

5071A Primary Frequency Standard User's Guide

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5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXA", where "XXXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB[®] IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.

PURPOSE OF THIS GUIDE

The 5071A user's guide provides basic recommendations for use of Microchip's 5071A primary frequency standard. The guidelines in the document are generic because specific product requirements vary from one application to the other.

This material consists of a brief description of 5071A features, programming, and operating instructions.

WHO SHOULD READ THIS GUIDE

This document is intended for engineers and telecommunications professionals who are designing, installing, operating, or maintaining time, frequency, and synchronization systems having a requirement for a primary frequency reference.

To use this document effectively, you should have a good understanding of digital telecommunications technologies and analog frequency generation and synthesis techniques.

DOCUMENT LAYOUT

This guide contains the following sections:

- **Chapter 1. "Introduction"**: Provides an overview of the product features, principle of operations, and safety considerations.
- Chapter 2. "Getting Started": Provides basic information on the indicators, controls, connectors and powering sequences.
- Chapter 3. "Using the 5071A": Provides detailed operating instructions for the instrument including configuration and disciplining to external sources.
- Chapter 4. "Troubleshooting Tips": Provides information on error messages, warning indicators, and interpreting log informations.
- Chapter 5. "Remote Operating and Programming": Contains information for remote control of the instrument and programming examples.
- Chapter 6. "Command Reference": Contains the detailed command list for programming and remote operation.

- **Chapter 7. "Specifications"**: Contains equipment specifications not included on the data sheet, and definitions of specifications on the data sheets.
- Chapter 8. "Installation": Provides information on external requirements and maintenance procedures.
- Appendix A. "Performance Tests": Provides information on the power up start test and serial port verifications.
- Appendix B. "Product Variations": Details all model numbers and product configurations.
- Appendix C. "Glossary"

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

Description	Represents	Examples	
Arial font:			
Italic characters	Referenced books	MPLAB [®] IDE User's Guide	
	Emphasized text	is the <i>only</i> compiler	
Initial caps	A window	the Output window	
	A dialog	the Settings dialog	
	A menu selection	select Enable Programmer	
Quotes	A field name in a window or dialog	"Save project before build"	
Underlined, italic text with right angle bracket	A menu path	<u>File>Save</u>	
Bold characters	A dialog button	Click OK	
	A tab	Click the Power tab	
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1	
Text in angle brackets < >	A key on the keyboard	Press <enter>, <f1></f1></enter>	
Courier New font:			
Plain Courier New	Sample source code	#define START	
	Filenames	autoexec.bat	
	File paths	c:\mcc18\h	
	Keywords	_asm, _endasm, static	
	Command-line options	-Opa+, -Opa-	
	Bit values	0, 1	
	Constants	OxFF, 'A'	
Italic Courier New	A variable argument	<i>file.o</i> , where <i>file</i> can be any valid filename	
Square brackets []	Optional arguments	mcc18 [options] <i>file</i> [options]	
Curly brackets and pipe	Choice of mutually exclusive	errorlevel {0 1}	
character: { }	arguments; an OR selection		
Ellipses	Replaces repeated text	<pre>var_name [, var_name]</pre>	
	Represents code supplied by user	<pre>void main (void) { }</pre>	

DOCUMENTATION CONVENTIONS

WARNINGS, CAUTIONS, RECOMMENDATIONS, AND NOTES

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this guide. The types of information included in each are displayed in a style consistent with the examples below.

WARNING

To avoid serious personal injury or death, do not disregard warnings. All warnings use this style. Warnings are installation, operation, or maintenance procedures, practices, or statements, that if not strictly observed, may result in serious personal injury or even death.

CAUTION

To avoid personal injury, do not disregard cautions. All cautions use this style. Cautions are installation, operation, or maintenance procedures, practices, conditions, or statements, that if not strictly observed, may result in damage to, or destruction of, the equipment. Cautions are also used to indicate a long-term health hazard.

Note: All notes use this style. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information, which may make your task easier or increase your understanding.

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- General Technical Support Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- Business of Microchip Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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- · Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the website at: http://www.microchip.com/support.

DOCUMENT REVISION HISTORY

Revision A (March 2022)

- Initial release of this document as Microchip DS50003249A.
 - Under Microsemi's literature system, this document was 05071-90041, Rev. J



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Table of Contents

Preface	3
Purpose of This Guide	3
Who Should Read This Guide	3
Document Layout	3
Conventions Used in this Guide	4
Warnings, Cautions, Recommendations, and Notes	5
Where to Find Answers to Product and Document Questions	5
Related Documents and Information	5
The Microchip Website	6
Customer Support	6
Document Revision History	7
Chapter 1 Introduction	12
1 1 What is the 5071A Drimary Frequency Standard?	12
1.2 How Does the 5071A Work?	12
1 3 5071A Major Features	12
1.4 System Applications	. 12
1.5 Instruments Covered by this User's Guide	13
1.6 Operating the 5071A	13
1.6.1 Signal Outputs	13
1.6.2 Clock Functions	13
1.7 Safety Considerations	. 15
1.7.1 General	15
1.7.2 Before Applying Power	15
1.7.5 Before Cleaning 1.7.4 Safety Earth Ground	. 10
1.7.5 Heeding Cautions	16
1.7.6 Rack Mounting	16
1.7.7 AC Power Supply	17
1.7.8 DC Power Supply (VDC Operation Model) Installation	17
1.7.9 Acoustic Noise Emissions	17
1.7.10 Electrostatic Discharge Immunity Testing	17
1.7.11 DC Power Supply (48 VDC Operation Model) Installation	17
1.7.12 Certification	18
1.7.13 Assistance	18
Chapter 2. Getting Started	. 20
2.1 The 5071A at a Glance	. 20
2.1.1 Indicators	20
2.1.2 Controls	20
2.1.3 Connectors	20

	2.2 Rear Panel Connections	22
	2.3 Starting the 5071A	24
	2.4 Performing Basic Tasks	25
	2.4.1 Synchronizing to an External 1PPS Reference	.25
	2.4.2 Setting Time and Date	.26
	2.4.3 Powering Down the 5071A	.26
Chapter 3. U	Ising the 5071A	28
	3.1 Using the Front-Panel Menus	28
	3.1.1 Keypad Descriptions	.28
	3.1.2 Controlling the 50/1A From the Front Panel	.28
	3.2 Setting the Output Port Frequency	29
	3.3 Setting the 1PPS and Clock Outputs	29
	3.3.2 To Synchronize the 1PPS Outputs Using a Time-Interval Counter	.29
	3.3.3 To Set the Clock	.30
	3.3.4 To Turn the Clock Display On or Off	.31
	3.3.5 To Schedule a Leap Second	.31
	3.4 Monitoring Status	31
	3.4.1 To Select Parameters	.31
	3.4.2 To Interpret Displayed Results	.31
	3.4.3 To Print a Status Report	.32
	3.5 Reading and Managing the Event Log	32
	3.5.2 To View Log Status	.32
	3.5.3 To Clear the Log	.32
	3.5.4 To Print the Log	.32
	3.6 Steering the Output Frequency	32
	3.6.1 Steering Explained	.32
	3.6.2 To Add an Offset	.33
	3.6.3 To Check an Offset	.33
	3.6.4 To Remove an Offset	.33
	3.7 Using Utility Features	34
	3.7.2 To Reset the Rear-Panel Status Output	.34
	3.7.3 To Display the Firmware Revision or CBT Identification String	.34
	3.7.4 Diagnostic Self-Tests	.34
	3.8 Configuring the 5071A	35
	3.8.1 To Set the Operating Mode	.35
	3.8.2 To Set the Printer Log Mode	.35
	3.8.3 To Set Up the Serial Port	.35
		.30
	3.9 Connecting a Printer	36
_	3.10 Disabling the Internal-Standby Battery	36
Chapter 4. T	roubleshooting Tips	38
	4.1 Front-Panel Indicators and Messages	38
	4.1.1 Clock Display	.38 20
	4.1.2 Automotic Light	38
	Continuous operation Light	

4.1.4 LCD Display	39
4.1.5 Instrument States	40
4.1.6 Front-Panel Warning Messages	40
4.2 Power-up Problems	41
4.3 Using Menus to Check Operational Status 4.3.1 INFOrmation Menu	41 41
4.3.2 LOG Menu	41
4.3.3 UTILities Menu	
4.3.4 CLOCK Menu	42
4.4 Operating System Failure 4.4.1 Operating System Failure Symptoms 4.4.2 Restarting the 50714	42 42 42
4.5 Coolum Boom Tube Life	
	43
Chapter 5. Remote Operating and Programming	44
5.1 Remote-Operation Setup	44
5.1.1 Remote Interface Features	
5.1.3 Hardware Connection	44 44
5.1.4 Serial-Port Configuration	
5 2 Programming Overview	46
5.3 SCPI Command Conformance	46
5.4 Command Types	
5.4.1 Common Command Format	46
5.4.2 SCPI Command and Query Format	47
5.4.3 *RST Reset Response	49
5.5 Sample Program Commands	49
5.5.1 Status Monitoring Tasks	50
	50
5.6 Batch Processing for the Program Commands	52
5.6.2 SCPI Considerations For HP BASIC	
5.6.3 Example Program	
5.7 Tips on Using the RS-232C Port on the 5071A	57
5.7.1 Keypad Lock-Ups: Why Do They Occur and How Are They Cleared?	[,] 57
5.7.2 Using Ctrl-Q in Programs	58
5.8 Setting the Serial Port Parameters with the Option 300 Front Panel	58
Chapter 6. Command Reference	60
6.1 5071A Command Summary	60
6.1.1 IEEE 488.2 Common Commands	60
6.1.2 SCPI Commands	
6.2 Description of SCPI Commands	65
0.2.1 Diagnosiic Commands	כס גא
6.2.3 Precision Time (Date and Time) Commands	69
6.2.4 Reference Oscillator Commands	
6.2.5 STATus Monitoring Commands	72
6.2.6 System Commands	75

5071A Primary Frequency Standard User's Guide

6.3 Status Reporting	78
6.4 Rear Panel Status Output Operation 6.4.1 Status Output Programming	80
6 5 Serial-Port Command/Printer Interface	82
6.5.1 Mode Selection	82
6.5.2 Pacing	82
6.5.3 The Prompt	82
6.5.4 End-Of-Line Characters	82
6.6 Error Messages/Codes	83
Chapter 7. Specifications	86
7.1 Supplemental Characteristics	86
7.1.2 Internal Standby Battery (Nominal Values)	00 86
7.1.3 Accessories and Options	87
7.2 Specification Definitions	88
Chapter 8. Installation	90
8.1 Initial Inspection	90
8.2 Preparation for Use	90
8.2.1 Power Requirements	90
8.2.2 Selecting Line Voltage and Fuse (For Units Delivered Prior to 23 Augus 2016)	st 91
8.2.3 AC Power Cabling	92
8.2.4 Operating Environment	93
8.3 Returning the 5071A to Microchip	93
8.4 Operator's Maintenance	95
8.5 Operating the 5071A From External DC Power	95
8.5.2 Replacing the External DC Input Power Fuse	95 96
8.6 Internal Standby Battery Maintenance	96
8.6.1 Battery Shelf Life and Storage	96
8.6.2 Battery Operating Temperatures	97
8.6.3 Battery Charging	97
8.6.5 Using the Battery Disconnect Switch	98 98
8.6.6 Removing and Replacing the Internal Battery	98
8.7 Cesium Beam Tube Replacement	99
8.8 Long-Term Storage	99
Appendix A. Performance Tests	100
A.1 Power-On Self-Tests and Servo Lock	100
A.2 RS-232 Serial Port Verification	101
Appendix B. Product Variations	102
Appendix C. Glossary	104
Worldwide Sales and Service10	



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 1. Introduction

This section describes the 5071A's features and provides information to better understand them so you can operate the instrument effectively. The following is a functional narrative description. For specific details such as signal levels, accuracy, stability, and more, see the most recent data sheet:

https://www.microsemi.com/document-portal/doc_download/133269-5071a-datasheet

1.1 WHAT IS THE 5071A PRIMARY FREQUENCY STANDARD?

The 5071A is a source of extremely accurate and stable output frequencies. The accuracy of the 5071A is within a few parts in 10^{13} of the internationally accepted definition of frequency. This accuracy is made more usable and practical by the 5071A's excellent environmental stability.

1.2 HOW DOES THE 5071A WORK?

The 5071A uses a fundamental property of the element cesium to define frequency. Inside the cesium beam tube assembly, an applied microwave signal causes energy-level transitions to occur in the cesium atoms. The microwave signal is synthesized from a 10 MHz voltage-controlled crystal oscillator (VCXO). Patented Cesium II circuit and software technology detects departures of the microwave frequency from the cesium energy-level transition frequency and corrects them by tuning the VCXO to run precisely at the proper rational-fraction of the cesium frequency. The microprocessor (an integral part of this servo loop) performs the error determination and correction several times a second to ensure that the VCXO is always closely locked to the cesium-transition frequency.

Many functions within the 5071A are under Cesium II software control. The software manages the initial warm-up and alignment, then continuously monitors the appropriate signals using this information to control all key operating parameters for optimum performance. Starting the 5071A merely requires connecting AC or DC power.

After a typical warm-up time of 15 minutes, the standard is fully operational and the operator may optionally press three keys to display a continuous operation signal. There are no maintenance procedures or adjustments needed even when necessary to replace the cesium beam tube. The 5071A meets all specifications within 30 minutes of power connection at room temperature.

1.3 5071A MAJOR FEATURES

- 5 MHz or 10 MHz programmable outputs
- Dedicated 1 MHz and 100 kHz outputs
- · Time and date clocks
- · Easily synchronized 1 pulse per second (1PPS) outputs
- 45-minute standby battery (some models do not have batteries. Refer to Appendix B. for more information.)
- · Accurate and precise output frequency steering
- · Event log

1.4 SYSTEM APPLICATIONS

As a system component, the 5071A's function is significantly enhanced by its capacity for complete remote control through an RS-232C port on the rear panel. All front-panel functions can be programmed through the port as well as many functions not available through the front panel controls. The RS-232C port allows the instrument to:

- · Print status reports and internal parameters to an external printer
- Communicate with and be controlled by a data terminal or computer

1.5 INSTRUMENTS COVERED BY THIS USER'S GUIDE

The 5071A has a two-part serial number in the form US00000000 that appears on the serial number plate attached to the rear of the instrument. The first four numerical digits constitute the serial number prefix and the last 4 significant digits form the suffix. The prefix is the same for all identical instruments. It changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. This manual applies directly to instruments having the serial prefix as US4935.

For information concerning a serial number prefix that is not listed, contact the nearest Microchip Customer Service Center.

1.6 OPERATING THE 5071A

Local operation of the 5071A is performed on the control panel located behind the front panel door. Here you will find the 5071A's controls and Liquid Crystal Display (LCD). The LCD is backlit for better visibility whenever any key is pressed.

Note: Not all models contain a display, door, or keypad. Please refer to Appendix B. for product configurations.

1.6.1 Signal Outputs

There are four sinusoidal outputs available on the 5071A: two fixed frequency outputs of 1 MHz and 100 kHz, and two programmable output ports. Each programmable output port can be set to emit a 5 MHz or 10 MHz signal. These ports are isolated from each other so that noise or impedance changes on one port cannot significantly affect the amplitude or phase of the signal on any other port. An additional property of these outputs is that they are phase consistent. That is, when the frequency on a port is changed then returned to the original frequency, the original phase is restored.

1.6.2 Clock Functions

The clock functions use the large six-digit LED display, the 1PPS outputs, and their control circuits. The 1PPS outputs are movable in time and can be automatically synchronized with other 1PPS sources. Clock adjustment procedures can be found in Using the 5071A.

Clock display: On power-up, the clock display is OFF so the clock will not display an incorrect time. The display may be set and turned on using the front-panel controls or the RS-232C interface. If you plan to use the Modified Julian Day (MJD) date system, the time should be set to Coordinated Universal Time (UTC). See more information about the MJD later in this section.

1PPS outputs: There are three 1PPS outputs on the 5071A, one on the front panel and two on the rear panel. All are synchronous (pulses occur at the same time) and isolated from each other so that a short circuit or other disturbance on one cannot affect the amplitude or timing on the others.

All 1PPS outputs are TTL-compatible and are designed for 50Ω termination. You can automatically synchronize the 1PPS signals to an external 1PPS, or manually change their timing by up to ±500 ms in 50 ns steps. For automatic sync, there are two reference inputs: one on the front panel and one on the rear panel. You select either input using the front-panel controls or via RS-232.

Leap second: The 5071A can be easily set to add or delete a leap second on a designated day. The leap second is automatically added-to or subtracted-from the last minute of the day. There is no need for operator intervention when the actual leap-second alteration occurs.

Modified Julian Day (MJD): The Modified Julian Day is a number that is unique for each day. This numbering system is widely used by astronomers and scientists to tag data and events. Within the 5071A, the MJD is used for two purposes:

- · To tag events kept in the instrument's event log
- To program the insertion or deletion of a leap second at a future date

The MJD increments at 00:00:00 hours Coordinated Universal time (UTC). To ensure proper synchronization of the MJD setting, the clock display must be set to UTC. If the MJD is not set, the 5071A will start with 00000 in its MJD counter and increment from there each time the clock display passes 00:00:00 hours. See Using the 5071A for information on how to determine and set the current MJD.

Steering (or offsetting) the 5071A output frequency: The 5071A output frequency can be steered in a very precise and calibrated manner. When steered, the stability of the output signals is identical to the un-steered signal.

You can steer the 5071A over a range of ± 1 part in 10^9 with a resolution of 6.331991 parts in 10^{15} . These specifications are called the settability of the 5071A.

Steering is accomplished by changing the ratio between the VCXO output frequency and the cesium transition frequency through a digital synthesizer. The reference frequency of the cesium beam tube is not disturbed. This system has the following advantages over previous cesium beam frequency standards:

- · No change in stability of steered output over un-steered output
- · Offset from un-steered frequency is precisely known
- Fast change to the precise steered frequency
- · Fast and precise return to the original frequency

As a result of knowing the exact amount that the 5071A has been steered, its value as an independent frequency source in an ensemble is maintained.

Event Log: The event log automatically stores significant events such as power supply changes, system warnings, and error messages. The event log has the following features:

- · Non-volatile memory: all data remains if power is lost
- Stores 190 events
- · Each logged event is time-and-date tagged
- · Log may be read locally or through the RS-232C port

Power input and management: The 5071A operates from either AC or DC power. An internal-standby battery provides at least 45 minutes of operating power (see Appendix B. for model numbers with batteries). Power-source priority is controlled by the 5071A. The priority order is:

- 1. AC-line power: when below the specified minimum voltage or if absent, the 5071A switches to,
- 2. External-DC power: if this fails or goes below 22VDC, the 5071A switches to,
- 3. Internal-standby battery power (if model is configured with battery).

For 48V option the priority order is:

- 1. External-DC power: when below the specified minimum voltage (40VDC on both DC inputs), or when absent, the 5071A switches to,
- 2. AC-line power

Remote operation: The 5071A may be operated completely through remote control. The RS-232C port on the rear panel allows the 5071A to be connected to a computer. The 5071A is programmed in a standard language called standard commands for programmable instruments (SCPI) based on IEEE 488.2.

Status output: The rear-panel status port gives you an additional option for remote monitoring of the 5071A's operating status. In its default mode, the rear-panel status output indicates when the continuous operation light goes out. You can re-program this output to activate on other combinations of internal events.

The status output is TTL with the active state asserted LOW. The status outputs of several 5071As can be connected in parallel (in a wired-OR configuration) to operate a system monitor or act as a service request signal for a computer. See Rear Panel Status Output Operation for details.

Operating modes: There are two operating modes: Normal and Standby. The default mode is Normal. The operating mode should never be changed from Normal to Standby except under special circumstances. These are described as follows. Placing the 5071A in standby mode will cause a loss of time and frequency accuracy.

- Normal mode: The 5071A always powers up in this mode. Use this mode for all normal operation and timekeeping.
- Standby mode: The Standby mode is enabled through the Utility menu and is used for two special purposes:
 - Long term storage: Use Standby when the 5071A is stored more than 3 months. For more information, see Long-Term Storage.
 - Service: If a failure occurs, diagnostics operate in Standby mode.

Remote operation: The remote state can only be entered through remote command through the RS-232C port. In this state, the 5071A operates normally with the front-panel controls locked out: no changes can be made to parameters (like 1PPS delay), and no actions can be taken through the front panel. Status information however, can be read when the front panel is locked. If any disallowed operations are attempted the 5071A beeps and displays a message. Remote operation is indicated on the front-panel display with a small lock symbol on the right-hand side.

1.7 SAFETY CONSIDERATIONS

1.7.1 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 Microchip, the protection provided by the equipment may be impaired.

1.7.2 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 the Getting Started section.

1.7.3 Before Cleaning

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

1.7.4 Safety Earth Ground

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

1.7.5 Heeding Cautions

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 through 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.

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.

1.7.6 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 overcurrent 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 (for example, use of power strips).

1.7.7 AC Power Supply

WARNING

The Model 5071A unit should only be plugged into a grounded receptacle. Microchip 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 outlet is not sufficient protection.

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 fuse holders.

1.7.8 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 (1.5 mm²) gauge wire is the minimum gage permitted by the NEC for DC power source hookup.
- The Unit Chassis must be grounded for proper safety.

1.7.9 Acoustic Noise Emissions

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

1.7.10 Electrostatic Discharge Immunity Testing

When the product is tested with 8 kV AD, 4 kV CD, and 4 kV 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.

1.7.11 DC Power Supply (48 VDC Operation Model) Installation

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 48VDC Operation Model.

WARNING

Remove any power connections prior to servicing the interior of a unit.

Connecting the 48VDC Operation Unit to DC power:

Note: The 48VDC Operation Model is supplied with two 48VDC inputs to accommodate input from an alternate DC Power Source.

• 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 (1.5 mm²) gauge wire is the minimum gage recommended for DC power source hookup.
- The 48VDC configuration unit is only to be used in a restricted access area.
- The screw torque on the power terminal block is 4.5- to 5.3-inch pounds.
- When connecting to a DC power source, first connect the positive power cable to "+" on the power supply, then connect the negative power supply cable to "-". The unit chassis must be grounded for proper safety.
- The 48VDC unit is supplied with a cover 05071-00053. This cover should be attached when operating with 48VDC supplies.

1.7.12 Certification

Microchip certifies that this product met its published specification at the time of shipment from the factory. Microchip 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.

1.7.13 Assistance

For complete warranty terms, certifications, product maintenance agreements, and other customer assistance agreements, please contact your nearest Microchip Sales and Service Office. NOTES:



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 2. Getting Started

This section introduces the front-panel interface menus and shows how to perform more complex time-keeping tasks.

2.1 THE 5071A AT A GLANCE

If you've unpacked and inspected the 5071A, and are ready to operate it, see Starting the 5071A.

The front-panel features are illustrated and briefly described on the following pages. The item numbers on this page correspond to the callouts in Figure 2-1, Figure 2-2, and Figure 2-3.

2.1.1 Indicators

- Clock display: Shows 24-hour time.
- Attention light: Indicates power-up sequence or the need for attention (refer to Troubleshooting Tips for more information).
- Continuous operation light: When lit continuously, indicates normal operation (no faults since last reset).Refer to Troubleshooting Tips for more information.
- LCD display: Shows instrument menus, functions, MJD, and internal operating parameters (see Performing Basic Tasks to adjust the LCD display for best view-ing).

2.1.2 Controls

- Data entry/function keypad: Selects six menu shortcuts and enters numeric data.
- Actions keypad: Controls cursor, menu choices, data entry termination, and display contrast.

2.1.3 Connectors

- 1PPS output: Provides a 20 µs pulse every second for synchronization and timing.
- SYNC input: Accepts a 100 ns to 100 µs pulse for synchronization of 1PPS. The electrical characteristics of these connectors are the same as the rear panel 1PPS output and sync input. For more information, see Rear Panel Connections.



2.2 REAR PANEL CONNECTIONS

The item numbers in the following table correspond to the callouts in Figure 2-2 and Figure 2-3.



5071A Primary Frequency Standard User's Guide



48V Option Rear Panel. FIGURE 2-3:

TABLE 2-1:	CONNECTOR DESCRIPTIONS
------------	------------------------

ltem Number	Function	Connector Type	Signal Characteristics	Program Control
1	Output: Port 1, 5 MHz or 10 MHz	Type N Female	Sinusoidal, 1V _{RMS} into 50Ω, Nominal	YES
2	Output: Port 1, 5 MHz or 10 MHz	Type N Female	Sinusoidal, 1V _{RMS} into 50Ω, Nominal	YES
3	1 MHz Output	BNC Female	Sinusoidal, 1V _{RMS} into 50Ω, Nominal	NO
4	100 kHz Output	BNC Female	Sinusoidal, 1V _{RMS} into 50Ω, Nominal	NO
5	1PPS Output	BNC Female	1PPS, 20 μs wide, TTL-compati- ble, into 50Ω	YES
6	1PPS Sync Input	BNC Female	100 ns to 100 μs wide, +2V to +10V into 50Ω, TTL Threshold	YES
7	Status Output, Active Low	BNC Female	TTL Open Collector, 1.6 kΩ pull-up to 5V	YES
8	Remote Data Transmission	9-Pin, Male, D-subminiature	RS-232C, DTE Configuration	YES
9	Internal Standby Battery Disconnect Switch Access	N/A	Switch disconnects Internal Standby Battery	NO
10	External DC Power	5-Pin Cannon, Series ME	22VDC to 42VDC, 100W, Pinout: +22VDC to +42VDC (pin A), Neg. DC (pin C), Chassis GND (pinE), pins B and D are not used.	NO
11	External DC Power Fuse	Cartridge Fuse	Fuses external DC power, 5 Amp fuse	NO

ltem Number	Function	Connector Type	Signal Characteristics	Program Control
12	AC Power Input and Fuse	3-prong, Grounded	120/240VAC, 1.5/0.75 Amp slow-blow fuse	NO
48V Option				
13	DC Power Fuse	Cartridge Fuse	Fuses external DC power, 2.5 Amp, 250V rating (P/N 2110-0952)	NO
14	Ext. DC Power Input	5-Screw Terminal Strip	40VDC to 58VDC, 100W Max., as labeled on rear panel	NO

TABLE 2-1:CONNECTOR DESCRIPTIONS (CONTINUED)

Note 1: Items 9, 10, and 11 are not present on 48V option instruments.

2.3 STARTING THE 5071A

- 1. Inspect the instrument for any damage (see Initial Inspection for details).
- 2. Ensure that the AC power setting, AC line fuse, (rear panel) and supplied power cord are appropriate for the AC power source. Refer to Installation for more detailed information.
- 3. Apply power to the instrument.

The amber Attention light illuminates, indicating normal power-up sequence, and the following messages are displayed on the LCD.

The message "Waiting for Stabilization" may appear. If so, it could stay on for up to 20 minutes before the following messages appear.

- a) Warming up (Indicates self-test passed successfully.)
- b) Setting Osc. Control
- c) Setting RF amplitude
- d) Setting E_mult voltage
- e) Logging signal levels
- f) Setting C-field
- g) Locking servo loops
- h) Operating normally
- 4. After about 15 minutes, the Attention (amber) light goes out and the Continuous (green) light flashes.
- Press Shift (in the ACTIONS keypad section), then 5 (Utilities): LCD display shows RESET. 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. (See Troubleshooting Tips for details.)

The 5071A will power 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: Cleared (One entry remains: "Power source is BATT". For 48V option, one entry remains: "Lock completed".)

If the application requires a different configuration, please see Configuring the 5071A.

Some variations of the 5071A have a mute feature (see Appendix B.). If the model has this incorporated, the 100 kHz, 5 MHz, and 10 MHz RF outputs will not provide a signal until the cesium beam tube has locked and the product has entered normal continuous operation.

2.4 PERFORMING BASIC TASKS

The following are things you may do at any time during these basic tasks:

- You may, at any time, return to the Top menu by pressing the Top key.
- At any time, you may cancel a pending operation or data entry task by pressing Prev.
- If you need to adjust the display for better readability, hold down Shift, then press Inc or Dec.

2.4.1 Synchronizing to an External 1PPS Reference

The 5071A requires a sync pulse with the following characteristics:

- +2V to +10V into 50Ω (TTL Threshold)
- Width = 100 ns minimum to 100 µs maximum, Rise time <50 ns

Note: The 1PPS output from a 5071A meets these sync pulse requirements. As an alternative, the 1PPS may be manually synchronized (see Setting the 1PPS and Clock Outputs).

Synchronize the 5071A's 1PPS Outputs (to the reference source) with the following procedure:

- 1. Connect a 1PPS sync pulse from the reference clock to the instrument's front (or rear) sync input.
- 2. Press Top, then press \rightarrow once to select the CLOCK option.
- 3. Press Enter.

The SET option of the CLOCK menu is selected.

4. Press \rightarrow three times.

The SYNC option (CLOCK menu) is selected.

- 5. Press Enter, then press \rightarrow to select ARM FRONT or ARM REAR.
- 6. Press Enter to arm the selected sync input connection. The 5071A will synchronize to within ±50 ns on the next sync pulse and the display will show Caught a Sync Pulse.

Note: While the sync input is armed, all 1PPS outputs and the clock display are stopped. These resume on synchronization or within 1.5 seconds, whichever occurs first.

Note: If no sync pulse is captured within 1.5 seconds after arming, the selected sync input is disarmed, and the instrument's LCD display shows: Sync Timed Out.

2.4.2 Setting Time and Date

Set the time, as follows:

- 1. Press Shift, then 8 (Set Clock).
- Set 24-hour time (numeric keys), then press Enter: the time displays increment immediately. Press → to select the Display ON/OFF field, then press Inc to turn on the Display. For information about the Modified Julian Day (MJD), see Setting the 1PPS and Clock Outputs.

Set the dates, as follows:

- 1. Press Shift, then 8 (Set Clock).
- 2. Press \rightarrow twice to select the DATE field.
- 3. Enter the Modified Julian day with the numeric keys. For information about the Modified Julian Day (MJD), see Setting the 1PPS and Clock Outputs.
- 4. Press Enter.

The new date is shown in the LCD display.

Note: Always synchronize the 1PPS pulse outputs before setting time and date, otherwise the clock may display incorrect time/date information.

2.4.3 Powering Down the 5071A

When removing power from the 5071A, you'll need to disable the internal-standby battery.

Note: Some models do not have internal-standby battery. See Appendix B.

If the 5071A is used in a system or operation where power is removed on a daily or more frequent basis, it is strongly recommended that the internal-standby batteries be physically disconnected. This will prevent excessive discharge/recharge cycles from prematurely depleting standby capacity.

Refer to Disabling the Internal-Standby Battery for the information on how to disable the internal-standby battery.

NOTES:



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 3. Using the 5071A

This section introduces the front-panel interface menus and shows how to perform more complex timekeeping tasks.

3.1 USING THE FRONT-PANEL MENUS

The following sections describe how to use the front-panel menus.

3.1.1 Keypad Descriptions

3.1.1.1 ACTIONS KEYPAD

The ACTIONS keypad makes menu selections, engages shift functions (DATA ENTRY/FUNCTION: in blue), terminates numeric entry, and controls LCD display contrast.

3.1.1.2 DATA ENTRY/FUNCTION KEYPAD

DATA ENTRY/FUNCTION keypad enters numeric data and selects secondary functions (in blue).

3.1.1.2.1 Action Key Functions

- Use the → arrow ← keys to move around the menus or, when shifted, tab through menu fields.
- Use the Inc and Dec keys to select the next or previous choice from a list (when shifted, they adjust LCD display contrast).
- Use the Top or Prev keys to move all the way or one level back up the menu tree.
- Use the Enter key to select a menu choice or trigger an action.

Refer to The 5071A at a Glance for the available menus, display icons, and conventions.

3.1.2 Controlling the 5071A From the Front Panel

You can customize the 5071A's operation by performing a number of tasks after the instrument is running normally (see Performing Basic Tasks). When you've completed most of these tasks, no further operator intervention will usually be required. Some of these operations can cause the instrument to gain or lose time and are clearly marked with cautions. The suggested operator tasks are:

- · Setting the Output-Port Frequency
- · Setting the Clock
- Monitoring Status
- Reading and Managing the Event Log
- Steering the Output Frequency
- Using Utility Features
- · Configuring the Instrument
- · Connecting a Printer
- Disabling the Internal-Standby Battery

More information for using the menus to check instrument status can be found in Troubleshooting Tips.

3.2 SETTING THE OUTPUT PORT FREQUENCY

Use this procedure to set the output frequencies at rear-panel ports 1 and 2 to either 5 MHz or 10 MHz.

Note: When the frequency of a port is changed and then returned to the previous frequency, the original phase is restored.

- 1. Select the CONFIG menu, then press Enter.
- 2. Select OUTPUTS, then press Enter.
- 3. Choose Port 1 or Port 2, then press Inc or Dec to set frequency.

3.3 SETTING THE 1PPS AND CLOCK OUTPUTS

Use the following information to adjust the 5071A's clock and synchronization functions.

3.3.1 To Set the 1PPS Outputs

Set the 1PPS outputs before setting the clock display for time or date. The timing of the 1PPS output signal can be synchronized with a reference 1PPS signal in two ways: automatically or manually.

- The automatic method requires a reference-sync input signal and is described in Performing Basic Tasks.
- The manual method is used when an appropriate reference-sync input pulse is not available or when you need to offset the instrument's 1PPS output signal from a reference pulse by a specific time interval.

The manual method can also be used to arbitrarily move (slew) the 1PPS signal in time. If you want to move the 1PPS signal without using a time-interval (TI) counter, simply use the last three steps of the following procedure.

All three of the instrument's 1PPS outputs are synchronous and isolated from one-another. Changes made to the 1PPS output signal timing have no effect on the 10 MHz, 5 MHz, 1 MHz, or 0.1 MHz output signals.

3.3.2 To Synchronize the 1PPS Outputs Using a Time-Interval Counter

You can manually synchronize the 1PPS outputs with another frequency standard or system (±50 ns) if a Sync input signal is not available as described in Getting Started. A high-resolution TI counter should be used when synchronizing the 5071A with another clock or system with the following considerations:

- TI measurements should include consideration of cable-length delay
- Use 50Ω termination on the 1PPS lines to reduce ringing.

Use the following procedure to synchronize the 1PPS outputs manually:

- 1. Connect the reference 1PPS signal to the START input of the TI counter.
- 2. Connect the 5071A's 1PPS Output to the STOP input of the TI counter.

- Set the counter's trigger-level controls to trigger on the leading edge of each signal at the 50% amplitude point. (for the 5071A with 50Ω termination: trigger slope = Positive, trigger level = +1.5 Volts)
- 4. Read the time difference on the counter.
- 5. Adjust the 1PPS timing (select Slew) by pressing Shift, then 9.
- 6. Enter the counter reading in microseconds into the Epoch Advance value field.
- 7. Press Enter and observe the TI counter reading for confirmation.

Note: Positive values advance the 5071A's 1PPS in time, while negative values retard it. The resolution of the Slew control is 50 ns (you will need to make more than one adjustment if the initial TI counter reading exceeds 500 ms). Check the time and date on the 5071A after you've synchronized the 1PPS outputs.

3.3.3 To Set the Clock

3.3.3.1 SETTING THE TIME

- 1. Select the CLOCK menu.
- 2. Set 24-hour time (numeric keys), then press Enter.

The clock setting increments immediately. You can use the Inc/Dec keys to make small adjustments.

3. To turn on the LED display, see To Turn the Clock Display On or Off

3.3.3.2 SETTING THE DATE

- 1. Select the CLOCK menu.
- 2. Press \rightarrow twice to bracket the DATE field.
- 3. Enter the correct Modified Julian Day (MJD) with the numeric keys (see the MJD information that follows).
- 4. Press Enter.

The new date is shown in the LCD display.

3.3.3.3 THE MODIFIED JULIAN DAY (MJD)

During the course of configuring and using the 5071A, you'll have occasion to set the date. The 5071A uses the MJD to date log entries as well as tagging the day that a leap second is to be added or subtracted.

The MJD is a widely accepted method of providing each day with a unique number and is used with Coordinated Universal Time (UTC). The MJD changes at midnight and increments in the 5071A when the clock display reaches 00:00:00. This ensures that the instrument is correctly synchronized with the MJD.

The easiest way to determine the MJD is to add the number of days between the current date and a recent known MJD. For example, December 31, 1991 is MJD 48621. January 5, 1992 was (48621 + 5) or MJD 48626. MJD's for December 31 are given in the following table.

December 31	MJD	December 31	MJD
1992	48987	1997	50813
1993	49352	1998	51178
1994	49717	1999	51543
1995	50082	2000	51909
1996	50448	2001	52274

TABLE 3-1: MODIFIED JULIAN DAY (MJD)

3.3.4 To Turn the Clock Display On or Off

Use the following procedure to control the clock display:

- 1. Select the CLOCK menu.
- 2. Press \rightarrow to enter the clock display control field.
- 3. Press the Inc or Dec keys to toggle the display ON or OFF.

3.3.5 To Schedule a Leap Second

You can pre-program the 5071A to add or subtract a leap second on a designated MJD.

- 1. Select the CLOCK menu.
- 2. Select LEAPSEC, press Enter, enter the effective date (MJD), and press Enter. This is the MJD on which the change is to occur at 23:59:59.
- 3. Select the next field by Pressing the \rightarrow key.
- 4. Press Inc or Dec to choose 59 or 61, depending on whether a leap second is to be added or subtracted.

Display shows Leap second is pending. The leap second will occur as desired without further input. When the desired MJD has arrived, an entry will be placed into the Status Log at 23:59:57 indicating that either a short or long minute has occurred.

3.4 MONITORING STATUS

Use the following procedures to check the 5071A's operational status and selected internal parameters.

3.4.1 To Select Parameters

Press Shift, then 7 (INFO): display shows instrument status.

Select the reading you want to check then use the cursor keys to examine the instrument's status.

3.4.2 To Interpret Displayed Results

The front-panel LCD display shows the current status (or value) of the selected parameter. The following table lists typical internal-parameter operating ranges and definitions.

Parameter	Description	Typical Range
Pump	Ion pump current	0 μA to 40 μA
Ovens	Cesium beam tube and VCXO oven monitor	0V to 10V and –5V to –10V
Ctrl	VCXO control voltage	–95% to 95%
C-Field	C-field control current	10.0 mA to 14.05 mA
Ampl	Microwave signal strength for CBT (% of maximum)	0 to 100%
E_Mult	CBT electron multiplier voltage	1000V to 2553V
Gain	Frequency control loop gain (% of maximum)	14.4% to 58%
Power	Voltage source	AC, DC, or Battery

TABLE 3-2: INTERNAL OPERATING PARAMETERS

3.4.3 To Print a Status Report

Use the following procedure to print a status report when a printer is connected to the rear-panel RS-232C serial port (see Connecting a Printer).

- 1. Select the INFO menu.
- 2. Select the PRINT option and press Enter.

3.5 READING AND MANAGING THE EVENT LOG

The event log contains a history of such things as power-supply status, errors, and warnings. A maximum of 192 entries can be recorded with each numbered entry time-and-date stamped. When the log is full, no more entries can accumulate. Therefore, you should periodically examine the log and clear entries.

3.5.1 To Check Log Status

Use the following procedure to see how many entries are in the event log.

- 1. Select the LOG menu, then press Enter.
- 2. Select STATUS.

The number of log entries is displayed.

3.5.2 To View Log Entries

Use the following procedure to read event-log entries.

- 1. Select the LOG menu, then press Enter.
- 2. Select BROWSE, then press Inc or Dec as needed to read the entries.

3.5.3 To Clear the Log

This procedure clears the entire log. Cleared entries cannot be recovered.

- 1. Select the LOG menu, then press Enter.
- 2. Select CLEAR, then press Enter to clear the entire log.

3.5.4 To Print the Log

Use the following procedure to print the log contents when a printer is connected to the rear-panel RS-232C serial port (see Remote-Operation Setup).

- 1. Select the LOG menu, then press Enter.
- 2. Select PRINT, then press Enter.

3.6 STEERING THE OUTPUT FREQUENCY

3.6.1 Steering Explained

In normal operation, the output frequencies of the 5071A are in fixed relation to the Cesium Beam tube response. This relationship provides the basis for traceability of the 5071A to the international definition of time.

The STEER menu lets you change output frequencies in a calibrated manner with great precision.

Changes can be made manually (front panel) or through the serial interface (SCPI commands). The 5071A's output steerability facilitates its use in active-clock ensembles. It also gives you a convenient way to make controlled changes in the phase of the rear-panel sinusoidal and 1PPS outputs. For example, a reserve standard can be brought into phase with a working standard before the two are interchanged. You can also make changes in the timing of the 1PPS output signal with greater precision than provided by the slew control's ±50 ns resolution. Simply, steer the output frequency for a suitable length of time.

The resolution unit of the STEER function is 6.331991×10^{-15} , and the range of the fractional frequency offset is $\pm 999999 \times 10^{-15}$. When you STEER the instrument's output frequency, you must take into account the exact amount of the offset to establish and maintain traceability and accuracy. The frequencies of the sinusoidal outputs and the rate of the 1PPS outputs change by the same fractional amount when the output is steered.

Use the following procedures to add, check, or remove a fractional frequency offset when using the 5071A.

3.6.2 To Add an Offset

- 1. Select the STEER menu, then press Enter.
- 2. Enter the desired fractional frequency offset in units of 1.0×10^{-15} using the numeric keypad.
- 3. Press Enter to initiate the offset, or Prev to cancel the operation and return to next-higher menu level.
 - **Note:** The 5071A rounds the entered offset to the nearest multiple of 6.331991 x 10^{-15} , and displays it when you press Enter. The rounded value is displayed to a resolution and accuracy of 1 x 10^{-15} . When the output frequency is steered, the ATTENTION light flashes, indicating that the output frequency and clock rate contain an intentional deviation.

Note: The steering value is not stored in the 5071A non-volatile memory. If the Continuous operation LED is flashing any time after a reset, it indicates that power was lost during operation. This would mean that any steering value you have previously entered is no longer in effect. You will need to re-enter the steering value as part of the reset procedure.

3.6.3 To Check an Offset

Use the following procedure to determine the value of an active offset.

- 1. Select the STEER menu, then press Enter. The LCD display shows the current offset value with an accuracy of 1 x 10^{-15} .
- 2. Leave the active menu by pressing Prev.

3.6.4 To Remove an Offset

- 1. Select the STEER menu, then press Enter.
- 2. Press 0, then Enter to clear the offset. The ATTENTION light goes out.

3.7 USING UTILITY FEATURES

Use the following procedures to run selected utility functions.

3.7.1 To Reset the Continuous Operation Light

Use the following procedure when the Continuous Operation light is flashing.

Note: If the continuous operation LED is flashing any time after a reset, it indicates that power was lost during operation. If you are concerned with timing, phase, or if you had been steering the frequency you will need to re-synchronize the timing and phase and/or re-enter the steering value as part of the reset procedure.

- 1. Press Shift, then 5 (UTILITIES): the LCD display shows RESET selected.
- 2. Press Enter.

The Continuous Operation light is now continuously lit.

3.7.2 To Reset the Rear-Panel Status Output

- 1. Select the UTIL menu, then press Enter.
- 2. Select CLEAR, then press Enter.

Note: Resetting the Status Output results in a "high" logic state when the instrument is operating normally.Resetting the Status Output results in a "high" logic state when the instrument is operating normally.

3.7.3 To Display the Firmware Revision or CBT Identification String

- 1. Select the UTIL menu, then press Enter.
- 2. Select CBT or VERS, then press Enter.

3.7.4 Diagnostic Self-Tests

CAUTION

Running these tests requires Standby Mode, disrupting the instrument's time keeping and output frequency functions.

The TEST option of the UTIL menu is provided for use by qualified personnel only. Refer to the Assembly-Level Service manual for more information.

3.8 CONFIGURING THE 5071A

Use the following procedures to customize the operation of the 5071A for your specific timekeeping needs.

3.8.1 To Set the Operating Mode

Use the following procedure to change the instrument's operating mode from Normal to Standby. The standby mode is useful for such things as long-term storage and non-operator maintenance procedures (refer to the Assembly-Level Service manual).

CAUTION

When you put the 5071A into Standby mode, the Cesium Beam tube is shut down except for the lon pump. The 5071A will not maintain accurate time or frequency in this mode. Placing the instrument back into Normal mode initiates the normal CBT power-up sequence.

- 1. Select the CONFIG menu, then press Enter.
- 2. Select MODE, then press Enter.
- 3. Use the \rightarrow or \leftarrow keys to select NORMAL or STANDBY, then press Enter.

3.8.2 To Set the Printer Log Mode

The internal event log can report several different levels of information to the instrument's rear-panel RS-232C serial port when a printer has been connected to the instrument and correctly configured. Four levels of information depth are available:

- Disable: No information is printed.
- Terse: Prints only Fatal errors.
- Verbose: Prints all functional and internal progress information.
- · Service: Adds detailed power-on and warm-up events to Verbose level.

Use the following procedure to select the printer-log mode for the 5071A:

- 1. Select the CONFIG menu, then press Enter.
- 2. Select Log, then press Enter.
- 3. Press the Inc or Dec keys to select DISABLED, TERSE, VERBOSE, or SER-VICE, then press Enter.

3.8.3 To Set Up the Serial Port

You can configure the instrument's rear-panel RS-232C serial port from the front-panel with the following procedure (Refer to Remote-Operation Setup for detailed remote operation set-up information).

- 1. Select the CONFIG menu, then press Enter.
- 2. Select SERIAL, then press Enter.
- 3. Use the → or ← keys to select a port parameter, then press Inc or Dec as needed to adjust each parameter value.

3.8.4 To Save a Configuration

Use this procedure to save the selected configuration choices into non-volatile memory.

- 1. Select the CONFIG menu, then press Enter.
- 2. Select STORE, then press Enter.

Note: This stores the Display angle, Output frequencies, Serial port settings, and Log mode in nonvolatile memory.

3.9 CONNECTING A PRINTER

You can connect a printer to the 5071A to create a hard copy output of the internal event log entries or print current status.

Refer to Remote Operating and Programming to connect and configure a serial printer to the instrument's RS-232C port.

3.10 DISABLING THE INTERNAL-STANDBY BATTERY

Note: This section does not apply for models without a battery (see Appendix B.).

When AC (or external DC) power is removed, the internal-standby battery will automatically power the instrument unless disabled. Use the following procedure to disable (turn off) the internal-standby battery. This is useful when you need to turn off the instrument without discharging the internal battery.

Note: Because of the long-term storage design of the 5071A internal lead-acid batteries, we do not recommend that the 5071A internal batteries be used in situations where power is removed on a daily basis. If this is your situation, the internal batteries will be constantly subjected to discharge and possibly not receive the necessary full 16 hours re-charge during each typical workday. Such repeated partial charge and discharge cycles can permanently damage the battery's storage capacity. Refer to Internal Standby Battery Maintenance and Battery Charging for more information.

If your situation requires you to operate the 5071A under these conditions, it is strongly recommended that the internal batteries be manually disconnected each time power is removed, or permanently disconnected. This will ensure that the batteries are not stressed by continual under-charging.

- 1. Locate the battery disconnect switch hole just above the battery-access door on its left side (rear panel).
- 2. Insert any insulated non-metallic 1/8" (3 mm) rod into the opening, depress the momentary switch button, and release.
- 3. Confirm that the instrument remains off by checking that no front-panel indicators are on.
- 4. If you need to disconnect the internal battery pack, (for instance, long-term storage) open the battery access door and unplug both pairs of the locking connectors.

Note: The 5071A will function normally from AC and auxiliary DC power with the internal battery disconnected.
NOTES:



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 4. Troubleshooting Tips

This section gives you information to examine, analyze, and resolve unexpected operating results and situations.

4.1 FRONT-PANEL INDICATORS AND MESSAGES

Note: All references to internal-battery power, battery status, or battery operation do not apply for 5071A 48V option.

You can use the front-panel indications and messages to assess the instrument's operation and status. The warning messages that can appear on the front panel LCD are listed and explained on the next two pages. Warning messages and states indicate that the instrument cannot proceed with an entered front panel command or has left the normal operation state. The front-panel indicators are shown and briefly explained in Getting Started. These displays and indicators have the following characteristics and functions.

4.1.1 Clock Display

Consists of six large seven-segment red LEDs that display 24-hour time.

4.1.2 Attention Light

Illuminates continuously to warn you if the instrument is running in a non-normal operating condition or needs attention. The Information Status display (read from the LCD display) will tell you why. See Monitoring Status for more information.

Flashes when the instrument is approaching (or has entered) a failure mode. See the Instrument States section for more information. View the Event Log for more detailed information. Refer to the front-panel Quick Reference Guide to Controls or Using the 5071A to read the Event Log.

4.1.3 Continuous Operation Light

Flashes after a normal power-on sequence then, is lit continuously after manual or remote Reset of the Continuous Operation state. The Continuous Operation light lets you verify that the instrument has been functioning continuously as a frequency standard since it was last Reset.

The light is off when the instrument enters a Fatal error state or is in standby mode. When this happens, the Attention light flashes (see Instrument States for more information).

Note: If the Continuous operation LED is flashing any time after a reset, it indicates that power was lost during operation. If you are concerned with timing, phase, or if you had been steering the frequency you will need to re-synchronize the timing and phase and/or re-enter the steering value as part of the reset procedure.

4.1.4 LCD Display

Some models do not have an LCD display, refer to Appendix B.

Consists of two 40-character lines that can show you:

- Active functions and menus
- · Active operating settings
- · Available menu choices and options
- Internal operating parameters
- Warning messages

Continuous Operation (Green) Light	ATTENTION (Amber) Light: OFF	ATTENTION (Amber) Light: Flashing	ATTENTION (Amber) Light: ON
OFF	Power is OFF, the internal battery is dis- charged, or disabled /disconnected	Fatal Error (See Fatal Error instrument state below)	Warm-up or Standby Mode (See Front- panel Message)
Flashing	Ready to set Continu- ous Operation (Con- tinuous Operation NOT Set)	Running on battery (Continuous Opera- tion Not Set)	Steered Output (Continuous Opera- tion NOT Set)
ON	Normal Operation (Continuous Opera- tion Set)	Normal Operation with Battery Power or Warning state (See Warning instrument state below)	Normal Operation with Steered Output

TABLE 4-1: FRONT PANEL STATUS LIGHTS

NOTICE

The flashing Continuous LED can also indicate that power has been disrupted and then restored. If this happens and timing, phase, or steering are critical to the application, you must check these and make any necessary corrections when performing a reset.

Note: Once the Continuous Operation light has been set to ON (not flashing) using the reset procedure, flashing could indicate that a power interruption has occurred. There are two important consequences involved with power interruption during continuous operation, and these should be considered:

If you are concerned with timing, phase, or if you had been steering the frequency you will need to resynchronize the timing and phase and/or re-enter the steering value as part of the reset procedure.

If the internal battery became exhausted while attempting to sustain operation, it cannot be assumed that it is completely re-charged until the 5071A has been connected to AC mains for at least 16 hours.

4.1.5 Instrument States

The 5071A has six operational states:

- Power On: Initial start-up phase; performs self-tests and initiates warm up.
- If any self-tests fail, the next state is "Fatal error", see below.
- Warm up: During warm up, CBT and VCXO ovens heat to operating temperature. The instrument then attempts to auto-lock its servo loops. If successful, the next state is Normal operation. If there is a failure, the next state is "Fatal error", see below.
- Normal Operation: Runs internal software continuously to check and adjust the instrument's operation. The Continuous Operation light flashes, and the user may reset continuous operation at this point. Transition to a "Warning" state occurs when internal software detects a Warning condition.
- Warning: The Yellow Attention light flashes while the Continuous Operation light remains ON. This continues as long as the warning condition exists. The instrument will return to Normal operation and the Attention light will stop flashing if the Warning condition clears. A message describing the cause on the warning may be read from the instrument's front panel through the LOG menu choice. Standby: This state may be entered any time the user requests. The only way to leave this state is by user request. The Cesium Beam tube is turned OFF (see Configuring the 5071A).
- Fatal Error: This state is active when the instrument detects a non-recoverable error. The only way to exit the fatal error state is by cycling power to the unit. Specific messages may be read from the instrument's front panel through the Log Menu choice.

4.1.6 Front-Panel Warning Messages

If you attempt an operation that isn't allowed, the 5071A will make an audible beep and display one of three possible warning messages:

4.1.6.1 REMOTE MODE

The LCD display shows the small padlock symbol at the far right-hand side of the screen. You attempt schedule a leap second, but when you press Enter, the instrument beeps and displays:

"Remote Mode: front panel locked out",

"(Press any key to continue)"

4.1.6.2 STANDBY MODE

The 5071A is in Normal mode. You attempt to run the diagnostic self-tests, but when you press Enter, the instrument beeps and displays:

"Valid only when in standby"

"(Press any key to continue)"

4.1.6.3 STEERED OPERATION

The 5071A is warming-up. You attempt to steer the output, but when you press Enter, the instrument beeps and displays:

"Valid only when operating normally"

"(Press any key to continue)"

4.2 POWER-UP PROBLEMS

In general, the 5071A will power-on and warm-up within approximately 15 minutes and operate to specifications after 30 minutes. Some instruments may take slightly more or less time to do so and represent a normal variation of start-up performance. There are, however, circumstances that are associated with a lack of any activity or, cause fatal error states to occur (see event log) by preventing a normal power-on/warm-up sequence. These situations are listed along with a suggested remedial procedure.

If you attempt to start the 5071A and observe no signs of activity:

- 1. Disconnect the instrument from AC and/or external DC power (if present).
- 2. Check the AC fuse located in the rear panel AC power module (also check the DC fuse if external DC power is present).
- 3. Replace the fuse as needed, then attempt restart.
- 4. If the fuse blows again, disconnect power immediately and contact the nearest Microchip Customer Service Center for assistance.

If you attempt to start the 5071A when its temperature is below 0°C, the allotted maximum 45 minute power-up/warm-up time may not be sufficient to heat both the Cesium Beam tube oven and VCXO oven.

- 1. Let the instrument warm up to room temperature.
- 2. Attempt to restart the instrument.

If you connect 240-volt power to the instrument when it is set for 120 volts, the AC-power fuse will blow.

- 1. Replace the AC-power fuse.
- 2. Wait at least 15 minutes as required by internal power supply circuit time constants.
- 3. Attempt to restart the instrument.

If you attempt to start the 5071A in a normal operating environment with the correct AC voltage set and the instrument reports a fatal error or appears otherwise unresponsive.

- 1. Attempt restart twice if the instrument does not power up.
- 2. Contact the local Microchip Customer Service Center for assistance.

4.3 USING MENUS TO CHECK OPERATIONAL STATUS

This section provides suggested ways to use the menus for checking the operational status of the 5071A. A specific procedure for each menu is provided in Using the 5071A.

4.3.1 INFOrmation Menu

Use the INFO (Information) menu to do the following:

- · Check overall operating status
- · Examine specific values of the instrument's internal operating parameters

4.3.2 LOG Menu

Use the LOG menu to check:

- Instrument's most recent operating history
- Print a copy of the current log contents

4.3.3 UTILities Menu

Use the UTIL (Utilities) menu to:

- · Check the firmware revision and View CBT Identification string
- Clear (reset) the rear-panel Status Output

4.3.4 CLOCK Menu

Use the CLOCK menu to check the:

- Active clock time and date settings
- · Current leap-second settings
- · Last-used slew value

4.3.5 CONFIGuration Menu

Use the CONFIGuration menu to check the current configuration for the instrument's:

- · Operating mode
- Printer log operation
- Output ports
- Serial port

4.4 OPERATING SYSTEM FAILURE

This section provides information to check symptoms associated with operating system failures and a procedure to restart the 5071A in the event of such a failure.

4.4.1 Operating System Failure Symptoms

The following five symptoms are associated with operating system failure:

- Continuous operation light extinguished: The front-panel Continuous Operation light is out and does not light with attempts to reset continuous operation.
- Deteriorating stability and accuracy: Although the instrument's rear-panel outputs are electrically active, the observed stability and accuracy are out of specification with no frequency offsets present or output steering active.
- Clock stops: The large front-panel LED clock display and CLOCK menu time display fail to show incrementing time.
- Unresponsive front-panel: Attempts to issue commands from the front-panel keys fail to cause any LCD display update or changes to the instrument's rear-panel output functions. Refer to the restart procedure.
- Unresponsive rear-panel RS-232C serial port: Attempts to issue commands through a correctly configured rear-panel RS-232C serial port fail to cause any remote terminal display update and/or changes to the instrument's rear-panel output functions. Refer to the restart procedure.

4.4.2 Restarting the 5071A

Check all configuration and operating commands issued from the front-panel or through the RS-232C serial port immediately prior to the operating system failure. Attempt to determine if the failure occurred in association with any recent changes in the instrument's environment or power source. Use the following procedure to restart the 5071A in the event of an operating system failure.

- 1. Remove external DC power (if connected).
- 2. Remove AC line power.
- 3. Disable the internal battery by operating the rear-panel battery-disconnect switch (refer to Disabling the Internal-Standby Battery for details). Note: This does not

apply to models without a battery.

- 4. Re-apply AC line power.
- 5. Observe the instrument for successful completion of the normal power-up and warm-up sequence.\

4.5 CESIUM BEAM TUBE LIFE

This section provides information to check the long-term operating status of the instrument's Cesium Beam tube.

The primary symptom associated with terminal Cesium Beam tube life is a progressive deterioration in the instrument's output stability or accuracy. Eventually, the Continuous Operation light may extinguish (for no discernible reason) but can be reset momentarily after any warnings have cleared.

If these symptoms occur:

- 1. Select the front-panel INFOrmation menu, then press Enter.
- Check the E_Mult parameter for an excessive increased or decreased value. (See Table 3-2 for typical values.)
- 3. Check the Gain parameter for an excessive increase in value. (See Table 3-2 for typical values.)
- 4. The presence of these two parameters at these extremes along with poor instrument output stability and accuracy is consistent with Cesium Beam tube failure.
- 5. Search for Log messages that contain information relevant to Cesium Beam tube performance.
- 6. Contact the nearest Microchip Customer Service Center for assistance.



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 5. Remote Operating and Programming

This section gives you the information required to set up and operate the 5071A as a remote device.

5.1 REMOTE-OPERATION SETUP

5.1.1 Remote Interface Features

The 5071A's remote or serial port interface provides a variety of features for such tasks as:

- Terminal operation (or terminal emulation) to allow single-line command entry and display of instrument response.
- Remote control through computer programs or scripts to facilitate multiple command-line tasks (with or without a modem).
- Output to a printer to provide hard copy record of the instruments internal operation and Event log.
- Remote communication using a modem (short-haul or telephone line) to increase the effective distance between an operator for controlling computer and the 5071A.

These features are discussed as they occur for hardware setup (in this section) and later for software beginning with the Programming Overview section in this chapter and the Command Reference chapter.

5.1.2 Serial-Port Description

The 5071A's serial port is a DTE device that may be connected to a printer, terminal, or computer. The available transmission protocol features are:

- RS-232C serial port supports both XON/XOFF (software) or DTR-DSR (hardwired) pacing. Both are always enabled with the DSR input transparent when not connected.
- Baud rate, Handshaking include 300-9600 baud, 7 or 8 data bits, 1 or 2 stop bits, and odd, even, or no parity
- Input End-of-Line character line-termination with CR (ASCII 13, decimal), LF (ASCII 10, decimal), one followed by the other in either order. The 5071A's line termination of formatted output is <CR> and <LF>.

5.1.3 Hardware Connection

The rear-panel serial-port connection uses a 9-pin male, D-subminiature connector. Signal voltage levels comply with the RS-232C standard. The serial-port connections are electrically isolated from the 5071A's ground and circuitry. The serial port pin assignments are listed as follows:

- Pin 1: Not connected
- Pin 2: Received data (to 5071A)
- Pin 3: Transmitted data (from 5071A)
- Pin 4: Not connected
- Pin 5: Signal ground

- Pin 6: Data set ready—DSR (to 5071A)
- Pin 7-9: Not connected

Use the appropriate setup that meets the remote operation needs.

Note: On laptops without an available COM port, a USB-to-RS-232 adapter, such as National Instrument's USB-232, can be used.

5.1.4 Serial-Port Configuration

Once the instrument is properly connected to a device (terminal, computer, or PC, and so on) configure the device to match the following default communications settings of the 5071A:

- Baud Rate 9600:
- · Parity: None
- Data Bits: 8
- Stop Bits: 1

If you are using a Windows-based PC to communicate with the 5071A, perform the following steps to configure the PC's serial port to match the 5071A's serial port. The following steps configure the PC's serial port.

- 1. In Windows main window, click the Start button then select Programs.
- 2. Select Accessories, Hyperterminal, and Hyper Terminal.

The Connection Description dialog box is displayed.

3. In the "Name" window, type 5071A (for example), select one of the icons (the first one will do), then click OK.

The Connect To dialog box is displayed.

4. In the "Connect using" window, select the appropriate port or connector (COM1 or COM2), then click OK.

The COM1 (or COM2) Properties dialog box is displayed. This dialog box allows you to configure the RS-232 port of the PC.

5. Set the RS-232 port of the PC to match the default values of the 5071A.

Once you've enabled the correct COM port from the PC, a prompt should appear each time you press the enter (or return) key.

Note: If Hyperterminal is unavailable on your machine, any serial port terminal emulator can be used.

Note: A serial-to-USB converter may be necessary on most PCs.

The prompt will look either like scpi > or something like E-113> if an error has occurred. Following the prompt you can type the command you want to send. For commands that produce a response, the reply will appear on screen. For example, sending *idn? asks the instrument to identify itself. The transaction might look something like this: scpi > *idn?

MICROCHIP,5071A,0, 4805

scpi >

After you've selected the communication parameters for the terminal, be sure to configure the 5071A's serial port with the same values, using the CONFIG menu's Serial option.

5.2 PROGRAMMING OVERVIEW

Programming for the 5071A includes several levels of control through the serial interface:

- Single SCPI command-line entry and instrument response
- · Multiple SCPI command-line entry as data communication program scripts
- · Automated SCPI control using an instrument controller

The control examples included in this chapter illustrate the single-line command entry level for a terminal session. Once this level is appreciated, you can build task scripts and more complex programs by reading further in this chapter and referencing the next chapter of command reference information.

The next several pages provide the minimum introductory information about the 5071A's programming command format, syntax, and *RST response (initialization state). After reading this section you will have a basic knowledge of how to use and understand the SCPI commands for the 5071A Primary Frequency Standard.

The details of the 5071A's SCPI and IEEE common commands appear in the next section and include summary tables that describe all command subsystems, syntax, parameter ranges, values, and response forms for possible command queries.

The next section, Sample Program Commands, illustrates the SCPI command format and syntax with tested examples for typical time-keeping tasks performed through RS-232C serial data communication.

The section following the sample programs describes how to use a typical personal computer-based data communications program to automate the program examples as pre-programmed batch tasks you can call up quickly. This same section also mentions some very important programming considerations for using HP BASIC with the 5071A's SCPI commands and serial interface.

5.3 SCPI COMMAND CONFORMANCE

The SCPI commands used in the 5071A are in conformance with the SCPI Standard Version 1990.0. The instruments SCPI command set consists of the following:

- Common Commands as defined in IEEE 488.2 1987.
- Subsystem commands as confirmed (and listed) in the SCPI standard. These are commands defined in SCPI Commands) as Standard.
- Subsystem commands designated for the instrument in conformance with SCPI standards but not yet listed in the SCPI standard. These are the commands defined in SCPI Commands as New.

5.4 COMMAND TYPES

There are two types of 5071A program commands: IEEE 488.2 Common and SCPI. The SCPI commands control instrument functions while the IEEE 488.2 Common commands control and manage communications between the 5071A and a terminal or personal computer.

5.4.1 Common Command Format

The IEEE 488.2 standard defines the Common commands that perform functions like reset, self-test, status byte query, and identification. Common commands are four or five characters in length, always begin with the asterisk (*) character, and may include one or more parameters. The command keyword is separated from the first parameter by a space character. Some examples of common commands are: *RST *ESR? *IDN?

5.4.2 SCPI Command and Query Format

SCPI commands perform functions like instrument setup, synchronization, adjusting epoch and reporting instrument-specific operating parameters. A subsystem command structure is a hierarchical structure that usually consists of a top level (or root) command, one or more lower-level commands, and their parameters. The following example shows part of a typical subsystem for an issued command and its associated query (?):

DIAGnostic:LOG:VERBosity <DISable|TERSe|VERBose|SERVice> :VERBosity? DIS|TERS|VERB|SERV

DIAGnostic is the root command with :LOG and :VERBosity (?) the second level commands with command and response parameters.

5.4.2.1 COMMAND SEPARATOR

A colon (:) always separates one command from the next lower-level command as shown here: DIAGnostic:CURRent:CFIeld?

5.4.2.2 ABBREVIATED COMMANDS

The command syntax shows most commands as a mixture of upper and lower case letters. Upper case letters indicate the abbreviated spelling for the command. For shorter program lines, send the abbreviated form. For better program readability, you may send the entire command. The 5071A accepts either command form and is not case sensitive.

For example, if the command syntax shows DIAGnostic, then DIAG and DIAGNOSTIC are both acceptable forms. Other forms of DIAGnostic, such as DIAGN or DIAGNOST will generate an error. You may use upper or lower case letters. Therefore, DIAGNOSTIC, diagnostic, and DiAgNoStIc are all acceptable.

5.4.2.3 IMPLIED CHANNEL

Some commands contain channel numbers in square brackets: [1|2]. The brackets indicate that the same programming sequence can be used for both channels, one of which must be specified. If a channel number is not specified, it will default to 1.

5.4.2.4 IMPLIED COMMANDS

Implied commands appear in square brackets ([]) in the command syntax. (The brackets are not part of the command and are not sent to the instrument.) Suppose you send a second level command but do not send the preceding implied command. In this case, the instrument assumes you intend to use the implied command and responds as if you had sent it.

Examine the portion of the DIAGnostic subsystem shown as follows:

SOURce]
 :PTIMe
 [:TIME] <hour>, <minute>, <second>
 [:TIME]? [MIN|MAX], [MIN|MAX], [MIN|MAX]

The root command SOURce is an implied command (as is :TIME). To set the instruments time to 9:30 am, you can send either of the following command statements:

SOURce:PTIMe:TIME 09,30,00

or

PTIMe 09,30,00

If a command is an implied form but can also accept channel numbers, the implied form pertains to channel 1 only. To switch channels, you must use the channel number in the command string. For example:

ROSC:FREQ2 5E6

5.4.2.5 PARAMETER TYPES

The following list describes parameter types typically encountered in SCPI programming.

- Numeric: Accepts all commonly used decimal representations of numbers with optional signs, decimal points and scientific notation: 123, 123E2, -123, -1.23E2, .123, 1.23E-2, 1.23000E-01. Special cases include MIN and MAX as follows: MIN selects the minimum value available, and MAX selects the maximum value available. Queries on MIN or MAX return the associated value. All decimal types also accept MIN or MAX and can be queried with them to produce a numeric value.
- Boolean: Represents a single binary condition that is either true or false: 1 or ON, 0 or OFF.
- Discrete: Selects from a finite number of choices. These parameters use mnemonics to represent each valid setting. An example is the DIAGnostic: LOG:VER-Bosity<mode> command where mode can be DISable, TERSe, VERBose, or SERVice.

The following list describes response types typically encountered in SCPI programming.

- <boolean>: Represents a single binary condition that is either true or false.
- ASCII_string: Represents a series of ASCII characters of arbitrary length.
- <NR1>:Represents integer numbers with an implied decimal point.
- <NR2>: Represents floating point numbers with an explicit decimal point.
- <NR3>: Represents floating point numbers with an explicit decimal point and an exponent.

5.4.2.6 OPTIONAL PARAMETERS

Parameters shown within square brackets ([]) are optional parameters. The brackets are not part of the parameter and are not sent to the instrument. If you do not specify a value for an optional parameter, the instrument selects the most appropriate value.

5.4.2.7 QUERY PARAMETERS

All selectable numeric parameters can be queried to return the minimum and maximum values that are capable of being set to by sending a MIN or MAX optional parameter after the ?. For example, consider the PTIMe:MJDate? [MIN|MAX] command. If you send the command without specifying a parameter, the present PTIMe:MJDate value is returned. If you send the MIN parameter, the command returns the minimum usable value. If you send the MAX parameter, the command returns the largest MJDate usable value. Be sure to place a space between the command and the parameter.

5.4.2.8 LINKING COMMANDS

To link IEEE 488.2 Common Commands with SCPI commands on the same line, use a semicolon between the commands. For example:

*RST;DIAG:CONT:RES?

Multiple SCPI commands with corresponding parameters can also be sent at the same time. Here, the first command is always referenced to the root node. Subsequent commands, separated by ;, are referenced to the same level as the previous command if no : is present immediately after the command separator. For example, sending:

SOUR:ROSC:FREQ1 5.0E+6;ROSC:FREQ2 1E+7

is equivalent to sending:

```
SOUR:ROSC:FREQ1 5.0E+6
```

```
SOUR:ROSC:FREQ2 1E+7
```

The ":" must be present to distinguish another root level command. For example,

SYST:REM ON;:DIAG:CONT:RESET

is equivalent to sending:

```
SYST:REM ON
```

DIAG:CONT:RESET

If the ":" in front of DIAG is omitted, the instrument assumes that you have sent SYST:DIAG:CONT:RESET and will generate an error.

5.4.3 *RST Reset Response

The 5071A reset response (Initialization state) is the configuration acquired at program reset. The following table summarizes this state. Once a configuration has been saved, it will persist even if power is removed or until it is reprogrammed (through SCPI commands or through the front-panel menus).

TABLE 5-1: *RST RESET CONDITIONS

Subsystem	Command/Parameter	State
DIAGnostic	:LOG:VERBosity	DISable
DISPlay	:ENABle	ON
[SOURce]:PTIMe	:SYNC	OFF
[SOURce]:ROSCillator	:STEer	0.0
SYSTem	:REMote	ON

The IEEE 488.2 *RST command returns the instrument to a specified state optimized for remote operation. Use *CLS to clear the status registers and the SCPI error queue.

5.5 SAMPLE PROGRAM COMMANDS

Several remote-operation task scenarios are provided that illustrate how to control the 5071A from a terminal with SCPI commands (Standard Commands for Programmable Instruments). The example programs cover the major time-keeping operations needed for remote control of the 5071A.

Each program contains several functions related to the overall task. The constituent functions are listed to the right of the corresponding program lines. You can use these function explanations to customize control programs for your own special needs.

The example programs are written with SCPI short-form notation. The full names, options, and parameters for these commands are contained in the SCPI Command Tree/Summary in Command Reference. A complete list of 5071A error messages including code numbers and causes is located at the end of Command Reference.

Note: Set Printer Log Verbosity to DISABLED for example programs in this section.

The programming examples provided must be run with the printer log verbosity set to DISABLED, otherwise the returned messages will differ from those presented in the examples.

5.5.1 Status Monitoring Tasks

5.5.1.1 EXAMPLE PROGRAM 1—STATUS REPORT INQUIRY

In the following tables (in the "Program Dialog" column), the command you send is listed in bold font, the 5071A's responses are in unbolded font. If you make a mistake (i.e., generate an error # at the scpi prompt) type "*cls" followed by <CR><LF> (Return Line Feed).

Note: All commands must be followed with an ASCII Carriage-Return/Line-Feed pair (not displayed in the examples below).			
Program Dialog		Task Function	
SYST: PRINT?	Reque	est an operating status repo	ort.
MJD 48587 21:03:42 CBT ID: 6-temp Status summary: Operating normally Power source: AC Log status: Empty			
<pre>Freq Offset: RF amplitude 1: Zeeman Freq: E-multiplier: CBT Oven: Osc. Oven: HW Ionizer: SAW Tuning: 87MHz PLL: +12V supply: +5V supply:</pre>	0e-15 20.2% 39949 1870V 6.2V -8.8V 1.0V 3.5V -0.8V 12.3V 5.3V	Osc.control: RF amplitude 2: Hz C-field curr: Signal Gain: BT Oven Err: Ion Pump Mass spec: DRO Tuning: µP clock PLL: -12V supply: Thermometer:	-1.67% 19.9% 12.137mA 28.8% 0.00C 0.2µA 9.1V 6.8V 2.9V -12.4V 35.0C
scpi >			

5.5.1.2 EXAMPLE PROGRAM 2 — PRINT LOG REQUEST

Program Dialog	Task Function	
DIAG:LOG:PRINT?	Print log (empty !)	
Log status: Empty <scpi></scpi>		

5.5.2 Instrument Control Tasks

In the following tables (in the "Program Dialog" column), the commands you send are in bold font, the 5071A's responses are in unbolded font. If you make a mistake (i.e., generate an error # at the scpi prompt) type *cls followed by <CR><LF>.

Note: All commands must be followed with an ASCII Carriage-Return/Line-Feed pair (not displayed in the examples below).

5.5.2.1 EXAMPLE PROGRAM 1—CONFIGURATION

Program Dialog	Task Function
DIAG:STAT:GLOB? "Operating normally" scpi >	Request the operating status of the 5071A.
SYST:REM ON DIAG:CONT:RESET scpi >	Command the 5071A to enter Remote mode. Set/Reset the Continuous Operation light on the front panel.
SOUR:ROSC:FREQ1 5.0E+6 scpi >	Set Port 1 output to 5 MHz.
SOUR:ROSC:FREQ2 1.0E+7 scpi >	Set Port 2 output to 10 MHz.
SYST:SCON scpi >	Save this configuration in memory.

5.5.2.2 EXAMPLE PROGRAM 2—SYNCHRONIZATION AND TIME/DATE SETUP

Program Dialog	Task Function
SOUR:PTIM:SYNC FRONT scpi >	Synchronize to external pulse with front-panel sync input.
SOUR:PTIM:TIME 20,54,40 scpi >	Set time.
SOUR:PTIM:MJD 48587 scpi >	Set modified Julian date.
SOUR:PTIM:SLEW 123.33425E-3 scpi >	Adjust Epoch with resolution to 50 ns.

5.5.2.3 EXAMPLE PROGRAM 3—LEAP SECOND INSERTION

Program Dialog	Task Function
SOUR:PTIM:LEAP:MJD 48621 scpi >	Set date of leap second.
SOUR:PTIM:LEAP:DUR 59 scpi >	Set time (show minute).
SOUR:PTIM:LEAP ON scpi >	Enable Leap second insertion.

5.5.2.4 EXAMPLE PROGRAM 4—STEERING THE OUTPUTS

Program Dialog	Task Function
SOUR:ROSC:STE -1.23E-13 scpi >	Steer all outputs with a fractional offset of -1.23×10^{-13} .

5.5.2.5 EXAMPLE PROGRAM 5—SLEWING THE CLOCK

Program Dialog	Task Function
SOUR: PTIM: SLEW 0.5	Adjust epoch: add one-half second.
scpi >	

5.6 BATCH PROCESSING FOR THE PROGRAM COMMANDS

This section provides information for automating the sample program commands presented in the previous section. HP/Agilent's AdvanceLink for Windows data communications program for the personal computer is discussed first. This is followed by some important considerations for using SCPI commands with HP BASIC on the HP 9000 Series 200/300 instrument controllers.

5.6.1 Command Scripts On a Personal Computer

You can use any terminal emulator program that supports scripting (batch file execution over a data communications line) such as Agilent's AdvanceLink for Windows. The following procedure applies specifically to AdvanceLink for Windows and may also provide a generic plan useful with other popular Data Communications software for your Personal Computer.

- 1. Use an ASCII text editor to type in and name one of the example programs (or your own).
- 2. Exit the text editor and open Agilent's AdvanceLink for Windows on your personal computer.
- 3. Select the Script menu choice from the pull-down menus at the top of the screen.
- 4. Choose the Do Commands in File ... task.
- 5. Type in the name of the SCPI task file you entered previously as ASCII text.
- Observe the successful completion of the script file by return of the scpi > prompt.

5.6.2 SCPI Considerations For HP BASIC

You can also use an HP 9000 Series 200/300 Instrument Controller with HP BASIC to operate the 5071A remotely. The following considerations require your attention as you attempt to utilize SCPI commands that follow protocols optimized for GP-IB or IEEE-488 bus parallel data transfer, status reporting, and SRQ polling.

5.6.2.1 SCPI ON RS-232C

The SCPI protocol has been adapted to fit the communication requirements of the 5071A. On one hand this facilitates extremely convenient programming, as a serial terminal can be used. On the other hand, some complexities arise since full-duplex communication is usually required, data is in serial form, and no control lines are available. The most important features added to the SCPI protocol for serial operation are as follows:

- Each character in the command string sent to the instrument is echoed back to the sender immediately.
- · Any command must be terminated with suitable characters.
- Following the execution of any command, the instrument outputs a prompt sequence, indicating that it is ready for more commands.
- The prompt sequence indicates whether an operational or communication error has occurred while attempting to execute the command.
- The error prompt is removed by reading the error.
- If the command sent to the instrument generates a response, the response is emitted as soon as it is ready.

More serial protocol details can be found in Serial-Port Command/Printer Interface.

An IEEE-488.2 to RS-232 converter can also be used to drive the 5071A from an IEEE-488.2 interface. The converter must provide buffering for the incoming serial data because the serial port of the 5071A uses full-duplex operation.

5.6.2.2 FULL-DUPLEX COMMUNICATION

The normal mode of serial communication for the 5071A is full-duplex. The instrument echoes the command sequence, thus emitting characters while others are being received. If an instrument controller is to be used to control the 5071A, it must buffer incoming data while sending data. If the loss of data-rate is acceptable, it is possible to suppress full-duplex operation using the XON/XOFF protocol. In the following example, full-duplex operation is assumed.

5.6.2.3 PRINTER-MODE OUTPUT

If you want to monitor instrument operation with a printer, the 5071A has an operating mode that automatically sends operational or warning messages out the serial port to a printer (or terminal).

Note: These "unprompted" messages may be inconvenient when the instrument is controlled by a computer and can be suppressed with the DIAG:LOG:VERB DISABLE command line.

The messages can then be obtained from the instruments non-volatile log on demand.

5.6.3 Example Program

The following HTBasic for Windows program demonstrates some of the points discussed. The program consists of a Main program and two Defined Functions. The FNConfig_ser_port\$ is used to configure serial interface. The buffering required for full-duplex operation is provided by the Microsoft Windows operating environment.

The commands and queries to be executed are passed to the defined function FNTalker\$ as the string Output\$. The function outputs the properly terminated string and returns the instruments reply. The operation of the program can be understood from the comments that are included.

HTBasic for Windows is available from TransEra Corporation.

```
1
    ! 5071A Manual Example
                                            Rev: 9/13/06
2
    !
3
     1______
4
     1
5
     CLEAR SCREEN
6
     1
     INTEGER Baud
7
8
     DIM Return$[80]
9
     !
10
     COM
/Io/Prompt$[4],Term$[1],@Ser in,@Ser out,Timeout,INTEGER
Com port
11
     !
12
     Prompt$="scpi"
13
     Term$=">"
14
     Timeout=2
15
     1
16
! - -
                         _____
17
     ! Set up serial port.
```

```
18
     Com port=9 ! Serial A/Com 1.
19
     Baud=9600
20
     !
     Return$=FNConfig ser port$(Com port,Baud)
21
22
    PRINT Return$
23
     !
24
     ASSIGN @Ser in TO Com port; FORMAT ON
     ASSIGN @Ser out TO Com port; FORMAT ON
25
26
     !
27
1------
28
    ! Command and Query 5071A.
29
    !
30
     Return$=FNTalker$("*CLS")
                                        ! Clear status
registers and
     PRINT Return$
31
                                         ! error queue.
32
     Return$=FNTalker$("SYST:REM ON")
                                         ! Enable remote
operation.
33
    PRINT Return$
34
    Return$=FNTalker$("DISP:ENAB ON") ! Set clock display
on.
    PRINT Return$
35
36
   Return$=FNTalker$("PTIM:TIME 13,09,24") ! Set 24-hour time.
37
    PRINT Return$
     Return$=FNTalker$("SYST:REM OFF") ! Disable remote
38
operation.
39
    PRINT Return$
40
    !
41
     Return$=FNTalker$("DIAG:VOLT:EMUL?") ! Query electron
multiplier
    PRINT Return$
42
                                         ! voltage.
43
    Return$=FNTalker$("ROSC:CONT?")
                                        ! Query reference
oscillator
    PRINT Return$
44
                                        ! control voltage.
45
    !
46
    END
47
     !
48
49
     1
50
     DEF FNConfig ser port$(INTEGER Sel code, Baud)
      ! This function sets up the serial interface at the
51
designated select
52
    !
          code.
```

5071A Primary Frequency Standard User's Guide

```
! The configuration is 8 data-bits, 1 stop-bit, and no
53
parity.
     ! The 5071a requires the interface to assert the DTR line,
54
or to
55
         leave it un-connected. There is no hardware handshake.
     !
56
     ! The returned string reports the details of the set-up.
     ! If the set-up fails, an error message is returned.
57
58
     1
59
       ON ERROR GOTO Err trap
60
       1
       CONTROL Sel code,0;1
                                             ! Reset interface
61
       CONTROL Sel code,3;Baud!
                                                  ! Baud rate
62
      CONTROL Sel code, 4;3!
                                            ! 8 bits, no parity
63
64
       CONTROL Sel code, 5;1!
                                                  ! Set DTR
       CONTROL Sel code, 12;176!
65
                                               ! HDSK disabled
66
        !
67
      RETURN "Serial interface at Select Code "&VAL$ (Sel code) &"
set up: "&VAL$(Baud) &",
68
     1
69
    Err trap:
               !
70
     RETURN ERRM$
71
     FNEND
72
      !
73
! _____
74
      1
    DEF FNTalker$(Output$)
75
76
     ! This function sends a command or query to the 5071A then
retrieves
        ! the 5071A response.
77
78
        1
79
        COM
/Io/Prompt$[4],Term$[1],@Ser in,@Ser out,Timeout,INTEGER
Com port
80
        !
81
        DIM Input$[2048], A$[1], Reply$[2048]
82
        83
       ON DELAY Timeout, 15 GOTO Hang
                                      ! 15 is highest
priority.
84
        1
85
        Chars in queue=READIO(Com port, 31)
86
        I.
87
     WHILE Chars in queue
                                               ! Empty @Ser in
input queue.
```

Remote Operating and Programming

```
ENTER @Ser in USING "#,B";Byte ! ! Enter one byte
88
(character).
89
          Chars in queue=READIO(Com port, 31)
       END WHILE
90
91
       !
92
    OUTPUT @Ser out;Output$
93
    WAIT .05
                                       ! Wait 50 msec for 5071A
94
     1
                                        ! to begin to respond.
95
       WHILE NOT Complete
96
         Chars in queue=READIO(Com port, 31)
         IF Chars in queue THEN
97
           ENTER @Ser in USING "#,A";A$ ! Enter one
98
character.
99 Input$=Input$&A$
                                     ! Add character to string.
100 IF A$=Term$ THEN
                                            ! and check for
termination
101
            WHILE NOT Complete
                                                 ! character.
When termination
    Chars in queue=READIO(Com port, 31) ! appears, one more
102
character
103
    IF Chars in queue THEN
                                    ! is unloaded and added to
     ENTER @Ser_in USING "#,A";A$ ! the string. It is the
104
105
               Reply$=Input$&A$
                                            ! trailing space.
106
                 Complete=1
107
               END IF
108 END WHILE
109 END IF
110
       END IF
      END WHILE
111
112
       !
113
      GOTO Exit
114
       !
115 Hang:
                                          ! I/O has timed out.
116
       BEEP
       Reply$="I/O timeout, no reply from serial port."
117
118
      !
119
    Exit: !
120
    OFF DELAY
    RETURN Reply$
121
    FNEND
122
123
    !
```

124

125

1

5.6.3.1 PROGRAM OUTPUT

The program output is shown below. Notice that the 5071A echoes the commands or queries it receives. After echoing a command, it returns a prompt. After echoing a query, it returns the result of the query and a prompt.

```
Serial interface at Select Code 9 set up: 9600, 8, None *CLS scpi
> SYST:REM ON scpi > DISP:ENAB ON scpi > PTIME:TIME 13,09,24 scpi
> SYST:REM OFF scpi > DIAG:VOLT:EMUL? +1.310+003 scpi >
ROSC:CONT? -4.17E-002 scpi >
```

5.7 TIPS ON USING THE RS-232C PORT ON THE 5071A

The RS-232C port on the 5071A rear panel is very useful for controlling the instrument and gathering data. However, communication through the RS-232C is not always a connect-and-go process. Until recently, there were many different vendors producing differing handshaking protocols, data rates, and wiring connections.

Because of the myriad of possible hardware, system, and software combinations, there are many ways to incorrectly set up and connect the RS-232C and potentially lock-up the system. This condition usually appears as non-sensible characters being received, or no communication at all.

This section is intended to give you a summary of how some RS-232C lock-ups occur and how best to clear them.

5.7.1 Keypad Lock-Ups: Why Do They Occur and How Are They Cleared?

5.7.1.1 DESCRIPTION

First, make sure the padlock symbol does not appear in the LCD display. If so, the 5071A is locked through the SCPI command SYST:REM ON and must be unlocked before some front panel operations can be accepted. Refer to this manual for instructions on how to unlock the front panel.

If this is not the case, the 5071A front panel can appear to be frozen (no key presses accepted) if it is communicating with another serial device through the RS-232C and receives a data holdoff from that device. There are two types of holdoffs: One is the XON/XOFF (software) protocol, and the other is the DSR (Data Set Ready) line (hardware). Either of these can be used by printers or terminals. The 5071A is capable of understanding both.

5.7.1.2 XON/XOFF

When a connected terminal or printer uses the XON/XOFF protocol the 5071A will hold off further data transmission when an XOFF (Control-S) is received.

This usually happens when a terminal/printer buffer is full or if a printer is out of paper.

The 5071A will then wait until it receives an XON signal (Control-Q) before resuming the transmission. The 5071A will wait indefinitely for an XOFF to clear.

One example of this is when the 5071A is printing the Status Log and the connected printer runs out of paper. If the printer uses the XON/XOFF protocol, it will send an XOFF (Control-S) that will stop the flow of data from the 5071A. The front panel is now busy waiting for an XON (Control-Q) to resume printing.

If the front panel is locked in a print operation to the Serial Port, the solution is to correct the cause of the problem. For example, add more paper to the printer.

If the printer is no longer connected but a terminal is available, ensure that the terminals Baud Rate, Parity, Data Bits, and Stop Bits are consistent with the 5071A, then send a Control-Q from the terminal keyboard. This should result in the remaining data from the 5071A being sent to the terminal and thereby clear the problem.

5.7.1.3 DSR

The DSR signal acts exactly like the XON/XOFF protocol, but instead of being implemented in software it is done in hardware. The DSR line (pin 6) is one of the three signals used by the 5071A in RS-232C communications (the other lines are Data Transmit and Data Receive). When DSR is false (negative voltage), data transmission from the 5071A will stop until the DSR is true again (positive voltage). If this line is not connected to any signal, then DSR is pulled positive inside the 5071A.

Example:

One example of how DSR can stop front panel operation is if the wrong cable is used, forcing a negative signal on the DSR (pin 6). If under these conditions, an INFO PRINT command is issued from the front panel, the 5071A will be busy until the DSR returns to a positive voltage.

Solution:

One way to find out if there is a DSR problem is to remove the Serial Port cable. The DSR will be pulled back to a positive voltage and the front panel should re-activate. As long as there are no other reasons for halting the data (for example, XOFF) the 5071A will send data to the RS-232C port even when there is no device attached.

5.7.2 Using Ctrl-Q in Programs

Because some hang-ups could occur without user intervention during program operations, it may be useful to add a routine that automatically sends a Ctrl-Q (XON) to the 5071A. This can be triggered by a timeout that monitors the RS-232 for incoming data.

5.8 SETTING THE SERIAL PORT PARAMETERS WITH THE OPTION 300 FRONT PANEL

All 5071A instruments are shipped with a CD-ROM that contains Serial Port Configuration software. The installation software is located at:

5071A Serial Port Configuration Management Software\Installer\Volume\setup.exe

Double click on the setup icon to install the software. Accept all default folder names and license agreements. When the installation is complete, an icon will be added on your desktop called "5071ASerialConfig".

The program "5071ASerialConfig " can be used to determine the current serial port configuration and to change it to your specific needs. When shipped from the factory a standard 5071A is set to 2400,N,8,1. It is also possible to change the configuration using this software.

Upon double clicking the icon, the user interface will appear (Figure 5-1). You will have the choice of either "Getting" the current serial configuration, "Setting" the serial port to a desired configuration from the left panel, or "Saving" the current configuration.

Select 5071A Settings	Current 5071A Settings
COM PORT: COM 1 baud rate 9600 data bits 8 parity NONE stop bits 1.0	COM PORT % Baud 0 Data bits 0 Parity Stop bits 0 Output

FIGURE 5-1: 5071A Serial Configuration.

Use the software in any PC with an RS-232 (COM) port connected to the 5071A as described in this manual.

You can contact your local Microchip Sales Office by email or phone and request a copy to be sent to you by email.



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 6. Command Reference

This section describes the SCPI and IEEE 488.2 commands and error messages applicable to the 5071A Primary Frequency Standard. Software interface and status reporting operation are also discussed.

6.1 5071A COMMAND SUMMARY

This section summarizes both the IEEE 488.2 common and 5071A standardized commands for programmable instruments (SCPI) commands in tabular format. IEEE 488.2 commands appear first followed by SCPI commands. The SCPI commands used in this instrument are in conformance with the SCPI Standard Version 1990.0. The SCPI command set consists of the following:

Subsystem commands as confirmed (and listed) in the SCPI Standard. These are the commands defined in SCPI Commands as Std.

Subsystem commands designed for the instrument in conformance with SCPI Standards but not yet listed in the SCPI Standard. These are the commands defined in SCPI Commands as New.

The IEEE 488.2 commands are summarized in Table 6-1 and followed by SCPI commands in Table 6-2. Details of all 5071A SCPI commands can be found in the SCPI Subsystem Commands section following the SCPI Command summary.

The SCPI command format, syntax, parameter and response types, and common command formats are explained in Remote Operating and Programming following the programming overview.

6.1.1 IEEE 488.2 Common Commands

The following table lists common commands by mnemonic, name, and function. More information concerning the operation of IEEE 488.2 status reporting commands and structure can be found in the Status Registers section of this chapter following the SCPI Subsystem Command descriptions. Detailed explanations of the 5071A Common Commands can be found in ANSI/IEEE Std. 488.2-1987, IEEE Standard Codes, Formats, Protocols and Common Commands.

	Mnemonic	Command Name	Function
Ì	*CLS	Clear Status	Clears the status registers and error queue
	*ESE	Standard Event Status Enable	Sets the Standard Event Status Enable Register bits
	*ESE?	*ESE Query	Returns Standard Event Status Enable Register contents
Ī	*ESR?	Event Status Register Query	Returns Event Status Register contents

TABLE 6-1: IEEE 488.2 COMMON COMMANDS

Mnemonic	Command Name	Function
*IDN?	Identification Query	Returns Instrument identification string. Note the IDN command will not return the instru- ment serial number, and the field is hard coded with a 0. Only the tube serial number can be accessed through RS-232 using the command listed below.
*OPC	Operation Complete	(accepted but ignored)
*OPC?	Operation Complete Query	(always returns +1)
*RST	Reset	Reset (See Table 5-1)
*SRE	Service Request Enable	Set service request enable register
*SRE?	*SRE Query	Returns contents of SRE register
*STB?	Status Byte Query	Returns summary status byte
*TST?	Self-Test Query	Same as DIAG:TEST? -1 (runs self tests)
*WAI	Wait for Completion	(accepted but ignored)

TABLE 6-1: IEEE 488.2 COMMON COMMANDS (CONTINUED)

6.1.2 SCPI Commands

The following tables list SCPI commands by keyword, syntax, parameter, and response form and provides brief explanatory comments.

TABLE 6-2: DIAGNOSTIC COMMANDS

Command	Parameter Form	Response Form	Comment
DIAGnostic:CBTSerial?	_	<string></string>	Returns CBT serial num- ber.
DIAGnostic:CONTinuous:RESet	_	_	Reset Continuous Opera- tion light.
DIAGnostic:CONTinuous: [:STATe]?	_	<off enab ON></off enab 	Returns Continuous Operation status.
DIAGnostic:CURRent :BEAM?	_	<nr3></nr3>	Returns beam current setpoint.
DIAGnostic:CURRent:CFIeld?	—	<nr3></nr3>	Returns C-field current.
DIAGnostic:CURRent :PUMP?	_	<nr3></nr3>	Returns ion-pump cur- rent.
DIAGnostic:GAIN?	—	<nr3></nr3>	Returns signal gain.
DIAGnostic:LOG:CLEar	—	—	Clears log entries.
DIAGnostic:LOG :COUNt?	_	<nr1></nr1>	Returns number of log entries.
DIAGnostic:LOG :PRINt?	—	<string></string>	Prints log entries.
DIAGnostic:LOG[:READ]?	[<numeric_value>]</numeric_value>	<string,string></string,string>	Returns log entry.
DIAGnostic:LOG:VERBosity	<disable terse VERBose SERVice></disable terse 	_	Selects printer log-report detail.
DIAGnostic:LOG:VERBosity?	_	DIS TERS VERB SERV	Returns printer-logging detail level.
DIAGnostic:RFAMplitude?	—	<nr3,nr3></nr3,nr3>	Returns RF amplitudes.
DIAGnostic:STATus[:GLOBal]?	—	<string></string>	Returns summary status.
DIAGnostic:STATus:SUPPly?	_	AC DC BATT LOW	Returns power supply status.
DIAGnostic:TEMPerature?	_	<nr3></nr3>	Returns ambient tem- perature.
DIAGnostic:TEST?	<numeric_value></numeric_value>	<0 1>	Runs Diagnostics (standby mode).

Command	Parameter Form	Response Form	Comment
DIAGnostic :VOLTage:COVen?	—	<nr3></nr3>	Returns CBT oven Volts.
DIAGnostic :VOLTage :EMULtiplier?	—	<nr3></nr3>	Returns Electron multi- plier Volts.
DIAGnostic :VOLTage:HWIonizer?	_	<nr3></nr3>	Returns Hot wire ionizer Volts.
DIAGnostic :VOLTage:MSPec?	_	<nr3></nr3>	Returns Mass spectrom- eter Volts.
DIAGnostic :VOLTage:PLLoop?	_	<nr3,nr3, NR3,NR3></nr3,nr3, 	Returns Phase-Lock Loop Volts.
DIAGnostic :VOLTage:ROSCillator?	_	<nr3></nr3>	Returns Quartz OSC Mon. Volts.
DIAGnostic :VOLTage:SUPPly?	_	<nr3,nr3, NR3,NR3></nr3,nr3, 	Returns Power Supply Volts.

TABLE 6-2: DIAGNOSTIC COMMANDS (CONTINUED)

TABLE 6-3:DISPLAY COMMANDS

Command	Parameter Form	Response Form	Comment
DISPlay:ENABle	<0FF 0 0N 1>	—	Sets the Clock Display ON or OFF.
DISPlay:ENABle?	_	<0 1>	Returns Clock display status.

TABLE 6-4:	PRECISION TIME (DATE AND TIME	COMMANDS

Command	Parameter Form	Response Form	Comment
[SOURce]:PTIMe[:TIME]	<hour>,<minute>, <second></second></minute></hour>	—	Sets 24-hour time.
[SOURce]:PTIMe[:TIME]?	[min max, min max, min max]	<nr1,nr1, NR1></nr1,nr1, 	Returns 24-hour time.
[SOURce]:PTIMe:MJDate	<numeric_value></numeric_value>	_	Sets modified Julian date (MJD).
[SOURce]:PTIMe:MJDate?	[MIN MAX]	<nr1></nr1>	Returns the MJD.
[SOURce]:PTIMe:LEAPsecond: DURation	<numeric_value></numeric_value>	_	Sets Leap second minute duration.
[SOURce]:PTIMe:LEAPsecond: DURation?	[MIN MAX]	<nr1></nr1>	Returns Leap second minute duration.
[SOURce]:PTIMe:LEAPsecond: MJDate	<numeric_value></numeric_value>	_	Sets MJD for a sched- uled leap second (LPS).
[SOURce]:PTIMe:LEAPsecond: MJDate?	[MIN MAX]	<nr1></nr1>	Returns MJD scheduled leap second (LPS).
[SOURce]:PTIMe:LEAPsecond:[: STATe]	<0FF 0 0N 1>	—	Sets or cancels a sched- uled LPS.
[SOURce]:PTIMe:LEAPsecond:[: STATe]?	_	<0 1>	Returns status of a scheduled LPS.
[SOURce]:PTIMe:SLEW	<numeric_value></numeric_value>	—	Adjusts clock Epoch.
[SOURce]:PTIMe:SLEW?	[MIN MAX]	<nr3></nr3>	Returns MIN/MAX acceptable Slew value.
[SOURce]:PTIMe:STANdby	<0FF 0 0N 1>	_	Sets/resets Standby mode.

Command	Parameter Form	Response Form	Comment
[SOURce]:PTIMe:STANdby?	_	<0 1>	Returns Standby mode status.
[SOURce]:PTIMe: SYNChronization	<off front REAR></off front 	—	Arms selected Sync port.
[SOURce]:PTIMe: SYNChronization?	_	<off fron REAR></off fron 	Returns armed Sync port, if any.

TABLE 6-4:	PRECISION TIME	DATE AND TIME	COMMANDS	(CONTINUED)	

TABLE 6-5: REFERENCE OSCILLATOR COMMANDS

Command	Parameter Form	Response Form	Comment
[SOURce]:ROSCillator:CONTrol	<numeric_value></numeric_value>	_	Sets OSC tune voltage (in Standby).
[SOURce]:ROSCillator:CONTrol?	[MIN MAX]	<nr3></nr3>	Returns OSC tuning volt- age.
[SOURce]:ROSCillator:STEer	<numeric_value></numeric_value>	—	Sets fractional frequency offset.
[SOURce]:ROSCillator:STEer?	[MIN MAX]	<nr3></nr3>	Returns set fractional fre- quency offset.
[SOURce]:ROSCillator: FREQuency[1 2]	<frequency></frequency>	_	Sets selected Output-port Hz.
[SOURce]:ROSCillator: FREQuency[1 2]?	[MIN MAX]	<nr3></nr3>	Returns Output-port Hz.
[SOURce]:ROSCillator:MVOLtage?	_	<nr3></nr3>	Returns OSC-oven moni- tor voltage.

TABLE 6-6: STATUS MONITORING COMMANDS

Command	Parameter Form	Response Form	Comment
STATus:OPERation[:EVENt]?	_	<nr1></nr1>	Returns/clears OEReg contents.
STATus:OPERation:CONDition?	_	<nr1></nr1>	Returns OCReg con- tents.
STATus:OPERation:ENABle	<numeric_value></numeric_value>	—	Sets OEReg to specified value.
STATus:OPERation:ENABle?	_	<nr1></nr1>	Returns OEReg con- tents.
STATus:OPERation:NTRansition	<numeric_value></numeric_value>	_	Sets NTRReg to speci- fied value.
STATus:OPERation:NTRansition?	_	<nr1></nr1>	Returns NTRReg con- tents.
STATus:OPERation:PTRansition	<numeric_value></numeric_value>	_	Sets PTRReg to speci- fied value.
STATus:OPERation:PTRansition?	_	<nr1></nr1>	Returns PTRReg con- tents.
STATus:QUEStionable[:EVENt]?	—	<nr1></nr1>	Returns/clears QEReg contents.
STATus:QUEStionable:CONDition?	_	<nr1></nr1>	Returns QCReg con- tents.

Command	Parameter Form	Response Form	Comment
STATus:QUEStionable:ENABle	<numeric_value></numeric_value>	—	Sets QEReg to specified value.
STATus:QUEStionable:ENABle?	_	<nr1></nr1>	Returns QEReg con- tents.
STATus:QUEStionable: NTRansition	<numeric_value></numeric_value>	_	Sets NTRReg to speci- fied value.
STATus:QUEStionable: NTRansi- tion?	_	<nr1></nr1>	Returns NTRReg con- tents.
STATus:QUEStionable:PTRansition	<numeric_value></numeric_value>	_	Sets PTRReg to speci- fied value.
STATus:QUEStionable: PTRansi- tion?	_	<nr1></nr1>	Returns PTRReg con- tents.
STATus:PRESet	_	_	Resets Control Regis- ters/clears Status Output.

TABLE 6-6: STATUS MONITORING COMMANDS (CONTINUED)

TABLE 6-7: SYSTEM COMMANDS

Command	Parameter Form	Response Form	Comment
SYSTem:ERRor?	_	<nr1,string></nr1,string>	Returns error numbers /messages
SYSTem:KEY	<numeric_value></numeric_value>	_	Inserts keycode in key- press queue.
SYSTem:KEY?	[MIN MAX]	<nr1></nr1>	Returns last keypress code.
SYSTem:PRINt?	—	<ascii_string></ascii_string>	Prints status report.
SYSTem:REMote	<0FF 0 0N 1>	—	Enables/disables remote operation.
SYSTem:REMote?	_	<0 1>	Returns remote operation status.
SYSTem:SCONfiguration	_	_	Saves instrument config- uration.
SYSTem:TIME	<hours>,<minutes>, <seconds></seconds></minutes></hours>	_	Sends SOUR:PTIM:TIME.
SYSTem:TIME?	[min max,min max, min max]	<nr1,nr1, NR1></nr1,nr1, 	Returns 24-hour time.
SYSTem:VERSion?	—	<nr2></nr2>	Returns SCPI Version number.
SYSTem:COMMunicate:SERial: BAUD	<numeric value=""> 9600, 4800, 2400, 1200, 600, 300</numeric>	_	Sets baud rate.
SYSTem:COMMunicate:SERial: BITS	<numeric value=""> 7 or 8</numeric>	—	Sets number of data bits.
SYSTem:COMMunicate:SERial: PARity	<none even ODD></none even 	_	Sets parity.
SYSTem:COMMunicate:SERial: SBITs	<numeric value=""> 1 or 2</numeric>	_	Sets number of stop bits.
SYSTem:COMMunicate:SERial: BAUD?	_	<nr1></nr1>	Returns baud rate.
SYSTem:COMMunicate:SERial: BITS?	_	<nr1></nr1>	Returns number of data bits.

Command	Parameter Form	Response Form	Comment
SYSTem:COMMunicate:SERial: PARity?	_	<none even ODD></none even 	Returns parity.
SYSTem:COMMunicate:SERial: SBITs?	_	<nr1></nr1>	Returns number of stop bits.

TABLE 6-7: SYSTEM COMMANDS (CONTINUED)

6.2 DESCRIPTION OF SCPI COMMANDS

This section describes the SCPI commands for the 5071A Primary Frequency Standard. The commands are grouped by functionality and are presented in alphabetical order with their group. See SCPI Commands for a summary of each SCPI command.

6.2.1 Diagnostic Commands

The DIAGnostic commands provide access to the instrument's internal operating parameter values, event log entries, and internal self-tests.

6.2.1.1 DIAGNOSTIC:CBTSERIAL?

This query returns the serial number of the installed CBT (Cesium-Beam tube). If the CBT ROM is faulty or unreadable, Factory Default returns. Returned format = <string quoted>.

Note: This command returns the serial number of the enclosed CBT, not the instrument itself.

6.2.1.2 DIAGNOSTIC:CONTINUOUS:RESET

This command resets the Continuous Operation light (illuminates continuously) if the instrument has triggered its warning mode. The 5071A must be in REMote mode to execute this command. If DIAG:

CONT? is OFF, sending :CONT:RESet will generate error +202, "Valid only when operating normally".

The function of this command is not affected by *RST.

Note: If the instrument's state is "Warning", execution of this command changes it to "Operating normally". If a warning condition still exists, the instrument re-enters the Warning state immediately. Otherwise, the warning is cleared.

6.2.1.3 DIAGNOSTIC:CONTINUOUS: [:STATE]?

This query returns Continuous Operation status.

Response format = OFF|ENAB|ON, defined as follows:

- · OFF Continuous Operation is neither enabled or reset,
- ENABle Continuous Operation may be reset: Light flashing, or
- ON Continuous Operation reset has occurred: Light On.

6.2.1.4 DIAGNOSTIC:CURRENT:BEAM?

This query returns the beam current setpoint in amperes.

Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻⁹A.

6.2.1.5 DIAGNOSTIC:CURRENT:CFIELD?

This query returns C-field current-setpoint value in amperes. Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻⁶A.

6.2.1.6 DIAGNOSTIC:CURRENT:PUMP?

This query returns the ion pump current in amperes.

Response format = $\langle NR3 \rangle$, precision = 2 x 10⁻⁷A.

6.2.1.7 DIAGNOSTIC:GAIN?

This query returns counter signal gain as fraction of full-scale value.

Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻³.

6.2.1.8 DIAGNOSTIC:LOG:CLEAR

This command purges all event log entries.

The 5071A must be in REMote mode to execute this command. This command is not affected by *RST and does not have a query.

6.2.1.9 DIAGNOSTIC:LOG :COUNT?

This query returns the number of entries in the log as an integer. (If the log has been deleted, this query returns a negative value.)

Response format = <NR1>.

6.2.1.10 DIAGNOSTIC:LOG :PRINT?

This query prints the entire contents of the event log. (Equivalent to the front panel "LOG PRINT" command.)

Response format = <arbitrary ASCII>

6.2.1.11 DIAGNOSTIC:LOG[:READ]? [<NUMERIC_VALUE>]

This query returns the time stamp and text of the most recent unread log entry if no parameter is supplied; otherwise, it returns the specified log entry.

Response format = <string quoted, string quoted>.

6.2.1.12 DIAGNOSTIC:LOG:VERBOSITY DISABLE|TERSE|VERBOSE|SERVICE

This command specifies the log stream events actually sent to the serial port.

The 5071A must be in REMote mode to execute this command.

The following four parameters of the DIAGnostic:LOG:VERBosity command allow you to select the log stream events that will be sent to the serial port:

- DISable prevents messages from being echoed to the serial port.
- · TERSe causes only fatal errors to be echoed to the serial port.
- VERBose echoes all progress information and user events.
- SERVice adds detailed power-on/warm-up events to VERBose content.

The VERBosity setting has no effect on which messages are saved in non-volatile log. It only specifies which messages echo to the serial port unrequested.

6.2.1.13 DIAGNOSTIC:LOG:VERBOSITY?

This query reports the active setting for log verbosity.

Return values = DIS, TERS, VERB, or SERV, (discussed above).

6.2.1.14 DIAGNOSTIC:RFAMPLITUDE?

This query returns RF Attenuator setpoints as fraction of full-scale. Response format = $\langle NR3, NR3 \rangle$, precision = 1 x 10-3.

6.2.1.15 DIAGNOSTIC:STATUS[:GLOBAL]?

This query returns instrument's summary status message.

Response format = <string quoted>.

6.2.1.16 DIAGNOSTIC:STATUS:SUPPLY?

Note: The response "BATT" does not apply to the 48V option.

This query returns a power supply status indication.

Response format = AC|DC|BATT|LOW, defined as follows:

- AC operating from AC power.
- DC operating from auxiliary DC power.
- BATT operating from internal battery backup.
- · LOW internal supply voltages below nominal.

6.2.1.17 DIAGNOSTIC:TEMPERATURE?

This query returns ambient temperature sensed within the instrument in Celsius.

Response format = <NR3>, precision = 0.1°C, accuracy = ±2.5°C

6.2.1.18 DIAGNOSTIC:TEST? <NUMERIC_VALUE>

This query executes the diagnostic test specified by the supplied parameter.

The 5071A must be in Standby mode or Fatal error state to successfully execute this command, otherwise error message +203 "Valid only in standby" returns.

Response format = <boolean> (0: tests passed, or 1: tests failed).

The available test parameters and corresponding functions are:

- -1. Execute tests 0 through 17
- 0. Cbt board register test
- 1. Cbt board thermistor window test
- 2. Cbt board thermistor test
- 3. Cbt board Cesium oven test
- 4. Cbt board hot wire ionizer test
- 5. Cbt board mass spectrometer test
- 6. Cpu board RTDS test
- 7. Cpu board phase lock loop test
- 8. DDFS board register test
- 9. DDFS board and 87 MHz module tuning voltage test
- 10. DDFS board 9.2 GHz module tuning voltage test
- 11. Servo board register test
- 12. Servo board DAC time-out test
- 13. Interface board register test
- 14. Interface board Analog bus test

15. Pps board register test

16. Pps board interrupt test

17. Power logic check

6.2.1.19 DIAGNOSTIC :VOLTAGE:COVEN?

This query returns the Cesium oven heater voltage.

Response format = <NR3>, precision = 0.1V.

6.2.1.20 DIAGNOSTIC :VOLTAGE :EMULTIPLIER?

:This query returns the electron multiplier voltage setpoint. Response format = <NR3>, precision = 1V.

6.2.1.21 DIAGNOSTIC :VOLTAGE:HWIONIZER?

This query returns the hot wire ionizer voltage setpoint. Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻¹V.

6.2.1.22 DIAGNOSTIC :VOLTAGE:MSPEC?

This query returns the mass spectrometer voltage setpoint.

Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻¹V.

6.2.1.23 DIAGNOSTIC :VOLTAGE:PLLOOP?

This query returns tuning voltages for each of four phase locked loops: 9.2 GHz, 640 MHz, 87 MHz, 9 MHz.

Response format = $\langle NR3, NR3, NR3, NR3 \rangle$, precision = 1 x 10⁻¹V.

6.2.1.24 DIAGNOSTIC :VOLTAGE:ROSCILLATOR?

This query is equivalent to "\[SOURce:\]ROSCillator:MVOLtage?" See \[SOURce:\]ROSCillator:MVOLtage?

6.2.1.25 DIAGNOSTIC :VOLTAGE:SUPPLY?

This query returns voltages from the +5, +12, and -12 volt power supplies. Response format = <NR3, NR3, NR3>, precision = 1 x 10^{-1} V.

6.2.2 Display Commands

The DISPlay command turns the front-panel LED clock display ON or OFF.

6.2.2.1 DISPLAY:ENABLE OFF|0|ON|1

This command enables or disables the LED clock display. The display will illuminate if the time has been set.

The 5071A must be in REMote mode to execute this command.

REMote mode can be set ON by sending *RST.

The available parameters are:

- OFF|0 turns the display OFF, or
- ON|1 turns the display ON.

6.2.2.2 DISPLAY:ENABLE?

This query returns the LED clock display status as ON or OFF (see above). The clock display is ON if enabled and time has been set. Response format <0 or 1>

Returns 1 if clock display is ON, 0 if display clock is OFF.

6.2.3 Precision Time (Date and Time) Commands

The \[SOURce\]:PTIMe commands provide the most-important time keeping functions for the 5071A. These functions include commands for:

- Setting Time and Date
- Adjusting, scheduling, and executing Leap-second insertion
- · Adjusting Epoch
- Setting operating mode
- Synchronizing 1 pps output

6.2.3.1 PTIME[:TIME] <HOUR>,<MINUTE>,<SECOND>

This command sets time in 24-hour format (SCPI standard).

The 5071A must be in REMote mode to execute this command.

Requires three parameters: hours, minute, and second.

Entered values are rounded to integer.

The maximum range limits are 23, 59, 59, respectively.

The function of this command is not affected by *RST.

6.2.3.2 PTIME[:TIME]? [MIN|MAX, MIN|MAX, MIN|MAX]

This query returns time in 24-hour format (SCPI Std) as hours, minute, second, or minimum-maximum range-limit values.

Response format = <NR1, NR1, NR1>, precision = 1 s.

6.2.3.3 PTIME:MJDATE <NUMERIC_VALUE>

This command sets the Modified Julian date to the specified value.

The 5071A must be in REMote mode to execute this command.

```
One parameter is required, range = 0 to 99999.
```

The function of this command is not affected by *RST.

6.2.3.4 PTIME:MJDATE? [MIN|MAX]

This query returns the instrument's current MJD.

If not set, the date starts at zero and increments at the instrument's transition for midnight.

Response format = <NR1>.

6.2.3.5 PTIME:LEAPSECOND:DURATION <NUMERIC_VALUE>

This command programs the length of the minute preceding a scheduled leap second.

If no leap second is pending, duration is active when STATe is set ON.

If a leap second is pending, this command changes the scheduled duration by canceling the prior leap second and scheduling a new one with the specified duration. The function of this command is not affected by *RST.

6.2.3.6 PTIME:LEAPSECOND:DURATION? [MIN|MAX]

This query indicates the duration of the minute preceding a pending leap second or minimum-maximum range-limit values.

If none is pending, the last specified value for DURation returns.

6.2.3.7 PTIME:LEAPSECOND:MJDATE <NUMERIC_VALUE>

This command programs the MJD for a scheduled leap second with the supplied parameter.

One parameter is required (MJD), range = 0 to 99999.

If no Leap second is pending, this date is active when STATe is ON.

If a leap second is pending, this command changes the scheduled duration by canceling the old leap second and scheduling a new one with the specified duration. The function of this command is not affected by *RST.

6.2.3.8 PTIME:LEAPSECOND:MJDATE? [MIN|MAX]

This query indicates the MJD of any pending leap second or minimum-maximum range-limit values.

If none is pending, the last specified value of MJD or the present MJD, (whichever is greater) returns.

6.2.3.9 PTIME:LEAPSECOND[:STATE] OFF|0|ON|1

This command activates or cancels a programmed leap second.

When STATe is turned ON, a leap second is scheduled for the last specified values of DURation and MJDate.

The function of this command is not affected by *RST.

6.2.3.10 PTIME:LEAPSECOND[:STATE]?

This query indicates whether a leap second is pending.

Response format = <0 or 1>

Returns 1 if pending, 0 if none pending.

6.2.3.11 PTIME:SLEW <NUMERIC_VALUE>

This command adjusts the epoch of the clock with the supplied parameter.

The 5071A must be in REMote mode to execute this command.

One parameter is required, accepts "S" suffix.

Parameter range = -0.5 S to 0.5 S, precision = 50 ns.

This is an event.

The function of this command is not affected by *RST.

6.2.3.12 PTIME:SLEW? MIN|MAX

This query returns the smallest and largest slew value which can be used. Response format = <NR3>.

6.2.3.13 PTIME:STANDBY OFF|0|ON|1

This command enables or disables STANDBY mode.

The 5071A must be in REMote mode to execute this command.

Disabling standby initiates normal operation, if possible. (This command is equivalent to the 5061B "cesium off" switch.)

The function of this command is not affected by *RST.

6.2.3.14 PTIME:STANDBY?

This query returns 1 if instrument is in standby, 0 otherwise. Response format <0 or 1> Returns 1 if in standby, 0 if not in standby.

6.2.3.15 PTIME:SYNCHRONIZATION OFF|FRONT|REAR

This command arms the specified sync port with the supplied parameter.

The 5071A must be in REMote mode to execute this command. Arming terminates when:

- · canceled from the command interface,
- a valid sync pulse is received at the armed port,
- or after 1-1/2 seconds has elapsed.

Examine the relative timing of the pulses to determine which event has occurred.

The function of this command is OFF at *RST. The available parameters are:

- OFF Turns off either Front or Rear Sync Input port connectors.
- FRONt enables the Front-panel Sync Input port connector.
- REAR enables the Rear-panel Sync Input port connector.

6.2.3.16 PTIME:SYNCHRONIZATION?

This query indicates which sync port is armed, if any.

Response format = OFF|FRON|REAR.

6.2.4 Reference Oscillator Commands

The [SOURce]:ROSCillator commands provides more advanced time keeping functions for the 5071A. These functions increase the flexibility of the 5071A by providing a means of:

- Setting reference oscillator tuning voltage,
- · Setting fractional frequency offsets,
- · Programming output-port frequency, and
- · Checking the monitor voltage for the ovenized oscillator.

6.2.4.1 ROSCILLATOR:CONTROL <NUMERIC_VALUE>

This command controls the reference oscillator tuning voltage as a signed fraction of full scale with the supplied parameter.

The 5071A must be in REMote mode to execute this command.

This command requires that PTIMe:STANdby is ON for successful completion; otherwise, the command is ignored.

Precision of control = one part in 32767. Range = $\pm 3.3 \times 10^{-7}$ in frequency.

6.2.4.2 ROSCILLATOR:CONTROL? [MIN|MAX]

This query returns the reference oscillator frequency control setpoint as a signed fraction of full scale or minimum-maximum acceptable range limits.

Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻⁴ or better.

6.2.4.3 ROSCILLATOR:STEER <NUMERIC_VALUE>

This command introduces a fractional frequency offset in the output frequencies with the supplied parameter.

The 5071A must be in REMote mode to execute this command.

The instrument maintains servo lock to the Cesium resonance.

Parameter range = -1×10^{-9} to $+1.0 \times 10^{-9}$.

The function of this command is set to 0.0 by *RST.

6.2.4.4 ROSCILLATOR:STEER? [MIN|MAX]

This query returns the active value of fractional frequency offset or minimum-maximum acceptable range limits. Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻¹⁵.

6.2.4.5 ROSC:FREQUENCY[1|2] <FREQUENCY>

This command sets the output frequency of the indicated port with the supplied parameter.

The 5071A must be in REMote mode to execute this command.

The frequency parameter is 5×10^6 Hz or 10×10^6 Hz.

Values are rounded to the nearest valid setting, unless out of range.

The function of this command is not affected by *RST.

6.2.4.6 ROSCILLATOR:FREQUENCY[1|2]? [MIN|MAX]

This query returns the programmed frequency at specified port, in Hz or minimum-maximum acceptable range limits. Response format = <NR3>.

6.2.4.7 ROSCILLATOR: MVOLTAGE?

This query returns the Oscillator oven monitor voltage. Response format = $\langle NR3 \rangle$, precision = 1 x 10⁻¹V.

6.2.5 STATus Monitoring Commands

The STATus commands allow you to examine the status of the instrument by monitoring the Operation Status register and the Questionable Data register. Figure 6-1 shows all of the instrument's status registers.

The STATus system contains four registers (and the Output Queue), two of which are under IEEE 488.2 control. These are the Standard Event Status Register (ESR) and the Status Byte Register (SBR). The other two are the Standard Operation Status register and Questionable Data register. Refer to the Common command descriptions in IEEE 488.2 Common Commands and the Status Reporting section of this chapter for more details.

The two registers under the instrument's control are the Standard Operation Status register and the Questionable Data register. These registers may be set and queried.

6.2.5.1 PARAMETER ENTRY

Parameter entry for both registers is numeric only. Numeric types may be Decimal, Hexadecimal, Octal, or Binary. The decimal numeric range is between 0 and 32767. The *RST value is 0. Sending a decimal value of 64 will set bit 6.

TABLE 6-8:	PA	PARAMETER ENTRY										
	-					_						

Bit Number	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Decimal Value	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	N/A
6.2.5.2 USING THE OPERATION STATUS REGISTER

The 16-bit Operation Status register monitors instrument operations currently being performed. The instrument implements bits 0, 8, 9, 10, 11, and 12 to monitor various internal operations. Refer to the Status Reporting section of this chapter for definitions of these bits.

The Operation Status register group consists of a condition (C) register, an event (EV) register, and an enable (EN) register as shown in the following figure. The commands in the STATus:OPERation subsystem control and monitor these registers.



6.2.5.3 STATUS:OPERATION[:EVENT]?

This query returns the contents of the OPERation event register, then clears the event register. The event register bits are determined by the settings of the corresponding rise, fall, and condition registers.

Response format = <NR1>.

6.2.5.4 STATUS:OPERATION:CONDITION?

This query returns the contents of the OPERation condition register, non destructively. Response format = <NR1>.

6.2.5.5 STATUS:OPERATION:ENABLE <NUMERIC_VALUE>

This command sets the OPERation enable register to the specified value. Meaningful values are in the range 0 to 32767.

6.2.5.6 STATUS:OPERATION:ENABLE?

This query reports OPERation enable register contents, non-destructively. Response format = <NR1>.

6.2.5.7 STATUS: OPERATION: NTRANSITION < NUMERIC_VALUE>

This command sets the negative transition filter (fall register) as specified. Meaningful values are in the range 0 to 32767.

6.2.5.8 STATUS:OPERATION:NTRANSITION?

This query returns the contents of the fall register. Response format = <NR1>.

6.2.5.9 STATUS: OPERATION: PTRANSITION < NUMERIC_VALUE>

This command sets the positive transition filter (rise register) as specified. Meaningful values are in the range 0 to 32767.

6.2.5.10 STATUS:OPERATION:PTRANSITION?

This query reports the contents of the rise register.

Response format = <NR1>.

6.2.5.11 USING THE QUESTIONABLE DATA REGISTER

The Questionable Data Register conveys information about the quality of the instrument's functions and outputs. The 5071A implements bits 2, 5, and 6 of the Questionable Data Register (refer to the Status Reporting section of this chapter for more details).

The Questionable Data Register group consists of a condition register, an event register, and an enable register as shown in Figure 6-1. The commands in the STATus: QUEStionable subsystem control and monitor these registers.

The STATus:QUEStionable subsystem commands query the QUEStionable Register to indicate whether an overflow has occurred for a specific function after an associated command has executed. When any of the bits are set (questionable data), bit 3 of the Status Register is set to 1 if enabled by the STAT:QUES:ENAB command.

6.2.5.11.1 STATus:QUEStionable[:EVENt]?

This query reports contents of the QUEStionable event register, then clears the event register.

The event register bits are determined by the settings of the corresponding rise, fall, and condition registers.

Response format = <NR1>.

6.2.5.11.2 STATus:QUEStionable:CONDition?

This query reports contents of the QUEStionable condition register, non-destructively. Response format = <NR1>. 6.2.5.11.3 STATus:QUEStionable:ENABle <numeric_value>

This command sets QUEStionable enable register to the specified value.

Meaningful values are in the range 0 to 32767.

6.2.5.11.4 STATus:QUEStionable:ENABle?

This query reports the contents of the QUEStionable enable register, non destructively. Response format = <NR1>

6.2.5.11.5 STATus:QUEStionable:NTRansition <numeric_value>

This command sets the negative transition filter (fall register) as specified. Meaningful values are in the range 0 to 32767.

6.2.5.11.6 STATus:QUEStionable:NTRansition?

This query reports the contents of the fall register.

Response format = <NR1>.

6.2.5.11.7 STATus:QUEStionable:PTRansition <numeric_value>

This command sets the positive transition filter (rise register) as specified.

Meaningful values are in the range 0 to 32767.

6.2.5.11.8 STATus:QUEStionable:PTRansition?

This query reports the contents of the rise register.

Response format = <NR1>.

6.2.5.12 STATUS:PRESET

This command clears the OPER and QUES enable registers, sets the rise registers, and clears the fall registers.

6.2.6 System Commands

The SYSTem commands control functions related to remote system communication, configuration, and any error messages.

Note:	Any commands which alter the state of the instrument will return error +201
	if the instrument is not in REMOTE mode when the command is issued.

Note: Use care when typing the following commands. Once a serial port configuration is altered it will be necessary to subsequently change your terminal emulator or modem settings to match the new configuration for communication to continue.

6.2.6.1 SYSTEM:ERROR?

This query returns error numbers and corresponding error messages in the error queue.

Refer to Table 6-14 for details of error codes, messages and meanings.

Response format = <NR1>.

When an error occurs within the instrument, its corresponding number and message are generated and stored in the error queue.

One error is removed from the error queue each time the SYSTem:ERRor? command is executed.

The errors are cleared in a first-in, first-out order. This means that if several errors are waiting in the queue, each SYSTem:ERRor? query returns the oldest (not the most recent) error. That error is then removed from the queue.

When the error queue is empty, subsequent SYSTem:ERRor? queries return +0, "No error". To clear all errors from the queue, execute the *CLS command.

The error queue has a maximum capacity of 30 errors. If the queue overflows, the last error is replaced with -350, "Too many errors". No further errors are accepted until space is available. The error queue is empty at power-on.

6.2.6.2 SYSTEM:KEY <NUMERIC_VALUE>

This command inserts the specified keycode into the keypress queue. Operates with remote OFF.

Input range: 0 to 19, 128 to 149.

Code 148 turns the SHIFT annunciator On, while code 0 turns it Off.

Codes 1 through 19 point to unshifted keys in left-right, top-bottom order.

Add 128 to any keycode to arrive at its shifted code.

Codes 20, 128, and 149 are reserved. See the key-code listing in the following table.

Кеу	Code	Shifted Key	Code
Shift OFF	0	INFO	129
Data 7	1	SET CLOCK	130
Data 8	2	SLEW	131
Data 9	3	\leftarrow	132
←	4	\rightarrow	133
\rightarrow	5	SERIAL	134
Data 4	6	ULTILITIES	135
Data 5	7	LOG	136
Data 6	8	Inc	137
Inc	9	Dec	138
Dec	10	Data 1	139
Data 1	11	Data 2	140
Data 2	12	Data 3	141
Data 3	13	Тор	142
Тор	14	Prev	143
Prev	15	Data 0	144
Data 0	16	Data .	145
Data .	17	Data ±	146
Data ±	18	Enter	147
Enter	19	Shift ON	148
Shift ON	148	—	

TABLE 6-9:KEY CODE LISTING

6.2.6.3 SYSTEM:KEY? [MIN|MAX]

This query returns the numeric code of the last keypress or minimum-maximum acceptable range limits. Does not reflect codes sent by the KEY command.

Response format = <NR1>

6.2.6.4 SYSTEM:PRINT?

This quires prints a status report.

This query or command is identical to the front-panel information print command. Output format = arbitrary ASCII (several lines of ASCII text). :REMote

6.2.6.5 SYSTEM:REMOTE OFF|0|ON|1

This command enables or disables REMOTE operation mode.

The function of this command is ON at *RST.

6.2.6.6 SYSTEM:REMOTE?

This query returns the state of REMOTE mode.

```
Response format = <0 or 1>
```

Returns 1 if REMOTE mode is ON, 0 if REMOTE mode is OFF

6.2.6.7 SYSTEM:SCONFIGURATION

This command saves the following instrument parameters in nonvolatile memory:

- · Serial port: baud rate, data bits, stop bits, and parity
- LCD angle
- Output port frequencies
- Printer report level

The 5071A must be in REMote mode to execute this command.

The function of this command is not affected by *RST.

6.2.6.8 SYSTEM:TIME <HOURS>,<MINUTES>,<SECONDS>

This command is equivalent to "SOUR:PTIM:TIME".

The function of this command is not affected by *RST.

6.2.6.9 SYSTEM: TIME? [MIN|MAX, MIN|MAX, MIN|MAX]

This query returns 24-hour time or minimum-maximum acceptable range limits. Response format = <NR1, NR1, NR1>, precision = 1 Second.

6.2.6.10 SYSTEM:VERSION?

This query returns the SCPI version number for which the instrument complies (1990.0).

Response format = <NR2>.

6.2.6.11 SYSTEM:COMMUNICATE:SERIAL:BAUD <NUMERIC_VALUE>

This command sets RS-232C baud rate.

Input values: 300, 600, 1200, 2400, 4800, 9600.

6.2.6.12 SYSTEM:COMMUNICATE:SERIAL:BITS <NUMERIC_VALUE>

This command sets RS-232C number of data bits.

Input values: 7 or 8.

6.2.6.13 SYSTEM:COMMUNICATE:SERIAL:PARITY < NONE|EVEN|ODD >

This command sets RS-232C parity. Input values: None, Even or Odd.

6.2.6.14 SYSTEM:COMMUNICATE:SERIAL:SBITS <NUMERIC_VALUE>

This command sets RS-232C number of stop bits. Input values: 1 or 2.

6.2.6.15 SYSTEM:COMMUNICATE:SERIAL:BAUD?

This query returns the RS-232C baud rate.

Response format = <NR1>.

6.2.6.16 SYSTEM:COMMUNICATE:SERIAL:BITS?

This query returns the RS-232C number of data bits.

Response format = <NR1>.

6.2.6.17 SYSTEM:COMMUNICATE:SERIAL:PARITY?

This query returns the RS-232C parity.

Response format = None, Even, or Odd

6.2.6.18 SYSTEM:COMMUNICATE:SERIAL:SBITS?

This query returns the RS-232C number of stop bits. Response format = <NR1>.

6.3 STATUS REPORTING

The 5071A status registers conform to the SCPI and IEEE 488.2 standards applicable with an RS-232C serial data-communications port. RS-232C does not support serial poll, parallel poll, or SRQ. Instead, IEEE SRQ and RQS signals will always have the same state, and will be reflected in the state of the (low TRUE) status output port (rear-panel status output BNC connector).

The conditions under which the rear-panel Status Output goes active can be programmed with the commands available in the SCPI STATus subsystem. These commands are used in conjunction with IEEE 488.2 Common commands. Refer to the next section of this chapter for information about, and examples of, programmed rear-panel Status Output states. The status registers of the 5071A are defined in the following tables.

Bit	Function	Bit Status		
0	Unused	—		
1	Unused	—		
2	Unused	—		
3	QUE	Summary of SCPI QUEStionable status register		
4	MAV	IEEE 488.2 MAV bit (unused, always zero)		
5	ESB	Summary of IEEE 488.2 Event Status Register		
6	MSS	MSS IEEE 488 request status (same state as status port)		
7	OPR Summary of SCPI OPERation status register			

TABLE 6-10: IEEE SUMMARY STATUS BYTE (STB)

Bit	Function Name		
0	OPC IEEE Operation complete		
1	RQC (not used)		
2	SCPI Query error		
3	SCPI Device Dependent Error		
4	SCPI Execution Error		
5	SCPI Command Error		
6	URQ (not used)		
7	PON Power On flag		

TABLE 6-11: IEEE STANDARD EVENT STATUS REGISTER (ESR)

TABLE 6-12: SCPI OPERATION STATUS REGISTER

Bit	Function	Bit Status
0	CALibrating	Set when performing auto calibration
1	SETTling	Always zero
2	RANGing	Always zero
3	SWEeping	Always zero
4	MEASuring	Always zero
5	awaiting TRIG	Always zero
6	awaiting ARM	Always zero
7	CORRecting	Always zero
8	Standby	Set when in standby state
9	On Battery	Set when power source is internal battery (this will always be 0 for 48V option instruments).
10	Normal	Set when operating normally
11	Fatal	Set when in fatal error state
12	Steered	Set when output frequency is being steered
13	INST summary	Always zero
14	PROG running	Always zero
15	Unused	Always zero

TABLE 6-13: SCPI QUESTIONABLE STATUS REGISTER

Bit	Function	Bit Status			
0	VOLTage	Always zero			
1	CURRent	Always zero			
2	TIME	Condition cleared when clock is set.			
3	POWer	POWer Always zero			
4	TEMPerature	TEMPerature Always zero			
5	FREQuency	Indicates out-of-lock condition (see log).			
6	PHASe	Indicates spurious bursts from servo chain.			
7	MODulation	Always zero			
8	CALibration	Always zero			
9	Unassigned	Always zero			

		, , , , , , , , , , , , , , , , , , ,
Bit	Function	Bit Status
10	Unassigned	Always zero
11	Unassigned	Always zero
12	Unassigned	Always zero
13	INST summary	Always zero
14	Command Warning	Always zero
15	Unused	Always zero

 TABLE 6-13:
 SCPI QUESTIONABLE STATUS REGISTER (CONTINUED)

6.4 REAR PANEL STATUS OUTPUT OPERATION

The status port is a rear-panel BNC (Status Output) connected to an open-collector output with pull-up to +5V. This output goes low (active) under circumstances which you can select from a set of programmable conditions listed in the SCPI Operation and Questionable status register descriptions (Table 6-12 and Table 6-13).

The status port is connected analogously to an SRQ line in an IEEE-488.2 bus (GP-IB) system. Specifically, the status port contact closes whenever the SRQ bit (RQS/MSS) of the IEEE 488.2 Status Byte Register is asserted (see Figure 6-1). Therefore, you use the SCPI and IEEE common commands which control the status model to select which conditions will trigger the status output.

After successful power-on and warm up, the 5071A will assert its status output active when the instrument leaves normal operation. This exit from normal operation may be programmed for a variety of conditions. Two example conditions are described below. The SCPI STATus:PRESet command restores the control registers to SCPI-required values.

6.4.1 Status Output Programming

Programming the rear-panel Status Output consists of eight general steps: (Examples for the Operation Status Register follow.)

- 1. Choose the conditions you wish to program by referencing Table 6-12 and Table 6-13 for the available choices.
- 2. Look up the equivalent decimal value for each associated condition "bit". See the STATus subsystem section, "Parameter Entry" in this chapter.
- 3. Sum all of these decimal values and use this total to enable all the possible conditions. See example on next page.
- 4. Use the STATus:OPERation(or QUEStionable:):ENABle command to program this value.
- 5. Sum all decimal values that must assert the Status Output active when they become true. See example on next page.
- 6. Use the STATus:OPERation(or QUEStionable:):PTRansition command to program this true value.
- 7. Sum all decimal values that must assert the Status Output active when they become false. See following example.
- 8. Use the STATus:OPERation(or QUEStionable:):NTRansition command to program this false value.
- 6.4.1.1 EXAMPLE 1: PROGRAMMING THE STATUS OUTPUT FOR A SINGLE TRUE CONDITION

The programming examples shown will work only when 48VDC power option is absent, but are still valid to describe the technique for programming the status output port.

This example describes how to program the Status Output to go active when the 5071A is operating on its Internal-Standby Battery.

According to the SCPI OPERation Status Register table, "On Battery" is bit "9". Bit 9 corresponds to decimal value 512. The resulting SCPI command entries are:

- STAT:OPER:ENAB 512
- STAT:OPER:PTR 512
- STAT:OPER:NTR 0

Be aware that even though no false conditions are programmed, the Negative transition command must however be programmed for zero. You may, at any time set the rise and clear the fall registers of the OPERation and QUEStionable subsystems by issuing the STATus:PRESet command.

6.4.1.2 EXAMPLE 2: PROGRAMMING THE STATUS OUTPUT FOR MULTIPLE TRUE AND FALSE CONDITIONS

This example describes how to program the Status Output to go active when the 5071A encounters any combination of the following transitional conditions:

Condition	Bit
CALibrating—true	1
Standby mode—true	256
On battery—true	512
Normal operation—false	1024
Fatal error state—true	2048
Steered output—true	4096

- 1. By adding all the condition bit values we get the sum 7937 which is used to program the STAT:OPER: ENAB command.
- 2. By adding all the true condition bit values we get the sum 6913 which is used to program the STAT: OPER:PTR command.
- 3. By adding all the false condition bit values (in this case, only one) we get the value 1024 which is used to program the STAT:OPER:NTR command. The resulting SCPI command entries are:
- STAT:OPER:ENAB 7937
- STAT: OPER: PTR 6913
- STAT:OPER:NTR 1024

You may, at any time set the rise and clear the fall registers of the OPERation and QUEStionable subsystems by issuing the STATus:PRESet command.

Note: Although these examples used the OPERation register functions, you can also use the QUEStionable register functions that are available for questionable conditions as well.

6.5 SERIAL-PORT COMMAND/PRINTER INTERFACE

The following paragraphs describe the operation of the serial-port command and printer interface.

6.5.1 Mode Selection

The serial port may be connected either to a printer or to a device which issues SCPI commands through RS-232C. The primary distinction is whether the instrument generates text in response to internal events.

For example, the serial port may be configured so that the instrument sends text only in response to SCPI commands. You may also configure it so that the serial port announces all changes in the state of the instrument. This sort of configuration is available on the front panel in the config/log screen. Set DISABLED if you want the serial port to be mute unless requested to respond. Set VERBOSE for detailed status and event reporting.

6.5.2 Pacing

The serial port supports both XON/XOFF (software) and DTR/DSR pacing.

Both pacing features are always enabled. The DSR input of the serial port is pulled up by a resistor so that it is transparent if not connected. Many RS-232C printers support this pacing arrangement. Some also support XON/XOFF. XON/XOFF is also useful when using a terminal. XOFF is the same as control-S, while XON is control-Q.

6.5.3 The Prompt

The SCPI program parser prints a prompt whenever ready for another command.

If no errors are in the queue, the prompt appears as: scpi>.

The prompt string ends with a space (ASCII 32).

Note: If there are errors in the queue, the prompt reflects the number of the most recent unread error in the queue. For example, E-100>.

You can read errors from the queue using the syst:err? query. This prints the error number and a short description of the error, popping that message from the queue. When the queue is clear, the prompt returns to its normal form.

Note: You can clear the queue without reading the messages using the IEEE common *CLS command.

6.5.4 End-Of-Line Characters

The 5071A will receive lines terminated with CR (ASCII 13 decimal), LF (ASCII 10 decimal), or one followed immediately by the other, in either order.

There is no support for IEEE 488 <EOI>. The instrument always terminates formatted output lines with <CR> and <LF>. (See also Prompt above.)

6.6 ERROR MESSAGES/CODES

The following table lists and describes the error messages.

Number	Error String	Cause
-100	Command error	This is the generic syntax error used if the
		5071A cannot detect more specific errors.
-101	Invalid character	Unrecognized character in specified parameter.
-102	Syntax error	Command missing space/comma between
102	Involid concreter	parameters.
-103		not comma.
-104	Data type error	Wrong data type specified in parameter.
-108	Parameter not allowed	Parameter specified in parameterless com- mand.
-109	Missing parameter	Parameter missing in entered command.
-112	Program mnemonic too long	Header contains more than 12 characters.
-113	Undefined header	Command header incorrectly specified.
-121	Invalid character in number	Entered character for numeric data is incorrect.
-123	Exponent too large	Exponent larger than 32000.
-124	Too many digits	More than 256 digits specified.
-128	Numeric data not allowed	Number specified for parameter not letter.
-131	Invalid suffix	Parameter suffix incorrectly specified.
-134	Suffix too long	The suffix contained more than 12 characters.
-138	Suffix not allowed	Parameter suffix specified when not allowed.
-141	Invalid character data	Parameter type specified not allowed.
-144	Character data tool long	Character data element has more than 12 char- acters.
-148	Character data not allowed	Entered character data not recognized by instrument.
-150	String data error	Entered string data contained a non-specific error.
-151	Invalid string data	Entered string data syntax invalid.
-158	String data not allowed	String data encountered but not allowed.
-160	Block data error	Entered block data contained a non-specific error.
-161	Invalid block data	Entered block data syntax invalid.
-168	Block data not allowed	Block data encountered but was not allowed.
-170	Expression error	Entered expression contained a non-specific error.
-171	Invalid expression	Entered block data syntax invalid.
-178	Expression data not allowed	Expression data encountered but was not allowed.
-180	Macro error	Entered macro command or parameter con- tained a non-specific error.
-200	Execution error	Requested function is not available.
-221	Settings conflict	Requested configuration conflicts with current setting(s): occurs upon attempt to set leap state ON when duration is 60 or date has expired.

TABLE 6-14:ERROR MESSAGES

Number	Error String	Cause
-222	Data out of range	Specified parameter value too large/small.
-223	Too much data	Excess data for memory/device-specific pro- cess requirements.
-224	Illegal parameter value	Specified numeric value not allowed.
-230	Data corrupt or stale	New function started but not completed since last access.
-231	Data questionable	Output data accuracy is suspect.
-300	Device-specific error	This is the generic device-dependent error.
-310	System error	Non-specific system error has occurred.
-350	Queue overflow	The error queue is full - more than 8 errors have occurred.
+201	SYSTem:REMote must be ON	Requested entry not allowed when REMote is OFF.
+202	Valid only when operating nor- mally	Requested entry not allowed in current operat- ing state.
+203	Valid only in Standby	Requested entry not allowed in Normal operat- ing mode.

 TABLE 6-14:
 ERROR MESSAGES (CONTINUED)

NOTES:



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 7. Specifications

The current specification and warranty information can be found on the most recent release of the data sheet:

https://www.microsemi.com/document-portal/doc_download/133269-5071a-datasheet

Supplemental characteristics are intended to provide information useful to apply the instrument by giving typical or nominal, but non-warranted performance parameters.

Note: All references to internal-standby battery power, battery status, or battery operation. Do not apply to models without batteries.

7.1 SUPPLEMENTAL CHARACTERISTICS

7.1.1 Time Standard

7.1.1.1 CLOCK DISPLAY

24-hour red LED display of hours, minutes, and seconds.

7.1.2 Internal Standby Battery (Nominal Values)

7.1.2.1 CAPACITY

45 minutes at +25°C from full charge.

7.1.2.2 CHARGE TIME

16 hours maximum from fully discharged state.

7.1.2.3 CHARGE SOURCE

AC input power only.

- 7.1.2.4 RS-232C (DTE CONFIGURATION)
- Provides complete remote control and interrogation of all instrument functions and parameters. RS-232C interface circuits are optically isolated and floating with respect to 5071A chassis.
- Software command set: Standard commands for Programmable Instruments (SCPI), version 1990.0 adapted for RS-232C.
- Connector: 9-pin male rectangular D-Subminiature type.
- Status Output: Provides a logic output to monitor normal and abnormal operation externally.
- Parameters that define abnormal operation can be user programmed.
- Output: TTL High, Normal. TTL Low, Fault.
- Circuit is TTL open collector with internal pull-up resistor.
- Circuit can sink up to 10 mA.
- Connector: BNC located on rear panel.

7.1.2.5 SUPPLEMENTAL POWER REQUIREMENTS FOR 24VDC OPERATION NOT LISTED IN DATA SHEET

Damage level: 55V

Note: Both DC input terminals are floating. Either input terminal may be connected to the chassis, or both may be left floating. The maximum allowable voltage between either input terminal and the chassis is 45V.

· AC: Primary power source; unit will draw AC power in preference to DC power

7.1.2.6 SUPPLEMENTAL POWER REQUIREMENTS FOR 48VDC OPTIONS LISTED IN DATA SHEET

This option equips the frequency standard to operate from 48VDC nominal power.

- The range that the frequency standard will accept is 40VDC to 58VDC.
- Maximum DC power consumption is 100W.
- Two independent 48VDC power sources may be supplied. The power sources must be of the same polarity but either polarity may be used.
- The instrument automatically uses 48VDC source if one is present. If no DC source is available, the instrument will attempt to use AC power. Unit will draw DC power in preference to AC power. The internal battery normally supplied with the 5071A is not available when 48V option is installed.
- Damage level: 72V. Maximum allowable voltage between either input terminal and chassis is 60V.
- Standby operation: Unit requires 20% less power.

7.1.3 Accessories and Options

7.1.3.1 ACCESSORIES FURNISHED

- Power Cord: 180 cm detachable.
- DC input Connector: Part number 1251-0126 (5 contact), Cannon MS3106E-14S-5S (series ME).
- · Cabinet front handles kit.

7.1.3.2 ACCESSORIES AVAILABLE

- Rack Slides: (see 5071A Options for other rack mounting hardware)
- Fixed Slides: Order part number 1494-0059.
- Application Note 1289, The Science of Timekeeping.

7.1.3.3 5071A OPTIONS

- 5071A-908: Rack Flange Kit. Use for mounting the 5071A when front handles will not be used. Also available under part number WARNING: Do not mount this product by the rack flanges alone. Always use a shelf, rails, or slides.
- 5071A-913: Rack Flange Kit. Use with front handles supplied with 5071A. Also available under part number. WARNING: Do not mount this product by the rack flanges alone. Always use a shelf, rails, or slides.

For other product configurations, see Appendix B.

7.2 SPECIFICATION DEFINITIONS

Accuracy: The degree to which the 5071A output frequency differs from that of the accepted definition. The currently accepted definition is that of the 13th General Conference of Weights and Measures and is based on Cesium (The hyperfine resonance of the Cesium 133 atom in zero magnetic field is 9.192631770 GHz.). In practice, this involves comparison with some generally accepted physical embodiment of this definition such as one of the time standards in the international time scale (TIA) monitored by the BIPM in Paris, France. The specified accuracy of the 5071A is intrinsic and is maintained without calibration.

Flicker Floor: The level at which the Allan variance time domain stability measurement remains constant with increased averaging time. The Allan Variance statistical method for measuring time domain stability responds in several ways to various noise processes in a cesium standard. Many of these noise processes produce contributions which average out or decrease as the averaging time increases. Flicker noise, on the other hand, gives rise to an Allan variance independent of averaging time. Thus, the Allan variance of a typical frequency standard will decrease with increasing time, until a relatively constant value is reached. This value is known as the flicker floor.

Flicker Floor Value, Typical: Typical flicker floor performance measure is based on long-term measurements made by NIST.

Frequency Domain Stability (also called single-sideband phase noise or additive noise): Describes the spectral noise in the specified output signal caused by phase modulation from internal noise sources. The measurement is normalized by expressing the ratio of noise power (in a 1 Hz bandwidth) to the signal power, then measured as a function of offset from that signal. For more information see NIST Technical Note 1337, Characterization of Clocks and Oscillators available from the Superintendent of documents, U.S. Government Printing Office, Washington DC 20402-9325.

Frequency Settability: The degree to which the frequency of the 5071A may be adjusted to correspond with a reference without loss of stability.

Isolation: The degree to which one output of the 5071A is affected by changes in loading on another output of the same standard. In practice, this represents a change in amplitude, frequency, or phase as seen at one terminal due to the effect of placing a short, open, or reactance on another terminal. In the 5071A, both Port 1 and Port 2 high isolation output frequencies are derived from the same source; there is no measurable change in frequency. The change in amplitude or phase is measured as the level of the sideband at one port, which results from applying and removing the load at a low frequency rate at the other port. The measurement is the level of the resulting sideband compared to the nominal output level, expressed in decibels.

Reproducibility: The degree to which the 5071A will reproduce the same frequency from one occasion to another after an interruption in operation. This does not include any calibration procedure, but may require degaussing.

Time Domain Stability (also called short-term stability): The standard deviation of fractional frequency fluctuations in the specified output signal due to random noise in the cesium standard. The mathematical method by which it is calculated is called the Root Allan Variance. Symbolically, it is represented by the term σy (2, τ) where σy is the standard deviation, 2 means that measurements are taken in pairs, and τ is the measurement time.

In the 5071A specifications, values for all averaging times are shown in one chart for convenience. However, short-term stability specifications for averaging times in excess of 1000 seconds are valid only under laboratory conditions (temperature $25^{\circ}C \pm 5^{\circ}C$, relative humidity $45\% \pm 10\%$). For more information on time domain stability, see NIST

Technical Note 1337, Characterization of Clocks and Oscillators available from the Superintendent of documents, U.S. Government Printing Office, Washington D.C. 20402-9325.



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Chapter 8. Installation

This section provides information to inspect, install, commission, and maintain the 5071A Primary Frequency Standard. Installation information is also provided for external DC operation and rack mounting.

8.1 INITIAL INSPECTION

Inspect the shipping container and cushioning material for signs of damage.

- If damage is evident, keep the packing materials until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically
- If the contents are incomplete, if there is mechanical damage or defect, or if the instrument or some component fails operational verification or full performance test, notify the nearest Microchip office.
- If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Microchip office.

Keep the shipping materials for the carrier's inspection. The Microchip office will arrange for repair or replacement at Microchip's option without waiting for a claim settlement.

WARNING

To avoid hazardous electric shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, connectors, LEDs, and so on).

8.2 PREPARATION FOR USE

The following section describes how to prepare to use the instrument.

8.2.1 **Power Requirements**

The 5071A can operate from AC power sources of 100VAC, 120VAC, 220VAC, or 240VAC, 45 Hz to 66 Hz for all voltages, 400 (10%) Hz for 100VAC and 120VAC. Maximum AC power consumption is 100W, 140VA.

Operating power may also be supplied as external DC voltages between 22VDC and 42VDC. Maximum DC power consumption is 85W. Refer to the data sheet for more details, and the section in this chapter that explains auxiliary DC power operation.

Note: For 48VDC option, the external DC voltages between 40VDC and 58VDC is required. Maximum DC power consumption is 100W.

WARNING

This is a Safety Class I product provided with a protective earth terminal. An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals, power cord, or supplied power-cord set. Whenever it is likely that the protection has been impaired, the instrument must be made inoperable and be secured against any unintended operation. If this instrument is to be energized through an external autotransformer for voltage reduction, make sure that the common terminal is connected to the earthed pole of the power source. Failure to ground the instrument can result in personal injury. Refer to the paragraph titled "AC Power Cabling".

8.2.2 Selecting Line Voltage and Fuse (For Units Delivered Prior to 23 August 2016)

Note: For units delivered after 23 August 2016, consult addendum 098-00745-000 for proper installation.

CAUTION

Before plugging this instrument into the Mains (line) voltage, be sure the correct line voltage and fuse have been selected. You must set the voltage selector turret wheel correctly to adapt the 5071A to the power source as described in the following paragraphs.

The 5071A is equipped with an AC power module (on the rear panel) that contains a turret wheel selector to select 100VAC, 120VAC, 220VAC, or 240VAC operation as shown in Figure 8-1. Before applying AC power to the 5071A, the turret wheel selector must be set to the correct position and the correct fuse must be installed as described in the following paragraphs.

Appropriate power-line connections are selected by the position of the plug-in turret wheel in the module. The correct-value fuse, with a 250-volt rating must be installed before the turret wheel is inserted. This instrument uses a 1.5A slow-blow fuse (part number 2110-0304) for 100/120-volt operation and a 0.75A slow-blow fuse (part number 2110-0360) for 200/240-volt operation.



FIGURE 8-1: Line Voltage and Fuse Selection with Power Module Turret Wheel.

To change the line voltage, first disconnect the AC power cord from the module. The following instructions describe how to select the operating voltage.

- 1. Using a small, flat-head screwdriver, snap open the power module door to access the fuse and turret wheel.
- 2. Remove the turret wheel before turning to desired voltage. DO NOT turn turret wheel while installed in module. Push wheel firmly into module slot.
- 3. To change or install fuse, pull fuse holder and re-insert fuse in holder, using caution to select correct fuse value. Re-insert fuse and holder.
- 4. Close the power module door. The selected operating voltage is shown in module window.

8.2.3 AC Power Cabling

This instrument is equipped with a three-wire power cable. When connected to an appropriate AC power receptacle, this cable grounds the instrument cabinet. The type of power cable shipped with each instrument depends on the country of destination. The following table lists the part number of the power cables and the available mains plugs.

Plug Type	Cable Part Number	Check Digit	Plug Description	Cable Length	Cable Color	For Use in Country
250V	8120-1351	0 6	Straight (Note 1) BS1363A 90°	90 in. 90 in.	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Zimbabwe, Singapore
250V	8120-1369 8120-0696	0 4	Straight NZSS198/ASC112 90°	70 in. 87 in.	Gray Gray	Australia, New Zealand
250V	8120-1689 8120-1692	7 2	Straight (Note 1) CEE7-Y11 90°	79 in. 79 in.	Mint Gray Mint Gray	East and West Europe, Egypt, (Unpolarized in many nations)
125V	8120-1348 8120-1389 8120-1754 45-00222 8120-1521 8120-1676 8120-4753	5 5 7 1 6 1 3	Straight (Note 1) NEMA5-15P 90° Straight (Note 1) NEMA5-15P Straight (Note 1) NEMA5-15P 90° Straight (Note 1) NEMA5-15P Straight (Note 1) NEMA5-15P	80 in. 80 in. 36 in. 80 in. 80 in. 30 in. 90 in.	Black Black Black Black Jade Gray Jade Gray Dark Gray	United States, Canada, 100V or 200V, Mexico, Philippines, Taiwan, Saudi Arabia, Japan
250V	8120-2104	3	Straight (<mark>Note 1</mark>) SEV10111959-24507	79 in.	Gray	Switzerland
250V	8120-0698	6	Straight (Note 1) NEMA6-15P	_	_	United States, Canada
220V	8120-2956 8120-2957	2 3	Straight (Note 1) DHCK 107 90°	79 in. 79 in.	Gray Gray	Denmark
220V	8120-4211 8120-4600	7 8	Straight 90°	_	Gray Gray	South Africa, India

TABLE 8-1: AC POWER CABLES AVAILABLE

Note 1: Part number shown for plug is industry identifier for plug only. Number shown for cable is Part Number for complete cable including plug. E = Earth Ground, L = Line, N = Neutral

8.2.4 Operating Environment

The 5071A may be operated in temperatures from 0°C to 55°C. Refer to the environmental specifications in the data sheet for more detailed information.

8.2.4.1 BENCH OPERATION

The instrument has plastic feet for convenience in bench operation. The plastic feet are keyed to facilitate self-alignment when stacking instruments.

	WARNING
The 5071 avoid pe	IA weighs 30 kg (66 lbs). Care must be taken when lifting the instrument to rsonnel injury. Always use sliding rails or rack tray when rack mounting.
8.2.4.2	INSTALLING OPTIONS 908 AND 913

Options 908 and 913 facilitate rack-mount installation for the 5071A. The options differ as follows:

- The option 5071-908 rack-mount kit provides the hardware necessary to mount the 5071A in a standard rack with flanges and no handles.
- The option 5071-913 rack-mount kit provides the hardware necessary to mount the 5071A in a standard rack with flanges and handles.

WARNING

When installing the 5071A in an instrument rack with either option 908 or 913, you must use either an instrument support tray or slide-mount rails on the inside of the instrument rack. Failure to do so will result in rack-mount flange failure and subsequent instrument damage.

The rack-mounting contents and detailed instructions are provided with each rack-mount kit. Be sure to remove the plastic feet from the instrument before installing in a rack. If a kit was not ordered with the instrument, it can be ordered through the nearest Microchip Customer Service Center by using the following part numbers: part number 5071A-908 for option 908, and part number 5071A-913 for option 913.

A rack slide-mount kit is also available. The rack-slide lessens the need to lift the 5071A and is required to support the instrument's weight when installed in a rack if an internal support tray is not present. The available Rack Slide-Mount Kit part number is 1494-0059.

8.3 RETURNING THE 5071A TO MICROCHIP

The following section describes how to properly package and ship the 5071A.

When packing has been completed:

- · Mark the shipping container as FRAGILE to ensure careful handling, and
- In any correspondence, refer to the contents by both the product model (or part) number and the product's full serial number.

If the original packing materials are not available, obtain a 59991-91105 Packing kit, which consists of the items listed in the following table.

Part Number	Quantity	Description	Callout
9220-4915	2	Tube, Corrugated	1
9211-6672	1	Tray	2
9220-4972	2	Insert	3 and 7
5040-6967	8	Pad, foam corner	4 and 8
5040-6968	1	Plastic Cap	5
9220-4914	1	Insert	6
9211-6671	1	Carton, corrugated cardboard	9
None	As Req'd	Reinforced packing tape	N/A
None	As Req'd	Staples	N/A

TABLE 8-2: CONTENTS OF 59991-91105 PACKING KIT

Perform the following steps to package the 5071A for shipment:

- 1. Pack the instrument as shown in the following illustration. Use the instructions provided with the packing kit. (You do not need to return the manual and power cord.)
- 2. After you've finished packing the instrument in the inner corrugated carton, please contact Microchip for further instruction.
- 3. Ensure that all labels are attached and instructions provided with the packing kit have been completed.



8.4 OPERATOR'S MAINTENANCE

The 5071A requires no operator maintenance or calibration during normal operation.

8.5 OPERATING THE 5071A FROM EXTERNAL DC POWER

In addition to AC power capability, the 5071A can also be operated from an external DC source with a voltage range of ±22VDC to 42VDC, 85W. The DC power source may be applied simultaneously, with the AC power source. DC power requirements are listed in the data sheet. DC power connections are made through the rear panel "Ext DC Input" connector.

WARNING

The 5071A runs from AC power when both AC and DC power are available. The 5071A will not run from DC power unless the AC power source fails or is disconnected.

48V Option: In addition to AC power capability, the 5071A can also be operated from an external DC source with a voltage range of \pm 40VDC to 58VDC, 100W maximum power. The DC power source may be applied simultaneously, with the AC power source. DC power requirements are listed in the data sheet. DC power connections are made through the rear panel "Ext DC Input" connector.

WARNING

The 5071A runs from AC power when both AC and DC power are available. The 5071A will not run from AC power unless the DC power source fails or is disconnected.

8.5.1 **Preparing the 5071A For External DC Operation**

Use the DC power connector (supplied) that mates with the Ext DC Input connector on the rear panel, to connect DC power to the 5071A. Follow the procedure below to set up and verify operation from auxiliary DC power:

- 1. Connect the positive (+) terminal of the 22VDC to 42VDC power to pin A of the 5-pin Series ME, Cannon connector.
- 2. Connect the negative terminal of the external DC power to pin C (either line of the external DC source may be grounded).
- 3. Connect the chassis ground to pin E (the two remaining pins are not used).
- 4. Check the connections for correct polarity and voltage range.
- 5. Connect external DC power to the rear-panel Ext DC Input connector.
- 6. Remove AC power from the rear-panel AC power input connector. Observe the front panel, the ATTENTION light remains extinguished and the front-panel status message will read: "Source: DC". Refer to Table 3-2 for more status details.
- 7. Re-apply AC power, the front-panel status message reads: "Source: AC".

48V Option: The following procedure describes how to set up and verify operation from auxiliary DC power:

- 1. Connect the positive (+) terminal of the 40VDC to 58VDC power to the + screw terminal of INPUT 1 on the rear-panel 5-terminal barrier strip.
- 2. Connect the negative (–) terminal of the 40VDC to 58VDC power to the screw terminal of INPUT 1 on the rear-panel 5-terminal barrier strip.
- 3. Connect the system or power source ground to the 3rd (center) screw terminal

of the rear-panel barrier strip labeled chassis GND.

- 4. Check the connections for correct polarity and voltage range, and tightness before you turn the DC power on.
- If a second 48VDC power source will be used, repeat steps 1 through 4 with INPUT 2 of the rear panel barrier strip. (INPUT 2 will be an alternate power source if INPUT 1 should fail, be disconnected, or sag below the voltage of INPUT 2).
- 6. Connect external AC power to the rear-panel AC input connector.
- Remove DC power from INPUT 1 (and INPUT 2 if connected) on the rear-panel barrier strip. Observe the front panel, the status message should read: "Source: AC".
- 8. Re-apply DC power, the front-panel status message reads: "Source: DC".

8.5.2 Replacing the External DC Input Power Fuse

- 1. Remove all power from the 5071A.
- Press down on the top edge of the DC FUSE cap located under the Ext DC Input connector, then grasp the top and bottom of the fuse holder and gently pull it out (back and slightly down). The first fuse to appear is a spare; the one behind it is the active DC fuse element.
- 3. Insert the replacement fuse (5A, 125-volt rating, part number 2110-0838).
- 4. Gently push the fuse holder back into the rear panel.

48V OPTION:

- 1. Remove all power from the 5071A.
- Press down on the top edge of the DC FUSE cap located under the 48VDC Input label, then grasp the top and bottom of the fuse holder and gently pull it out (back and slightly down). The first fuse to appear is a spare; the one behind it is the active DC fuse element.
- 3. Insert the replacement fuse (2.5AT, 250-volt rating, part number 2110-0952).
- 4. Gently push the fuse holder back into the rear panel.

8.6 INTERNAL STANDBY BATTERY MAINTENANCE

Note: This section does not apply for 48V option instruments.

The 5071A uses two, sealed, 12-volt lead-acid battery packs as an internal back-up power source. These battery packs are designed specifically for use with the 5071A. The battery's operating time and life can be optimized by understanding and following some guidelines for sealed lead-acid rechargeable batteries.

8.6.1 Battery Shelf Life and Storage

When not in use, the internal standby batteries have a nonlinear self-discharge rate. Additional discharge (always less than 500 microamperes), results from monitor circuits connected across the battery, even when all power to the instrument is removed and the battery disconnect switch has been activated.

Under these conditions (25°C), the useful storage life is roughly three months, does not cause full discharge, and still provides at least 45 minutes of battery operation. The storage time required to deplete all capacity is at least one year. Continued storage beyond one year could jeopardize future battery operation or reduce the remaining number of discharge cycles. For storage times beyond one year, always physically disconnect the batteries from the instrument.

When disconnected, (shelf life at 25° C) the batteries may be stored for up to two years without recharging. The permissible storage temperature range is -65° C to $+65^{\circ}$ C, with storage life decreasing rapidly as ambient temperature increases.

8.6.2 Battery Operating Temperatures

The battery pack(s) is designed for use between -40° C and $+65^{\circ}$ C. At 25° C, the 5071A is specified to operate for at least 45 minutes. At 0° C, the 5071A will typically operate for approximately 50 minutes. At 55° C, the instrument operates between 60 and 75 minutes.

For the operating temperature of 25°C, the battery provides 200 cycles of operation with 100% discharge depth for each cycle (when the 5071A automatically shuts down). The battery will provide 2000 cycles of operation at 25°C with 25% discharge depth for each cycle.

The expected battery service life (trickle charged by the internal charger with few discharge cycles) at 23°C is approximately 4 to 6 years.

8.6.3 Battery Charging

Lead-acid batteries are designed for occasional usage and long periods of continual trickle charging currents. Unlike Nickel-cadmium batteries, they are not designed for continual deep discharge/charge usage. This makes lead-acid the ideal choice for typical constant operating installations of the 5071A. They will last much longer in a full-charge state and provide more reliable capacity when they are needed.

Because of the long-term storage design of lead-acid batteries, we do not recommend that the 5071A internal batteries be used in situations where power is removed on a daily basis. If this is your situation, the internal batteries will be constantly subjected to discharge and possibly not receive the necessary full 16 hours of re-charge during each typical workday. Such repeated partial charge and discharge cycles can permanently damage the lead-acid battery storage capacity. If you need to operate the 5071A under these conditions, it is recommended that one of the two following processes be used to ensure that the batteries not be stressed by over-use and under-charging.

- Either press the BATTERY DISCONNECT switch on the rear panel each time the power is turned off, or
- Disconnect the battery wires (inside the rear door) to completely remove them from use.

Refer to Disabling the Internal-Standby Battery for instructions on how to disconnect the batteries.

The rechargeable lead-acid batteries in the 5071A are charged only when the instrument is connected to the AC mains. The typical charging time between a fully discharged state and fully charged state is approximately 16 hours. Shorter charging periods will reduce the operating time you can expect from a single battery charge.

Charging occurs automatically when AC power is connected to the 5071A. The battery is either boost- or trickle-charged depending upon the terminal voltage read by the charging circuit. The charger automatically switches from one state to another as it monitors the battery terminal voltage.

Charging the battery pack(s) outside the instrument with an external charger is not recommended. The 5071A's charging circuit is designed specifically for lead-acid batteries and incorporates temperature compensated threshold levels to determine the point at which charging rates switch from boost to trickle. These threshold levels are critical to the long-term performance and reliability of the internal battery packs.

WARNING

Do not attempt to disassemble, incinerate, or mutilate the battery packs(s). The packs may burst or release toxic materials. Do not connect together or otherwise short-circuit the battery terminals; the packs may melt or cause serious burns.

CAUTION

The 5071A should NOT be operated in a gas-tight enclosure, to minimize the possibility of any hazardous accumulation of hydrogen gas associated with battery overcharging or failure. The possibility of such gaseous accumulation during normal operating circumstances is very remote but requires care as a preventive measure.

8.6.4 Battery Disposal

The spent lead-acid battery pack(s) is considered hazardous waste in some countries. Dispose only in accordance with local environmental regulations. Contact the nearest regional office of environmental health service for guidance.

The battery is recyclable as shown by the recyclable symbols that appear on the battery case. Contact the nearest regional office-of-environmental-health-service for guidance.

8.6.5 Using the Battery Disconnect Switch

Refer to Disabling the Internal-Standby Battery for information about using the rear panel Battery Back-up Disconnect switch.

8.6.6 Removing and Replacing the Internal Battery

The batteries are supplied in a nearly-full charged state at instrument shipment. Use ONLY the direct replacement batteries (part number 1420-0514, 2 required) for replacement.

CAUTION

Use of any batteries other than the Battery Pack (part number 1420-0514) may result in damage to the instrument or impaired instrument performance.

Use the following procedure to remove and replace the internal battery pack(s):

- 1. Open the Battery Access Panel on the rear panel of the instrument.
- 2. Carefully disconnect the two battery cables from their mating instrument connections.
- 3. Remove the battery pack(s) by sliding them out of the battery compartment.
- 4. Install the new battery pack(s) by sliding them into the battery compartment.
- 5. Re-connect the battery pack(s) cables to their mating instrument connections.
- 6. Apply AC power to the instrument: the batteries will begin charging.

8.7 CESIUM BEAM TUBE REPLACEMENT

Refer to the 5071A Assembly-Level Service Manual for information about removal, replacement, and disposal of the Long-Life or High-Performance Cesium Beam tube.

8.8 LONG-TERM STORAGE

WARNING

Prolonged periods of non-operation of the 5071A can result in decreased cesium beam tube life or permanent tube damage. Never store the 5071A longer than six months without periodic (or continuous) operation.

You can safely store the 5071A for extended periods of time by leaving the instrument connected to AC power and placing it into the Standby Mode of operation. Refer to Configuring the 5071A for details.

If you need to store the 5071A for extended periods without power, the minimum amount of standby operation time required to maintain the tube's vacuum is 24 continuous hours for each six months of storage time. Remember to physically disconnect the instrument's internal standby battery before placing the instrument into prolonged unpowered storage (see Disabling the Internal-Standby Battery for more information). Internal-standby batteries do not apply for 48V option.



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Appendix A. Performance Tests

Only the power on self tests and the RS-232 remain in the document as the information previously included was significantly out of date or required specialized equipment that was not readily available for many customers. The 5071A does not require maintenance or calibration during its operating life.

A.1 POWER-ON SELF-TESTS AND SERVO LOCK

- 1. Inspect the 5071A for any damage (see Initial Inspection for detailed inspection information).
- 2. Ensure that the AC power setting, AC line fuse (rear panel), and supplied power cord are appropriate for the AC power source (refer to Installation for detailed information).
- Now, apply power to the instrument by connecting AC power source to the instrument through 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:

The message "Waiting for Stabilization" may appear. If so, it could stay on for up to 20 minutes before the following messages appear.

- a) Warming up (this indicates self-test passed successfully)
- b) Lowering E_mult voltage
- c) Setting Osc. Control
- d) Setting RF amplitude
- e) Setting E_mult voltage
- f) Logging signal levels
- g) Setting C-field
- h) Locking servo loops
- i) 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.

The 5071A will power 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 complete

These first-time power-up configurations can be changed by using the front-panel controls. See Setting the Output Port Frequency for instructions on how to perform this.

A.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.
- 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.
 - **Note:** 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. See Remote Operation Setup for serial-port pin assignments.
- · Check and verify all cables and connections for open or shorted lines.



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Appendix B. Product Variations

There are many product variations of the 5071 that have been supplied to customers. The table includes models that may be restricted to specific customers or are no longer generally available. This table was created for reference on November 12, 2021 and may not be current. For the most current information on available configurations please review the data sheet or contact Microchip directly.

Model Number	Performance	DC Voltage	Battery	Mute Function	Display and Keyboard (Note 1)	Door	Available to Order
5071A-C001	High	24	Yes	No	Yes	Yes	Yes
5071A-C002	Standard	24	Yes	No	Yes	Yes	Yes
5071A-C003	Standard	24	No	No	No	No	Contact Factory
5071A-C004	Standard	24	No	Yes	No	No	Discontinued
5071A-C005	High	24	Yes	No	Yes	Yes	Discontinued
5071A-C006	Standard	48	No	No	No	No	Discontinued
5071A-C007	High	48	No	No	Yes	Yes	Yes
5071A-C008	Standard	48	No	No	Yes	Yes	Yes
5071A-C009	High	24	No	No	Yes	Yes	Discontinued
5071A-C012	High	24	No	Yes	No	No	Discontinued
5071A-C014	Standard	24	Yes	No	Yes	No	Contact Factory
5071A-C015	High	24	Yes	No	No	No	Contact Factory
5071A-C016	Standard	48	No	No	Yes	Yes	Customer Restricted
5071A-C017 (Note 2)	High	24	Yes	No	Yes	Yes	Contact Factory
5071A-C018 (Note 2)	Standard	24	Yes	No	Yes	Yes	Contact Factory
5071A-C019	High	24	Yes	Yes	Yes	Yes	Customer Restricted

TABLE B-1:5071A VARIATIONS

Note 1: Blank Front Panel. This option deletes the LED time display, the user keypad interface, the 40-character LCD display, and the front panel door. The Continuous Operation and Attention indicators are still present, and one each BNC connector for 1 PPS output and Sync input are still present. All communication and control of the 5071A is done through the rear-panel RS-232 (serial) port. 046: This option removes the internal 45-minute standby batteries. The 5071A will only operate on AC mains or external nominal +24VDC power. This option is not compatible with 48V option.

2: EU RoHS exempt models with restricted use. Please contact Microchip for further information.

NOTES:



5071A PRIMARY FREQUENCY STANDARD USER'S GUIDE

Appendix C. Glossary

Accuracy The degree to which the 5071A output frequency differs from that of the accepted definition. The currently accepted definition is that of the 13th General Conference of Weights and Measures and is based on Cesium (The hyperfine resonance of the Cesium 133 atom in zero magnetic field is 9.192631770 GHz.). In practice, this involves comparison with some generally accepted physical embodiment of this definition such as one of the time standards in the international time scale (TIA) monitored by the Bureau International L'Heure (BIH) in Paris, France. The specified accuracy of the 5071A is intrinsic and is maintained without calibration.

Epoch (Time) A selected instant in time, used as a reference point.

Flicker Floor The level at which the Allan variance time domain stability measurement remains constant with increased averaging time. The Allan Variance statistical method for measuring time domain stability responds in several ways to various noise processes in a cesium standard. Many of these noise processes produce contributions which average out or decrease as the averaging time increases. Flicker noise, on the other hand, gives rise to an Allan variance independent of averaging time. Thus, the Allan variance of a typical frequency standard will decrease with increasing time, until a relatively constant value is reached. This value is known as the flicker floor.

Frequency Domain Stability (also called single-sideband phase noise or additive noise). Describes the spectral noise in the specified output signal caused by phase modulation from internal noise sources. The measurement is normalized by expressing the ratio of noise power (in a 1 Hz bandwidth) to the signal power, then measured as a function of offset from that signal.

For more information see NIST Technical Note 1337, Characterization of Clocks and Oscillators available from the Superintendent of documents, U.S. Government Printing Office, Washington DC 20402-9325.

Isolation The degree to which one output of the 5071A is affected by changes in loading on another output of the same standard. In practice, this represents a change in amplitude, frequency, or phase as seen at one terminal due to the effect of placing a short, open, or reactance on another terminal. In the 5071A, both the Port 1 and Port 2 high isolation output frequencies are derived from the same source; there is no measurable change in frequency. The change in amplitude or phase is measured as the level of the sideband at one port, which results from applying and removing the load at a low frequency rate at the other port. The measurement is the level of the resulting sideband compared to the nominal output level, expressed in decibels.

Reproducibility The degree to which the 5071A will reproduce the same frequency from one occasion to another after an interruption in operation. This does not include any calibration procedure but may require degaussing.

Short-Term Stability See Time Domain Stability.

Standards

- **House:** The most stable and accurate frequency source available as a reference within the user's facility. Usually kept referenced to national frequency standards.
- **Reference/Transfer:** The reference standard used to transfer frequency or time from the house standard to working standards.
- Working: The standard against which instruments are compared for test or repair purposes.

Settability The degree to which the frequency of the 5071A may be adjusted to correspond with a reference without loss of stability.

Time Domain Stability (also called short-term stability); The standard deviation of fractional frequency fluctuations in the specified output signal due to random noise in the cesium standard. The mathematical method by which it is calculated is called the Root Allan Variance. Symbolically, it is represented by the term Ty $(2, \sigma)$ where Ty is the standard deviation, 2 means that measurements are taken in pairs, and T is the measurement time.

In the 5071A specifications, values for all averaging times are shown in one chart for convenience. However, short-term stability specifications for averaging times in excess of 1000 seconds are valid only under laboratory conditions (temperature $25^{\circ}C \pm 5^{\circ}C$, relative humidity $45\% \pm 10\%$). For more information on time domain stability, see NIST Technical Note 1337, Characterization of Clocks and Oscillators available from the Superintendent of documents, U.S. Government Printing Office, Washington D.C. 20402-9325.

Time Interval Time between events.

UTC Coordinated Universal Time An internationally agreed upon time scale having the same rate as Atomic Time. UTC is corrected in one-second step adjustments, as needed, to remain within 0.7 seconds of Astronomical Time.

UT1 A non-uniform time scale based on the earth's rotation and corrected for the effects of polar motion.



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China - Hong Kong SAR Tel: 852-2943-5100

China - Nanjing Tel: 86-25-8473-2460

China - Qingdao Tel: 86-532-8502-7355

China - Shanghai Tel: 86-21-3326-8000

China - Shenyang Tel: 86-24-2334-2829

China - Shenzhen Tel: 86-755-8864-2200

China - Suzhou Tel: 86-186-6233-1526

China - Wuhan Tel: 86-27-5980-5300

China - Xian Tel: 86-29-8833-7252

China - Xiamen Tel: 86-592-2388138 China - Zhuhai

Tel: 86-756-3210040

ASIA/PACIFIC

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India - New Delhi Tel: 91-11-4160-8631 India - Pune

Tel: 91-20-4121-0141 Japan - Osaka

Tel: 81-6-6152-7160

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Tel: 82-53-744-4301 Korea - Seoul

Tel: 82-2-554-7200

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Singapore Tel: 65-6334-8870

Taiwan - Hsin Chu

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Taiwan - Taipei Tel: 886-2-2508-8600

Thailand - Bangkok Tel: 66-2-694-1351

Vietnam - Ho Chi Minh Tel: 84-28-5448-2100 Denmark - Copenhagen Tel: 45-4485-5910

EUROPE

Austria - Wels

Tel: 43-7242-2244-39

Fax: 43-7242-2244-393

Fax: 45-4485-2829 Finland - Espoo Tel: 358-9-4520-820

France - Paris Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany - Garching Tel: 49-8931-9700

Germany - Haan Tel: 49-2129-3766400

Germany - Heilbronn Tel: 49-7131-72400

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