Physical Property Measurement System

GPIB Commands Manual

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San Diego, CA

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Chapter One: Introduction

1.1 Introduction

This manual describes GPIB commands that are supported by the PPMS. The following sections are presented in this manual:

- PPMS System Commands (Immediate and Sequence)
- Sequence Commands
- Communications Commands
- Error and Status Reporting Commands
  Miscellaneous Commands and Queries
- Restricted Commands

There are also Appendix A and Appendix B describing further the restricted commands and status register error messages, respectively.

1.2 PPMS-Supported GPIB Commands

The following is a listing of GPIB command types that are supported by the PPMS Command items fall into the following categories:

Immediate Mode Only These commands are executed immediately on receipt by the Model 6000 and may not be used as part of a sequence.

Sequence File Only These commands, which may be used only in a sequence file, correspond to specific operations which may be performed when the Model 6000 is running a sequence.

- **All** These commands may be used in either Immediate Mode or in a sequence file.

Chapter Two: PPMS System Commands (Immediate and Sequence)

ADVNUM?

Advisory Code Number Query - (Immediate Mode Only) Returns the advisory number of any advisory presently in effect. (An advisory is in effect from the time an advisory is issued until the sequence resumes execution, either after 5 seconds or after all HOLDOFF commands have been cancelled.) If no advisory is currently in effect, this query will return a zero. (Also see the HOLDOFF command within this chapter (page 2-9) for additional information on using the ADVISE (page 3-1) and HOLDOFF commands.)

APPEND SequenceFileLineText

Append to Sequence File Command - (Immediate Mode Only) Appends the text as a new command to the end of the sequence file. The SequenceFileLineText must be a legal sequence file command.

BEEP [Duration] [Frequency]

Beep Command - (Immediate and Sequence Mode) Causes the speaker to make a standard beep if no parameters are given. The Duration, in seconds (0.1 to 5), and the Frequency in Hz (500 to 5000) may be optionally specified.

BRIDGE Ch# Excitation PowerLimit [dcFlag] [Mode]

Bridge Setup Command - (Immediate and Sequence Mode) Configures the user's bridge channel (Resistance Bridge Board Option) (Ch#) to perform a 4-wire resistance measurement. The assignment of numbers is as follows:

Ch#	
1-4	User Bridge Channels 1-4
5-8	User Calibration

Only channels 1-4 are available when performing measurements of external devices. Channels 5-8 are used for internal calibrations only. The Excitation (excitation current) in microamps (0 or .01 to 5000.0) and the PowerLimit (the maximum power to be applied to the external device) in microwatts (0 or 0.001 to 1000.0) must also be specified. If zero is specified for either Excitation or PowerLimit the channel is turned off.

The optional dcFlag is an integer parameter which selects either AC or DC excitation for the resistance measurement. The **AC excitation** is a square wave excitation of approximately 7.5Hz synchronized to the ac line frequency (50 or 60 Hz) to reject ac line noise. The dcFlag selects AC or DC excitation as follows:

0 - AC excitation (default)
- DC excitation

The Mode parameter determines how frequently the analog-to-digital convertor (A/DC) will read internal precision resistors to recalibrate its readings. The Mode parameter may have a value from 0 - 2 as follows:

0 - Standard Mode
1 - Fast Mode
2 - High res (High Resolution) Mode

In the **Standard** mode compensation for hardware linearity errors, drift and offset error are taken into account. This mode utilizes the bridge's calibration resistors whenever possible. In **Fast** mode bridge channel readings are performed as quickly as possible and the internal calibration resistors are not consulted. In **Hi-Res** mode bridge channel readings are performed by consulting the internal calibration resistors multiple times and averaged.

BRIDGE? Ch#

Bridge Setup Query - (Immediate Mode Only) Returns the configuration last specified for the designated bridge channel (Ch#).

CHAMBER ChamberCode

Sample Chamber Command - (Immediate and Sequence Mode) Sets valves to evacuate or vent sample chamber as specified by the integer ChamberCode. ChamberCode values are as follows:

0 - Seal Immediately
- Purge and Seal
2 - Vent and Seal
3 - Pump Continuously
4 - Vent Continuously

The **Seal Immediately** operation (mode = 0) immediately isolates the sample chamber from both the vacuum pump and the helium dewar by closing the flush and vent valves. **Purge and Seal** (mode = 1) comprises three Pump/Vent cycles with a final Pump cycle before sealing. During the pump operation the flush valve is opened, and the vent valve is opened during the vent operation. **Vent and Seal** (mode = 3) performs a single vent cycle before sealing. **Pump Continuously** (mode = 4) connects the sample chamber to the vacuum pump until otherwise specified, and **Vent Continuously** (mode = 5) connects the sample chamber to the helium dewar until otherwise specified.

CHAMBER?

Sample Chamber Query - (Immediate Mode Only) Returns the value of the ChamberCode parameter last sent to the sample chamber.

COMMENT TextString

Annotate DataFile Command - (Immediate and Sequence Mode) Places the specified TextString into the data file as a comment. The string, TextString, does not have to be a valid sequence file command. Enclose your text with quotation marks.

DATA? [LineCode]

Read Data Query? - (Immediate Mode Only) Returns a line from the PPMS data file. Numerical data is returned in comma-separated ASCII format using the appropriate decimal representation. String data is enclosed in double quotation marks. The DATA query will be processed by the Model 6000 whether or not a sequence is being executed, but it cannot be placed into a sequence file. The line to be returned from the data file is determined by the value of LineCode as follows:

LineCode	Line Returned
0	Next line (default)
	first line in the file
2	last completed line in the data file

Reading past the end of the valid data in the file returns blank lines. To obtain a complete image of the data file, read the first line with a "DATA? 1;" command, then read all subsequent lines with a "DATA? 0;" command until a blank line is returned. Additional "DATA? 0;" commands will continue to return a blank line until the next line in the data is filled, at which time a "DATA? 0;" command will return the new data. Using this feature, data can be read from the Model 6000 as it is accumulated by continuously sending "DATA? 0;" queries, discarding the blank lines, and storing the valid data as it is returned.

DATE Month Date Year

Date Command - (Immediate Mode Only) Sets the internal clock as specified. The Month, Date, and Year are specified as integer values. For the Year field, it is only necessary to enter two digits, a single digit (X) will be interpreted as 0X and more than two digits will be an invalid entry.

DATE?

Date Query - (Immediate Mode Only) Returns the present date and time from the internal clock as three integers: Month, Day, Year.

DATSIZE?

Data Size Query - (Immediate Mode Only) Returns two integers that indicate the size of the data file in the Model 6000. The first integer returned is the number of records presently stored in the data file. The second integer indicates what percent of the data file is filled.

DIGIN?

External Digital Input Lines - (Immediate Mode Only) Returns an integer value of 0-255 in which each bit of the binary representation of the number specifies the state of one of the external digital input lines. The six least significant bits indicate the state of the two limit switch lines on the P10-MOTOR, the two sense lines on the P8-AUXILIARY port, and the Busy and User lines on the P11-EXTERNAL port according to **Table 2-1**. A bit value of one indicates the line is asserted.

Table 2-1 Bit Numbers and Pinouts of the External Digital Input Lines

Bit #	Description	Pinouts
1	Motor Port - Limit 1	P10-4,5
2	Motor Port - Limit 2	P10-9,5
3	Auxiliary Port - Sense 1	P8-18,19
4	Auxiliary Port - Sense 2	P8-6,19
5	External Port - Busy(Hold)	P11-9
6	External Port - User	P11-5
7,8	(not assigned)	--

DIGSET LineFlags [MaskFlags]

Digital Line Set Command - (Immediate and Sequence Mode) Sets the digital output lines to control external 24 volt dc relays, valves and other devices. The digital output lines are set according to the bit values in the binary representation of the integer LineFlags parameter, which can have values of 0-15 as indicated in **Table 2-2**. A bit value of 1 will set the corresponding output line voltage to -24 volts, and a bit value of zero will set the output line voltage to zero. The optional MaskFlags parameter allows the user to specify which external lines will not be affected by the DIGSET command. For example, if LineFlags is set to a value of 16, indicating that all the output lines are to be set to -24 volts, and MaskFlags is set to a value of 1, only output lines 2, 3, and 4 would be set to -24 volts. The state of output line 1, which is "masked" by the MaskFlags parameter, will remain unchanged.

Table 2-2 Bit Numbers, Ports, and Pinouts of the Digital Output Lines

Bit #	Output Line	Connector Port	Pinouts
0	Drive Line #1	Auxiliary Port	P8-1,14
1	Drive Line #2	Auxiliary Port	P8-2,15
2	Drive Line #3	Auxiliary Port	
3	Actuator Drive	Motor Port	

DIGSET?

Digital Line Set Query - (Immediate Mode Only) Returns an integer value of 0-16 indicating the state of the digital output lines. Each bit in the binary representation of the returned value indicates the status of one of the digital output lines according to Table A-2. A bit value of one indicates the output line is asserted (at -24 volts), and a bit value of zero indicates that the line is not asserted (at zero volts or ground).

DRVOUT Ch# Current PowerLimit

Driver Output Command - (Immediate and Sequence Mode) Directly sets a driver output Current (0.0 to 1000.0 mA) and PowerLimit (0.0 to 20.0 watts) on the specified channel (Ch#). Only driver channels 1 and 2 can be controlled with this command. (Driver channels 3 and 4, which are used by the PPMS temperature control system, cannot be accessed via this command.)

DRVOUT? Ch#

Driver Output Query - (Immediate Mode Only) Returns the driver output current and power limit last set by a DRVOUT command to the specified driver channel (Ch#).

ERASE FileTypeCode

Erase File - (Immediate Mode Only) Erases the file type specified by the FileTypeCode as follows:

Code	File Type to Erase
0	Data File
1	Sequence File

EXTSET LineFlags [MaskFlags]

External Select Output Lines Command - (Immediate and Sequence Mode) Sets the external select lines to according to the bit values in the binary representation of the integer LineFlags parameter as indicated in the **Table 2-3**. The optional MaskFlags parameter allows the user to specify which external select lines will not be affected by the DIGSET command. (For example, if LineFlags is set to a value of 7, indicating that all three select lines are to be asserted, and MaskFlags is set to a value of 1, only select lines 2 and 3 would be asserted. The state of select line 1, which is "masked" by the MaskFlags parameter, will remain unchanged.)

Table 2-3 Bit Numbers, Port, and Pinouts of the External Select Output Lines

Bit #	Flag	Connector Port	Pinouts
0	Select 1 (C, E)	External Port	P11-1,6
1	Select 2 (C, E)	External Port	P11-2,7
2	Select 3 (C, E)	External Port	P11-3,8
3	not assigned	n/a	--

The pins for each external select output line are connected to the collector and emitter of a transistor switch as indicated in **Table 2-3**. A bit value of one will close the switch for the corresponding external select line, and a bit value of zero will open the switch.

EXTSET?

External Digital Line Set Query - (Immediate Mode Only) Returns an integer value of 0-16 indicating the state of the external select lines. Each bit in the binary representation of the returned value indicates the switch closure status of one of the external select lines according to the table shown under the EXTSET command. A bit value of one indicates the external select line is asserted (switch closed), and a bit value of zero indicates that the line is not asserted (switch open).

FIELD Field Rate [ApproachMode] [MagnetMode]

Magnetic Field Command - (Immediate and Sequence Mode) This command sets the specified magnetic Field using the specified Rate and ApproachMode. The MagnetMode parameter specifies how the charging operation is to be terminated. (See section 3.3 of the PPMS Hardware Manual for more extensive discussions of magnet operation.)

The value of Field in oersteds specifies the next magnetic field that is to be set, and the range depends on the particular magnet installed in your system. The Rate parameter in oersteds/second specifies the charging rate at which the magnetic field is to be ramped from its starting value to the value specified by Field. (See section 2.15.1 of the PPMS Firmware Manual for information on the **Magnet Configuration** menu to determine the allowable ranges of the Field and Rate parameters for your system.)

The ApproachMode parameter specifies the process by which the magnet charges to the new field. Using the **Linear** approach, the magnetic field ramps linearly to the new field, the **No Overshoot** approach ensures that the magnetic field does not overshoot past the target field, while the **Oscillate** approach oscillates the magnetic field about the final value through a series of decreasing amplitude oscillations. The approach mode is selected by specifying a value of the integer ApproachMode, as follows:

0 - Linear Approach (default)
1 - No Overshoot Approach
2 - Oscillate Approach

The MagnetMode parameter specifies the mode in which the magnet is to be left at the end of the charging process as **Persistent** or **Driven**. In the **Persistent** mode, the magnetic field is set to the new value and the magnet's persistent switch is placed in the persistent (superconducting) state with the persistent switch heater and magnet power supply turned off. When the **Driven** mode is selected the magnet power supply continues to supply current to the magnet. The magnet mode is selected by specifying the integer MagnetMode parameter as follows:

0 - Persistent Mode (default)
1 - Driven Mode

FIELD?

Magnetic Field Query - (Immediate Mode Only) Returns the Field, Rate, ApproachMode, and MagnetMode as specified by the last FIELD command. (See the FIELD command for explanations of the numerical values returned.)

GETDAT? DataFlags [NoUpdateFlag]

Get Data Query - (Immediate Mode Only) Returns the data items specified in the DataFlags parameter. Each bit in the binary representation of the 32-bit integer, DataFlags, specifies one item The data item is returned for each bit that is set to a value of one. See Appendix A for a complete discussion of use of the GETDAT query and the data items that may be specified by the DataFlags parameter.

Some data items in the Model 6000 are updated very infrequently and updating all readings may require several seconds. The optional NoUpdateFlag parameter specifies whether the most current readings are to be returned immediately, or if all values are to be updated before the data are returned.

0 - Update all readings before returning data (default)
1 - Return the most current values for all data immediately

HOLDOFF Code

Holdoff Command - (Immediate Mode Only) Causes the system to temporarily halt execution of a sequence file. When the system encounters an ADVISE command in a sequence, an advisory is generated via the IEEE-488 interface, and execution of the sequence is suspended for 5 seconds. If a HOLDOFF command is received during the 5 second suspension with the value of Code set to 1, the execution of the sequence file is halted completely until a second HOLDOFF command is received with the value of Code set to 0. Multiple HOLDOFF commands received by the system will be honored and each HOLDOFF command with Code=1 must be specifically cancelled by a subsequent HOLDOFF command with Code=0. In addition, a HOLDOFF command with Code=-1 may be used to cancel ALL previous HOLDOFF commands. This is summarized as follows:

1 - Suspend sequence execution
0 - Cancel ONE previous HOLDOFF command
-1 - Cancel ALL previous HOLDOFF commands and resume sequence execution

LEVEL?

Read Level Command - (Immediate Mode Only) Returns a floating-point number that indicates the liquid level in the dewar, and an integer value that indicates how recently the liquid level reading has been updated. The liquid level is reported as percentage full, where 100% indicates that the dewar is full and 0% indicates that the cryostat must be refilled before the system can be operated. (If the level sensor has not been calibrated, the value returned will be zero.) In many PPMS dewar configurations, a negative value for the liquid level may be reported indicating that there may still be liquid in the cryostat, but its level is so low that it is not safe to operate the magnet.

To minimize dewar consumption in the system, the cryogen level reading is only updated once per hour. The second parameter returned by this query is a code that indicates how recently the level reading has been updated. Values of the code are 0-2 and are interpreted as follows:

Code	Interpretation
0	The level reading is over one hour old or an update is in progress but the information is not available yet.
1	The level reading is under one hour old.
2	The level meter is continuously on and the present reading was taken from the level meter in response to this query.

After the level meter has been turned on for continuous operation (using the LEVELON command), the level sensor must stabilize for 5 to 10 seconds before a valid reading can be obtained. After the sensor has stabilized, there may still be a delay on the order of one second, to allow the level reading to settle, before a valid level reading is returned.

When filling the dewar, the LEVEL? query and the LEVELON command can be used to monitor the filling process by placing the level meter in continuous operation and then periodically reading the level using the LEVEL? query. After the level sensor is turned on with the LEVELON command, allow approximately 10 seconds before requesting the first reading and each subsequent LEVEL? query will return the level reading of the cryogen as the filling operation proceeds. Note, however, that if more than 60 seconds pass after the level sensor is turned on or since the last LEVEL? query is received, the level sensor will be turned off automatically to reduce cryogen loss.

LEVELON [OpCode]

Activate Level Meter Command - (Immediate Mode Only) This command activates the PPMS level sensor and reads the cryogen level as indicated by the optional integer operation code, OpCode. OpCode may have a value of 0 to 3 as follows:

Value	Action
0	Turn on level sensor, read cryogen level, and turn level sensor off (default).
1	Turn on level sensor for continuous operation.
2	Enable hourly updates of level reading.
3	Turn off hourly updates.

The updated level reading will be available via the LEVEL? query approximately 10 seconds after a LEVELON command with OpCode = 0 is received. After the level sensor is turned on for continuous operation (by setting OpCode = 1), if a LEVEL? query is not received within 60 seconds, the level sensor will be turned off. Subsequently, a LEVEL? query must be received at least once every 60 seconds to keep the level meter turned off. If the LEVELON command is received with OpCode = 2, the level reading will be updated when the command is received and at one-hour intervals, on the even hour, thereafter. When a LEVELON command is received with OpCode = 3, the level sensor hourly updates are disabled. The level meter is turned off by sending the LEVELON command with OpCode = 0.

LEVSET PercentageOrVoltage [VoltageFlag]

Level Meter Setup Command - (Immediate Mode Only) Sets the level sensor calibration value. The voltage output of the helium level sensor is zero when the level sensor is at 90% (when the dewar is full), and voltage increases linearly as the level drops below 90%. Hence, the level meter can be calibrated over its entire range by specifying the voltage at any specific level reading. The LEVSET command allows the level sensor calibration to be calibrated either by specifying the present helium level in the dewar or by specifying the voltage at which the helium level should read zero percent. (Because of the small voltages involved for level readings above 90%, the Model 6000 will not accept level sensor calibrations above 90% when the percent helium level is specified.) Consequently, the PercentageOrVoltage parameter specifies the level sensor calibration as either:

Present helium level in percent (zero percent is empty), or
Voltage which corresponds to zero percent reading.

The optional VoltageFlag specifies whether the PercentageOrVoltage calibration parameter is to be used as a percentage full value or a voltage which corresponds to the zero percent reading. The integer value of VoltageFlag is interpreted as follows:

0 - Parameter is present helium level in percent (default)
1 - Parameter is voltage at which level should be zero percent

LEVSET?

Level Meter Setup Query - (Immediate Mode Only) Returns the floating-point voltage which corresponds to a zero percent reading as set by the most recent level sensor calibration. The query also returns the VoltageFlag as a second parameter with its value set to one.

LINK Output# ParamCode FullScale MidScale

Link Output Command - (Immediate Mode Only) Sets a rear panel BNC analog output channel, specified by the Output# parameter, to provide an analog output representing a specified system parameter. The ParamCode parameter specifies which parameter is to be tracked by the analog output according to the table shown below. Any of the parameteres numbered from 1 to 29 may be linked to any of the BNC analog output jacks. Parameter zero, the general system status, cannot be linked to any output jack. A ParamCode value of zero unLINKs the BNC output channel specified by Output#. See Appendix A for a complete description of the parameters shown in **Table 2-4**.

The FullScale and MidScale parameters specify the values of the system parameter which will correspond to the full-scale and mid-scale voltages of the analog output. The analog output has a range of +10 to -10 volts, so FullScale specifies the value at which the output voltage will be 10 volts, and MidScale specifies the value at which the output voltage will be zero volts.

Table 2-4 Parameters Associated with the Bits of the LINK Command

Bit	Description	Format/Units
0	General System Status	Packed Codes
1	Temperature at Sample	kelvin
2	Magnetic Field at Sample	oersted
3	Position of Sample	User Units
4	User Bridge Channel 1	ohms
5	User Bridge Channel 1	microamps
6	User Bridge Channel 2	ohms
7	User Bridge Channel 2	microamps
8	User Bridge Channel 3	ohms
9	User Bridge Channel 3	microamps
10	User Bridge Channel 4	ohms
11	User Bridge Channel 4	microamps
12	Signal Input Channel 1	volts
13	Signal Input Channel 2	volts
14	Digital Inputs - Aux, Ext	Bit Flags (8)
15	User Driver Channel 1	milliamps
16	User Driver Channel 1	watts
17	User Driver Channel 2	milliamps
18	User Driver Channel 2	watts
19	Sample Space Pressure	User Units
20	User Mapped Item	User Calibration
21	User Mapped Item	User Calibration
22	User Mapped Item	User Calibration
23	User Mapped Item	User Calibration
24	User Mapped Item	User Calibration
25	User Mapped Item	User Calibration
26	User Mapped Item	User Calibration
27	User Mapped Item	User Calibration
28	User Mapped Item	User Calibration
29	User Mapped Item	User Calibration
30	Not Used	
31	Not Used	

Note: The bits that are listed in **Table 2-4** start with the Least Significant Bit (LSB).

LINK? Output#

Link Output Query - (Immediate Mode Only) Returns the parameter-code, FullScale, and MidScale values set up by a previous LINK command for the specified Output#. See also the TBLMODE? query to determine whether a table has been provided in case the FullScale value has the special value of zero.

MAGCNF MaxField B/I_Ratio Inductance LoBChrgVoltage HiBChrgVoltage SwitchHeatTime SwitchCoolTime

Magnet Configuration - (Immediate Mode Only) This command sets the magnet configuration according to the parameters specified in the command line. The parameters are interpreted according to **Table 2-5**.

Table 2-5 Parameters of Magnet Configuration

Parameter	Interpretation
MaxField	Maximum magnetic field (oersteds)
B/I_Ratio	Field-to-Current ratio (oersteds/amp)
Inductance	Magnet inductance (henries)
LoBChrgVoltage	Charging voltage used at low field (volts)
HiBChrgVoltage	Charging voltage used at maximum field (volts)
SwitchHeatTime	Warming time for persistent switch (seconds)
SwitchCoolTime	Cooling time for persistent switch (seconds)

MAGCNF?

Magnet Configuration Query - (Immediate Mode Only) Returns the current magnet configuration in the form of five floating-point numbers and two integers. (The SwitchHeatTime and SwitchCoolTime are returned as integers.) See the MAGCNF command for an explanation of the magnet configuration parameters.

MAPDAT MapIndex SourceIndex

Map Data Command - (Immediate Mode Only) Creates a mapping link between the system parameter specified by SourceIndex, and another data index specified by MapIndex. When used in conjunction with the TABLE and TBLMODE commands, the MAPDAT command allows the user to provide a calibration table for any of the system parameters from 1 to 18 as described in Appendix A. After the mapping link has been established and the calibration table loaded using the TABLE command, the values returned for this parameter will be in the units appropriate to the calibration table. See Appendix A for a more complete discussion and examples of using the MAPDAT, TABLE and TBLMODE commands.

MAPDAT? MapIndex

Map Data Query - (Immediate Mode Only) Returns two integer parameters indicating the present mapping of the data item specified by MapIndex. The first parameter returned is the MapIndex as received, and the second parameter indicates the SourceIndex which has been linked to the data item specified by MapIndex. See Appendix A for further information regarding the MapIndex and SourceIndex parameters.

MEASURE DataFlags

Measure Command - (Immediate and Sequence Mode) Acquires all data items specified in the DataFlags parameter and places them into the data file. Numbers are converted into comma-delimited, ASCII floating-point format (unless specified otherwise) when read with a DATA command. The data record is prepended with the DataFlags and a TimeStamp. The format of the data returned is the same as the format used in the GETDAT command. A complete description of the data items that can be stored in the data file is given in Appendix A.

MOVE Position [Mode] [SlowDownCode]

Move Sample Position Command - (Immediate and Sequence Mode) Moves the sample to the position specified by the Position parameter. Note that Position must be given in "user units" as specified in the MOVECFG menu (see the MOVECFG command).

The Mode parameter defines the operation to be performed. Depending upon the value of Mode, the sample can be moved to the specified position; the sample may be moved to the limit switch, which is then defined to be at the position specified by the Position parameter; or the present sample position can be redefined without moving the sample. The values of Mode are interpreted as follows:

0 - Move to the specified position using SlowDownCode (default)
1 - Move to limit switch and define this position as Position
2 - Redefine present position as the value given by Position

The SlowDownCode parameter specifies the speed at which the stepping motor is to move the sample. The value of SlowDownCode can range from zero (approximately 200 steps/second) to 14 (approximately 15 steps/second). The default value for the SlowDownCode is zero.

MOVE?

Move Sample Position Query - (Immediate Mode Only) Returns three parameters as Position, Mode, and SlowDownCode that indicate the present position of the sample and the Mode and SlowDownCode used to reach that position. (See the MOVE command for explanations of these parameters.)

MOVECFG UnitsCode UnitsPerStep Range

Sample Motion Configuration Command - (Immediate Mode Only) Configures the sample positioning system to define the units to be used, the proportional relationship between the stepping motor and the sample position, and the allowable range for the sample travel. The UnitsCode parameter, which specifies the units to be used for the sample motion, can have values of 0 to 7 which are interpreted as follows:

0 - Steps referenced to the stepping motor
1 - Degrees
2 - Radians
3 - Millimeters
4 - Centimeters
5 - Mils (.001 inches)
6 - Inches
7 - User Units

Using the units specified by the UnitsCode parameter, the UnitsPerStep specifies the conversion factor between the physical sample position and the incremental steps of the stepping motor drive system. The Range parameter specifies the total travel range that is allowed for the sample position.

The following example illustrates how the MOVECFG command can be used: Assume that the sample positioning system drives a rotation mechanism which allows the sample to be rotated through 360 degrees. A typical configuration would be to set the position configuration parameters to use degrees as the unit of sample position with a total range of 360 degrees. The UnitsPerStep would reflect the relationship between the stepping motor and the actual sample rotation. (For one type of sample rotator supplied by Quantum Design, the sample rotates 0.125 degrees for each step of the motor. In this rotation mechanism, the proper command would be "MOVECFG 1 0.125 360;".) Further assume that the position of the sample limit switch is now defined to be zero by using a "MOVE 0 1;" command. (This command causes the sample drive system to move to the limit switch and then define the switch position as zero.) Subsequent MOVE commands of the form "MOVE angle 0;" will then move the sample from 0 to 360 degrees, in accordance with the value of range of 360 degrees specified in the MOVECFG command. (Note that if the limit switch position had been defined as 180 degrees, the total sample motion would be 180 to 540 degrees.)

MOVECFG?

Sample Motion Configuration Query? - (Immediate Mode Only) Returns the three position configuration parameters which specify the units being used by the sample motion system: the UnitsCode, the UnitsPerStep, and the Range. The UnitsCode is returned as an integer and the UnitsPerStep and Range are returned as floating-point numbers. See the MOVECFG command for an explanation of these parameters.

MOVELIM?

Position Limits Query? (Immediate Mode Only) Returns the position of the sample position limit switch and the maximum travel limit referenced to the most recent MOVE command. Both values are returned as floating-point numbers in the units most recently selected by a MOVECFG command or from the front panel **Position Configuration** screeen.

REV?

Revision Number Query - (Immediate Mode Only) Returns a string containing the revision number and the date in the following form: "Revision Number: 1.00, Date: Aug 23 1992".

SEQCTRL SequenceCode [StartLine] [EndLine]

Sequence Operation Command - (Immediate Mode Only) Provides control for executing sequences in the Model 6000. The SequenceCode parameter specifies the sequence operation that is to be performed according to the following table.

0 - Abort the present sequence
1 - Run the present sequence
2 - Pause (suspend) execution of the present sequence
3 - Continue (resume) execution of the present sequence

The **Abort** operation (0) halts execution of the present sequence and aborts any field and temperature operations that may be in progress. The **Run** operation (1) executes the present sequence. The **Pause** operation (2) temporarily suspends execution of the sequence file and can be used in conjunction with the **Continue** (3) operation which continues execution of the sequence file at the end of the **Pause**.

If the run code is given, the option parameters, StartLine and StopLine, can be used to specify on which lines of the sequence file execution will begin and end. (Note that since commands located inside a scans command do not have a line number, sequence execution cannot start or end on any command inside a scan command.)

SEQSIZE?

Sequence File Size Query - (Immediate Mode Only) Returns one parameter which indicates the number of commands in the present sequence file. The returned integer is the line number which has been assigned to the End-Of-File command which is the last instruction in the sequence file. If the sequence file contains no commands, a value of 1 will be returned indicating that the EOF command is the first command in the file.

SEQSTAT?

Sequence File Status Query - (Immediate Mode Only) Returns the sequence file status parameters: the present operation code, and the command string for the command presently being executed.

The integer operation code indicates the status of the sequence file as either idle, executing a sequence, sequence execution suspended, or sequence file "locked". The operation code is interpreted as follows:

0 - Idle (not executing sequence commands)
- Executing sequence commands
2 - Sequence execution suspended
3 - Sequence file is locked.

The sequence file is locked (operation code 3) whenever the host computer is using the APPEND command to load sequence file commands via the GPIB interface. The file remains locked until an "APPEND EOF;" command is receive, or the sequence is aborted.

The second parameter returned is a string giving the sequence file command number and the command which is presently being executed. The command number returned corresponds to exactly the same number that appears when viewing the sequence file on the Model 6000 front panel. The **CommandString** is the actual command that is being executed, which is reported in the same format as it would normally be received via the GPIB interface. The string is returned in the following format:

Line#: CommandString

SHUTDOWN

Temperature Controller Shutdown - (Immediate Mode Only) Places the temperature controller code in standby mode; in which both drivers used to control the system temperature are turned off and the helium flow is set to a minimum value.

SIGOUT Ch# Voltage

Signal Command - (Immediate and Sequence Mode) Sets the indicated output BNC jack (Ch#) to the specified Voltage between -10 and +10 volts. If the channel was previously associated with a system parameter through the LINK command, this linkage will be terminated by the direct SIGOUT command.

SIGOUT? Ch#

Signal Output Query - (Immediate Mode Only) Returns the present voltage set on the specified output BNC (Ch#). If this channel has been linked to a system parameter, possibly including a user table, the query will return the voltage last set by this linkage.

TABLE Index SensorCode CalCode #0 Sensor#1, Cal#1, Sensor#2, Cal#2, . . . Sensor#n, Cal#n

Table Command - (Immediate Mode Only) Loads a calibration table for a data item that is specified by the Index parameter. The parameter, Index, can have a value from 19 to 29, corresponding to any of the user mapped items in the table shown under the GETDAT? query. This feature allows the user to specify a calibration table for any of the first 18 items in the table after using a MAPDAT command to map the data item into one of the user mapped items. A calibration table can be loaded the sample space pressor sensor (item 19) or for any parameter which has been mapped into one of the user mapped items (items 20 to 29). Hence, calibration tables for up to 10 system parameters can be loaded at any given time.

The SensorCode and CalCode parameters specify the mathematical functions which are to be applied to the calibration table before storing it in internal memory in the Model 6000. This feature can be used to improve the linearity of the calibration tables. For example, the resistance versus temperature graph for a germanium resistance thermometer is much more linear if one plots Log10R versus 1/T. The SensorCode and CalCode parameters, which allow the user to specify a variety of mathematical functions, are interpreted as follows:

0 - X
1 - 1/X
2 - ln(X)
3 - Root(X)
4 - Log10(X)

The #0 parameter, which must be included in the command, specifies that the calibration data for the sensor is to be read by the Model 6000 according to the Arbitrary Block Program Data protocol, and the numbers represented as Sensor#1 Cal#1 Sensor#2, Cal#2 ... are entries for the actual calibration table. (Consult a manual on the IEEE-488.2 Standard for more information on the Arbitrary Block

Program Data protocol.) The command must include at least 3 pairs of calibration data, and no more than 50 data pairs. Refer to Appendix A for further discussion and an explain of how to use the TABLE command.

TABLE? Index

Table Query - (Immediate Mode Only) Returns the Index, SensorCode, CalCode, #0, and the calibration table for the specified value of the Index parameter. If no calibration table has been loaded for the specified Index, a zero is returned. The entire calibration table is returned as sent with the last TABLE command. Individual numbers are separated by commas and terminated with a semicolon and an End Of String character if one has been specified.

TABLE_ERR?

Table Error Query - (Immediate Mode only) Returns one of six possible Table Error Strings. The Table Error String is generated whenever a table is received by the Model 6000, so the TABLE? query returns only the string for the most recent table received. The possible Table Error Strings and their meanings are shown in **Table 2-6**.

Table 2-6 Table Error Strings

Error String	Explanation
No Table Error Detected	
Prescaler operation on table element	Invalid number for specified prescaling (e.g. 0 for 1/H prescale)
Table non-monotonic or multi-valued	Table data must be monotonic and single-valued
Table non-monotonic or multi-valued after prescaler	Table data must be monotonic and single-valued after prescaling
Coefficient error in sensor values	Quadratic interpolation failure in sensor values
Coefficient error in calibration values	Quadratic interpolation failure in calibration values

TBLMODE Index TableMode

Table Mode Command - (Immediate Mode Only) Specifies whether the calibration table is to be used when data is returned for the user mapped item specified by the Index parameter. This command allows the user to load a calibration for a user mapped item, then receive data from that item either as a raw data reading or in the form of a calibrated reading. The TableMode parameter specifies whether the data is to be returned as a raw data reading or as a calibrated reading as follows:

0 - Return raw reading
1 - Return calibrated reading

TBLMODE? Index

Table Mode Query - (Immediate Mode Only) Returns the value of Index, and the value of the TableMode parameter that is presently being used for the specified Index. See the TBLMODE command for an explanation of the TableMode parameter.

TEMP Temp Rate [ApproachCode]

Temperature Command - (Immediate and Sequence Mode) Sets the new set point for the sample temperature in kelvin, the temperature slew rate, and the type of approach to the set point. The allowable range for Temp is 1.9 K to 350 K, the Rate may be set from 0 to 20 K/minute, and the ApproachCode indicates the manner in which the system will approach the new temperature set point. Using the Fast Settle mode will produce more overshooting of the set point than the No Overshoot mode. (Note, however, that the No Overshoot mode is not guaranteed to have zero overshoot.) The ApproachCode is interpreted as follows:

0 - Fast Settle Approach (default)
1 - No Overshoot Approach

TEMP?

Temperature Query - (Immediate Mode Only) Returns the present temperature set point, approach rate, and approach mode code. See the TEMP command for interpretations of these parameters.

TIME Hour Min Sec

Time Command - (Immediate Mode Only) Sets the internal system clock as specified by the Hour, Min, and Second parameters. 24-Hour time is used.

TIME?

Time Query - (Immediate Mode Only) Returns the data from the internal clock in the same format as specified in the command form of this message.

TIME_SMP?

Time In Seconds Query - (Immediate Mode Only) Returns the number of seconds since the beginning of the year (Midnight, January 1). This is the value used to assign a time to operations on data events in the Model 6000 data file.

Chapter Three: Sequence Commands

ADVISE AdvisoryNumber

External Advisory Command - (Sequence Mode Only) Generates a software advisory that can be used to initiate program activity in software applications which use the PPMS. The AdvisoryNumber parameter, that can have a value of 0 to 999, is used to specify which advisory has occurred. At the time an advisory occurs, a readable flag is set within the Model 6000 Controller. The advisory can also be made to generate a Service Request on the GPIB interface if the appropriate functions are enabled. (See Application Note 1070-202 for additional information on using Service Requests.)

When an ADVISE command is encountered in a sequence, sequence execution is halted for 5 seconds. If a HOLDOFF command is received within 5 seconds, sequence execution will be suspended until the HOLDOFF Command is cancelled. By using the ADVISE and HOLDOFF commands in this manner, an external software application (which might be operating an experiment, for example) can be notified when the sequence has reached any specific point, then suspend execution of the sequence while it performs a measurement or experiment. (See the HOLDOFF command on page 2-9 in chapter 2 of this manual for additional information on using the ADVISE and HOLDOFF commands. See Application Note 1070-202 for additional information on using advisories.)

EOF

End Of File - (Sequence Mode Only) Specifies the end of file for a sequence file. When transmitting sequence instructions to the Model 6000, the EOF command is used to initiate a consistency check on the instructions already loaded into the sequence file. If the sequence file is not valid (that will occur when a scan command is incomplete or unterminated), an error condition will be generated that can be detected by reading back the appropriate error condition codes.

EOS

End Of Scan - (Sequence Mode Only) Marks the end of a scan command. All instructions that occur after a scan command and before its corresponding EOS command will be executed within the scan command. An error will be generated if an EOS command is received with no corresponding scan command. (See the SCANC, SCANH, SCANT, and SCANP commands presented in this chapter for additional information on using scan commands.)

SCANC OverallTime Steps SpacingCode

Scan Chronologically Command - (Sequence Mode Only) The SCANC command allows the user to specify, in a single command, a series of timed events that can be used to generate well-defined time intervals for triggering events or experiments. The SCANC command uses three parameters to specify the duration and spacing of the timed events. (For example, if one places an ADVISE command after the SCANC command but before its corresponding End Of Scan (EOS) command, an advisory will occur at the times specified by the SCANC command.)

OverallTime	- Total time over which events will occur
Steps	- Number of events that will occur
SpacingCode	- Specifies spacing between temperature steps

The OverallTime, specified in seconds, determines the total length of time over which the events will occur. A time of zero is defined as the time when the first event occurs, of which the SCANC command is first. The Steps parameter specifies the number of timed events that will occur, and the SpacingCode indicates the spacing between the steps, such as equal spacing, or equally spaced in ln(t). The SpacingCode parameter is interpreted as follows:

0 - Uniform spacing in time.
1 - Uniform spacing in natural log of time (ln t).

For purposes of generating the timing sequence, the first event will always occur at the time the SCANC command is first encountered in the sequence file. All of the events will then occur over the interval of time specified by the parameter OverallTime, and the spacing of the events over that interval will be as specified by the SpacingCode.

SCANH StartField EndField Rate Steps SpacingCode ApproachMode PauseMode

Scan H-Field (Magnetic Field) Command - (Sequence Mode Only) The SCANH command allows the user to specify in a single command an entire series of magnetic fields that are to be sequentially set. The seven parameters specified in the SCANH command specify the multiple field operation as follows:

StartField	- First field to be set
EndField	- Last field to be set
Rate	- Rate to ramp field between set point
Steps	- Number of fields to set (includes first & last)
SpacingCode	- Specifies spacing between field steps
ApproachMode	- How field steps are approached
PauseMode	- Specifies magnet mode for each field set point

The StartField and EndField are specified in oersteds, and the Rate is specified in oersteds/second. The number of Steps specifies how many values of field will be set, including the StartField and EndField. The SpacingCode indicates the spacing between steps, such as equal spacing, or equally spaced in the square of H. The SpacingCode parameter is interpreted as follows:

0 - Uniform spacing in field.
1 - Uniform spacing in the square of the field (H^2)

As in the FIELD command, the ApproachMode specifies whether the set point field is to be approached in a **Linear**, **No Overshoot**, or **Oscillate** approach. In addition, the SCANH command allows an additional mode called the **Sweep** approach. In the **Linear**, **No Overshoot**, and **Oscillate** approaches, the magnetic field is held stable at each of the field set points until the next field is to be set. In the **Sweep** approach, the magnetic field ramps linearly from the StartField all the way to the EndField without stopping. When operating in this mode, an ADVISE command placed after the SCANH command (but before its corresponding End Of Scan command) can be used to notify the user's application that the magnetic field is passing through one of the specified set points. The ApproachMode parameter is interpreted as follows.

0 - Linear Approach (default)
- No Overshoot Approach
2 - Oscillate Approach
3 - Sweep Approach

The PauseMode parameter specifies if the magnet is to be placed in its persistent mode at each field set point or if the power supply is to continue to supply current to the magnet. When the ApproachMode is set to sweep, the PauseMode parameter is not used. The PauseMode parameter is interpreted as follows.

0 - Persistent Mode (default)
1 - Driven Mode

SCANP StartPos EndPos SlowDownCode Steps

Scan Position Command - (Sequence Mode Only) The SCANP command allows the user to specify in a single command an entire series of sample positions which are to be sequentially set. The four parameters of the SCANP command specify the multiple position operation as follows:

StartPos	- First position to be set
EndPos	- Last position to be set
SlowDownCode	- Defines rate at which position is changed
Steps	- Number of positions to set (includes first & last)

The StartPos and EndPos are specified in user units. (See the MOVE and MOVECFG commands for additional information about user units for defining the sample position.) The parameter, SlowDownCode, specifies the speed at which the stepping motor is to move the sample. The value of SlowDownCode can range from zero (approximately 200 steps/second) to 14 (approximately 15 steps/second). The number of Steps specifies how many positions will be set, including the start and end positions. Positions set using the SCANP command will be equally spaced (as referenced to the stepping motor).

SCANT StartTemp EndTemp Rate Steps SpacingCode ApproachMode

Scan Temperature Command - (Sequence Mode Only) The SCANT command allows the user to specify in a single command an entire series of temperatures which are to be sequentially set. The six parameters specified in the SCANT command specify the multiple temperature operation as follows:

StartTemp	- First temperature to be set
EndTemp	- Last temperature to be set
Rate	- Rate to ramp temperature between set points
Steps	- Number of temperatures to set (includes first & last)
SpacingCode	- Specifies spacing between temperature steps
ApproachMode	- How temperature steps are approached

The StartTemp and EndTemp are specified in kelvin, and the Rate is specified in kelvin/second. The number of Steps specifies how many temperatures will be set, including the start temperature and end temperature. The spacing code indicates the spacing between the steps, such as equal spacing, or equally spaced in 1/T. The SpacingCode parameter is interpreted as follows:

0 - Uniform spacing in temperature
- Uniform spacing in inverse temperature (1/T)

As in the TEMPERATURE command, the ApproachMode specifies whether the set point temperature is to be approached in the **Fast Settle** or **No Overshoot** approach. In addition, the SCANT command allows an additional mode called the **Sweep** approach. In the **Fast Settle** and **No Overshoot** approaches, the temperature is allowed to stabilize at each of the temperature set points until the next temperature is to be set. In the **Sweep** approach, the temperature ramps continuously from the StartTemp all the way to the EndTemp, without stopping, at the Rate specified. When operating in this approach, an ADVISE command placed after the SCANT command (but before its corresponding End Of Scan (EOS) command) can be used to notify the user's application that the magnetic field is passing through one of the specified set points. The ApproachMode parameter is interpreted as follows:

0 - Fast Settle (default)
- No Overshoot Approach
2 - Sweep Approach

SYNC [LineCode] [TimeOut]

Synchronize External Device - (Sequence Mode Only) Provides hardware synchronization between the Model 6000 Controller and external hardware devices. When encountered in a sequence file, the SYNC command causes one or more of the external digital output lines, as specified by the LineCode parameter, to be pulled low for a period of approximately 0.25 seconds. If the Busy line (rear panel EXTERNAL port, pin 9) is pulled low while the external digital output lines are being held low, sequence execution will be suspended until the Busy line is released. The TimeOut parameter specifies how long the Model 6000 will wait for the Busy line to be released before continuing sequence execution. The TimeOut is specified as a number of seconds from 1 to 65,535. If a value of zero is specified for TimeOut, the Model 6000 will wait indefinitely for the Busy line to be released. This digital "handshake" allows an external hardware device to suspend execution of the sequence while the external device performs a measurement or experiment.

The SYNC command can also be used to coordinate hardware activity with external applications software. When the Model 6000 executes the SYNC command, bit 9 in the Device Event Register (Status Event Register 3), and a GPIB Service Request will be generated if the Service Request Enable Flag for this bit is set. (See Application Note 1070-202 for additional information on using Service Requests.)

Note that the external digital output lines can also be directly controlled by the EXTSET command. When using the SYNC and EXTSET commands in a sequence, the user must be sure to avoid situations in which the two commands conflict.

WAITFOR DelayTime [TempFlag] [FieldFlag] [PosFlag] [Chamber] [AbortMode]

Wait For Command - (Sequence Mode Only) Suspends further execution of a sequence file until the system has completed the operations specified by the various optional flag parameters. A non-zero value of DelayTime (specified in seconds) will suspend sequence execution for that additional period of time (up to 3600 seconds is permitted) after all operations are complete. The temperature and field operations are considered complete when the temperature and field controls systems have reached their set points. Position and chamber functions are complete when the sample motion or chamber operation has been completed. The parameters flags are interpreted as follows:

DelayTime:		After operations are complete wait this additional time (seconds).
TempFlag:	0	- Do not wait for temperature stability
		- Wait for temperature stability
FieldFlag	0	- Do not wait for magnetic field stability
	1	- Wait for magnetic field stability
PosFlag:	0	- Do not wait for sample position operation to finish
		- Wait for sample position operation to finish
Chamber:	0	- Do not wait for sample chamber operation to finish
		- Wait for sample chamber operation to finish

The optional AbortMode parameter specifies the action to be taken if the system fails to report that all operations have been completed within a reasonable period of time. If the AbortMode is set to zero, no extra action will be taken when the WAITFOR command fails, and the system will resume executing the sequence file. If AbortMode specifies that the system should abort present operations, all operations (temperature, magnetic field, position, and chamber) will be aborted. If the AbortMode specifies that an ONFAIL instruction is to be executed and the sequence filed contains an ONFAIL instruction, that instruction will be executed. (See the ONFAIL command for additional information regarding its use.) The value of AbortMode is interpreted as follows:

0 - No action
1 - Abort all functions
2 - Execute the ONFAIL instruction.

Unless a WAITFOR command is placed after the TEMP, FIELD, and MOVE commands (and inside the corresponding Scan commands), the next commands may be executed before the temperature, magnetic field, and sample position have stabilized to the user's requirements. Note that the sequence execution system has been designed this way because it may also be desirable to not wait for system stability in some cases.

Recap of all Commands that can be used in Sequence Files:

Chapter Four: Communications Commands

BADCMD?

Bad Command Query - (Immediate Mode Only) Returns the last illegal command received by the Model 6000 as an ASCII string. A command will be declared illegal if the command is not recognized, if required parameters are not included, or if one or more of the parameters have illegal values. At the time the illegal command is returned, the string value is set to <empty>, and subsequent queries will return the string <empty> until another illegal command is received. In combination with the BADPRM query, the BADCMD query can be used to diagnose problems with GPIB communications with the Model 6000.

BADPRM?

Bad Parameter Query - (Immediate Mode Only) Returns one integer value that indicates the source of the error in the command identified by the BADCMD? query. A returned value of zero indicates an illegal or unknown command. A non-zero value indicates which parameter was illegal or not found as follows:

0 - Illegal or unknown command
- First parameter illegal
2 - Second parameter illegal
3 - Third parameter illegal

n - nth parameter illegal

If the parameter returned refers to an illegal element in a table that has been loaded into the Model 6000, the returned value indicates the data pair which has been identified as containing an illegal value. If the error occurs because the table values violate a mathematical requirement, such as being non-monotonic or multi-valued, the position index will be returned with a negative value.

GPTERM EOIFlag [EOSValue]

GPIB Response Termination Command - (Immediate Mode Only) Enables or disables the action of the EOI line when the last byte in a response string is sent out by the Model 6000. If enabled, the EOI line will be asserted Low at the time the last byte is sent. If disabled, the EOI line is not asserted. The EOIFlag is interpreted as follows:

0 - EOI line is disabled
- EOI line is enabled

The optional integer parameter, EOSValue, specifies the End Of String (EOS) character that is to be used with each response from the Model 6000. If no EOS parameter is specified, a semicolon will sent as the last character in any string returned by the Model 6000. If an integer value from 0 to 255 is specified for EOSValue, the character with that ASCII value will be appended to the returned string after the semicolon. When enabled, the EOI line will be asserted at the time the last character returned - the final EOS character if one is specified, or the final semicolon otherwise.

GPTERM?

GPIB Response Termination Query - (Immediate Mode Only) Returns the present value of the EOIFlag and the integer value of the EOS character. If no EOS character has been specified, the ASCII value for a semicolon will be returned.

SPMD BaudRate ModeCode [UseXon]

Serial Port Mode - (Immediate Mode Only) Sets certain parameters of the P5-RS-232 serial port located on the Model 6000 rear panel. The BaudRate is the rate of information flow in bits per second. The BaudRate value may be up to 38.4 Kpbs. The ModeCode specifies the port mode. The four codes are as follows:

0 - 8,N,1
- 8,O,1
2 - 8,E,1
3 - 8,N,2

The bit size is **8**, representing how many bits are in a transmitted word. The letters signify parity; where **N** is **N**one, **O** is **O**dd, and **E** is **E**ven. The number of stop bits is either **1** or **2**. The UseXon is the handshakes and specifies the flow control mode. The handshake is interpreted as follows:

0 - None
- Xon/Xoff
2 - RTS/CTS
3 - Both

Xon/Xoff is a software handshake protocol. **RTS/CTS** is a hardware handshake protocol.

SPMD?

Serial Port Mode Query - (Immediate Mode Only) Returns the contents of the Serial Port configuration; that is the baud rate, port mode, and handshake protocol. See SPMD for interpretations of these parameters.

SPSC ASCIICode

Serial Port Service Request Character - (Immediate Mode Only) Determines the value of ASCIICode which specifies that a bad command is entered through the P5-RS-232 serial port. The character is selected from ASCII 0 to 255. Note that a zero-valued Service Request (SRQ) Character will turn off the service request. Also, Microsoft Windows' Terminal mode does not support the SPSC command.

SPSC?

Serial Port Service Request Character Query - (Immediate Mode Only) Returns the ASCIICode value selected to indicate a bad command was entered.

SPTS Terminator-code

Serial Port Terminator String Command - (Immediate Mode Only) This function is not yet implemented. The serial port parameters cannot be changed from the factory settings in this firmware revision.

SPTS?

Serial Port Terminator String Query - (Immediate Mode Only) This function is not yet implemented. The serial port parameters cannot be changed from the factory settings in this firmware revision.

Chapter Five: Error and Status Reporting Commands

5.1 Introduction

Error and status reporting is handled according to the Service Request protocol of the IEEE-488.2 interface standard. A Service Request from the Model 6000 is initiated through the 8-bit register referred to as the Service Request Status Byte. The contents of the Service Request Status Byte can be obtained by performing a Serial Poll of the Model 6000, or by sending a Status Byte (*STB?) Query. Sending a Status Byte Query to the unit does not affect the contents of the Status Byte, but when a Serial Poll is performed the Status Byte (except for bit 4) is cleared.

Each bit in the Service Request Status Byte corresponds to a certain class of events or status conditions in the Model 6000. The use of bits 4, 5, and 6 are specifically assigned to particular functions by the IEEE-488.2 standard. Bit 4 is reserved to indicate that there is data awaiting retrieval in the GPIB device's output buffer, bit 5 is assigned as a summary of the Standard Event Register, and bit 6 indicates a pending Service Request. The use of the remaining bits depends on the specific GPIB device. With the exception of bit 6, each bit of the Service Request Status Byte represents a summary of an Event Status Register. **Table 5-1** lists the bits of the associated Event Status Registers, showing how they are assigned in the Model 6000.

Table 5-1 Event Status Registers Bit Assignment

Bit	Register
0	Command Error Event Register
1	Execution Error Event Register
2	not used
3	File Event Register
4	Data Ready Register
5	Standard Event Register
6	not used
7	not used

The contents of each of the Event Status Registers can be retrieved using the Indexed Event Status Register (ISR?) Query described below. (The contents of the Standard Event Register can also be retrieved using the *ESR? query.) The ISRE command and ISRE? query allow the user to set and retrieve the Enable registers for each of the Event Status Registers, and the ISRC command allows any of the Event Status Registers to be cleared.

5.2 Command Errors

Commands errors are as follows:

ISR? Index

Indexed Event Status Register Query - (Immediate Mode Only) Returns two integer parameters, the first of which is the Index value received in the ISR? command. The second parameter is an integer from 0 to 65,535 which is the numerical representation of the bits in the 16-bit register specified by Index. The bits in the seven different Event Status Registers indicate events, status changes, and error conditions in the Model 6000. (See section 5.1 for more information on Event Status Registers and their interpretation.)

The Event Status Registers, with the exception of the Message Available bit (bit 4), are automatically cleared when the register status is returned by the Model 6000, so subsequent readings of the registers return only those events that have occurred since the last reading. (The Message Available bit is cleared only when the data buffer is empty.)

Each bit in the Event Status Registers can generate a Service Request if the corresponding bit in the Service Request Enable register is set to one. The Event Status Registers correspond to the individual bits in the GPIB Serial Poll Register, and the value of Index (0 to 7) specifies which register is to be returned as listed in section 5.1. (See Appendix B for more information on Status Register error messages.)

ISRC IndexSelectFlags

Indexed Status Register Clear Command - (Immediate Mode Only) Clears the Indexed Status Registers specified by the integer IndexSelectFlags parameter, which can have a value of 0 to 255. The binary representation of the integer specifies the status registers which are to be cleared according to the following interpretation:

0 - Do not clear the specified register
1 - Clear the specified register

For example, if IndexSelectFlags has a value of 5, its binary representation is 00000101. Referring to **Table 5-1**, this value of IndexSelectFlags specifies that the Command Error Event Register (Register 0 - corresponding to the least significant bit) and the Internal Error Event Register (Register 2 - corresponding to the third least significant bit) are to be cleared.

ISRE Index EnableFlags

Indexed Status Register Enable Command - (Immediate Mode Only) Enables the generation of a Service Request by events in the Event Status Register specified by the Index parameter. The EnableFlags parameter specifies which events in the Event Status Register will generate a Service Request. The value of Index (0 to 7) specifies the Event Status Register to which the Service Request EnableFlags are being applied. The EnableFlags parameter, with values from 0 to 65,535, specifies which bits in the 16-bit register will generate Service Requests. The bit values in EnableFlags are interpreted as follows:

0 - Service Request is disabled
- Service Request is enabled

For example, a command of "ISRE 0 7" will cause Service Requests to be generated for the events assigned to bits 0, 1, and 2 (according to the binary representation of the number 7), in the Event Status Register 0. As listed in **Table 5-1**, Event Status Register 0 is the Command Error Event Register. (See the ISR? for more information. Also see Appendix B for additional information.)

ISRE? Index

Indexed Status Register Enable Query - (Immediate Mode Only) Returns two integer parameters, the first of which is the Index value received in the ISRE? command. The second parameter is an integer from 0 to 65,535 which is the numerical representation of the bits in the 16-bit Event Status Enable Register specified by Index. The individual bits in the Event Status Enable Register indicate whether this event will generate a Service Request according as described in the ISRE command.

Chapter Six: Miscellaneous Commands and Queries

The commands in this chapter support specific requirements of the GPIB IEEE-488.2 Standard or provide specific hardware support functions. For additional information pertaining to the following commands, refer to the IEEE-488.2 specifications.

CAUTION

These commands are provided for the express purpose of fulfilling the requirements of the IEEE-488.2 standard. The following commands are implemented in the Model 6000 firmware as indicated below, but at this time these commands are not supported by PC software supplied with the PPMS system. Because many of the commands listed in this section cause information, registers, or data to be erased in the Model 6000, use of these commands, even through the PPMS Server, will cause the PPMS Server to fail.

*CAL?

Calibration Query - (Immediate Mode Only) The calibration query causes all A/D chips to perform an internal self-calibration. The response indicates whether or not self- calibration has been completed without error. A value of zero indicates the calibration completed without any detected errors. A non-zero value indicates the calibration did not complete or completed with errors detected.

*CLS

Clear Status Command - (Immediate Mode Only) Clears and resets all event registers. When this command is executed by the Model 6000, all existing information regarding previous events in the Indexed Event Status Registers and in the Indexed Device Condition Registers is lost.

*ESE EnableMask

Standard Event Enable Command - (Immediate Mode Only) Sets the Standard Event Enable Register bits specifying which events in the Standard Event Register will generate a Service Request. The parameter EnableMask can have values from 0 to 255. The binary representation of the value of EnableMask specifies which events in the Standard Event Register will generate a Service Request. The bit values are interpreted as follows:

0 - Service Requests are disabled.
- Service Request are enabled.

The command "ISRE 5;" performs the identical function of this command. The *ESE command is provided to fulfill the requirements of the IEEE-488.2 standard. (See section 5.1 and the ISRE command for additional information on using the Standard Event Status Enable Registers.)

*ESE?

Standard Event Enable Query - (Immediate Mode Only) Returns the current contents of the Standard Event Enable Register. The command "ISRE? 5;" performs the identical function of this command. The *ESE? command is provided to fulfill the requirements of the IEEE-488.2 standard. (See section 5.1 and the ISRE? query for additional information on using the Standard Event Status Enable Registers. Also see Appendix B for additional information.)

*ESR?

Standard Event Register Query - (Immediate Mode Only) Returns the Standard Event Register. (The command "ISR? 5;" performs the identical function - the *ESR? command is provided to fulfill the requirements of the IEEE-488.2 standard. See the ISR? query for additional information on using the Event Status Registers.)

*IDN?

Identification Query - (Immediate Mode Only) Returns the following unit identification string:

QUANTUM DESIGN PPMS TEMPERATURE CONTROLLER, 0, 0

*PSC Flag

Power-On Status Clear Command - (Immediate Mode Only Specifies if a power-on operation will automatically clear the Service Request Enable Register, the Standard Event Status Enable Registers, and the Device Condition Enable Registers. The value of Flag specifies if the enable flags for the registers will be cleared as follows:

0 - All Enable Flags will be saved.
- All Enable Flags will be cleared.

*PSC?

Power-On Status Clear Query - (Immediate Mode Only) Returns the value of the Power-On Status Clear flag. See the *PSC command for interpretation of the Power-On Status Clear flag.

*RST

Reset Command - (Immediate Mode Only) Resets the Model 6000. This command causes the unit to perform a complete system re-initialization equivalent to that performed at its initial power-up.

*SRE EnableMask

Service Request Enable Command - (Immediate Mode Only) Sets the Top Level Service Request Enable Register according to the value of EnableMask, which can be 0 to 255. The bits in the binary representation of EnableMask, correspond directly to the bits in the Serial Poll Register to determine which bits in the Serial Poll Register will generate a Service Request. Service Requests will be generated according to the following interpretation: (See Application Note 1070-202 for additional information on using Service Requests.)

0 - Service Requests are disabled.
- Service Request are enabled.

*SRE? EnableMask

Service Request Enable Query - (Immediate Mode Only) Returns the contents of the Top Level Service Request Enable Register. See the *SRE command for more information about this register.

*STB?

Status Byte Query - (Immediate Mode Only) Returns the contents of the Top Level Service Request Register. The integer value returned, which will have a value from 0 to 255, is identical to the byte returned when a Serial Poll is performed. However, the *STB command will NOT cause the Top Level Service Request Register to be cleared, whereas the register IS cleared when Serial Poll is performed.

*TST?

Self-Test Query - (Immediate Mode Only) Returns an integer value that reports the results of the most recent self-test operation. The binary representation of the returned parameter will have a value of 0 to 65,535 with its individual bits corresponding to the conditions listed in **Table 6-1**.

Table 6-1 Description of *TST? Bit Values

Bit Value	Description
0	Self-test results okay
1	IRQ locked, subsystem disabled; Interrupt line to CPU chip is stuck. CPU/Hardware Error - Contact Quantum Design
2	Internal CPU Error, CPU chip has internal failure - Contact Quantum Design
3	Reset Error, last reset was not normal. May be due to noisy environment or firmware error
4	LCD Error, CPU board is unable to communicate with the front panel LED
5	GPIB Chip Error, GPIB chip has failed
6	Real-Time Clock Error
7	Keyboard Error. May be caused by pressing a key during power-up test
8	RAM Memory Error, a RAM memory error has been detected - Contact Quantum Design
9	ROM Memory Error, a ROM memory error has been detected - Contact Quantum Design
10-15	Not Assigned

Chapter Seven: Restricted Commands

The following is a list of commands that are potentially dangerous to the server and any other programs connected to it. Some of the queries are also dangerous because they clear certain bits that the server may be relying on.

*CLS

Clear Status Command - Common Command (Immediate Mode Only) See IEEE-488.2 specification.

*ESE

Standard Event Status Enable Command - Common Command (Immediate Mode Only) See IEEE-488.2 specification.

*ESE?

Standard Event Status Enable Query - Common Query (Immediate Mode Only) See IEEE-488.2 specification.

*ESR?

Standard Event Status Register Query - Common Query (Immediate Mode Only) See IEEE-488.2 specification.

*OPC

Operation Complete Command - (Immediate Mode Only) Sets operation complete flag in standard events register after all pending selected device operations are completed.

*OPC?

Operation Complete Query - (Immediate Mode Only) Returns an ASCII character 1 after all pending selected device operations are completed.

*RST

Reset Command - Common Command (Immediate Mode Only) See IEEE-488.2 specification.

*SRE

Service Request Enable Command - Common Command (Immediate Mode Only) See IEEE-488.2 specification.

*SRE?

Service Request Enable Query - Common Query (Immediate Mode Only) See IEEE-488.2 specification.

Appendix A

Restricted Commands

A.1 Using GPIB with the PPMS

When using the GPIB for PPMS data collection, some special considerations are required with the Getdat, Measure, Data, Link, Table, and Tblmode commands. Syntax and specific information about all of the GPIB commands are provided in this manual, while this appendix addresses the specific use of these commands with the PPMS. The DATA? and GETDAT? queries along with the MEASURE command allow the user to store data to, and retrieve data from, the Model 6000 data file. The LINK, TABLE, and TBLMODE commands provide the user with significant flexibility in storing calibrated values of various parameters.

All of these commands require the designation of an index or bit parameter as listed in **Table A-1**. While the bit values have nearly the same meaning for each command, there are some specific distinctions within the table. Each note (section A.5) describes these special circumstances.

A.2 The Getdat, Measure, and Data Commands

These three commands are closely related in that the Getdat query may be considered to be a combination of the Measure command and the Data query. When a GETDAT? query is received by the Model 6000, the requested information is generated and returned to the user. In contrast, the Measure command places the specified data item into the data file without returning any information to the user. The DATA? query is used to retrieve information from the data file in the Model 6000.

The Getdat and Data Queries

The data retrieved by the Getdat (Getdat?) and Data (Data?) queries share the following format:

DataFlag, TimeStamp, Data Element 1, Data Element 2,

DataFlag is the digital number, corresponding to the **Table A-1** items specified in the original query. If you have specified a bit which is turned off or disabled, (e.g. a channel bridge which is not enabled), the returned DataFlag value will be zero to acknowledge the query and to indicate that the channel is not active. TimeStamp is the system time given in seconds since midnight, January 1st of the present year (±1/16 sec). When the returned DataFlag is zero (indicating that the channel is disabled), the TimeStamp will be displayed, however, no additional information will follow. The Data Element will be given in the units appropriate for the data being retrieved (see **Table A-1**).

An example may be useful in understanding the operation of the Data and Getdat queries, however, before performing a data query, one must have a record in the data file to read. By using the Measure command, specific items will be placed into the data file at specified intervals. The following command will place Sample Temperature (bit 1), Magnetic Field at Sample (bit 2), and User Bridge Channel 4 resistance (bit 10) into the data file:

MEASURE 1030

The number 1030 is the decimal representation of the binary string, 10000000110, in which bits 1 (temperature), 2 (field), and 10 (Bridge Channel) are on (1) and all other bits are off (0). The bit values that are set to one (1) indicate the data items that are to be read. When using the PPMS, the MEASURE command can be executed at selected times throughout an experiment to generate a data file which will contain a record for each execution of the measure command. With this data file in place, the Data query can be used to display or return each record of the data file. For this example, assume the measure command was executed every 10 seconds during a measurement. Execution of the Data query would be performed to display the results in the following manner:

DATA? 1

The number 1 is the optional LineCode parameter which indicates that you want to read the first record of the data file. (Other LineCodes are 0 [next line] and 2 [last line], the default is 0.) This will result in a returned record which could look something like the following:

6, 12961220.00, 4.5, 2000.0;

The first field (6) is the FormatCode that indicates which bit numbers are represented in the following fields. The value 6 is the digital representation of the binary number 00000000110 in which bits 1 (temperature) and 2 (field) are on and all other bits are off. The FormatCode of 6, in this example, indicates that the User Bridge Channel 4 is disabled and therefore no data were collected for this item (see Section A.5, note 1). The next field is the TimeStamp which indicates the number of seconds since midnight, January 1. The remaining fields display the data for the system temperature (4.5 kelvin), and the magnetic field (2000.0 oersted). Subsequent data queries would have the same format.

To read the next data line, the following command would be used:

DATA?

This will result in the display of the next (second) record of the data file, which might look like this:

6, 12961230.00, 4.5, 2001.8;

Note that the TimeStamp has changed to reflect the later time at which this record was recorded, and the magnetic field has changed slightly. The Bridge Channel is still disabled, and the temperature was still at 4.5 K.

This example demonstrates the use of the Measure command and Data query. The Getdat query will return data in the same format, and does not require a prior Measure command.

Execution of the Getdat query is different from the Data query in the following ways. The Getdat query does not access the data file, but rather the information returned reflects the status of the system at the time of the query. If the NoUpdateFlag is set (1), the Model 6000 will not return any data until all system information has been updated to ensure that the data returned represents current values. If the NoUpdateFlag is not set, the Model 6000 will immediately return values for the requested items without waiting for further updates.

A.3 Using the Tables and Mapping Data

The Mapdat, Table, and Tblmode commands are used to take existing system data and filter it through a calibration table to produce customized output. For example, the Mapdat command may be used to place the User Bridge Channel 1 data (Bit #4) into bit position 29, by the following command:

MAPDAT 29 4

However, the User Bridge Channel 1 data will have the format of resistance (ohms). In the case of a thermocouple, for example, specific resistance values would correspond to specific temperatures (according to, for example, the manufacturer's calibration table). This calibration table would be entered into the Model 6000, using the Table command. The following command:

TABLE 29 0 0 1, 5, 2, 7, 3, 10, 4, 14

will translate a resistance reading of 4 ohms to 14 kelvin (starting with the last calibration pair 4, 14), a reading of 3 ohms to 10 kelvin, 2 ohms to 7 kelvin, and 1 ohm to 5 kelvin.

Note, however, that this table is disabled, and hence not used, until the Tblmode command has been used to specify how data is to be returned. In order to enable the table, the following command would be given:

TBLMODE 29 1

This command specifies that data in bit position 29 be returned in calibrated (tabled) form. To disable the table, resulting in uncalibrated data return, you would use the command:

TBLMODE 29 0

This command will leave the calibration table intact, but not used, for later use. In summary; Mapdat is used to map information from a specific bit (one of bits 1-19) into another bit (one of bits 20-29); Table is used to filter data through a calibration table, converting it to a new form; and Tblmode specifies whether the calibration table (specified by the Table command) is to be used when data are mapped with the Mapdat command.

Used alone, Mapdat will directly map uncalibrated data from one bit to another. The mapped data will be presented in units according to Table One. The only exception to this is the Sample Space Pressure (see Table One, note 5). Sample Space Pressure data will be returned in their "raw" form, i.e. voltage rather than pressure.

Specific details for the use of these items is provided in the main portion of this manual.

A.4 Mapping Information

Bit positions 20 through 29 have been left open for user mapping, however, future PPMS systems may make use of bits 20-25. Therefore, it is recommended that User Mapped Items be utilized beginning with bit 29 and filling down to bit 20.

A.5 Notes for Table A-1

1 When using the Data query (Data?) or Getdat query (Getdat?), for a bit which is turned off or disabled, a bit value of zero (0) will be returned to indicate that the item is disabled. A TimeStamp will be returned following the zero, however, no additional information will follow. With the General System Status bit (bit 0) Data? and GetDat? is off.

2 When using the Link or Mapdat commands, the zero bit will disable the designated link, or map. Therefore, you may not Link or Map the General System Status as this will effectively unLink or unMap the item.

3 The Table and Tblmode commands cannot be used on bits 0 through 18. The Table, Tblmode, and Mapdat commands may be used on bits 19-29. When the table is enabled, the returned data will be provided in the units specified in the table command. If the table is disabled, data are returned in their "raw" format (see note 5).

4 When using the Link or Mapdat commands, note that bit 14 is a digital input therefore, the output will be a step function, and as such, will not be meaningful except for very specific applications. This bit is made available for use with the Link and Mapdat commands, however, the user should be aware of the effect of the digital data.

5 Bits 19 through 29 may have lookup tables down-loaded to them when used with the Mapdat, Table, and Tblmode commands. When the down-loaded table is enabled (Tblmode command), the data will be returned in user-units as defined within the table. If data are mapped (by the Mapdat command) to a bit, and the table is disabled, data will be returned in its "raw" format. For example, if the Mapdat command is used to map data from bit 19 (Sample Space Pressure) to bit 20, and no table has been enabled for bit 20, data will be returned in volts. (In fact, this is one way to verify that the pressure gauge is properly calibrated.) Data mapped from bits 1-18 will be returned in the format designated in **Table A-1** without regard to the Table status.

Table A-1 Rules for Selected GPIB Commands

Bit	Description of	Format/Units	Link	Mapdat	Table	Tblmode
0	General System Status See note (1).	Packed Codes	unLink (2)	unMap (2)	not used (3)	not used (3)
1	Temperature at Sample	kelvin			not used (3)	not used (3)
2	Magnetic Field at Sample	oersted			not used (3)	not used (3)
3	Position of Sample	User Units			not used (3)	not used (3)
4	User Bridge Channel 1	ohms			not used (3)	not used (3)
5	User Bridge Channel 1	microamps			not used (3)	not used (3)
6	User Bridge Channel 2	ohms			not used (3)	not used (3)
7	User Bridge Channel 2	microamps			not used (3)	not used (3)
8	User Bridge Channel 3	ohms			not used (3)	not used (3)
9	User Bridge Channel 3	microamps			not used (3)	not used (3)
10	User Bridge Channel 4	ohms			not used (3)	not used (3)
11	User Bridge Channel 4	microamps			not used (3)	not used (3)
12	Signal Input Channel 1	volts			not used (3)	not used (3)
13	Signal Input Channel 2	volts			not used (3)	not used (3)
14	Digital Inputs -Aux, Ext, etc	Bit Flags (8)	digital (4)	digital (4)	not used (3)	not used (3)
15	User Driver Channel 1	milliamps			not used (3)	not used (3)
16	User Driver Channel 1	watts			not used (3)	not used (3)
17	User Driver Channel 2	milliamps			not used (3)	not used (3)
18	User Driver Channel 2	watts			not used (3)	not used (3)
19	Sample Space Pressure	User Units/volts			not used (3)	not used (3)
20	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
21	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
22	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
23	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
24	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
25	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
26	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
27	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
28	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
29	User Mapped Item	User Calibration		see (5)	see (5)	see (5)
30	Reserved					
31	Reserved					

Table A-2 The Status Associated with the Bits of the General System Status Field

Bits	Description of General System Status Measure Codes	
	Value	**Status, Temperature**
0-3	0	Status unknown
	1	Normal stability at target temperature
	2	Stable
	5	Within tolerance, waiting for equilibrium
	6	Temperature not in tolerance, not valid
	7	Filling/Emptying reservoir
	10	Standby mode invoked
	13	Temperature control disabled
	14	Request cannot complete, impedance not functioning
	15	General failure in temperature system, contact Quantum Design
	Value	**Status, Magnet**
4-7	0	Status unknown
	1	Persistent mode, stable
	2	Persist switch warming
	3	Persist switch cooling
	4	Driven mode, stable at final field
	5	Driven mode, final approach
	6	Charging magnet at specified voltage
	7	Discharging magnet
	8	Current error, incorrect current in magnet
	15	General failure in magnet control system
	Value	**Status, Chamber**
8-11	0	Status unknown
	1	Purged and sealed
	2	Vented and sealed
	3	Sealed, condition unknown
	4	Performing purge/seal routine
	5	Performing vent/seal sequence
	8	Pumping continuously
	9	Flooding continuously
	15	General failure in gas control system
	Value	**Status, Sample Position**
12-15	0	Status unknown
	1	Sample stopped at target value
	5	Sample moving toward set point
	8	Sample hit limit switch
	9	Sample hit index switch
	15	General failure

Appendix B

Status Register Error Messages

B.1 Introduction

The Standard Event Status Register is an 8-bit structure with bits 4, 5, and 6 reserved by GPIB. Bits 0-3 and 7 are used by the Model 6000. For a readout of each bit use the **ISR?** query described in Appendix A of this manual. To read an individual bit, use the ***ESR?** query. It is important to distinguish between the definitions of "Status" and "Event". IEEE-488.2 uses "Event" to refer to an activity that is currently taking place. The hardware will reset the appropriate bit when the activity is complete. On the other hand, "Status" -- according to IEEE-488.2 -- is an activity that may be taking place now or has taken place recently. The hardware flag will not reset until a new "Status" is reported. To further distinguish these two states, the PPMS/GPIB documentation will refer to the 488.2 "Event" as a Device Condition to reflect the current condition of the particular device.

All the information contained in **Table B-1** through **Table B-4** provide status information. All the information provided in these tables are for people who want to program their own direct interface with the Model 6000. Do not manipulate any of these bits if you run any Quantum Design provided software. Not all bits have been implemented. In each table the bit numbers are indicated from the Least Significant Bit (LSB), starting with 1.

Table B-1 GPIB Command or Parameter Error Class (ISR? 0;)

Bit	Bit Name	Problem Description
1	Illegal Command	An unknown commands has been received. A common cause of this error is placing a space between a command and the query (?) mark.
2	Command too Long	The command string is too long or has no terminator (;). The maximum allowed string length is 256 characters.
3	Bad Parameter Count	A wrong number of parameters has been entered with the commands.
4	Bad Parameter	The entered command is illegal or contains inconsistent parameters.
5	Illegal Channel Number	An illegal channel number has been specified.
6	Command Rejected	The command has been rejected. The most likely cause of this error is that the requested task is unavailable or locked by another job in process.
7	Sequence File Full	The sequence file is full.
8	Not a Sequence Command	The command entered is not a sequence command.
9	Not Installed	A command has been entered for a hardware option that is not present in your system.
14	Command Not Done	The requested command is not available yet because another job is in process.
15	Reserved	
16	Reserved	

Table B-2 GPIB Communication or Execution Error Class (ISR? 1;)

Bit	Bit Name	Problem Description
1	Hardware Error	A hardware error has been detected. When this message is displayed the user should perform a *TST? to determine the location of the hardware error.
2	Transmit Overrun	This is a transmit buffer overrun error. The MAV (Message Available) bit is full and should be cleared (using Device Clear) or a serial poll should be performed until the MAV bit is empty.
3	Receive Overrun	The receive buffer is full. Information is being sent too fast or the connection to the receiving device is not working properly.
4	Uncleared Command, Device Clear	This is a GPIB error. If a Device Clear has just been performed, this message will appear, indicating that the bus has reset and communications are ready to continue. If no Device Clear has been performed, this will indicate static on a transmission line or poor/improper connections.
5	Bus Error	This is a GPIB handshake protocol error that indicates the host is not responding. Check connections.
6	Time Out	This error should not appear on current PPMS systems.
7	RS232 Receive Error	RS-232 has an overrun error flag, parity error flag, or frame error flag.
8	QSM Transmit Error	This error indicates a communication error between the mother board and CPU. If this error consistently occurs, it indicates a hardware problem.
16	Firmware Error	This indicates a firmware error. Contact Quantum Design for further assistance.

Table B-3 GPIB File Operations Status Class (ISR? 3;)

Bit	Bit Name	Status Description
1	New Data Record	This status bit reports a new data record is present.
2	Data File Overrun	This status bit reports the data file is full.
3	Done Running	A batch file has finished running.
4	Aborted	A batch file was aborted.
5	Paused	A batch file was paused.
6	Error During Execution	An error occurred in the batch file during execution.
7	Next Command has been Executed	The next command in the batch file has been executed.
9	Advisory Executed	This status bit reports that an ADVISE command has been executed.
10	Sync Executed	This status bit reports that a SYNC command has been executed.

Table B-4 GPIB DC 5000 Class (ISR? 5; or *ESR?)

Bit	Bit Name	Status Description
7	User Request	This status bit is set as a result of the execution of the USERREQ command.
8	Power On	This status bit reports that the Model 6000 has either been turned on or has been reset.