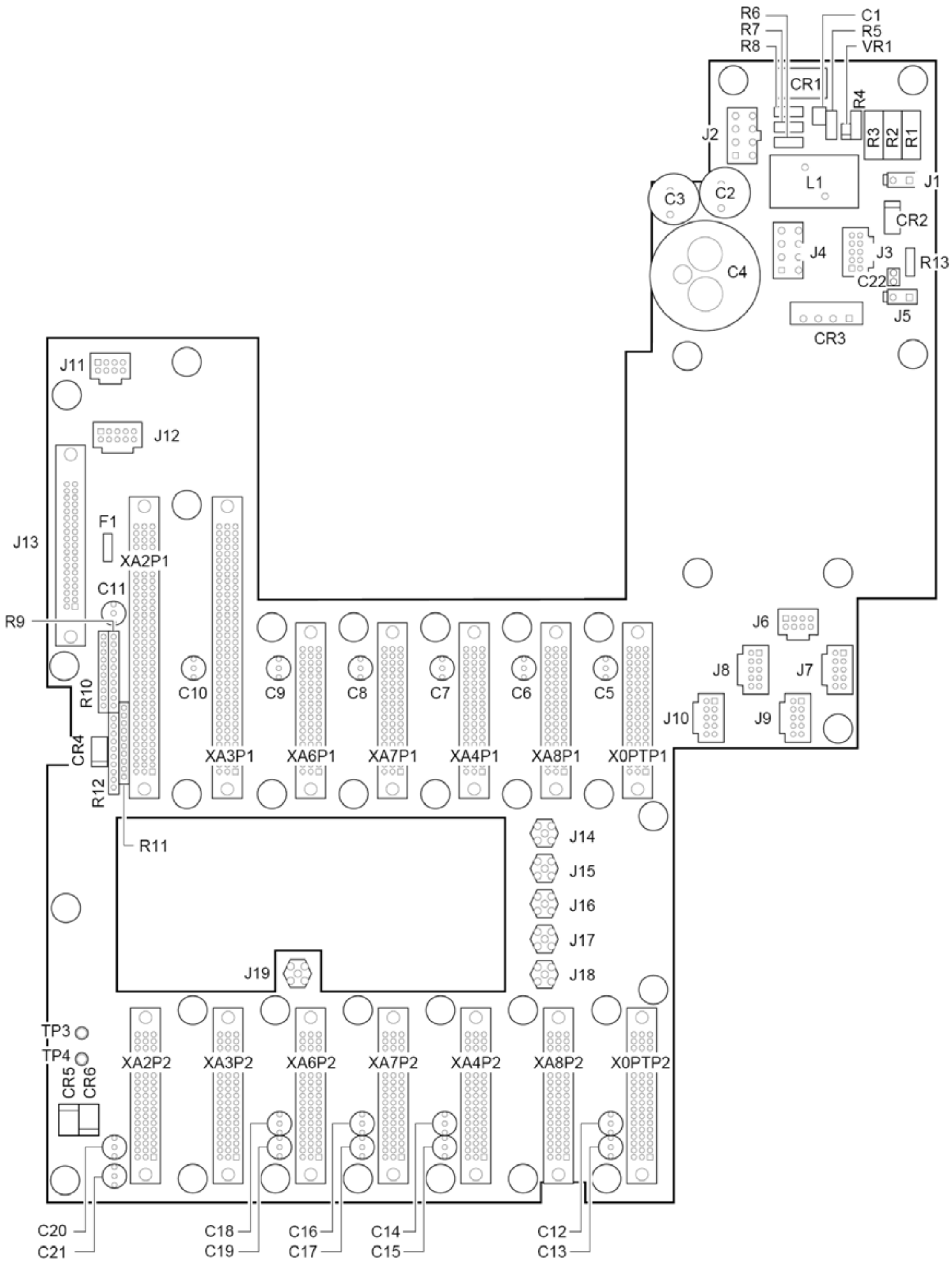


Figure 3-9. A1 Component Locator Diagram

4. Replacing Assemblies - Disassembly and Reassembly

Introduction

This chapter contains the instructions for removing major assemblies in the 5071A. To install an assembly, reverse the removal instructions (except for A17 CBT).

WARNING **HAZARDOUS VOLTAGES ARE ON THE A16 POWER SUPPLY MODULE. WAIT AT LEAST THREE MINUTES FOR THE CAPACITORS ON THE A16 POWER SUPPLY MODULE TO DISCHARGE BEFORE WORKING ON THIS INSTRUMENT.**

CAUTION Do not replace assemblies with the instrument turned on. Damage to components can occur.

Figures 2-1, and 5-1 are provided to complement the removal and replacement procedures. Refer to Chapter 5, “Replaceable Parts,” for the part number of assemblies and modules.

Tools Required

The following tools are required for the removal and replacement procedures:

- Hand TORX® 8 screwdriver and bit (T8)
- Hand TORX® 10 screwdriver and bit (T10)
- Hand TORX® 15 screwdriver (T15)
- Hand TORX® 25 screwdriver (T25)
- 9/16-inch Spintite®
- 7-mm Spintite®
- 1/4-inch open end wrench
- 7-mm open end wrench
- 7/16-inch socket and an 8.5 inch-pound torque wrench
- 6-mm combination wrench
- 5/16-inch combination wrench
- Small Diagonal Side Cutter
- Clean linen for dress-surface cleaning
- 95/100 % Methyl, Ethyl, or Isopropyl alcohol for cleaning

Do This First

Before performing any of the removal and replacement procedures, turn off the 5071A by removing the ac-line power cord from the rear-panel ac line socket, disconnecting both internal-standby batteries, and external-dc power input if present.

To Remove the Covers

The following steps are for removing the covers. The covers are removed to access the board and cable assemblies, and all other internal parts.

WARNING

WHEN THE COVERS ARE REMOVED FROM THE 5071A, AC LINE AND A16 OUTPUT VOLTAGES ARE EXPOSED WHICH ARE DANGEROUS AND MAY CAUSE SERIOUS INJURY IF TOUCHED. DISCONNECT ALL EXTERNAL AND INTERNAL POWER SOURCES.

CAUTION

Always follow ESD precautions to prevent static damage to assemblies, modules, and any other internal components.

Refer to Figure 5-1. when performing the following steps:

1 Ensure that ALL external and internal power is OFF.

2 Remove the four rear feet from the instrument before attempting to remove the top or side instrument covers with a TORX® T10 driver. Refer to steps 4 and 5 below to remove the bottom cover.

3 Remove the top, and left-right side cover(s) with a TORX® T15 driver as required for access to assemblies and modules. (Carefully alternate between backing-out each screw 1 or 2 turns and then pulling the cover out 1/16” to avoid stripping these captive-screws.)

4 Remove the four bottom feet by grasping and un-latching the release tabs on each foot. (Pull-up, then slide forward/backward and out.)

5 Remove the bottom cover as described in step 3 if required for access.

To remove the A2 CBT Control Assembly

Remove the two multiple pin connectors from the A2 CBT Controller assembly. These are held in place with sliding locks.

Use the extractor tabs at each end simultaneously to draw the PC board out of its mating connectors.

Install a new A2 by first aligning the PC board in the slot and then use only the extractors to press into place. This avoids damaging the mating connectors.

Ensure that the extractors are flush.

To Remove Any Other PC Boards

Use the extractor tabs at each end simultaneously to draw the PC board out of its mating connectors.

Install a new PC board by first aligning the PC board in the slot and then use only the extractors to press into place. This avoids damaging the mating connectors.

Ensure that the extractors are flush.

To Remove A1 Motherboard Assembly

Due to the cost and complexity of the process, the A1 Motherboard Assembly is no longer available for repair and replacement by the user. Contact Symmetricom Customer Assistance for repairs and service. No parts are available for the A1 Motherboard.

To Remove A10 Output Frequency Distribution Amplifier Module

7 Ensure that the top, bottom, right-side, and inner-RF shield covers are removed.

8 Disconnect all SMA, SMB, and module-to-A1 cable assembly connections for A9, A10, and A18.

3 Remove the small plate holding A5, A9, and A18 at top left of the module group (as viewed from the front) attached with five screws.

9 Remove 2 round-head screws from the right-rear chassis for each module other than A10 (and A5 if its removal is not required).

5 Lift A9 and A18 out and set aside. (Install new/functional unit if either (or both) is being replaced at this time.)

6 If A5 is being replaced at this time, remove the 2 round-head screws holding it to the right-rear side chassis, lift it out and install a new/functional unit.

7 Remove the ten flat-head screws that hold A10 to the chassis from the rear panel located around the module's perimeter.

7 Push A10 towards the front until its rear-panel connectors clear the rear panel mounting hole, then lift out.

9 Reverse the above steps to install a new/functional A10 unit. (Remember to replace the A5 and A9 RF shields when reassembling these modules. Be sure to tighten semi-rigid coax connector to 8.5 inch-pounds to eliminate RF leakage.)

To Remove A12 Dc-Dc Power Converter Module

1 Ensure that the top, bottom, and left-side covers are removed.

2 Remove 3 screws from the plate that holds A16 in place, attached at the top of A12 (1 screw) and the Toroid power transformer T1 (2 screws).

3 Remove 11 flat-head screws from the left-rear chassis frame located within the perimeter of A12.

4 Remove 4 screws holding a small (11/16” x 1 3/16”) plate (used for rack mounting).

5 Loosen (do not remove) 2 screws that hold the line filter/cable assembly to the rear panel to gain clearance for A12 removal.

6 Clip the A12 cable assembly wire tie.

7 Disconnect A12 power cable from A1.

8 Push A12 forward from the rear and up from the bottom, alternately back and forth until the unit is free.

9 Lift A12 out from the chassis and set aside and install a new/functional unit.

10 If A16 requires replacement at this time, disconnect its cable assembly-to-instrument connections and remove it from the instrument.

(Be sure to tag the high-voltage lines attached to the CBT before unscrewing these connectors, using only your fingers to avoid damage.)

11 Install new/functional A16 as required by reversing the above procedural steps.

To Remove A13 Front Panel Module

Use the following procedure to remove the entire A13 front-panel assembly and the PCB contained. No other lower-level parts are available for replacement on this assembly.

1 Ensure that the top, bottom, and both-side covers are removed.

2 Open the front-panel door.

3 Carefully remove the 9/16" dress nuts that hold the 1 pps Output and Sync Input BNC connectors to the inside front panel.

4 Close the front door securely.

5 Remove trim strips from sides of the front-panel frame.

6 Remove the four screws that hold the front-panel assembly to the left and right side chassis members.

7 Carefully disconnect the front-panel ribbon cable assembly at its A13 front-panel connector end.

8 Install a new front-panel assembly by reversing the order of the above procedural steps.

To Remove A14 Signal Amplifier Module

1 Ensure that the top cover and inner-RF (top) shield are removed.

2 Clip the wire tie that bundles the A19 input/output SMA connector cable assemblies.

3 Clip the wire tie that bundles the A16 power/control/HV output cables to the A19 ground strap(s).

4 Clip the wire tie that bundles the small-black CBT output coax, A19 power/control cable, and A16 power/control cable assemblies.

5 Disconnect the A19 A1P11 power/control cable assembly from A1J11.

6 Disconnect both input/output A19 SMA and SMB connectors from A19.

7 Remove the 2 round-head screws that mount the A19/A14 bracket to the 5/16” thick vertical aluminum CBT bulkhead.

8 Carefully slide the A19/A14 bracket and units upward until the A14 connections are about even with the top of the CBT bulkhead.

9 While holding the A19/A14 units in this position, carefully disconnect the A14 SMB CBT input cable connector and unplug the 05071-60243 six-wire power and output connector from A14.

10 Place the A19/A14 modules/bracket on a clean-flat work surface.

11 Remove the three round-head screws that hold A19 to the three rubber shock-absorbing grommets and mounting bracket.

12 Replace A19 with a new/functional module if replacement is required at this time.

13 If A14 requires replacement, remove the 2 round-head screws that hold it to the bottom of the A19/A14 mounting bracket.

14 Install a new/functional A14 module

15 Reverse the order of the appropriate steps to reinstall A19/A14.

NOTE Be sure to tighten semi-rigid coax connector to 8.5 inch-pounds to eliminate RF leakage.

To Remove A15 9.2 GHz Microwave Generator Module

1. Follow the instructions as described in “To Remove the Covers”.
2. Place the instrument on its side.
3. On the bottom side of the instrument, loosen all SMA connectors from A15 J1 through J5.
4. Remove the four nuts that attach A15 to the chassis.
5. Clip the wire ties that bundle the cables connected to J2, J3, J4, and +4.5Vdc on A15.
6. Carefully slide A15 out far enough to gain the clearance required to remove all SMA connectors.
7. Reverse the order of steps used to install a new/functional module.

To Remove A16 High Voltage Supply Module

1. Refer to the A12 removal and replacement procedure near the beginning of this section.
2. Use the appropriate steps to remove and replace A16.

WARNING

HAZARDOUS VOLTAGES ARE PRESENT ON THE A16 POWER SUPPLY MODULE. WAIT AT LEAST THREE MINUTES FOR THE CAPACITORS ON THE A16 POWER SUPPLY MODULE TO DISCHARGE BEFORE WORKING ON THE INSTRUMENT.

3. Reverse the order of steps used to install a new/functional module.

To Remove A17 CBT Assembly

The following procedures provide information required to remove and replace the Long-Life (10890A) or high-performance (10891A) Cesium-Beam tube.

NOTE During CBT replacement it is advisable to check (and if necessary adjust) the VCXO set-point. Refer to procedure 3.9.1.8 in chapter 2.

Preparation

If any questions about operation and programming arise while performing the procedures in this section, refer to the 5071A Operating and Programming Manual (part number 05071-90041).

With power still applied to the instrument do the following:

1 Connect a terminal or printer to the RS-232C port and configure for serial data communication to monitor and record the power-up sequence after installation is complete.

2 Set 5071A serial communications parameters so that they match the printer/terminal connected.

3 Set 5071A Diagnostic Log mode to “Service.”

4 Save the settings in 5071A memory using the Store function.

5 Check that communication works by selecting Info/Print and pressing Enter.

6 Leave the printer connected during the next steps.

10890A or 10891A CBT Removal

1 Remove all power from the instrument and disable the internal battery by momentarily pressing the Battery Disconnect switch.

2 Use a TORX® T10 driver to remove the four rear feet from the instrument.

3 Use the TORX® T15 driver to remove the bottom and top covers, being careful to “work” the covers toward the rear of the instrument. This “push and turn” process will prevent the cover screws from being stripped.

4 Look for the black coax cable that comes from the left side of the CBT and enters under a perforated RF cover. This is held in place with a tie wrap in a bundle with other wires. If the tie wrap is easy to access, proceed to step 5. If not, it may be necessary to remove the inner-top shield. This requires using a TORX® T10 driver to remove the 31 screws holding the cover in place.

5 With the bottom exposed, disconnect the right-angle SMB connector from the A14 Signal Amplifier module. This connector is part of a black coax cable connected to the Cesium Beam Tube.

Perform the remaining steps from the top of the instrument.

6 Clip the tie wrap holding the black signal coax cable in a bundle with other cables.

7 Use the 5/16” open-end wrench to carefully loosen SMA nut holding the rigid coax to the Microwave Adapter. Continue to loosen the SMA nut with your fingers until it is completely disconnected. The Microwave Adapter is a small metal device that is part of the CBT, towards the rear, near the tube center.

8 Record the position of the two High Voltage cables for later reassembly.

9 Unscrew the two High Voltage connectors using only your fingers. Do not use any pliers or wrenches, as these can crack the plastic or ceramic.

10 Remove the two multiple pin connectors from the A2 CBT Controller assembly. These are held in place with sliding locks.

11 Use the TORX® T25 driver to remove the four screws holding brackets and CBT in place.

12 Being careful not to bend the rigid coax, lift the CBT directly up from the cavity. The black signal coax should come free without interference, but pay attention to it to be sure it is not damaged.

CBT Installation

NOTE Follow the installation instructions carefully. They are NOT simply the reverse order of the previous process.

13 While guiding the black signal coax into its proper place, lower the replacement CBT into the cavity in the same position as the one removed.

14 Affix snugly, but DO NOT TIGHTEN the brackets to hold the CBT in place, allowing for rotation of the CBT.

15 Rotate the CBT so that the SMA nut and rigid coax are aligned as straight as possible with the connector on the Microwave Adapter.

16 Using your fingers only, begin screwing the SMA nut onto the Microwave Adapter. If aligned properly, the SMA nut should rotate easily until it is “finger tight”. It may be necessary to rotate the CBT slightly while tightening the SMA nut.

17 Finish tightening the four T25 TORX® screws to hold the CBT firmly in position.

18 Now, finish tightening the SMA nut to a final torque of 8.5 inch-pounds, using the 1/4” wrench to hold the semi-rigid coax in position while tightening the SMA nut.

NOTE Following the above procedure ensures that there will be no RF leakage at the SMA connection after final torque has been applied.

19 If a settable wrench is not available, use both a standard 5/16” and a 1/4” open end wrench and do your best to assure a tight connection. A good rule of thumb is to make the connection as tight as it was when initially removed.

20 Connect the two multiple-pin connectors to the A2 CBT Controller assembly, being sure to lock them into place.

21 Refer to your notes to correctly and carefully re-connect the High Voltage leads snugly to the CBT. DO NOT OVER TIGHTEN. Use only your fingers to prevent breaking the plastic or ceramic threads.

22 Turn the unit on its side to allow connecting the right-angle SMB connector to the A14 Signal Amplifier module.

23 Attach a new wire tie to bind the black signal coax to the same bundle as before. Trim excess tie wrap.

24 Before replacing the top and bottom covers, be sure that there are no cables or wires that will be pinched in the process.

25 Replace the top and bottom covers and the rear feet.

Operation Verification

1 Be sure the printer/terminal is on and that there will be a hard copy of the information captured.

2 Connect power to the instrument, noting the time.

3 If the message "`Cs Oven is Up`" does not appear within 25 minutes, there may be a problem with the connections to the A2 CBT Controller assembly. Remove all power, disconnect the internal-standby battery, and re-check your work.

4 When the message "`Operating Normally`" appears, the instrument is operating. No further adjustments are needed.

Disposal Procedure for Symmetricom Cesium Beam Tubes

Both the Long-Life (10890A) and High Performance (10891A) Cesium Beam Tubes contain non-radioactive cesium. After a defective cesium beam tube has been removed from the 5071A chassis, it must be disposed of properly, applying WORLDWIDE to all 5071A customers.

Two methods of disposal are described:

a. local-regional environmental procedures or,
b. direct shipment to the Symmetricom factory.

One of these methods must be used for disposal.

Local-Regional Environmental Procedures

The defective A17 CBT assembly is considered hazardous waste in some countries. **Dispose only in accordance with local environmental regulations. Contact your nearest regional office of environmental health service for guidance.**

Direct Shipment to the Symmetricom Factory

The following steps describe how to package and ship a defective 5071A cesium beam tube back to the Symmetricom factory.

1 If you do not have appropriate CBT packaging materials, you can obtain a CBT Packaging Kit from Symmetricom by requesting part number 59991-91102.

2 Use the packaging diagram that comes with the kit to package the cesium beam tube correctly.

3 Contact Symmetricom and order Service item # 999-72000-81 “Cesium Tube Disposal” and follow their instructions for pre-pay of freight and the delivery address. All marking/labeling instructions can be obtained from the 5071A shipping web page at http://www.symmttm.com/5071A/Shipping/

4 Clearly mark the container to indicate that the CBT is being returned for disposal.

To Remove A19 Reference Oscillator Module

1 Refer to the A14 removal and replacement procedure near the middle of this section.

2 Use the appropriate steps to remove and replace A19.

3 Reverse the order of steps used to install a new/functional module

5. Replaceable Parts

Introduction

This chapter contains information for ordering parts.

Replaceable Parts Table

Table 5-1 is a list of replaceable parts and is organized as follows:

1. Electrical assemblies in alphanumerical order by reference designation.
2. Chassis-mounted electrical parts in alphanumerical order by Chassis-mounted mechanical parts in alphanumerical order by reference designation.

The information given for each part consists of the following:

1. Reference designation.
2. Part number.
3. Description of the part.

Table 5-2 lists parts that are unique to the 48Vdc or telecomm output options.

How To Order A Part

Symmetricom wants to keep your parts ordering process as simple and efficient as possible. To order parts perform the following steps:

1 Identify the part and the quantity you want.

2 Determine the ordering method to be used and contact Symmetricom.

Parts Identification

To identify the part(s) you want, first refer to the exploded view in Figure 5-1 at the back of this chapter or Figure 2-1 in chapter 2.

When ordering from Symmetricom, the important numbers to note from the Parts List are the Part Number and the quantity of the part you want.

If the part you want is NOT identified in the manual, then it is not available for replacement and the 5071A must be sent to Symmetricom for servicing. Table 5-1 lists those parts that can currently be purchased.

Contacting Symmetricom

When ordering parts, contact your Symmetricom sales representative or distributor. They can assist in placing your order.

To arrange for service and repair, contact Symmetricom Customer Assistance.

Table 5-1. 5071A Replaceable Parts

Reference Designation	Part Number	Description
A1	Not Available	Motherboard
A2	05071-60202	CBT Controller
A3	05071-60003	Microprocessor
A4	05071-60004	Digital Synthesizer
A5	05071-60272	87 MHz PLL Module
A6	05071-60006	Servo
A7	05071-60007	Interface
A8	05071-60008	1 PPS
A9	05071-60292	Frequency Multiplier Module
A10	05071-60210	Output Frequency Distribution Amplifier Module
A11	05071-60029	Power Steering Logic, Std
A11	05071-60033	Power Steering Logic, 48VDC Version
A12	05071-60212	DC-DC Power Converter Module
A12	05071-60279	DC-DC Power Converter , 48VDC Version
A13	05071-60213	Front Panel Module
A14	05071-60214	Signal Amplifier Module
A15	05071-60215	9.2 GHz Microwave Generator Module
A16	05071-60216	High Voltage Supply Module
A17	10890A	Cesium Beam Tube, Long Life
A17	10891A	Cesium Beam Tube, High Performance
A18	05071-60218	9.2 GHz PLL Module
A19	05071-60294	Reference Oscillator Module
BT1	1420-0514	Battery 12V 2.5 Ah Lead Acid
MP4	05071-00027	Cover, Top
MP9	05071-00028	Cover, Bottom
MP13	05071-00037	Cover, Side, Perforated
MP25	5041-8821	Standoff -Rear
MP27	5062-4071	Rack Kit – Front Handle

Table 5-1. 5071A Replaceable Parts (Continued

Reference Designation	Part Number	Description
MP27	5062-3977	Rack Kit - No Front Handle
	0510-0182	Door Latch
	1251-0126	External DC Mating Connector, 5-pin Circular
	1400-3290	Rack Slide Hardware Kit
	1494-0458	Rack Slide (One pair). Must also order P/N 1400-3290
	59991-91102	Shipping Kit for 10890A/10891A CBT
	59991-91105	Shipping Kit for 5071A
	10890A	Standard Long-Life CBT. 12-year warranty
	10891A	High-Performance CBT. 5-year warranty
	05071-67006	Firmware Kit

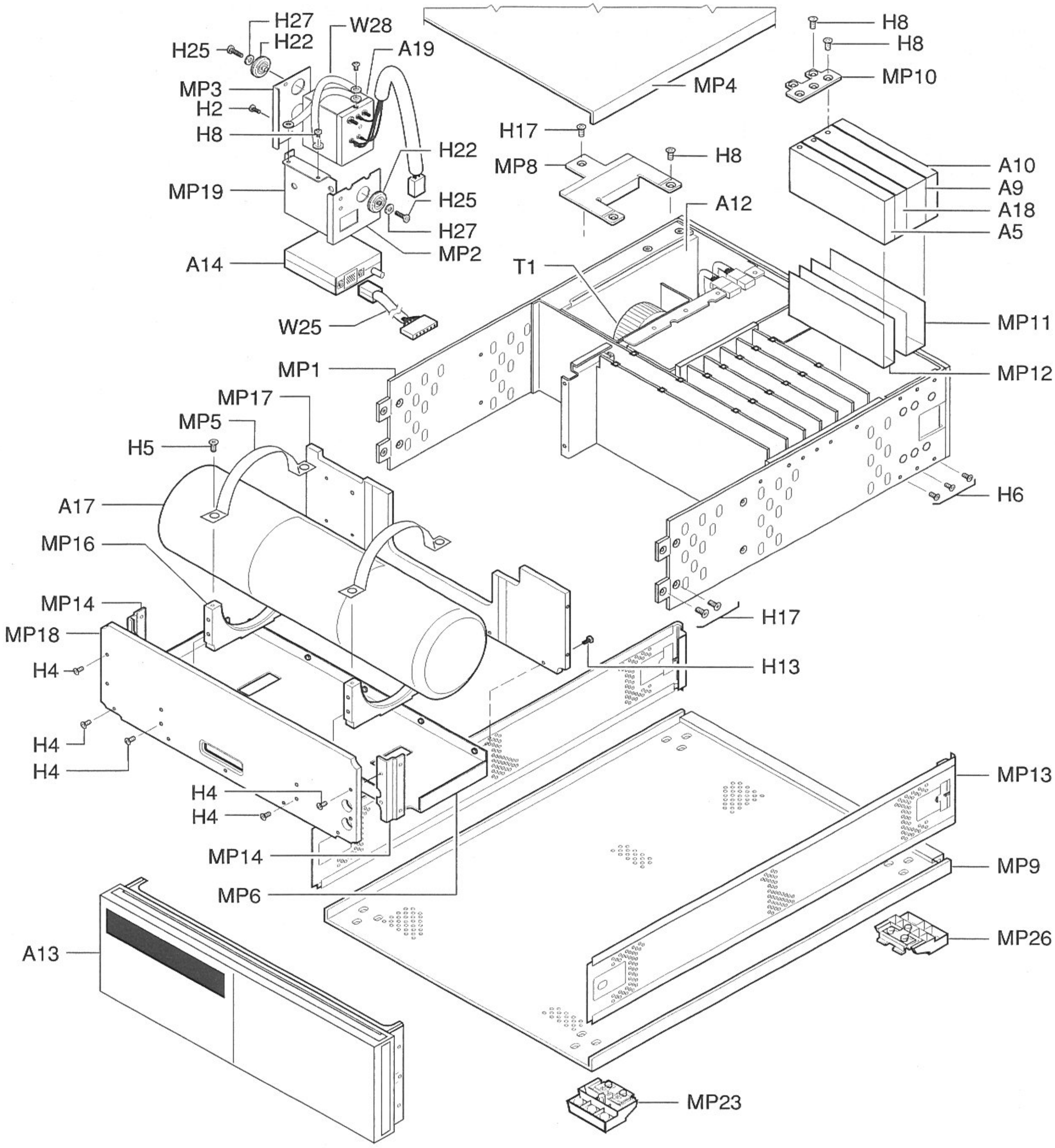


Figure 5-1. 5071A Exploded View (Chassis Parts)

6. Specifications

Introduction

The information in this chapter is identical to that found in the 5071A Operating and Programming manual P/N 05071-90041. Please refer to Chapter 6 in that document for any references to specifications in this manual.

7. Service and Support

Symmetricom's Customer Assistance Centers are a centralized resource to handle all of your customer needs.

Customer Assistance Center Telephone Numbers:

- Worldwide (Main Number): 1-408-428-7907
- USA, Canada, Latin America including Caribbean, Pacific Rim including asia, Australia and New Zealand: 1-408-428-7907
- USA toll-free: 1-888-367-7966 (1-888-FOR-SYMM)
- Europe, Middle East & Africa: 49 700 32886435

Technical Support can be obtained either through the Online Support area of our website (http://www.symmetricom.com/support/index.aspx), or by calling one of the above Customer Assistance Center numbers.

When calling the worldwide, or USA-based number, select Option 1 at the first prompt. Telecom Solutions Division customers should then select Option 1; Timing, Test and Measurement Division customers should then select Option 2.

Technical Support personnel are available by phone 24 hours a day, 7 days a week through the Main Customer Assistance Center number above and from 8 a.m to 5 p.m Central European Time, weekdays, at the Europe, Middle East and Africa number.

Customers who have purchased Technical Support Contracts may e-mail support requests to:

- support@symmetricom.com (Americas, Asia, Pacific Rim)
- emeasupport@symmetricom.com (Europe, Middle East, Africa)

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