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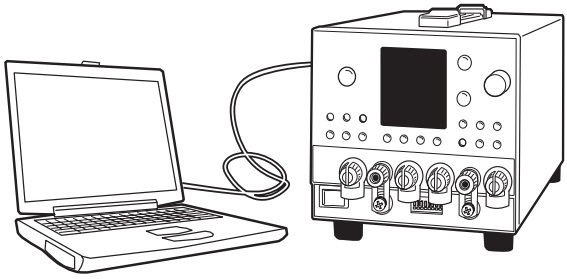
Communication Interface Manual

Multiple-output Regulated DC Power Supply

PMP Series



KIKUSUI

Use of Operation Manual

Please read through and understand this Operation Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

If you find any misplaced or missing pages in this manual, they will be replaced. If the manual gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the "Kikusui Part No." given on the cover.

This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

How to Read This Manual

Preface

This manual is intended for first-time users of the PMP Series (with a GPIB, RS232C, or USB interface option). It gives an overview of the PMP and describes various settings, etc.

Read this manual thoroughly to use the functions of the PMP effectively. You can also review this manual when you are confused about an operation or when a problem occurs.

How to read this manual

The Multiple-output Regulated DC Power Supply PMP Series Communication Interface Manual explains the settings and commands for remotely controlling the PMP using the interface and gives sample programs.

Related manuals

For the safety precautions, installation, operation, and specifications of the PMP, read the accompanying Multiple-output Regulated DC Power Supply PMP Series Operation Manual.

Intended readers of this manual

This manual is written for readers with sufficient basic knowledge of how to control instruments using a personal computer.

Structure of this manual

This manual consists of the following chapters. The following outlines each chapter.

Chapter 1 Remote Control

This chapter gives an overview of the remote control function and explains the SCPI command structure, syntax, and so on used in the remote control.

Chapter 2 Commands

This chapter describes the details of commands and registers.

Appendix

The appendix contains lists of messages, lists of command errors, tutorials, sample programs, and interface specifications.

Notations used in the manual

- The following marks are used with the corresponding explanations in this manual.

NOTE

Indicates information that you should know.

See

Indicates reference to detailed information.

>

Indicates menu settings that you select. The menu item to the left of the > symbol is a higher level menu.

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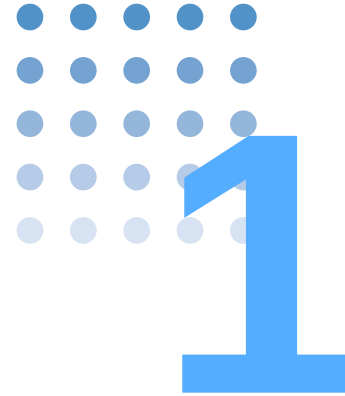


Remote Control

This chapter gives an overview of the remote control function and explains the SCPI command structure, syntax, and so on used in the remote control.

1.1 Remote Control Overview

In addition to using the front panel, the PMP can be controlled remotely using one of the following interfaces.

- RS232C interface
- GPIB interface
- USB interface

The remote interface complies with IEEE Std 488.2-1992 and SCPI Specification 1999.0.

See page 1-15

Use the SCPI commands only after you have understood the SCPI command syntax of the PMP.

When the PMP is operating under remote control, the REMOTE LED of the display on the front panel illuminates. To switch from the remote mode to the local mode (panel operation) from the panel, press the LOCAL switch.

1.2 Instrument Interface Standards

The PMP conforms to the following standards.

- IEEE Std 488.2-1992 IEEE Standard Codes, Formats, Protocols, and Common Commands for use with IEEE Std 488.1-1987
- IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation
- Standard Commands for Programmable Instruments (SCPI) version 1999.0
- Universal Serial Bus Specification Rev 2.0
- Universal Serial Bus Test and Measurement Class Specification (USBTMC) Rev 1.0
- Universal Serial Bus Test and Measurement Class, Subclass USB488 Specification (USBTMC-USB488) Rev 1.0

1.3 VISA Library

If you are using a VISA library (VISA COM) for the I/O library, the VISA library must be installed on the computer (herein after called “the computer”).

A device driver supporting USB T&M Class (USBTMC) is required to control the PMP through the optional USB interface. The USBTMC driver is automatically installed by the VISA library.

VISA (Virtual Instrument Software Architecture) is a specification for standard software for connecting instruments that was defined by the VXIplug&play Systems Alliance.

One of the VISA libraries (driver software implemented in compliance with the VISA specifications) below is necessary.

Older version of VISA libraries does not support USB. USB functions for those cannot be used on Windows 95 or Windows NT 3.5x or 4.0.

- NI-VISA by National Instruments (Ver. 3.0 or later, Ver. 3.2 or later for Windows 2000 and Windows XP)
- Agilent VISA by Agilent Technologies (Agilent IO Libraries M01.00 or later)
- KI-VISA Ver. 3.0.0 or later

KI-VISA is Kikusui original VISA library compatible with VXIplug&play VISA Specifications 3.0. The latest version can be downloaded from Kikusui website (http://www.kikusui.co.jp/download/). KI-VISA is not required if NI-VISA or Agilent VISA is already installed.

KI-VISA Library Programming Guide is also available on the Kikusui’s website.

1.4 Interface Setup

The factory default setting of remote control interface depends on the type of installed interface board.

If any of the factory option interface board is installed, a menu for the interface is added in the CONFIG settings and it will be shown on the display.

The CONFIG parameters vary depending on the interface installed as a factory option. Change the settings as necessary.

The voltmeter displays the CONFIG parameter, and the ammeter displays the setting.

1.4.1 RS232C Control

This interface is valid only when the factory option RS232C interface board is installed.

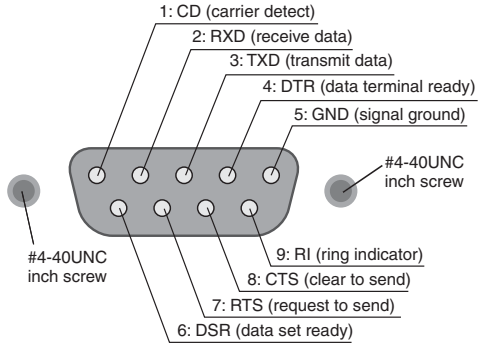
RS232C connection

The RS232C port on the PMP is a standard D-sub 9-pin male connector.

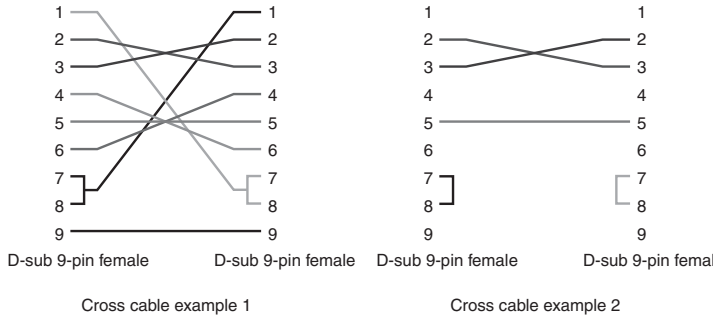
Check that the POWER switches of the PMP and the computer are turned off, and connect the PMP to the computer using a standard cross cable (null modem cable).

Use a D-sub 9-pin female-to-female AT type for the cross cable. Fig. 1-1 shows the connector pin assignments.

The PMP does not use hardware handshaking (cross cable example 2).



Facing the PMP rear panel



Cross cable example 1 Cross cable example 2

Fig. 1-1 9-pin AT type connector

RS232C configuration

Set the RS232C protocol and the error trace function by carrying out the steps below. The voltmeter, ammeter, CONFIG switch, rotary knob, and output display selection switch are used in the configuration.

Table 1-1 CONFIG parameters (RS232C)

Voltmeter		Description of the setting or display
ON.PO	On.Po	Power-on output-on setting
TR.CH	tr.CH	Tracking setting
SENS	SEnS	Remote sensing setting
VO.LI	Vo.L i	Operation setting at upper/lower voltage limit
CU.LI	Cu.L i	Operation setting at upper/lower current limit
VO.FI	Vo.F i	Voltage fine setting
CU.FI	Cu.F i	Current fine setting
TRAC	trAc	Error trace function setting
BAUD	bAud	Baud rate setting
FCTL	FCtL	Flow control setting

See PMP Series Operation Manual CONFIG Setup

1. Press the CONFIG switch to show the CONFIG display.
2. Set the error trace (trAc), baud rate (bAud), and flow control (FCtL).

   For the settings, see Table 1-2 and Table 1-3.
3. Press the CONFIG switch to return to the normal display.
4. Turn the POWER switch off.

   The settings are fixed when the POWER switch is turned off.

Protocol

Table 1-2 shows the RS232C protocol. The underline indicated in the table specifies the factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 1-2 RS232C protocol

Item	Setting
Connector	9-pin D-sub terminal on the rear panel
Baudrate	1200 bps/ 2400 bps/ 4800 bps/ 9600 bps/ 19200 bps / 38400 bps (1.2 / 2.4 / 4.8 / 9.6 / 19.2 / 38.4)
Data (data length)	Fixed to 8 bit
Stop (stop bit)	Fixed to 1 bit
Parity	Fixed to none
Flow (flow control)	XFLOW / none (on / oFF)

Break signal

The break signal functions as a substitute for the IEEE488.1 dcl/sdc (Device Clear, Selected Device Clear) message.

Error trace function

This function is to select whether to show or hide the error number on the display when there is an error log in the SCPI error queue during remote control.

The underline indicated in the Table 1-3 specifies the status of factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 1-3 RS232C error trace function

Item	Setting
Error trace function	Error number display/no display (on/oFF)

RS232C communication

Use flow control for RS232C communication. DC (device control) codes are used as the control codes.

Transmission/reception may not work correctly through unilateral transmission.

Table 1-4 DC codes

Code	Function	ASCII code
DC1 (Xon)	Transmission request	11H
DC3 (Xoff)	Transmission stop request	13H

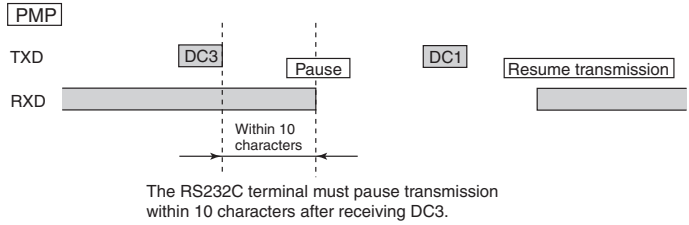


Fig. 1-2 RS232C terminal and transmission control of the PMP

1.4.2 GPIB Interface

This interface is valid only when the factory option GPIB interface board is installed.

GPIB connection

Use a standard IEEE488 cable to connect the PMP to the computer.

GPIB configuration

Set the GPIB error trace function and address by carrying out the steps below. The voltmeter, ammeter, CONFIG switch, rotary knob, and output display selection switch are used in the configuration.

Table 1-5 CONFIG parameters (GPIB)

Voltmeter		Description of the setting or display
ON.PO	On.Po	Power-on output-on setting
TR.CH	tr.CH	Tracking setting
SENS	SEnS	Remote sensing setting
VO.LI	Uo.L i	Operation setting at upper/lower voltage limit
CU.LI	Cu.L i	Operation setting at upper/lower current limit
VO.FI	Uo.F i	Voltage fine setting
CU.FI	Cu.F i	Current fine setting
TRAC	trAc	Error trace function setting
ADRS	AdrS	Address setting

See PMP Series Operation Manual CONFIG Setup

1. Press the CONFIG switch to show the CONFIG display.
2. Set the error trace (trAc) and address (AdrS).

   For the settings, see Table 1-6.
3. Press the CONFIG switch to return to the normal display.
4. Turn the POWER switch off.

   The settings are fixed when the POWER switch is turned off.

Error trace function and GPIB address

For the error trace function, select whether to show or hide the error number on the display when there is an error log in the SCPI error queue during remote control.

The underline indicated in the Table 1-6 specifies the status of factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 1-6 GPIB error trace function and address

Item	Setting
Error trace function	Error number display/no display (on/oFF)
GPIB address.	1 to 30 (1 to 30)

GPIB function

Table 1-7 GPIB functions

Function	Subset	Description
Source handshaking	SH1	Full capability
Acceptor handshaking	AH1	Full capability
Talker	T6	Capability available (excludes the talk-only capability)
Listener	L4	Capability available (excludes the talk-only capability)
Service request	SR1	Full capability
Remote local	RL1	Full capability
Parallel polling	PP0	No capability
Device clear	DC1	Full capability
Device trigger	DT1	Full capability
Controller	C0	No capability
Electrical interface	E1	Open collector driver

Service request

Service request and serial polling functions are implemented.

1.4.3 USB Interface

This interface is valid only when the factory option USB interface board is installed.

See page 1-3

A device driver supporting USB T&M Class (USBTMC) is required to control the PMP through the USB interface. The USBTMC driver is automatically installed by the VISA library.

USB connection

Use a USB cable.

USB configuration

Set the error trace function of USB by carrying out the steps below. You can check the vendor ID and product ID. The voltmeter, ammeter, CONFIG switch, rotary knob, and output display selection switch are used in the configuration.

Table 1-8 CONFIG parameters (USB)

Voltmeter		Description of the setting or display
ON.PO		Power-on output-on setting
TR.CH		Tracking setting
SENS		Remote sensing setting
VO.LI		Operation setting at upper/lower voltage limit
CU.LI		Operation setting at upper/lower current limit
VO.FI		Voltage fine setting
CU.FI		Current fine setting
TRAC		Error trace function setting
VID		Vendor ID display
PID		Product ID display

See PMP Series Operation Manual CONFIG Setup

1. Press the CONFIG switch to show the CONFIG display.
2. Set the error trace (trAc).

   For the settings, see Table 1-9.
3. Press the CONFIG switch to return to the normal display.
4. Turn the POWER switch off.

   The settings are fixed when the POWER switch is turned off.

Error trace function

This function is to select whether to show or hide the error number on the display when there is an error log in the SCPI error queue during remote control.

The underline indicated in the Table 1-9 specifies the status of factory default condition. The value inside the parentheses is the CONFIG setting value.

Table 1-9 USB error trace function

Item	Setting
Error trace function	Error number display/no display (on/oFF)

Service request

Service request and serial polling functions are implemented.

USB function

Complies with USB Specification 2.0.

Complies with USBTMC Specification 1.0 and USBTMC-USB488 Specification 1.0.

Data rate: 12 Mbps maximum (full speed).

Vendor ID (VID): 0x0B3E ()

Product ID (PID): 0x1011 ()

1.5 Additional Feature

Interface board

See page 2-22

The following feature is available for the optional interface board only when it is operated in the remote control.

- Increased number of memory sets from 3 to 10.

NOTE

- If operating from the panel, only memories 1 to 3 can be recalled.

1.6 Overview of Messages

The information that is exchanged between the computer and the PMP is called a message.

The PMP uses the SCPI language for the messages.

There are two types of messages, commands that are sent from computer to the PMP and responses that are sent from the PMP to the computer.

Commands are used to execute functions of the PMP, change settings, and query settings and status. Responses return the settings and status of the PMP.

Command hierarchy

SCPI is an ASCII-based command language designed for test and measurement devices. The command hierarchy is structured around the common root or node, which is the construction block of the SCPI sub system. A command consists of a program header, parameters, and punctuations.

The hierarchy is explained using the SOURce subsystem as an example.

Program header	Parameter	Node hierarchy
[SOURce:]		Root node
VOLTage		2nd level
[:LEVel]		3rd level
:TRACking		4th level
[:RATio]	<numeric>	5th level
CURRent		2nd level
[:LEVel]		3rd level
[:IMMediate]		4th level
[:AMPLitude]	<numeric>	5th level
:TRIGgered		4th level
[:AMPLitude]	<numeric>	5th level

A higher node is separated from a lower node using a colon (:).

1.6.1 SCPI Command Syntax

Command syntax

This manual denotes SCPI commands using the following format.

(Example)

```
[SOURce:]CURRent[:LEVel][:IMMediate]
  [:AMPLitude] {<current>|MINimum|MAXimum}
```

- There are two forms of SCPI commands, the long form in which the command is written out in its entirety and the short form in which the letters written in lowercase are omitted.

  SCPI commands can be sent either in the long form or short form.

- SCPI commands are not case sensitive. CURR, Curr, and curr are all accepted as short forms of CURRent.

  CURRENT, Current, current are all accepted as long forms.

- A space is required between the program header section and the parameter section.

- Multiple parameters, when available, are concatenated using commas.

- Compound commands can be created by concatenating two commands with a semicolon.

  (Example)

  ```
  SOURce:CURRent MINimum;VOLTage MINimum
  ```

  This compound command is the same as entering the following two commands.

  ```
  SOURce:CURRent MINimum
  SOURce:VOLTage MINimum
  ```

  The first command, SOURce:CURRent MINimum, sets the path to SOURce. Therefore, the root node, SOURce, can be omitted in the second command.

  An error occurs if a node that is not defined in the current path (except CURRent and VOLTage) is designated.

- A colon is required between program headers.
- Commands of different subsystems can be concatenated using colons and semicolons.

  (Example)

  ```
  SOURce:CURRent MINimum;:MEASure:CURRent?
  ```

  This compound command contains two root nodes, SOURce and MEASure.

  When the second or subsequent command starts with a colon, the path specified by the previous command is cleared.
- The maximum number of characters that can be transmitted in a single line is 256.

Special symbols and characters

Special symbols and characters used in this manual to describe SCPI commands are defined as indicated in Table 1-10.

Table 1-10 Definitions of special symbols and characters

Symbols or Characters	Description
< >	Characters strings inside the < and > symbols indicate program data. Do not include these symbols in the actual program.
{ }	Characters and numbers delimited by "|" in braces indicate that one of the items is to be selected. Do not include the braces in the actual program.
[ ]	Characters strings inside brackets indicate optional data. When option data is not sent with the program, the default value is sent. Do not include the brackets in the actual program.

Query

The device settings or status can be queried.

To make a query, add a question mark at the end of the program header section. If a query has parameters, enter a space after the question mark followed by the parameters.

(Example)

```
CURRent? MIN
```

NOTE

- When transmitting two queries in separate lines, read the response to the first query before transmitting the second line. If you send two lines of queries at once, an incomplete response may be received.

  For GPIB or USB, an SCPI error (-410, “Query INTERRUPTED”) may occur.

String termination

All commands must be terminated using a valid terminator.

The available terminators are <line feed> (ASCII 0x0A) and EOI (end-or-identify).
Either one can be used as a terminator.

Because EOI is not available on the RS232C, be sure to use <line feed>.

When a command string is terminated, the path is reset to the root level.

NOTE

- CR (ASCII 0x0D) is not a terminator.

Common commands

See page 2-2

The IEEE-488.2 and SCPI standards contain a set of common commands for reset, self-test, and other functions. These common commands always start with an asterisk. The commands may have one or multiple parameters.

1.6.2 Parameters

The parameter format of SCPI is derived from the program parameter format defined in IEEE 488.2.

The representation system of the program data that is used on the PMP is indicated below.

Non-numeric parameters

The PMP uses the following two types of numeric parameters.

Table 1-11 Non-numeric parameters

Symbols or Characters	Description
Character data	Used when only a limited number of values is available for the program setting. Responses are returned in the short form. (Example) `TRIGger:SOURce {IMMediate|BUS}`
Boolean data	Expresses a 1 or 0 condition or an ON or OFF condition. Responses are returned as 1 or 0. (Example) `OUTPut {ON|OFF|1|0}`

Numeric parameters

The PMP uses the following five types of numeric parameters.

Table 1-12 Numeric parameters

Symbols or Characters	Description
NR1	Represents an integer. *1
NR2	Represents a real number (floating point). *1
NR3	Represents a real number (exponential).*1
NRf	NRf is a generic term that includes NR1, NR2, and NR3.
Numeric	Represents a decimal point, optional sign, and measurement unit. The numeric representation syntax is the same as NRf. MINimum and MAXimum are available as substitutes for declaring certain values. Units such as V, A, and S can also be used in a numeric parameter. If a value that cannot be assigned is entered, the device rounds the value to the closest possible value. (Example) `SOURce:CURRent:TRACking 300` The range of values for SOUR:CURR:TRAC is 0 to 200. Thus, 200 is set even if 300 is specified.

*1. Details are given in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.

Special form numeric parameters

The special form numeric parameters MINimum and MAXimum can be used as substitutes for limit values when the parameter is numeric.

In the example below, the current is set to the minimum value.

```
CURRent MINimum
```

The minimum and maximum values can be inquired for most parameters using queries.

```
CURRent? MIN
CURRent? MAX
```

Measurement unit

Below are the default measurement units.

- V (voltage)
- A (current)
- S (second)
- PCT (percent)

The following optional prefixes are supported.

- M (milli)
- U (micro)

NOTE

- In accordance with the International System of Units, the unit symbols contain lowercase characters. The IEEE standard uses uppercase characters. SCPI commands are not case sensitive.
- Commands are accepted even if measurement units are not specified.
- To enter “μ” in the data, use “U” instead.

1.7 Command Description in This Manual

This manual describes the commands in the following manner.

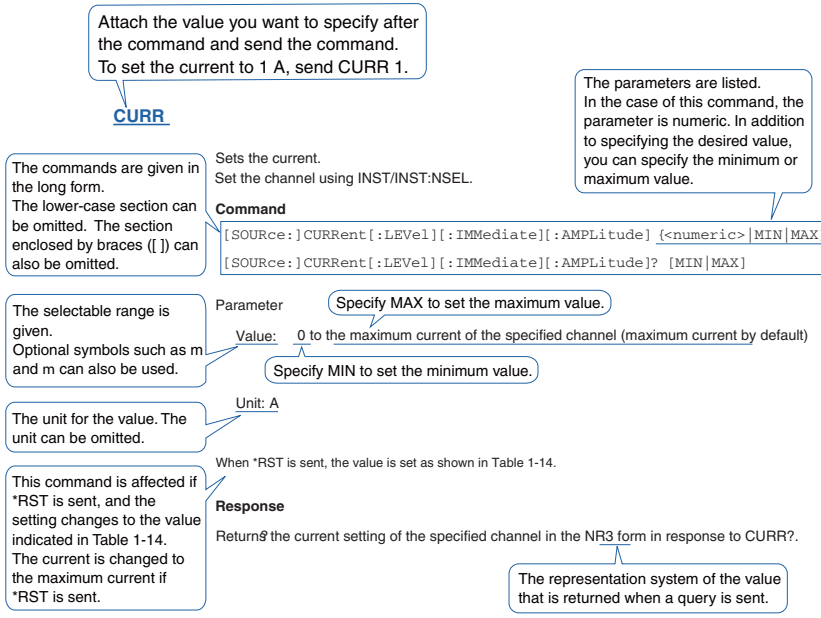


Table 1-13 Command items and reference pages

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1.8 Default Conditions

See page 2-5

Table 1-14 shows how the PMP is set when the *RST command is executed, at the time of factory shipment, and when the power is turned on.

Table 1-14 Conditions after sending a *RST and at power-on

Setting	Value			Unit	Function
	*RST	Factory default	At power-on		
OUTP	0/OFF	0/OFF	0/OFF*1	–	Turns the output on/off.
OUTP:TRAC	OFF	OFF	OFF	–	Sets the tracking operation.
OUTP:DEL	0/OFF	0/OFF	Setting immediately before turning the POWER switch off.	–	Sets the delay operation on/off setting between channels.
OUTP:PON:STAT	RST*2	RST*2		–	Output status at power-on.
VOLT	0	0		V	Sets the voltage.
VOLT:TRAC	100	100	100	PCT	Sets the tracking function 2 voltage.
CURR	Maximum current	Maximum current	Setting immediately before turning the POWER switch off.	A	Sets the current.
CURR:TRAC	100	100	100	PCT	Sets the tracking function 2 current.
INST:SEL / INST:NSEL	CH1/1	CH1/1	CH1/1	–	Sets the channel to be controlled.
INST:FOC	CH1	CH1	Setting immediately before turning the POWER switch off.	–	Sets the channel to be displayed.
INST:COUP	NONE	NONE	NONE	–	Sets multiple channels.
OUTP:TRIG	0/OFF	0/OFF	0/OFF	–	Sets whether to turn the output on/off using a trigger.

Setting	Value			Unit	Function
	*RST	Factory default	At power-on		
VOLT:TRIG	0	0	0	V	Target voltage using a trigger
CURR:TRIG	Maximum current	Maximum current	Maximum current	A	Target current using a trigger
TRIG:SOUR	BUS*3	BUS*3	BUS*3	–	Sequence 1 trigger source
TRIG:SEQ2:DEL:ON / TRIG:OUTP:DEL:ON	0	0	Setting immediately before turning the POWER switch off.	S	Sets the output on delay.
TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF	0	0		S	Sets the output off delay.
TRIG:SEQ2:SOUR / TRIG:OUTP:SOUR	BUS*3	BUS*3	BUS*3	–	Sequence 2 trigger source
SYST:CONF:TRAC	0/OFF	0/OFF	Setting immediately before turning the POWER switch off.	–	Sets the tracking function.
SYST:CONF:RSEN	0/OFF	0/OFF		–	Sets the remote sensing.
SYST:KLOC	No change	OFF		–	Locks the panel operation.
SYST:TRAC		0/OFF		–	Sets the debug trace.

*1. The PMP may power up at 1/ON depending on the OUTP:PON:STAT setting.
*2. Output on when RST:POWER is on.
*3. BUS: Start on a software trigger.

Commands

This chapter describes the details of commands and registers.

2.1 IEEE488.2 Common Commands

*CLS

Clears all event registers including the status byte, event status, and error queue.

See page 2-39

Command

```
*CLS
```

*ESE

See page 2-43

Sets the event status register that is counted by the event summary bit (ESB) of the status byte.

Command

```
*ESE <NR1>
*ESE?
```

Parameter

Setting: 0 to 255

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(ex) When *ESE 16 is transmitted, bit 4 of the event status enable register is set. Each time the execution error bit (bit 4) of the event status register is set, the summary bit (ESB) of the status byte is set.

Response

Returns the value of the event status enable register in the NR1 form in response to *ESE?.

*ESR

See page 2-43

Queries the event status register. Registers that are read are cleared.

Command

```
*ESR?
```

Response

Returns the value of the event status register in the NR1 form in response to *ESR? and clears the register.

*IDN

Queries the model name, serial number, and firmware version of the PMP.

Command

```
*IDN?
```

Response

The response to *IDN? is indicated below.

(ex) For PMP16-1QU with a serial number AB123456, firmware version 1.00, and option firmware version 1.01

```
Returns     KIKUSUI,PMP16-1QU,AB123456,1.00
1.01.
```

NOTE

- The option firmware version is 0.00 if the RS232C interface board is installed.

*OPC

See Section 12.5.3 in IEEE 488.2-1992

Sets the OPC bit (bit 0) of the event status register when the processing of all commands standing by is complete.

Command

```
*OPC
*OPC?
```

Response

Returns 1 when all the commands processing in stand by are completed in response to *OPC?.

*OPT

Queries the option interface board that is installed in the PMP.

Command

```
*OPT?
```

Response

Returns the interface board that is installed as character data in response to *OPT?.

*PSC

See Section 10.25 in IEEE 488.2-1992

Sets whether to clear the event status enable register and the service request enable register when the POWER switch is turned on (power-on status).

Command

```
*PSC {0|1}
*PSC?
```

Parameter

Setting:	0	Does not clear the *ESE and *SRE settings when the POWER switch is turned on.
	1	Clears the *ESE and *SRE settings when the POWER switch is turned on.

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(ex) To enable the power-on SRQ function

```
*PSC 0;*SRE 32;*ESE 128
```

Response

Returns the power-on status setting in the NR1 form in response to *PSC?

*RST

See page 1-22

Aborts the measurement operation and initializes the PMP to factory default condition.

For the commands that are affected by *RST, see Table 1-14.

Command

```
*RST
```

*SRE

Sets the service request enable register.

The service request enable register is used to select the summary messages in the status byte register that will be able to perform service requests.

To clear the service request enable register, send *SRE 0. If the register is cleared, service requests cannot be generated by status information.

Command

```
*SRE <NR1>
*SRE?
```

Parameter

Setting: 0 to 255

An SCPI error (-222, “Data out of range”) occurs if outside the range.

(ex) Sending *SRE 8 sets bit 3 of the service request enable register. Each time the summary bit (bit 3) of the QUESTionable status register in the status byte is set, a service request message is generated.

Response

Returns the value of the service request enable register in the NR1 form in response to *SRE?.

*STB

See page 2-41

Queries the contents of the status byte register and the MSS (master summary status) message.

The response is the same as serial polling only with the exception that the MSS message appears in place of the RQS message in bit 6.

Command

```
*STB?
```

Response

Returns the value of the status byte register and the MSS message (bit 6) in NR1 form in response to *STB?.

*TRG

See Section 10.37 in IEEE 488.2-1992

Trigger command.

This is a substitute command for the IEEE488.1 get message (Group Execute Trigger).

This command applies a software trigger to all sequence groups.

If the PMP is not in a condition to accept triggers, an SCPI error (-211,“Trigger ignored”) occurs.

Command

```
*TRG
```

*TST

See Section 10.38 in IEEE 488.2-1992

This command is for executing a self-test, but the PMP is not equipped with this feature.

Command

```
*TST?
```

Response

Always returns 0 in response to *TST?.

*WAI

Prevents the PMP from executing subsequent commands until all operations in standby are complete.

Command

```
*WAI
```

2.2 Output Setting

OUTP

Turn the output on/off.

If the delay output operation is set to on or off, the output turns on or off after the specified time elapses.

See
page 2-10
page 2-29
page 2-30

Set the output delay operation using OUTP:DEL, TRIG:SEQ2 :DEL:ON / TRIG:OUTP:DEL:ON or TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF.

Command

```
OUTPut[:STATe][:IMMediate] {ON|OFF|1|0}
OUTPut[:STATe][:IMMediate]?
```

Parameter

Setting:	ON(1)	Output on
	OFF(0)	Output off (default)

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the output status in the NR1 form in response to OUTP?.

OUTP:PON:STAT

Sets the output state at power-on.

Command

```
OUTPut:PON:STATe {RST|AUTO}
OUTPut:PON:STATe?
```

Parameter

Setting:	RST	Output off at power-on (default)
	AUTO	Output on at power-on

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the output state at power-on as character data in response to OUTP:PON:STAT?.

OUTP:DEL

See PMP Series Operation Manual Delay Function

Sets the delay operation for turning on or off the output.

You can also set the output delay operation in sequence 2.

Set the delay time using TRIG:SEQ2:DEL:ON / TRIG:OUTP :DEL:ON or TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF.

Command

```
OUTPut:DELay[:STATe] {ON|OFF|1|0}
OUTPut:DELay[:STATe]?
```

Parameter

Setting:	ON(1)	Delay operation on
	OFF(0)	Delay operation off (default)

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the delay operation setting in the NR1 form in response to OUTP:DEL?.

OUTP:TRAC

Sets the output tracking operation.

If tracking function 1 is set, the channel specified using INST / INST:NSEL becomes the reference channel and reference value.

Command

```
OUTPut:TRACking[:MODE] {OFF|RAT|ABS}
OUTPut:TRACking[:MODE] ?
```

Parameter

Setting:	OFF	Tracking operation off (default)
	ABS	Tracking function 1 (absolute change)
	RAT	Tracking function 2 (proportional change)

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the tracking operation setting as character data in response to OUTP:TRAC?.

Voltage Settings

VOLT

Sets the voltage.

See page 2-18

Set the channel using INST / INST:NSEL.

Command

```
[SOURce:]VOLTage[:LEVel][:IMMediate]
   [:AMPLitude] {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel][:IMMediate]
   [:AMPLitude]? {MIN|MAX}
```

Parameter

Setting:	0 to the maximum voltage of the specified channel (zero by default)
Unit:	V

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the voltage setting of the specified channel in the NR3 form in response to VOLT?.

VOLT:TRAC

Sets the ratio of the voltage change for the tracking function 2.

Set the channel using SYST:CONF:TRAC.

Send OUTP:TRAC RAT to specify tracking function 2 before sending VOLT:TRAC.

Command

```
[SOURce:]VOLTage[:LEVel]:TRACking[:RATio]
  {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel]:TRACking[:RATio]?
  [MIN|MAX]
```

Parameter

Setting:	0.0 to 200.0 (default: 100.0)
Unit:	PCT

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the ratio of change for the tracking function 2 in the NR3 form in response to VOLT:TRAC?.

Current Settings

CURR

Sets the current.

See page 2-18

Set the channel using INST / INST:NSEL.

Command

```
[SOURce:]CURRent[:LEVel][:IMMediate]
   [:AMPLitude] {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel][:IMMediate]
   [:AMPLitude]? [MIN|MAX]
```

Parameter

Setting:	0 to the maximum current of the specified channel (maximum current by default)
Unit:	A

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the current setting of the specified channel in the NR3 form in response to CURR?.

CURR:TRAC

Sets the ratio of the current change for the tracking function 2.

Set the channel using SYST:CONF:TRAC.

Send OUTP:TRAC RAT to specify tracking function 2 before sending CURR:TRAC.

Command

```
[SOURce:]CURRent[:LEVel]:TRACking[:RATio]
  {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel]:TRACking[:RATio]?
  [MIN|MAX]
```

Parameter

Setting: Value: 0.0 to 200.0 (default: 100.0)

Unit: PCT

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the ratio of change for the tracking function 2 in the NR3 form in response to CURR:TRAC?.

2.3 Measurement Operation Settings

The response data is always generated using the latest measured values.

MEAS and READ perform the same operations.

MEAS:VOLT / READ:VOLT

Queries the measured value of the voltage output.

See page 2-21

To query the measured values of multiple channels simultaneously, use the INST:COUP command.

Command

```
MEASure[:SCALar]:VOLTage[:DC]?
READ[:SCALar]:VOLTage[:DC]?
```

Response

Returns the measured value of the voltage output in the NR3 form in response to MEAS:VOLT? / READ:VOLT?.

If multiple channels are specified, the measured values are returned in ascending order by channel number with a comma separating each value.

MEAS:CURR / READ:CURR

Queries the measured value of the current output.

See page 2-21

To query the measured values of multiple channels simultaneously, use the INST:COUP command.

Command

```
MEASure[:SCALar]:CURRent[:DC]?
READ[:SCALar]:CURRent[:DC]?
```

Response

Returns the measured value of the current output in the NR3 form in response to MEAS:CURR? / READ:CURR?.

If multiple channels are specified, the measured values are returned in ascending order by channel number with a comma separating each value.

2.4 Clearing the Alarm

OUTP:PROT:CLE

Clears the alarm.

Command

```
OUTPut:PROTection:CLEar
```

⚠CAUTION

- When the alarm signal is applied by the external contact, the output can be shut off, however, the alarm signal may not be generated if the time for the short-circuit of contact is less than 0.5 s. In this case, this command can not clear the function completely. Therefore, turn off the POWER switch once.

2.5 Setting the Channels

Specifies settings related to the channel function.

INST / INST:NSEL

Sets the channel for applying the commands using a channel name or channel number.

INST / INST:NSEL only applies to commands, but not to change for the channel displayed on the panel. To select the channel for applying both the commands and the channel shown on the panel display at the same time as with the output display selection switch, you must send the INST:FOC command along with this command.

If you execute the command while tracking function 1 is in operation, the channel specified with this command becomes the reference channel. The amount of change is cleared, and the value at that point becomes the reference value.

Command

```
INSTrument[:SELect] {CH1|CH2|CH3|CH4}
INSTrument[:SELect]?
INSTrument:NSELect {1|2|3|4}
INSTrument:NSELect?
```

Parameter `(INST)`

Setting:		
	CH1	Apply the commands to channel 1 (default)
	CH2	Apply the commands to channel 2
	CH3	Apply the commands to channel 3
	CH4	Apply the commands to channel 4 (4-output model only)

Parameter `(INST:NSEL)`

Setting:		
	1	Apply the commands to channel 1 (default)
	2	Apply the commands to channel 2
	3	Apply the commands to channel 3
	4	Apply the commands to channel 4 (4-output model only)

Response

Returns the channel for applying the commands as character data in response to INST?.

Returns the channel for applying the commands in the NR1 form in response to INST:NSEL?.

INST:FOC

Sets the channel displayed on the panel.

Command

```
INSTrument[:SELect]:FOCus {CH1|CH2|CH3|CH4}
INSTrument[:SELect]:FOCus?
```

Parameter

Setting:	CH1	Display channel 1 on the panel (default)
	CH2	Display channel 2 on the panel
	CH3	Display channel 3 on the panel
	CH4	Display channel 4 on the panel (4-output model only)

Response

Returns the channel displayed on the channel as character data in response to INST:FOC?.

INST:COUP

Specifies the applicable channels when applying the commands to the plural number of channels.

Commands that can be applied are MEAS:CURR / READ:CURR and MEAS:VOLT / READ:VOLT.

Be sure to execute INST:COUP at the same time as INST or INST:NSEL.

If channels specified by INST or INST:NSEL are not included in the channels specified by INST:COUP, commands will not be applied to multiple channels.

Command

```
INSTrument:COUPle
  {<list>|ALL|NONE}[,<list>][,<list>][,<list]
INSTrument:COUPle?
```

Parameter

<list> is a collective term that includes CH1, CH2, CH3, and CH4.

Setting:	CH1 to CH4	Specify any channels between channel 1 and channel 4 (CH4 available only on the 4-output model)
	ALL	Specify all
	NONE	Not specify (default)

(ex) To apply the commands to CH1 and CH3

```
INST CH1
INST:COUP CH1,CH3
```

Response

Returns the setting for applying the commands to multiple channels as character data in response to INST:COUP?.

2.6 Memory Function

This section explains the commands related to the memory functions of the PMP.

MEM:SAV

Saves the present voltage, current, and delay time settings of the PMP to the memory.

```
MEMory:SAV <NRf>
```

Setting: 1 to 10

(4 to 10 available only during remote control)

An SCPI error (-222, “Data out of range”) occurs if outside the range.

MEM:RCL

Recall the memory value.

The memory value cannot be recalled while the delay function is in operation.

Command

```
MEMory:RCL <NRf>
```

Setting: 1 to 10

(4 to 10 available only during remote control)

An SCPI error (-222, “Data out of range”) occurs if outside the range.

2.7 Trigger Function

Specifies settings related to the trigger function.

Setting the trigger

The trigger is classified into two sequence groups, TRIGger[:SEQuence[1]] and TRIGger:SEQuence2.

There are two second level nodes for each sequence in the TRIGger subsystem. The same operation is carried out regardless of the node that is used.

■ Sequence 1

TRIGger subsystem that changes the settings

Second level node: SEQuence[1] or TRANsient

■ Sequence 2

A TRIGger subsystem for the output on/off delay

Second level node: SEQuence2 or OUTPut

2.7.1 Setting Changes (Sequence 1: TRANsient Settings)

See page A-20

The sequence 1 group can synchronize the output changes using triggers.

When ABOR is sent, INIT:SEQ1 is cancelled. The VOLT:TRIG setting does not change.

If the voltage (VOLT) is changed, the voltage setting that is applied with a trigger is cancelled and it will be overwritten to the setting value. Table 2-1 shows the responses when the voltage is set to 2 V (VOLT 2) and when the voltage setting that is applied with a trigger is set to 1 V (VOLT:TRIG 1).

Table 2-1 Responses after sending VOLT 2;:VOLT:TRIG 1

	Response	
	VOLT?	VOLT:TRIG?
Immediately after the setting	2	1
After a trigger is sent	1	1
After *RST is sent	0	0
ABOR is sent before sending a trigger	2	2 (cancel)
Voltage change VOLT 3 is sent before sending a trigger	3	3 (cancel)

TRIG:SOUR

Sets the condition (trigger source) for the practical change of setting after the sequence 1 group receives INIT:SEQ1 / INIT:NAME TRAN.

Command

```
TRIGger[:SEQuence[1]]:SOURce {IMMediate|BUS}
TRIGger[:SEQuence[1]]:SOURce?
TRIGger[:TRANsient]:SOURce {IMMediate|BUS}
TRIGger[:TRANsient]:SOURce?
```

Parameter

Setting:	IMM	Starts the setting immediately
	BUS	Wait for a software trigger (*TRG, TRIG, or IEEE488.1 get (Group Execute Trigger)) to change the setting (default)

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the trigger source of the sequence 1 group as character data in response to TRIG:SOUR?.

VOLT:TRIG

Sets the voltage that is applied when INIT:SEQ1 / INIT:NAME TRAN and a software trigger are sent.

Set the channel using INST / INST:NSEL.

See page 2-18

Command

```
[SOURce:]VOLTage[:LEVel]:TRIGgered
  [:AMPLitude] {<numeric>|MIN|MAX}
[SOURce:]VOLTage[:LEVel]:TRIGgered
  [:AMPLitue]? [MIN|MAX]
```

Parameter

Setting: 0 to the maximum voltage of the specified channel (zero by default)

Unit: V

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the voltage value that is applied when a trigger is received in the NR3 form in response to VOLT:TRIG?.

CURR:TRIG

Sets the current value that is applied when INIT:SEQ1 / INIT:NAME TRAN and a software trigger are sent.

Set the channel using INST / INST:NSEL.

See page 2-18

Command

```
[SOURce:]CURRent[:LEVel]:TRIGgered
  [:AMPLitude] {<numeric>|MIN|MAX}
[SOURce:]CURRent[:LEVel]:TRIGgered
  [:AMPLitude]? [MIN|MAX]
```

Parameter

Setting: 0 to the maximum current of the specified channel (maximum current by default)

Unit: A

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the current value that is applied when a trigger is received in the NR3 form in response to CURR:TRIG?.

Starting the trigger function (sequence 1)

INIT / INIT:NAME TRAN

Starts the trigger function of the sequence 1 group.

If TRIG:SOUR is set to IMM, the change starts immediately. If set to BUS, the change starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate][:SEQuence[1]]
INITiate[:IMMediate]:NAME TRANsition
```

TRIG

Applies a software trigger to the sequence 1 group.

Command

```
TRIGger[:SEQuence[1]][:IMMediate]
TRIGger[:TRANsient][:IMMediate]
```

2.7.2 Output On/Off Delay Function (Sequence 2: OUTPUT Settings)

See page A-22

The sequence 2 group enables the output on/off delay to be controlled with triggers.

OUTP:TRIG

Sets whether to turn the output on or off when a trigger is applied.

See page 2-32

The actual operation is executed using INIT:SEQ2 / INIT:NAME OUTP. The delay time is set using TRIG:SEQ2:DEL:ON / TRIG :OUTP:DEL:ON or TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL :OFF.

Command

```
OUTPut[:STATe]:TRIGgered {ON|OFF|1|0}
OUTPut[:STATe]:TRIGgered?
```

Setting:

ON(1)	Turn the output no when a trigger is applied
OFF(0)	Turn the output off when a trigger is applied (default)

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns whether the output is turned on or off when a trigger is applied in the NR1 form in response to OUTP:TRIG?.

TRIG:SEQ2:DEL:ON / TRIG:OUTP:DEL:ON

See page 2-18

Sets the delay for turning on the output.

Set the channel using INST / INST:NSEL.

Command

```
TRIGger:SEQuence2:DELay:ON
  {<numeric>|MIN|MAX}
TRIGger:SEQuence2:DELay:ON?
TRIGger:OUTPut:DELay:ON {<numeric>|MIN|MAX}
TRIGger:OUTPut:DELay:ON?
```

Parameter

Setting:	0.0 to 99.9	0 is no delay (The default value is 0.0)
Unit:	S	

For the setting that is applied when *RST is sent, see Table 1-14.

(ex) When the delay until the CH1 output turns on is 0.5 seconds

```
INST CH1
TRIG:OUTP:DEL:ON 0.5
```

Response

Returns the delay time until the output is turned on in the NR3 form in response to TRIG:SEQ2:DEL:ON? / TRIG:OUTP :DEL:ON?.

TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF

See page 2-18

Sets the delay for turning off the output.

Set the channel using INST / INST:NSEL.

Command

```
TRIGger:SEQuence2:DELay:OFF
  {<numeric>|MIN|MAX}
TRIGger:SEQuence2:DELay:OFF?
TRIGger:OUTPut:DELay:OFF {<numeric>|MIN|MAX}
TRIGger:OUTPut:DELay:OFF?
```

Parameter

Setting:	0.0 to 99.9	0 is no delay (The default value is 0.0)
Unit:	S	

For the setting that is applied when *RST is sent, see Table 1-14.

(ex) When the delay until the CH2 output turns off is 1.5 seconds

```
INST CH2
TRIG:OUTP:DEL:OFF 1.5
```

Response

Returns the delay until the output is turned off in the NR3 form in response to TRIG:SEQ2:DEL:OFF? / TRIG:OUTP:DEL:OFF?

TRIG:SEQ2:SOUR / TRIG:OUTP:SOUR

Sets the condition (trigger source) for the practical start of the delay action after the sequence 2 group receives INIT:SEQ2 / INIT:NAME OUTP.

Command

```
TRIGger:SEQuence2:SOURce {IMMediate|BUS}
TRIGger:OUTPut:SOURce {IMMediate|BUS}
TRIGger:SEQuence2:SOURce?
TRIGger:OUTPut:SOURce?
```

Parameter

Setting:	IMM	Start the delay action immediately
	BUS	Wait for a software trigger (*TRG, TRIG:SEQ2, or IEEE488.1 get (Group Execute Trigger)) to start the delay action

For the setting that is applied when *RST is sent, see Table 1-14.

Response

Returns the trigger source of the sequence 2 group as character data in response to TRIG:SEQ2:SOUR? / TRIG:OUTP:SOUR?.

Starting the trigger function (sequence 2)

INIT:SEQ2 / INIT:NAME OUTP

Starts the trigger function of the sequence 2 group.

If TRIG:SEQ2:SOUR or TRIG:OUTP:SOUR is set to IMM, the delay action starts immediately. If it is set to BUS, the delay action starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate]:SEQuence2
INITiate[:IMMediate]:NAME OUTPut
```

TRIG:SEQ2 / TRIG:OUTP

Applies a software trigger to the sequence 2 group.

Command

```
TRIGger:SEQuence2[:IMMediate]
TRIGger:OUTPut[:IMMediate]
```

2.7.3 Aborting the Operation

Aborts the operation in all sequence groups.

ABOR

Aborts operations such as setting and change in all sequence groups.

The status of trigger after the power is immediately turned on is the same as the condition when the ABOR command is sent.

If ABOR is sent while the sequence 2 group (output on/off delay) is in operation, the output on/off status returns to the status before the sequence 2 group was started.

The output turns off while the output on delay is in progress. The output turns on while the output off delay is in progress.

A specific sequence group cannot be specified with the ABOR command. It is always interpreted as ALL.

Command

```
ABORt
```

2.8 System Settings

SYST:CONF:TRAC

Sets the channel that performs the tracking operation.

To set the reference channel for tracking function 1, use INST / INST:NSEL.
Set the tracking function of the reference channel to be turned on. When the tracking function of the reference channel is turned off, the tracking operation is not performed.

- 3-output model

```
SYSTem:CONFigure:TRACking[:STATe]
  {ON|OFF|1|0},{ON|OFF|1|0},{ON|OFF|1|0}
SYSTem:CONFigure:TRACking[:STATe]?
```

- 4-output model

```
SYSTem:CONFigure:TRACking[:STATe]
  {ON|OFF|1|0},{ON|OFF|1|0},{ON|OFF|1|0},
  {ON|OFF|1|0}
SYSTem:CONFigure:TRACking[:STATe]?
```

Parameter

Setting:	ON(1)	Tracking operation on
	OFF(0)	Tracking operation off (default)

(ex) If the tracking operation of CH1, CH2, and CH3 on a 3-output model is off, on, and on, respectively

```
SYST:CONF:TRAC 0,1,1
```

Response

Returns the on/off states of the tracking operation in ascending order by channel number separated by commas in the NR1 form in response to SYSTem:CONFigure:TRACking[:STATe]?.

SYST:CONF:RSEN

Sets the channel that performs the sensing operation.

Command

- 3-output model

```
SYSTem:CONFigure:RSENsing[:STATe]
  {ON|OFF|1|0},{ON|OFF|1|0},{ON|OFF|1|0}
SYSTem:CONFigure:RSENsing[:STATe]?
```

- 4-output model

```
SYSTem:CONFigure:RSENsing[:STATe]
  {ON|OFF|1|0},{ON|OFF|1|0},{ON|OFF|1|0},
  {ON|OFF|1|0}
SYSTem:CONFigure:RSENsing[:STATe]?
```

Parameter

Setting:	ON(1)	Sensing operation on
	OFF(0)	Sensing operation off (default)

(ex) If the sensing operation of CH1, CH2, CH3, and CH4 on a 4-output model is on, off, on, and off, respectively

```
SYST:CONF:RSEN 1,0,1,0
```

Response

Returns the on/off states of the sensing operation in ascending order by channel number separated by commas in the NR1 form in response to SYSTem:CONFigure:RSENsing[:STATe]?.

SYST:TRAC

Sets the status whether to display or not to display of the communication errors by performing a debug trace. If the error trace function is turned on, error codes (example: Err-100) are shown on the PMP display.

Command

```
SYSTem:TRACe {ON|OFF|1|0}
SYSTem:TRACe?
```

Parameter

Setting:	ON(1)	Error trace function on
	OFF(0)	Error trace function off (default)

Response

Returns the on/off setting of the debug trace function in the NR1 form in response to SYSTem:TRACe?.

SYST:ERR

Reads the oldest error information or the event information from the error queue. The error queue can store up to 255 errors.

The error queue is cleared using the *CLS command.

Command

```
SYSTem:ERRor[:NEXT]?
```

Response

Returns the oldest error or the event information in the error/event queue in response to SYST:ERR? as follows:

(ex) If there is no error or event

```
Returns 0, "No error".
```

(ex) If a command that cannot be executed in the current operating condition is received

```
Returns -221, "Settings conflict".
```

SYST:KLOC

Sets or releases the panel operation lock.

Command

```
SYSTem:KLOCk  {ON|OFF|1|0}
SYSTem:KLOCk?
```

Parameter

Setting:	ON (1)	Lock the panel operation
	OFF (0)	Release the panel operation lock (default)

Response

Returns the panel operation lock setting in the NR1 form in response to SYST:KLOCk?.

SYST:LOC (RS232C and USB only)

Sets the PMP operation to local mode (panel operation). This is a substitute command for the IEEE488.1 REN message (Remote Disable).

SYST:REM or SYST:RWL is used to return to remote mode.

Command

```
SYSTem:LOCal
```

SYST:REM (RS232C and USB only)

Sets the PMP operation to remote mode. All panel operations except the LOCAL switch are locked. This is a substitute command for the IEEE488.1 REN message (Remote Enable) and address designation.

SYST:LOC is used to return to local mode.

Command

```
SYSTem:REMote
```

SYST:RWL (RS232C and USB only)

Sets the PMP operation to remote mode. All panel operations are locked (the LOCAL switch is also locked). This is a substitute command for the IEEE488.1 llo message (Local Lock Out).

SYST:LOC is used to return to local mode.

Command

```
SYSTem:RWLock
```

SYST:VERS

Queries the version of the SCPI specifications to which the PMP conforms.

Command

```
SYSTem:VERSion?
```

Response

Always returns 1999.0 in response to SYST:VERS?.

2.9 Status Register and Status Report Function

IEEE488.2 and SCPI registers are used for the status reports.

In each SCPI status register, there are sub registers, CONDition register, EVENt register, ENABle register, PTRansition filter, and NTRansition filter.

Fig. 2-1 shows the SCPI status register structure. The character "+" represents the logic sum of the register bits. Table 2-1 to Table 2-4 describe the bit number, bit weight, and the meaning of each bit.

CONDition register

The CONDition register transits automatically and reflects the condition of the PMP in real-time. Even when this register is read, it does not affect the contents.

EVENt register

The EVENt register bits are automatically set according to the changes in the CONDition register. The rule varies depending on the positive and negative transition filters (PTRansition and NTRansition). The EVENt register is reset when it is read.

ENABle register

The ENABle register enables the reports to the summary bit or status bit of the event bit.

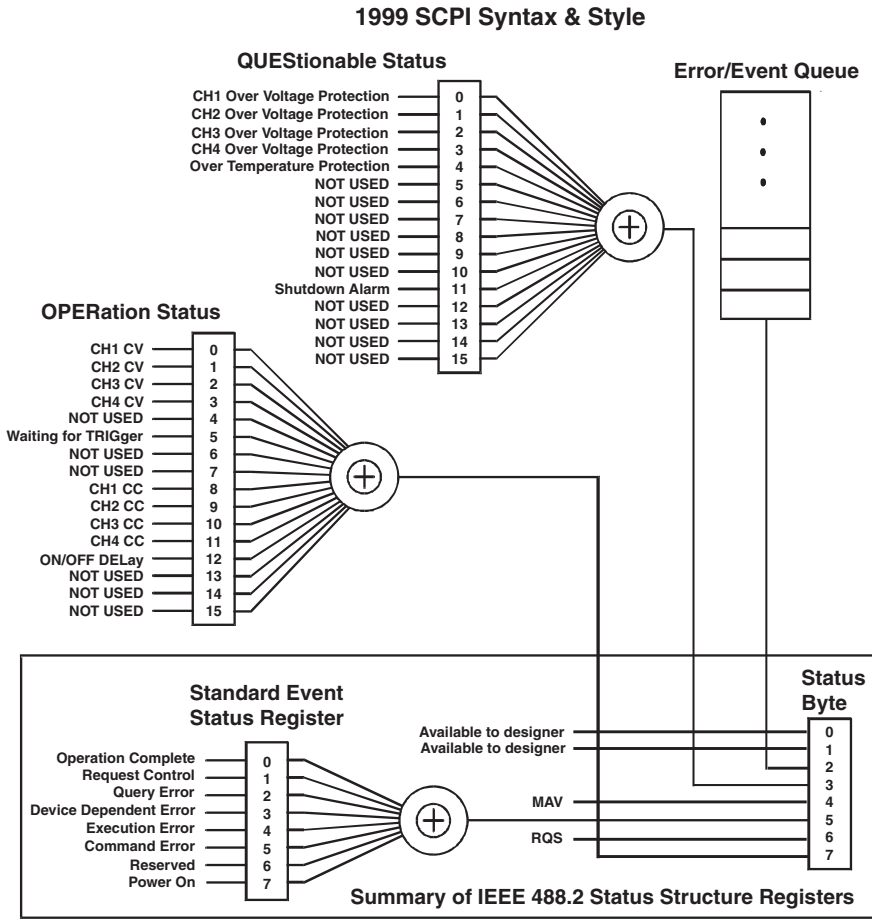
Transition filter

By using the PTRansition (positive transition) filter, it enables to report the events when the condition changes from false to true.

By using the NTRansition (negative transition) filter, it enables to report the events when the condition changes from true to false.

When both the positive filter and the negative filter are set to true, the events can be reported each time the status changes.

If both filters are cleared, reporting the event becomes disabled.



Partially changed SCPI Standard 1999.0 Volume1 fig.9-1.

Fig. 2-1 Status register

2.9.1 IEEE488.2 Register Model

Status byte register

The status byte register stores STB and RQS (MSS) messages as defined by the IEEE488.1 standard. The status byte register can be read using IEEE488.1 serial polling or IEEE488.2 common command *STB?.

When the serial polling is carried out, bit 6 responds with the request service (RQS). The status byte value is not changed by the serial polling.

*STB? makes the device transmit the contents of the status byte register and the master status summary (MSS) message.

*STB? does not change the status byte, MSS, and RQS.

Table 2-1 Status byte register

Bit	Bit Weight	Bit Name	Description
0	1	Reserved	Reserved for future use by the IEEE488. The bit value is notified as zero.
1	2	Reserved	
2	4	Error/Event Queue	If data exists in the error or event queue, this bit is set to true.
3	8	Questionable Status Register (QUES)	This bit is set to true when a bit is set in the QUEStionable event status register and the corresponding bit in the QUEStionable status enable register is true.
4	16	Message Available (MAV)	This bit is set to true when a request is received from the digital programming interface and the PMP is ready to output the data byte.
5	32	Standard Event Status Bit Summary (ESB)	This bit is set to true when a bit is set in the event status register.
6	64	Request Service (RQS)	This bit is set to true when a bit is set in the service request enable register, and the corresponding bit exists in the status byte. The SRQ line of the GPIB is set.
		Master Status Summary (MSS)	This bit is set to true when any of the bits in the status byte register is set to 1 and the corresponding bit in the service request enable register is set to 1.
7	128	Operation Status Register (OPER)	This bit is set to true when a bit is set in the OPERation event status register and the corresponding bit in the OPERation status enable register is set.
8-15	–	NOT USED	–

Event status register

The event status register bits are set when certain events occur during PMP operation. All bits of the event status register are set by the error event queue.

The register is controlled by common commands *ESE, *ESE?, and *ESR? as defined by the IEEE488.2 standard.

Table 2-2 Standard event status register

Bit	Bit Weight	Bit Name	Description
0	1	Operation Complete (OPC)	Set when an *OPC command is received and all operations in standby are completed.
1	2	Request Control (RQC)	Not used
2	4	Query Error (QYE)	Set when an attempt is made to read data from the output queue when there is no output or the error queue is in wait status. Indicates that there is no data in the error queue.
3	8	Device Dependent Error (DDE)	Set when there is a device-specific error.
4	16	Execution Error (EXE)	Set when the PMP evaluates the program data following the header is outside the formal input range or does not match the performance of the PMP. This indicates that a valid SCPI command may not be executed correctly depending on the conditions of the PMP.
5	32	Command Error (CME)	Set when an IEEE 488.2 syntax error is detected, when an unidentifiable header is received, or when a group execution trigger (*TRG) enters the internal IEEE 488.2 SCPI command input buffer.
6	64	NOT USED	–
7	128	Power ON (PON)	Set when the power is turned on.
8-15	–	NOT USED	–

2.9.2 SCPI Register Model

OPERation status register

The OPERation status register is a 16-bit register which contains information about conditions sa the part of normal operation of the PMP.

Table 2-3 OPERation status register (STATus:OPERation)

Bit	Bit Weight	Bit Name	Description
0	1	CH1 CV	CH1 CV output
1	2	CH2 CV	CH2 CV output
2	4	CH3 CV	CH3 CV output
3	8	CH4 CV	CH4 CV output
4	16	NOT USED	–
5	32	Waiting for TRIGger	Indicates whether the PMP is waiting for a trigger.
6	64	NOT USED	–
7	128	NOT USED	–
8	256	CH1 CC	CH1 CC output
9	512	CH2 CC	CH2 CC output
10	1024	CH3 CC	CH3 CC output
11	2048	CH4 CC	CH4 CC output
12	4096	ODEL (ON/OFF DELay)	Indicates whether the output delay operation is in progress.
13	8192	NOT USED	–
14	16384	NOT USED	–
15	32768	NOT USED	–

STAT:OPER

Queries the event of the OPERation status register.

A query clears the contents of the register.

Command

```
STATus:OPERation[:EVENt]?
```

Response

Returns the event of the OPERation status register in the NR1 form.

STAT:OPER:COND

Queries the condition of the OPERation status register.

A query does not clear the contents of the register.

Command

```
STATus:OPERation:CONDtion?
```

Response

Returns the condition of the OPERation status register in the NR1 form.

STAT:OPER:ENAB

Sets the enable register of the OPERation status register.

Command

```
STATus:OPERation:ENABle <NRf>
STATus:OPERation:ENABle?
```

Parameter

Setting: 0 to 32767

Response

Returns the enable register of the OPERation status register in the NR1 form.

STAT:OPER:PTR

Sets the positive transition of the OPERation status register.

Command

```
STATus:OPERation:PTRansition <NRf>
STATus:OPERation:PTRansition?
```

Parameter

Setting: 0 to 32767

Response

Returns the positive transition of the OPERation status register in the NR1 form.

STAT:OPER:NTR

Sets the negative transition of the OPERation status register.

Command

```
STATus:OPERation:NTRansition <NRf>
STATus:OPERation:NTRansition?
```

Parameter

Setting: 0 to 32767

Response

Returns the negative transition of the OPERation status register in the NR1 form.

QUEStionable status register.

The QUEStionable status register is a 16-bit register which contains information related to the questionable events and status during PMP operation.

These register bits may indicate problems with the measured data of the PMP.

Table 2-4 QUEStionable status register (STATus:QUEStionable)

Bit	Bit Weight	Bit Name	Description
0	1	CH1 OV(Over Voltage Protection)	CH1 overvoltage protection activated
1	2	CH2 OV(Over Voltage Protection)	CH2 overvoltage protection activated
2	4	CH3 OV(Over Voltage Protection)	CH3 overvoltage protection activated
3	8	CH4 OV(Over Voltage Protection)	CH4 overvoltage protection activated
4	16	OT (Over Temperature Protection)	Over heat protection activated
5	32	NOT USED	–
6	64	NOT USED	–
7	128	NOT USED	–
8	256	NOT USED	–
9	512	NOT USED	–
10	1024	NOT USED	–
11	2048	SD(Shutdown Alarm)	Alarm input by external contact activated
12	4096	NOT USED	–
13	8192	NOT USED	–
14	16384	NOT USED	–
15	32768	NOT USED	–

STAT:QUES

Queries the event of the QUEStionable status register.

A query clears the contents of the register.

Command

```
STATus:QUEStionable[:EVENt]?
```

Response

Returns the event of the QUEStionable status register in the NR1 form.

STAT:QUES:COND

Queries the condition of the QUEStionable status register.

A query does not clear the contents of the register.

Command

```
STATus:QUEStionable:CONDition?
```

Response

Returns the status of the QUEStionable status register in the NR1 form.

STAT:QUES:ENAB

Sets the enable register of the QUEStionable status register.

Command

```
STATus:QUEStionable:ENABle <NRf>
STATus:QUEStionable:ENABle?
```

Parameter

Setting: 0 to 32767

Response

Returns the enable register of the QUEStionable status register in the NR1 form.

STAT:QUES:PTR

Sets the positive transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:PTRansition <NRf>
STATus:QUEStionable:PTRansition?
```

Parameter

Setting: 0 to 32767

Response

Returns the positive transition of the QUEStionable status register in the NR1 form.

STAT:QUES:NTR

Sets the negative transition of the QUEStionable status register.

Command

```
STATus:QUEStionable:NTRansition <NRf>
STATus:QUEStionable:NTRansition?
```

Parameter

Setting: 0 to 32767

Response

Returns the negative transition of the QUEStionable status register in the NR1 form.

Preset Status

STAT:PRES

Resets the ENABle, PTRansition, NTRansition filter registers of all status registers (including sub registers) to their default values.

Default values:

STATus:ENABle = 0x0000

STATus:PTRansition = 0x7FFF

STATus:NTRansition = 0x0000

Command

```
STATus:PRESet
```

Appendix

The appendix contains lists of messages, lists of command errors, tutorials, sample programs, and interface specifications.

A.1 A List of Messages

SCPI command: Command name in the short form

Affected: Yes for commands that are affected by *RST

r/w: Query command (r)/set command (w).

*: 1, 2, and 3 indicate SCPI standard command, command in review, and KIKUSUI original command, respectively.

For default values, see Table 1-14.

Table A-1 INSTrument subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Parameter		Unit					
INST								
[:SEL]	char	CH1 | CH2 | CH3 | CH4		char	Yes	Sets the channel for applying the commands.	r/w	1
:NSEL	NRf	1 to 4		NR1	Yes	Sets the channel for applying the commands by channel number.	r/w	1
[:SEL]:FOC	char	CH1 | CH2 | CH3 | CH4		char	Yes	Sets the channel to be displayed.	r/w	3
:COUP	char	CH1 | CH2 | CH3 | CH4 | ALL | NONE		char	Yes	Sets multiple channels for applying the commands.	r/w	3

Table A-2 MEASure subsystem | READ susytem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Parameter		Unit					
MEAS[:SCAL] | READ[:SCAL]								
:VOLT[:DC]			V	NR3		Queries the measured value of the voltage output.	r	1
:CURR[:DC]			A	NR3		Queries the measured value of the current output.	r	1

Table A-3 MEMory subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Parameter		Unit					
MEM								
:RCL	NRf	1 to 10				Recalls the memory.	w	3
:SAV	NRf	1 to 10				Saves to the memory.	w	3

Table A-4 OUTPut subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Parameter		Unit					
OUTP								
[:STAT]								
[:IMM]	bool			NR1	Yes	Turns the output on/off	r/w	1
:TRIG	bool			NR1	Yes	Sets whether to turn the output on/off using a trigger.	r/w	3
:PROT:CLE						Clears the alarm.	w	1
:PON:STAT	char	RST | AUTO		char	Yes	Output status at power-on.	r/w	3
:DEL[:STAT]	bool			NR1	Yes	Sets the output delay operation.	r/w	3
:TRAC[:MODE]	char	OFF | RAT | ABS		char	Yes	Sets the output tracking operation	r/w	3

Appx

Table A-5 STATus subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Param-eter		Unit					
STAT								
:OPER								
[:EVEN]				NR1		Queries the event.*1	r	1
:COND				NR1		Queries the register status.*1	r	1
:ENAB	NRf	0 to 32767		NR1		Sets the enable register.*1	r/w	1
:PTR	NRf	0 to 32767		NR1		Sets the positive transition.*1	r/w	1
:NTR	NRf	0 to 32767		NR1		Sets the negative transition.*1	r/w	1
:PRES						Resets the enable register.	w	1
:QUES								
[:EVEN]				NR1		Queries the event.*2	r	1
:COND				NR1		Queries the register status.*2	r	1
:ENAB	NRf	0 to 32767		NR1		Sets the enable register.*2	r/w	1
:PTR	NRf	0 to 32767		NR1		Sets the positive transition.*2	r/w	1
:NTR	NRf	0 to 32767		NR1		Sets the negative transition.*2	r/w	1

*1. OPERation status register
*2. QUEStionable status register.

Table A-6 SOURce subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Parameter		Unit					
[SOUR:]								
VOLT[:LEV]								
[:IMM][:AMPL]	numeric	0 to the maximum voltage	V	NR3	Yes	Sets the voltage.	r/w	1
:TRIG[:AMPL]	numeric	0 to the maximum voltage	V	NR3	Yes	Sets the target voltage using a trigger.	r/w	1
:TRAC[:RAT]	numeric	0 to 200	PCT	NR3	Yes	Sets the voltage ratio for tracking function 2.	r/w	3
CURR[:LEV]								
[:IMM][:AMPL]	numeric	0 to the maximum current	A	NR3	Yes	Sets the current.	r/w	1
:TRIG[:AMPL]	numeric	0 to the maximum current	A	NR3	Yes	Sets the target current using a trigger.	r/w	1
:TRAC[:RAT]	numeric	0 to 200	PCT	NR3	Yes	Sets the current ratio by tracking function 2.	r/w	3

Table A-7 SYSTem subsystem

SCPI Command		Setting		Resp.	Affected	Description	r/w	*
Program Header	Param-eter		Unit					
SYST								
:CONF								
:TRAC[:STAT]	bool			NR1	Yes	Sets the channel that performs the tracking operation.	r/w	3
:RSEN[:STAT]	bool			NR1	Yes	Sets the channel that performs the sensing operation.	r/w	3
:TRAC	bool			NR1		Sets whether to display or hide the communication error.	r/w	3
:ERR[:NEXT]				string		Reads the error information.	r	3
:LOC						Sets to local mode.	w	1
:KLOC	bool			NR1		Locks the panel operation.	r/w	1
:REM						Sets the operation to remote. Locks the panel keys except the LOCAL switch.	w	3
:RWL						Sets the operation to remote. Locks the panel operation.	w	3
:VERS				char		Queries the version of complied SCPI specification.	r	1

Table A-8 TRIGger subsystem

SCPI Command		Setting		Response	Affected	Description	r/w	*
Program Header	Parameter		Unit					
ABOR						Aborts the operation of all sequences.	w	1
INIT[:IMM]								
:NAME	char	TRAN | OUTP				Sequence 1 and 2: Starts the measurement trigger function	w	1
[:SEQ1]						Sequence 1: Starts the voltage/ current setting trigger function.	w	1
:SEQ2						Sequence 2: Starts the OUTPUT ON/OFF DEL trigger function.	w	1
TRIG[:SEQ[1]] | TRIG[:TRAN]								
[:IMM]						Sequence 1: Software trigger.	w	1
:SOUR	char	IMM | BUS		char	Yes	Sequence 1: Trigger source.	r/w	1
TRIG:SEQ2 | TRIG:OUTP								
[:IMM]						Sequence 2: Software trigger.	w	1
:SOUR	char	IMM | BUS		char	Yes	Sequence 2: Trigger source.	r/w	1
:DEL								
:OFF	numeric	0 to 99.9	S	NR3	Yes	Sequence 2: Sets the output off delay.	r/w	1
:ON	numeric	0 to 99.9	S	NR3	Yes	Sequence 2: Sets the output on delay.	r/w	1

Table A-9 IEEE488.2 common commands

IEEE488.2 common commands	Parameter	Description	r/w
*CLS		Clears the status data structures.	w
*ESE	NR1	Sets the event status enable register.	r/w
*ESR		Queries the event status register.	r
*IDN		Queries the model, serial number, and firmware version.	r
*OPC		Sets the OPC bit of the event status register when the processing of all commands standing by is complete.	r/w
*OPT		Queries the interface board.	r
*PSC	0 | 1	Sets whether to clear the event status enable register and the service request enable register at power-on.	r/w
*RST		Performs a device reset.	w
*SRE	NR1	Sets the service request enable register bits.	r/w
*STB		Reads the status byte and master summary status bits.	r
*TRG		Trigger command.	w
*TST		The PMP is not equipped with a self-test function. A zero is always returned.	r
*WAI		Prevents the PMP from executing subsequent commands until all operations in standby are competed.	w

A.2 A List of Errors

Command errors

An error in the range [-199, -100] indicates that an IEEE 488.2 syntax error has been detected by the instrument's parser. The occurrence of any error in this class shall cause the command error bit (bit 5) in the event status register to be set.

Table A-10 Command errors

Error Code		Error Message Description
-100	Command error	Generic syntax error.
-101	Invalid character	A syntactic element contains a character which is invalid.
-102	Syntax error	An unrecognized command or data type was encountered.
-103	Invalid separator	The parser was expecting a separator and encountered an illegal character.
-104	Data type error	The parser recognized a data element different than one allowed.
-105	GET not allowed	A Group Execute Trigger was received within a program message.
-108	Parameter not allowed	More parameters were received than expected for the header.
-109	Missing parameter	Fewer parameters were received than required for the header.
-110	Command header error	An error was detected in the header.
-120	Numeric data error	Generated when parsing a data element which appears to be numeric, including the nondecimal numeric types.
-130	Suffix error	Generated when parsing a suffix.
-131	Invalid suffix	The suffix does not follow the syntax, or the suffix is inappropriate for the PMP.
-134	Suffix too long	The suffix contained more than twelve characters.
-138	Suffix not allowed	A suffix was encountered after a numeric element which does not allow suffixes.
-140	Character data error	Generated when parsing a character data element.
-141	Invalid character data	Either the character data element contains an invalid character, or the element is not valid.
-144	Character data too Long	The character data element contains more than twelve characters.
-148	Character data not allowed	A legal character data element was encountered where prohibited by the PMP.
-150	String data error	Generated when parsing a string data element
-160	Block data error	Generated when parsing a block data element.
-170	Expression error	Generated when parsing an expression data element.
-180	Macro error	Generated when defining a macro or executing a macro.

Execution errors

An error in the range [-299, -200] indicates that an error has been detected by the instrument's execution control block. The occurrence of any error in this class shall cause the execution error bit (bit 4) in the event status register to be set.

Table A-11 Execution errors

Error Code		Error Message Description
-200	Execution error (generic)	A generic error for this PMP.
-203	Command protected	Password protected program or query command cannot be executed.
-210	Trigger error	A trigger error.
-211	Trigger ignored	A trigger was received but discarded.
-213	Init ignored	Measurement initiate operation was ignored because measurement is in progress.
-214	Trigger deadlock	Dead lock occurred because a query was received before the software trigger.
-220	Parameter error	A program data element related error occurred.
-221	Settings conflict	Received a command that cannot be executed in the current condition of the PMP.
-222	Data out of range	Parameter value was outside the legal range.
-223	Too much data	Too many parameters were received than the requirements.
-224	Illegal parameter value	Received an invalid parameter data.
-230	Data corrupt or stale	Received a data query before the measurement was completed.
-241	Hardware missing	Cannot be executed because the optional hardware is not installed.

Query errors

An error in the range [-499, -400] indicates that the output queue control of the instrument has detected a problem with the message exchange protocol described in IEEE 488.2, chapter 6. The occurrence of any error in this class shall cause the query error bit (bit 2) in the event status register to be set.

Table A-12 Query errors

Error Code		Error Message Description
-400	Query error (generic)	This is the generic query error for devices that cannot detect more specific errors.
-410	Query INTERRUPTED	Received a new command before the response was read.
-420	Query UNTERMINATED	The controller attempted to read the response after the device received an unsupported query or has not received a query. The -100 "COMMAND ERROR" and this error is stored in the error queue. The controller will time out.
-430	Query DEADLOCKED	The error queue, input buffer, and output buffer are full when sending large binary data as a response, and the transmission timing is off.
-440	Query UNTERMINATED after indefinite response	Received a separate query in semicolon-delimited format after a query that returns a response in an indefinite form. (Example) *IDN?;SYST:ERR?

Errors specific to the PMP

Table A-13 Errors specific to the PMP

Error Code		Error Message Description
101	Operation denied while in LOCal state	Operation is denied because the PMP is in local mode.
102	Operation denied while in OUTPut ON state	Operation is denied because the output is on.
103	Operation denied while in PROTection state	Operation is denied because a protection function is activated.

A.3 Processing time of main commands

The time until the next command is accepted.

The processing times indicated here are standard values. They are not warranted.
The processing time varies according to the setting and measuring condition.

It does not include the response time of the hardware.

Table A-14 Command processing time

Command	GPIB*1 Processing Time (ms)	RS232C*2 Processing Time (ms)	USB Processing Time (ms)	Description
OUTP	16	8	8	Turns the output on/off
VOLT	16	8	9	Sets the voltage
MEAS:VOLT?	31	31	24	Queries the measured value of the voltage output
CURR	16	8	9	Sets the current
MEAS:CURR?	31	31	24	Queries the measured value of the current output
MEM:RCL	239	200	260	Recalls the memory
MEM:SAV	77	73	74	Saves to the memory
*CLS	16	4	4	Clears the status data structures
*RST	16	3	5	Performs a device reset

*1. Using USB-GPIB by National Instruments.
*2. Data rate setting: 19200 bps. Flow control: On

A.4 Tutorial

This section describes the procedures to make measurements through remote control on the PMP.

A.4.1 Resetting the Instrument

When the PMP is turned on, all panel settings are set to the state as it was turned off the last time. However, the tracking function is always turned off.

See Table 1-14

There are settings specific to remote control that are not related to the panel settings. They are the SYSTem, TRIGger, and STATus subsystems. Most of the settings are reset when the PMP is turned on. The following commands are automatically executed when the power is turned on.

```
*CLS
*SRE 0
*ESE 0
:STATus:PRESet
:OUTPut:PROTection:CLEar
:TRIGger:SEQuence1:SOURce BUS
:TRIGger:SEQuence2:SOURce BUS
```

■ Reset command

The *RST command is used to initialize the panel settings of the PMP.

```
*RST
```

See Table 1-14

The *RST command is used to reset the panel settings to their default conditions. However, some items are not affected by the *RST command.

If you want to completely reset the panel settings, change the items below after executing the *RST command.

```
:SYSTem:TRACe OFF          ' Turn off the error trace function
:SYSTem:KLOCk OFF          ' Unlocking the panel operation
```

- RS232C baud rate: 19200 (when the RS232C option is installed)
- RS232C flow control: ON (when the RS232C option is installed)
- GPIB address: 1 (when the GPIB option is installed)

NOTE

- If you turn on the POWER switch while holding down the LOCAL switch, the voltmeter displays “ini”, and the SET switch blinks. If you press the SET switch in this condition, all panel settings, panel memory contents, and configuration settings are reset.
  The RS232C baud rate, RS232C flow control, and GPIB address are not reset. Change them in CONFIG settings from the front panel.

A.4.2 Output programming

Voltage and current

The output voltage and output current are controlled by the VOLTage and CURRent commands. The output ON/OFF state is controlled by the OUTPut command.

```
:INSTrument:NSELect 1      ' Set the channel for applying the
                           ' commands to CH1
:VOLTage 5.0               ' Set the voltage to 5.0 V
:CURRent 1.5               ' Set the current to 1.5 A
:OUTPut ON                 ' Turn the output on
```

The arbitrary value can be set in the parameter of the VOLTage and CURRent commands.

To set the preset current to the maximum value when the PMP is used in CV mode, set the value of the CURRent command to MAXimum.

```
:VOLTage 5.0               ' Set the voltage to 5.0 V
:CURRent MAXimum           ' Set the current to the maximum
                           ' value
```

To set the preset voltage to the maximum value when the PMP is used in CC mode, set the value of the VOLTage command to MAXimum.

```
:VOLTage MAXimum           ' Set the voltage to the maximum
                           ' value
:CURRent 1.5               ' Set the current to 1.5 A
```

The upper limit value of setting range is limited by the output specifications of the PMP. You can confirm the maximum allowed value that can be specified in the VOLTage and CURRent commands by specifying the MAXimum parameter in the VOLTage? and CURRent? queries, respectively.

Setting the tracking function

This function permits changing multiple channels simultaneously. There are two kinds of tracking function.

The “tracking function 1” varies the output of the specified channel by an absolute value equal to the amount of change in the reference channel. The “tracking function 2” varies the output of the specified channel in the proportional amount (%) of change in the assigned channel.

■ Tracking function 1 (Absolute value change)

In the “tracking function 1”, it is used to vary the absolute value of output voltage of CH3 by the amount equal to the voltage change of CH1 as the reference channel.

```
:INSTrument:NSELect 1          ' Set the channel for applying
                               ' the commands to CH1
:VOLTage 5.0                   ' Set the CH1 voltage to 5.0 V
:INSTrument:NSELect 3          ' Set the channel for applying
                               ' the commands to CH3
:VOLTage 3.0                   ' Set the CH3 voltage to 3.0 V
:SYSTem:CONFigure:TRACking     ' Set the channels that perform
 1,0,1                         ' tracking operation to CH1 and
                               ' CH3
:OUTPut:TRACking ABS           ' Specify tracking function 1
:INSTrument:NSELect 1          ' Set the reference channel to
                               CH1
:OUTPut ON                     ' Turn the output on
:VOLTage 4.0                   ' Set the CH1 voltage to 4.0 V
```

Because the CH1 voltage changes by -1.0 V from 5.0 V to 4.0 V, the CH3 voltage also changes by -1.0 V from 3.0 V to 2.0 V.

Set the status of reference channel for the “tracking function 1” by the command SYST:CONF:TRAC. If the tracking function of the reference channel is off status, the tracking operation is not performed.

■ Tracking function 2 (Proportional value)

In the “tracking function 2”, it is used to vary the output voltage in the proportional value (%) of CH1 and CH2.

```
:INSTrument:NSELect 1          ' Set the channel for applying
                               ' the commands to CH1
:VOLTage 5.0                   ' Set the CH1 voltage to 5.0 V
:INSTrument:NSELect 2          ' Set the channel for applying
                               ' the commands to CH2
:VOLTage 10.0                  ' Set the CH2 voltage to 10.0 V
:SYSTem:CONFigure:TRACking     ' Set the channels that perform
 1,1,0                         ' tracking operation to CH1 and
                               ' CH2
:OUTPut:TRACking RAT           ' Specify tracking function 2
:INSTrument:NSELect 1          ' Set the reference channel to
                               CH1
:OUTPut ON                     ' Turn the output on
:VOLTage:TRACking 120          ' Set the amount of output
                               ' voltage change to 120 %
```

Because the amount of output voltage change was set to 120 %, the CH1 voltage changes from 5.0 V to 6.0 V, and the CH2 voltage changes from 10.0 V to 12.0 V.

Setting the delay function

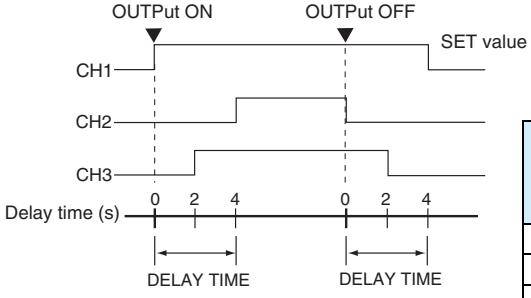
This function enables to set the time from when the OUTPUT switch is pressed until the output is actually turned on (ON DELAY) or off (OFF DELAY).

Set the channel that performs the delay operation using INST / INST:NSEL, and execute using OUTP:DEL.

Set the delay time using TRIG:SEQ2:DEL:ON / TRIG:OUTP :DEL:ON or TRIG:SEQ2:DEL:OFF / TRIG:OUTP:DEL:OFF.

```
:INSTrument:NSELect 1          ' Set the channel for applying
                               ' the commands to CH1
:VOLTage 5.0                   ' Set the CH1 voltage to 5.0 V
:TRIGger:OUTPut:DELay:ON 0     ' Set the delay until the output
                               ' is turned on to 0 second.
:TRIGger:OUTPut:DELay:OFF 4    ' Set the delay until the output
                               ' is turned off to 4 seconds.
:INSTrument:NSELect 2          ' Set the channel for applying
                               ' the commands to CH2
:VOLTage 6.0                   ' Set the CH2 voltage to 6.0 V
:TRIGger:OUTPut:DELay:ON 4     ' Set the delay until the output
                               ' is turned on to 4 seconds.
:TRIGger:OUTPut:DELay:OFF 0    ' Set the delay until the output
                               ' is turned off to 0 second.
:INSTrument:NSELect 3          ' Set the channel for applying
                               ' the commands to CH3
:VOLTage 3.0                   ' Set the CH3 voltage to 3.0 V
:TRIGger:OUTPut:DELay:ON 2     ' Set the delay until the output
                               ' is turned on to 2 seconds.
:TRIGger:OUTPut:DELay:OFF 2    ' Set the delay until the output
                               ' is turned off to 2 seconds.
:OUTPut:DELay ON               ' Turn the delay function on
:OUTPut ON                     ' Turn the output on
:OUTPut OFF                    ' Turn the output off
```

▼ indicates the timing of the command transmission.



Item	ON DELAY SET value	OFF DELAY SET value
CH1	0 s	4 s
CH2	4 s	0 s
CH3	2 s	2 s

The CH1 output turns on when OUTPut ON is sent. Then, the CH3 output turns on 2 seconds later, and the CH2 output turns on 4 seconds later. The CH2 output turns off when OUTPut OFF is sent. Then, the CH3 output turns off 2 seconds later, and the CH1 output turns off 4 seconds later.

A.4.3 Triggering Output Changes

The PMP offers two different trigger subsystems: TRANsient and OUTPut. These features are mapped to SEQuence1 and SEQuence2 respectively, as the SCPI specification generally categorizes each trigger subsystem as a numbered Trigger Sequence.

The sequence 1 (TRANsient) group is a trigger subsystem that changes the output voltage and output current settings. The sequence 2 (OUTPut) group is a trigger subsystem that turns the output on/off using the delay function.

The assignments of function for each sequence number is designed to limited in use of the PMP. Therefore, the assignment is not necessarily the same as other models that have the SCPI language implemented.

States

The following three states are available in the sequence operation.

■ IDLE state

When the PMP is turned on, all the trigger subsystems are in the IDLE state. In this state, the trigger subsystems ignore all triggers. Sending any of the following commands at any time causes the trigger subsystems to return to the IDLE state.

The sequence does not start in the IDLE state, even when TRG is sent.

```
:ABORt
*RST
*RCL
```

Device clear (GPIB and USB) or break signal (RS232C)

■ INITiated state

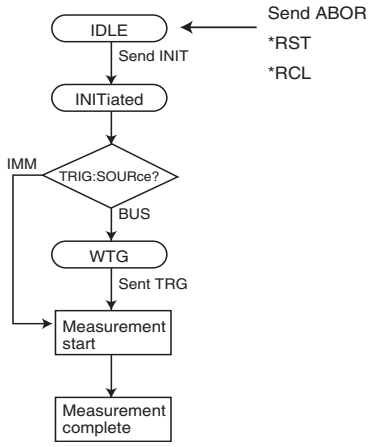
If the INIT is sent in the IDLE state, the trigger function starts and the PMP enters the INITiated state.

If the trigger source is set to IMMediate, the setting or delay operation starts immediately.

If the trigger source is set to BUS, the PMP enters the WTG (Waiting for Trigger) state.

■ WTG (Waiting for Trigger) state

If a trigger is sent in the WTG state, setting or delay operation starts.



Output change control (Sequence 1: TRANsient)

Using the TRIGger:SEQuence1 or TRIGger:TRANsient subsystem allows the VOLTage and CURRent settings to be synchronized having with triggers. This is convenient if you want to synchronize output changes with the action of other instruments such as electronic loads. To reserve triggered settings, use the VOLTage:TRIGgered and CURRent:TRIGgeredd commands.

```
:INSTrument:NSELect 1        ' Set the channel for applying
                             ' the commands to CH1
:VOLTage 5.0                 ' Set the voltage to 5.0 V
:CURRent 1.5                 ' Set the current to 1.5 A
:OUTPut ON                   ' Turn the output on
:VOLTage:TRIGgered 6.0       ' Set the trigger voltage to 6.0 V
                             '
:CURRent:TRIGgered 2.5       ' Set the trigger current to 2.5 A
                             '
:TRIGger:SOURce BUS          ' Set the trigger source of
                             ' sequence 1 to BUS
:INITiate:SEQuence1          ' Initiate sequence 1
:TRIGger                     ' Apply a software trigger to
                             ' sequence 1
```

The TRIGger:SOURce command sets the trigger source to either BUS or IMMediate. The INITiate:SEQuence1 command makes the trigger subsystem exit from the IDLE state and enter to the initiated state. If the Trigger Source is set to IMMediate, the transient action is executed immediately causing the voltage and/or current to change to the new setting. If the Trigger Source is set to BUS, the trigger subsystem goes to the WTG (Waiting For Trigger) state. When the software trigger is applied with the TRIGger or *TRG command, the transient action is executed. When the operation is completed, the trigger subsystem returns to the IDLE state again. If the ABORt or the equivalent command is sent without executing the trigger, the transient action is cancelled, and then the trigger subsystem returns to the IDLE state.

The TRIGger command applies a software trigger to the sequence 1 group. You can also use the *TRG common command or the IEEE488.1 get (Group Execute Trigger) command for the same purpose. However, these commands also apply a software trigger to the sequence 2 group. Therefore, if the sequence 2 group is in the INITiated state, the delay operation starts.

Output on/off delay function (Sequence 2: OUTPut)

Using the TRIGger:SEQuence2 or TRIGger:OUTPut subsystem allows to use the output on/off delay function. To reserve the operation of the output change by triggers, use the OUTPut:TRIGgered command.

```
:TRIGger:SEQuence2:SOURce BUS   ' Set the trigger source of
                                ' sequence 2 to BUS
:INSTrument:NSELect 1           ' Set the channel for
                                ' applying the commands
                                ' to CH1
:TRIGger:SEQuence2:DELay:ON     ' Set the output on delay
 0.5                            ' to 0.5 s
:OUTPut:TRIGgered ON            ' Set the output to be
                                ' turned on when a trigger
                                ' is applied
:INITiate:SEQuence2             ' Initiate sequence 2
:TRIGger:SEQuence2              ' Apply a software trigger
                                ' to sequence 2
```

The TRIGger:SEQuence2:SOURce command sets the trigger source to either BUS or IMMediate. The :TRIGger:SEQuence2 :DELay:ON command sets the output on delay time. If this value is set to 0, the output is turned on without delay. Though not used in the example above, the :TRIGger:SEQuence2 :DELay:OFF command sets the output off delay time.

The INITiate:IMMediate:SEQuence2 command makes the trigger subsystem exit from the IDLE state and enter to the INITiated state. If the trigger source is set to IMMediate, the output on/off delay starts immediately. If the trigger source is set to BUS, the trigger subsystem moves to the WTG (Waiting For Trigger) state. When the software trigger is applied with the TRIGger:SEQuence2 or *TRG common command, the delay action is executed. When the operation is completed, the trigger subsystem returns to the IDLE state again. If the ABORt or the equivalent command is sent without executing the trigger, the delay action is cancelled, and then the trigger subsystem returns to the IDLE state.

If the on or off state specified with the OUTPut:TRIGgered command is the same as the present output state, the SEQuence2 (OUTPut) trigger subsystem completes the apparent action immediately, because there is no actual action that needs to be taken. No error is generated in this case.

When the delay action in progress is aborted by sending the ABORt command, Device Clear (GPIB/USB), or break signal (RS232C), the output state returns to the state that existed before the delay action was executed. Likewise, the *RST command also aborts the operation, but the output state is always set to off.

If the output state is set by force with an OUTPut command while the delay action is in progress, the delay action is aborted, and the output is set to the state specified by the OUTPut command.

A.4.4 Measurement

Voltage/current measurement

Use the MEASure command to query the measured voltage and current.

To measure the voltage and current, use the following queries.

```
:INSTrument:NSELect 1      ' Set the channel for applying the
                           ' commands to CH1
:MEASure:VOLTage?          ' Query the output voltage
:MEASure:CURRent?          ' Query the output current
```

The PMP also supports the READ command. The READ and the MEASure operate in the same way.

Waiting for operation complete

The *OPC command has a function to wait for the operation complete. In case the output on/off delay function is in used this command will take the time (up to 99.9 s) which is set by the output on/off delay function.

If the *OPC command is sent, the PMP goes to Operation Complete Command Active State (OCAS). When the operation is completed and there is no other operation pending, the PMP returns to Operation Complete Command Idle State (OCIS) and sets the OPC bit (bit 0) of the Standard Event Status Register to TRUE (1). This information can be confirmed with the OPC bit (bit 0) of the *ESR? query.

The following is an example of sending *OPC commands to start with having the output on/off delay action. When the measurement is completed, an SRQ (Service Request) is generated, as the Standard Event Status Enable Register and the Service Request Enable Register are unmasked so that an SRQ is signaled when the delay action completes.

```
*ESE 1;*SRE 32;*CLS;:INITiate:SEQuence2;*TRG;*OPC
```

Using the *OPC? query command instead of the *OPC command makes the PMP enters to Operation Complete Query Active State (OQAS). If the measurement is completed and there is no other operation pending, the PMP returns to Operation Complete Query Idle State (OQIS) and sets a response data “1” (in NR1 format) in the output queue.

At power-on or when the IEEE488 sdc/dcl or *RST command is received, the PMP is in the OCIS and OQIS state.

NOTE

- In case of the RS232C interface operation, the SRQ feature cannot be used. The MSS bit of the *STB query can be used in the same manner as the SRQ function.

A.4.5 Status Monitoring

The PMP has two mandatory SCPI standard registers, STATus:OPERation and STATus:QUEStionable, in addition to the IEEE488.2 standard registers.

Register basics

See page2-39

All SCPI registers have standard event/filter architecture, employing CONDition, EVENt, ENABle, and optionally PTRansition and NTRansition. The CONDition and EVENt are read-only registers working as status indicators, and the ENABle, PTRansition and NTRansition are read-write registers working as event and summary filters.

STATus:OPERation

See page2-45

The STATus:OPERation register records events or signals that occur during normal operation.

For example, to check if the PMP is being regulated in CV state, check the CH1 CV it (bit 0) in the STATus:OPERation register.

```
:STATus:OPERation?        ' Check whether the CH1 CV bit is
                          ' set
```

STATus:QUEStionable

See page2-48

The STATus:QUEStionable register is used as the record of report or the events occurred in that abnormal operation.

For example, to check if the overvoltage protection is activated on CH1 of the PMP, check the CH1 OV bit (bit 0) in the STATus:QUEStionable register.

```
:STATus:QUEStionable?     ' Check whether the CH1 OV bit is
                          ' set
```

PON (Power ON) bit

The PON bit (bit 7) in the Standard Event Status Register is set whenever the power of the PMP is turned on. The most common use for the PON is to generate an SRQ at power-on keeping track of unexpected loss of power or power line failure. To do this, follow the steps shown below.

1. Set *PSC (Power-on Status Clear) to 0 (or OFF).

   Enable the backup function of the event status enable register and service request enable register (*PSC0).

2. Set the PON bit (bit 7) of the event status enable register.

   Permit the transmission of a power-on event to the upper layer (*ESE128).

3. Set the ESB bit (bit 5) of the status byte enable register.

   Permit the generation of an SRQ caused by a standard event (*SRE32).

```
*PSC 0;*ESE 128;*SRE 32
```

In case the RS232C interface is in used, the PON bit cannot be assigned to the service request, because SRQs are not generated.

In case the USB interface is in used, even though the SRQ feature itself is provided by the USBTMC Interrupt-IN endpoint on the USB interface, a Connection Lost error in the VISAI I/O session occurs immediately before the power-on event. It may be difficult to handle the PON events.

A.4.6 Error Check

Error/event queue

The SCPI specifications define the standard error reporting scheme --- Error/Event Queue. This is a FIFO (First In First Out) queue, which records errors and events. The maximum number of errors/events that the PMP can record is 255. Each error/event can be read with the SYSTem:ERRor query.

```
:SYSTem:ERRor?
```

The response to this query contains a numeric part (error/event number) and a textual description, such as:

```
-222,"Data out of range"
```

The error/event queue is empty when the *CLS command is sent, when the last item in the queue is read, or when the PMP is turned on. When the error/event queue is empty, the query returns the following:

```
0,"No error"
```

Displaying communication errors

The PMP has an error trace function. The oldest item among the errors and events (if they are present) can be displayed on the PMP. This function is convenient when you debug your remote applications.

The communication error trace function can be enabled or disabled with the SYSTem:TRACe command.

```
SYSTem:TRACe {ON|OFF}
```

While an error/event item is displayed, the normal voltmeter and ammeter are disabled.

If the error/event queue is empty, communications errors are not displayed. Sending the *CLS command clears the communication error display.

When in local mode, the communication error trace function is temporarily disabled.

A.5 Sample Program

Sample code (Visual Basic 6.0)

See page1-3

The samples given in this section assumes Microsoft Visual Basic 6.0. The VISA library (VISACOM) is used for the I/O library.

Opening a VISA session and setting communication parameters

To acquire the VISA session and to set the communication parameters, it is required to execute before starting the communication with the PMP.

The format of the VISA resource string that is substituted in the variable strVisaAddress varies for GPIB, RS232C, and USB.

For the GPIB operation, device address of 5 is assumed.

For the RS232C, the communication parameters are required for 19200 bps, Data 8 bits, Stop 1 bit, Parity NONE, and XFlow, and the COM port 2 is also required. Set the PMP interface to match these conditions.

For the USB operation, there are no interface parameters that need to be set on the PMP, but the USBVID (vendor ID), PID (product ID), and serial number must be specified explicitly in the VISA resource string. The VID and PID values can be verified also on the CONFIG setting display of the PMP. You can check the serial number on the rear panel of PMP.

Sample 1 (Voltage and current output and measurement)

This sample program is an example to query the output voltage/current value after the output is turned on via the RS232C interface having with voltage current setting and over voltage/over current setting. The queried value is converted from the character string to the numeric value and each of those will be substitute for the variable in double data type.

```
Private Sub main_EZ_Click()

' A variable necessary to operate VISA COM
Dim rm As IResourceManager
Dim io As IMessage
Dim serial As ISerial

' Substitute the VISA address
' explicitly into this variable
Dim strVisaAddress As String
strVisaAddress = "ASRL2::INSTR"     ' Set the RS232C port on the PC to COM2
                                    ' when using RS232C

' Set the GPIB address of the PMP
' to 5 when using GPIB
' strVisaAddress ="GPIB0::5::INSTR"

' VID::PID::serial number (the serial
' number is different for each product)
' when using USB
' strVisaAddress =
' "USB0::0x0B3E::0x1011::AB123456::INSTR"

' Create the Resource Manager object
' (Try VISA Global Resource Manager first
' If the resource cannot be found, try
' Resource Manager by Agilent)

On Error Resume Next
Set rm = CreateObject("VISA.GlobalRM")
If rm Is Nothing Then
Set rm = CreateObject("AgilentRM.SRMCls")
End If
On Error GoTo 0

' Open a VISA session
Set io = rm.Open(strVisaAddress, NO_LOCK)

' Set additional properties for
' serial communication (RS232C)
```

```
If io.HardwareInterfaceType = 4 Then
Set serial = io
serial.BaudRate = 19200                    ' Baud rate: 19200 bps
serial.DataBits = 8                        ' Data length: 8 bits
serial.StopBits = ASRL_STOP_ONE            ' Stop bits: 1 bit
serial.Parity = ASRL_PAR_NONE              ' Parity: None
serial.FlowControl = ASRL_FLOW_XON_XOFF    ' Flow control: Xon/Xoff
serial.EndIn = ASRL_END_TERMCHAR           ' Input termination character: LF
serial.EndOut = ASRL_END_TERMCHAR          ' Output termination character: LF
End If

' Reset the PMP
io.WriteString "*RST"

' Query the PMP ID
Dim strIDN As String
io.WriteString "*IDN?"                     ' Send the ID query command *IDN?
strIDN = io.ReadString(256)                ' Read 256 bytes from the receive buffer and
                                           ' substitute into strIDN

' This example sets the channel,
' voltage, and current.
Dim iChannel As Integer
Dim dVolt As Double
Dim dCurr As Double

iChannel = 1       'channel                ' Channel setting 1
dVolt = 5          'volts                  ' Voltage setting 5 V
dCurr = 1.5        'amps                   ' Current setting 1.5 A

' Set the channel
io.WriteString ":INST:NSEL" & Str$(iChannel)

' Set the voltage
io.WriteString ":VOLT" & Str$(dVolt)

' Set the current
io.WriteString ":CURR" & Str$(dCurr)

' Turn the output on
io.WriteString ":OUTP ON"

' Query the output voltage and current
Dim dVoltMeasure As Double
Dim dCurrMeasure As Double

io.WriteString ":MEAS:VOLT:DC?"            ' Send the output voltage query
                                           ' command
dVoltMeasure = Val(io.ReadString(256))     ' Read 256 bytes from the receive
                                           ' buffer, convert the string to a
                                           ' value,and substitute into dVolt
                                           ' Measure
```

```
io.WriteString ":MEAS:CURR:DC?"              ' Send the output current query
                                             ' command
dCurrMeasure = Val(io.ReadString(256))       ' Read 256 bytes from the receive
                                             ' buffer, convert the string to a
                                             ' value,and substitute into dCurr
                                             ' Measure

' Query the instrument error
Dim strErr As String
io.WriteString ":SYST:ERR?"                  ' Send the system error query command
strErr = io.ReadString(256)                  ' Read 256 bytes from the receive buffer and
                                             ' substitute into strErr

' Close the VISA session
io.Close                                     ' Issue the Close command

End Sub
```

Sample 2 (Voltage and current output and measurement (using triggers))

This sample program is an example to change the setting condition from the present voltage and current settings to the preset value of the trigger voltage/current when the *TRG command is sent. It is required to send The ":INIT:SEQ1" before the *TRG is sent. The queried value is converted from the character string to the numeric value and each of those will be substitute for the variable in double data type.

```
Private Sub main_Trig_Click()

' A variable necessary to operate VISA COM
Dim rm As IResourceManager
Dim io As IMessage
Dim serial As ISerial

' Substitute the VISA address
' explicitly into this variable
Dim strVisaAddress As String
strVisaAddress = "ASRL2::INSTR"     ' Set the RS232C port on the PC to COM2
                                    ' when using RS232C

' Set the GPIB address of the PMP to
' 5 when using GPIB
' strVisaAddress ="GPIB0::5::INSTR"

' VID::PID::serial number (the serial
' number is different for each product)
' when using USB
' strVisaAddress =
' "USB0::0x0B3E::0x1011::AB123456::INSTR"

' Create the Resource Manager object
' (Try VISA Global Resource Manager first
' If the resource cannot be found,
' try Resource Manager by Agilent)

On Error Resume Next
Set rm = CreateObject("VISA.GlobalRM")
If rm Is Nothing Then
Set rm = CreateObject("AgilentRM.SRMCls")
End If
On Error GoTo 0

' Open a VISA session
Set io = rm.Open(strVisaAddress, NO_LOCK)
```

```
' Set additional properties for serial
' communication (RS232C)
If io.HardwareInterfaceType = 4 Then
Set serial = io
serial.BaudRate = 19200                    ' Baud rate: 19200 bps
serial.DataBits = 8                        ' Data length: 8 bits
serial.StopBits = ASRL_STOP_ONE            ' Stop bits: 1 bit
serial.Parity = ASRL_PAR_NONE              ' Parity: None
serial.FlowControl = ASRL_FLOW_XON_XOFF    ' Flow control: Xon/Xoff
serial.EndIn = ASRL_END_TERMCHAR           ' Input termination character: LF
serial.EndOut = ASRL_END_TERMCHAR          ' Output termination character: LF
End If

' Reset the PMP
io.WriteString "*RST"

' Query the PMP ID
Dim strIDN As String

io.WriteString "*IDN?"                     ' Send the ID query command *IDN?
strIDN = io.ReadString(256)                ' Read 256 bytes from the receive buffer and
                                           ' substitute into strIDN

' This example sets the channel,
' voltage, current, trigger voltage,
' and trigger current.
Dim iChannel As Integer
Dim dVolt As Double
Dim dCurr As Double
Dim dVoltTrig As Double
Dim dCurrTrig As Double

iChannel = 1       'channel        ' Channel setting 1
dVolt = 5          'volts          ' Voltage setting 5 V
dCurr = 1.5        'amps           ' Current setting 1.5 A
dVoltTrig = 6      'volts          ' Trigger voltage setting 6 V
dCurrTrig = 2.5    'amps           ' Trigger current setting 2.5 A

' Set the channel
io.WriteString ":INST:NSEL" & Str$(iChannel)

' Set the voltage immediately
io.WriteString ":VOLT" & Str$(dVolt)

' Set the current immediately
io.WriteString ":CURR" & Str$(dCurr)

' Set the triggered voltage
io.WriteString ":VOLT:TRIG" & Str$(dVoltTrig)

' Set the triggered current
io.WriteString ":CURR:TRIG" & Str$(dCurrTrig)
```

```
' Turn the output on
io.WriteString ":OUTP ON"

' Measure the output voltage and current
' before sending the trigger command
Dim dCurrMeasure As Double
io.WriteString ":MEAS:VOLT:DC?"          ' Send the output voltage query
                                         ' command
dVoltMeasure = Val(io.ReadString(256)    ' Read 256 bytes from the receive
                                         ' buffer, convert the string to a value,
                                         ' and substitute into dVoltMeasure
io.WriteString ":MEAS:CURR:DC?"          ' Send the output current query
                                         ' command
dCurrMeasure = Val(io.ReadString(256)    ' Read 256 bytes from the receive
                                         ' buffer, convert the string to a value,
                                         ' and substitute into dCurrMeasure

' Start the trigger subsystem, and send
' the trigger command
io.WriteString ":INIT:SEQ1"              ' Send initiate sequence 1
io.WriteString "*TRG"                    ' Send the trigger command

' Measure the output voltage and current
' after the trigger command is sent
io.WriteString ":MEAS:VOLT:DC?"          ' Send the output voltage query
                                         ' command
dVoltMeasure = Val(io.ReadString(256))   ' Read 256 bytes from the receive
                                         ' buffer, convert the string to a value,
                                         ' and substitute into dVoltMeasure

io.WriteString ":MEAS:CURR:DC?"          ' Send the output current query
                                         ' command
dCurrMeasure = Val(io.ReadString(256))   ' Read 256 bytes from the receive
                                         ' buffer, convert the string to a value,
                                         ' and substitute into dCurrMeasure

' Query the instrument error
Dim strErr As String
io.WriteString ":SYST:ERR?"          ' Send the system error query command
strErr = io.ReadString(256)          ' Read 256 bytes from the receive buffer and
                                     ' substitute into strErr

' Close the VISA session
io.Close                             ' Issue the Close command

End Sub
```

Appx

A.6 Specifications

Unless specified otherwise, the interface specifications are for the following conditions.

Interface

Common specifications	Soft ware protocol	IEEE Std 488.2-1992
	Command language	Complies with the SCPI Specification 1999.0 specifications.
RS232C	Hardware	Complies with EIA232D.
		D-SUB 9-pin connector (male)*1
		Baud rate: 1200, 2400, 4800, 9600, 19200, 38400 bps
		Data length: 8 bits, stop bit: 1 bit, and parity bit: None
		Flow control X-Flow or none.
	Program message terminator	LF during reception, CR/LF during transmission.
GPIB	Hardware	Complies with IEEE Std 488.1-1987.
		SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, C0, E1
	Program message terminator	LF or EOI during reception, LF+EOI during transmission.
	Primary address	1 to 30
USB	Hardware	Complies with USB 2.0. Data rate: 12 Mbps (full speed).
	Program message terminator	LF or EOM during reception, LF+EOM during transmission
	Device class	Complies with the USBTMC-USB488 device class specifications.

*1. Use a cross cable (null model cable).

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