Communication Interface Manual | Regulated DC Power Supply PAT-T Series

Introduction

The PAT-T series Communication Interface Manual explains the settings and commands for remotely controlling the PAT-T series using the communication interface.

- RS232C interface
- GPIB interface (factory option)
- USB interface (factory option)
- LAN interface (factory option)

When the PAT-T is operating under remote control, the RMT LED on 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.

How to read this manual

This manual is in HTML format that can be viewed with a WWW (World Wide Web) browser. The HTML manual can be viewed using the following browsers.

Operating environment: Windows 98 or later

Browser: Microsoft Internet Explorer 5.5 or later

Related manuals

For the safety precautions, installation, operation, and specifications of the PAT-T, read the accompanying PAT-T User's Manual.

Intended readers

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

Structure of the manual

This manual consists of the following sections.

- Overview
- Setup
- Overview of messages
- Command (list*1)
- Appendix
- Tutorial

*1. The list of command is provided in a PDF file. Adobe Reader 6.0 or later is required to view the file.

Trademarks

Firmware version of the product to which this manual applies

This manual applies to 8 kW type products with firmware version 5.xx and 4 kW type products with firmware version 4.xx.

Instrument Interface Standards

The PAT-T 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
- TCP/IP Instrument Protcol Specification VXI-11 Rev 1.0

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Setup

A VISA library is required to use the software application. The VISA library (any one of NI-VISA, AgilentVISA, and KI-VISA) must be installed in the controller (Windows).

When the product is controlled by the LAN interface, middleware which applies to the VXI-11 protocol is required. Middleware is automatically installed by VISA library.

Installing the VISA Library

VISA (Virtual Instrument Software Architecture) is a specification for a 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. USB functions for those cannot be used on Windows 95 or Windows NT 3.5x or 4.0.

•NI-VISA by National Instruments (Ver. 4.0 or later)

•Agilent VISA by Agilent Technologies (Agilent IO Libraries Suite14.2 or later)

•KI-VISA Ver. 3.1.3 or later

Installing KI-VISA

KI-VISA is Kikusui's original VISA library that supports VXIplug&play VISA Specifications. The newest version can be downloaded from Kikusui website (http://www.kikusui.co.jp/en/download/).

KI-VISA is not required if NI-VISA or Agilent VISA is already installed.

1. Load the accompanying CD-ROM into the CD-ROM drive.
2. Move to the VISA folder using the menu program of the CD-ROM or Explorer.
3. Double-click Kivisa_x_x_x.exe.
   The value for x varies depending on the revision of the VISA library stored on the CD-ROM.
4. Proceed with the installation according to the instructions on the screen.

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Setup

The PAT-T is equipped with RS232C as standard. If the factory option interface board is installed, you can use GPIB, USB or LAN.

Interface Setup

The GPIB, RS232C, USB and LAN interfaces cannot be used simultaneously.

- RS232C
- GPIB
- USB
- LAN
- Accessing and Operating the PAT-T from a Web Browser (LAN interface)

Overview of Messages

The information that is exchanged between the controller (computer) and the device (PAT-T series) is called a message.

The PAT-T uses the SCPI language for the messages.

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

Command hierarchy

SCPI commands are ASCII-based commands 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	Hierarchy of node
SOUR:		Root node
CURR		Secound level
[:PROT]		Third level
[:LEV]	<numeric>	Forth level
:STAT	<bool>	Forth level
VOLT		Secound level
[:PROT]		Third level
[:LEV]	<numeric>	Forth level
:STAT	<bool>	Forth level

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

Command Syntax

This manual denotes SCPI commands using the following format.

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

SCPI commands can be issued using the short form. The short form of a SCPI command is the section of the command written in uppercase.

SCPI commands can be sent in the long form or short form. Since SCPI commands are not case-sensitive, CURR, Curr, and curr are all accepted as the short form of CURRent. In the long form, CURRENT, Current, and current are all acceptable.

- A space is required between the program header section and the parameter section.
- Multiple parameters, when available, are concatenated using commas.
- Commands are concatenated using semicolons (compound command).

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

In the second command, SOURce is omitted. This is because the path is set to SOURce by the first command SOURce:CURRent MINimum.

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

```
SOURce:CURRent MINimum

SOURce:VOLTage MINimum
```

An error occurs if a node that is not defined in the current path is designated.

Commands of different subsystems can be concatenated using a colon and a semicolon together.

```
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 128.

Special symbols

Special symbols used in this manual to describe SCPI commands are defined below.

- 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.

- The characters <> indicate program data.

  Do not write <> in the actual program.

- Brackets indicate option data.

  When option data is not sent with the program, the default value is applied.
  Do not write [ ] in the actual program.

Queries

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.

```
SOURce:CURRent? MIN
```

Response

A response returned as an answer to a query. It is a message that is always sent from the device to the computer. The status of the device or measured values are transmitted to the computer.

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 query commands at once, an incomplete response may be received.

Program terminator

All commands must be terminated using a valid terminator.

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

EOI is not available on the RS232C. Be sure to use <new line>.

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

NOTE

CR (ASCII 0x0D) is not a terminator.

Common commands

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.

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Overview of messages

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 PAT-T is indicated below.

Non-numeric parameters

Character string data(String)

Used when a series of ASCII characters are requested.

Be sure to enclose a string in single quotations or double quotations. The start and end quotation marks must match.

```
FUNCtion "IMP"
```

If you wish to use a quotation mark as a part of the string, enter two quotation marks consecutively (with no characters in between).

Character data

Character data is used when only a limited number of values is available for the program setting. Responses are returned in the short form.

```
TRIGger:SOURce {BUS|IMMediate|TIMer}
```

Boolean data

Boolean data expresses a 1 or 0 condition or an ON or OFF condition. Responses are returned as 1 or 0.

```
OUTPut {ON|OFF|1|0}
```

Numeric parameters

R1

Represents an integer.

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

NR2

Represents a real number (floating point).

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

NR3

Represents a real number (exponential).

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

The value +3.80000+E02 is returned for the response data 380. The number of digits to the right of the decimal is 5.

NRf

NRf is a generic term that includes NR1, NR2, and NR3.

Numeric

A numeric parameter such as a decimal point, optional prefix, or measurement unit.

The syntax as a numeric representation is the same as NRf.

MINimum and MAXimum are available as substitutes for declaring certain values.

Units such as V, A, and W 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.

For PAT20-400T:

```
CURR 500
```

The range of values for SOUR:CURR is 0 % to 105 % of the rated output current. Thus, 500 is set even if 420 is specified.

Special form numeric parameter

The special form numeric parameters MINimum, MAXimum and DEFault can be used as substitutes for limit values when the parameter is numeric. In the example below, the current limit is set to the minimum value.

```
CURRent:PROTection MINimum
```

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

```
CURRent:PROTection? MAX
```

```
CURRent:PROTection? MIN
```

Measurement unit

Below are the default measurement units.

·V (voltage) ·A (current)
·S (second)

The following optional prefixes are supported.

·M (milli) ·U (micro)

NOTE

- The unit symbols in the International System of Units (SI) contain lowercase characters. The IEEE standard uses uppercase characters. SCPI commands are not case-sensitive.
- Commands are accepted even if a measurement unit are not specified.
- To enter "μ" in the data, use "U" instead.

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Overview of Messages

Default Conditions

Conditions after sending a *RST and at power-on

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

Setup item	Setting			Unit	Function
	*RST	Factory default	At power-on		
OUTP	0/OFF	0/OFF	0/OFF*1	--	Output on/off setting.
OUTP:PON:STAT	RST*2	RST*2	Setting immediately before turning the POWER switch off	--	Output condition at power-on.
OUTP:EXT	NORM	NORM		--	Logical setting of the output on/off using external contact.
VOLT	0	0		V	Voltage setting.
VOLT:EXT:SOUR	NONE*3	NONE*3		--	Control mode setting of constant voltage.
VOLT:FINE*7	0	0		--	Fine adjustment setting for voltage.
VOLT:LIM:AUTO	0/OFF	0/OFF		--	Voltage limit setting.
VOLT:PROT	111.5 % of the rated output voltage			V	OVP setting.
VOLT:TRIG	0	0		V	Target voltage using a trigger.
CURR	105.0 % of the rated output current			A	Current setting.
CURR:EXT:SOUR	NONE*3	NONE*3		--	Control mode setting of constant current.
CURR:FINE*7	0	0		--	Fine adjustment setting for current.
CURR:LIM:AUTO	0/OFF	0/OFF		--	Current limit setting.
CURR:PROT	111.5 % of the rated output current			A	OCP setting.
CURR:TRIG	105.0 % of the rated output current			A	Target current using a trigger.
OUTP:TRIG	0/OFF	0/OFF		--	Setting of whether to turn the output on/off using a trigger.
TRIG:SOUR	BUS*4	BUS*4	BUS*4	--	Sequence 1 trigger source.

TRIG:SEQ2:DEL:ON/ TRIG:OUTP:DEL:ON	0.0	0.0	Setting immediately before turning the POWER switch off	S	Output on delay setting.
TRIG:SEQ2:DEL:OFF/ TRIG:OUTP:DEL:OFF	0.0	0.0		S	Output off delay setting.
TRIG:SEQ2:SOUR/ TRIG:OUTP:SOUR	BUS*4	BUS*4	BUS*4	--	Sequence 2 trigger source.
TRIG:SEQ3:SOUR/ TRIG:ACQ:SOUR	IMM*5	IMM*5	IMM*5	--	Sequence 3 trigger source.
TRIG:CONT:SEEQ3/ TRIG:CONT:NAME ACQ	0/OFF	0/OFF	0/OFF	--	Sequence operation auto continue mode of sequence 3.
SYST:CONF:BTR:PROT	0/OFF	0/OFF	Setting immediately before turning the POWER switch off	--	Breaker trip setting when the OVP or OCP is activated.
SYST:CONF:BTR:SHUT	0/OFF	0/OFF		--	Breaker trip setting when the SD signal is applied.
SYST:CONF:MSL	MAST	MAST		--	Status setting during parallel operation.
SYST:CONF:PAR	No change	1		--	Setting the number of units in Master-Slave Parallel Operation.
SYST:CONF:PST	NORM*6	NORM*6		--	Status signal setting of the output on/off.
SYST:CONF:TRAC	No change	0/OFF		--	Communication error display/hide setting.
SYST:KLOC		--		--	Panel operation lock.
MEM:KLOC		1/ON		--	Preset memory recall setting while locked.
SYST:CONF:SPH*8		0/OFF		--	Input Mode (single-phase/ three-phase) setting.

*1 The PAT-T may power up at 1/ON depending on the OUTP:PON:STAT setting.
*2 RST: Output turns off at power-on.
*3 NONE: Panel control
*4 BUS: Wait for a software trigger to start the measurement
*5 IMM: Start the measurement immediately
*6 NORM: Output a low level signal while the power is on.
*7 This command is available for 8 kW type products only.
*8 This command is available for 4 kW type products only.

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Command (Function/ Sub-system)

IEEE488.2 Common commands

*CLS	Clears all the event registers.
*ESE	Sets the event status enable register bits.
*ESR	Queries the event status register.
*IDN	Queries the identification string (manufacturer information).
*OPC	Causes the device to generate the operation complete message in the event status register when all pending selected device operations have been finished.
*OPT	Queries the hardware interface board that is installed.
*PSC	Initializes *ESE and *SRE.
*RST	Performs a device reset. Configures the PAT-T to a known condition independent from the usage history of the device.
*SRE	Sets the service request enable register bits.
*STB	Reads the status byte and master summary status bits.
*TRG	Trigger command
*TST	Executes a self-test
*WAI	Prevents the device from executing subsequent commands or queries until the No Operation Pending flag becomes true.

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Command (Function)

Output Setting

Output on / off

OUTP	Output on/off.
OUTP:PON:STAT	Output status at power-on.

Voltage Settings

VOLT	Sets the voltage.
VOLT:FINE	Sets the fine adjustment setting for voltage.

Current Settings

CURR	Sets the current.
CURR:FINE	Sets the fine adjustment setting for current.

Command (Function)

Protection and Clear the Alarm

Overvoltage protection settings

CURR:PROT	Sets the OCP.
CURR:LIM	Queries the current setting limit.
CURR:LIM_AUTO	Enables/Disables the current setting limit.

Overcurrent protection settings

VOLT:PROT	Sets the OVP.
VOLT:LIM	Queries the voltage limit setting.
VOLT:LIM_AUTO	Enables/Disables the voltage limit setting.

Operation when a protection function is activated

SYST:CONF:BTR:PROT	Turns breaker trip on/off when the OCP/OVP activates.
SYST:CONF:BTR:SHUT	Turns the breaker trip on/off when the SD signal is applied.

Releasing the Alarm

OUTP:PROT:CLE	Clears the alarm.

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Command (Function)

System Configuration

Setting tp be related to the Output

OUTP:EXT	Sets the logic of the output on/off using external contact.
OUTP:PON:STAT	Output status at power-on.
SYST:CONF:MPR	Sets the output-on startup state. (Only on the PAT350-22.8T and PAT850-9.4T)

Setting of Control source

CURR:EXT:SOUR	Sets the constant current control mode.
VOLT:EXT:SOUR	Sets the CV control mode setting.

Breaker trip settings when protection activates.

SYST:CONF:BTR:PROT	Turns breaker trip on/off when the OCP/OVP activates.
SYST:CONF:BTR:SHUT	Turns the breaker trip on/off when the SD signal is applied.

Setting of Parallel Operation

SYST:CONF:PAR	Setting the number of units in Master-Slave Parallel Operation.
SYST:CONF:MSL	Sets the status during parallel operation.

Setting tp be related to the POWER on/off

SYST:CONF:BTR	Breaker trip.
SYST:CONF:PST	Sets the status signal of the power on/off.

PAT-T status

SYST:CONF:RSEN	Queries the sensing switch status.

Setting of the Communication error Display

SYST:CONF:TRAC	Sets whether to display or hide the communication error.

Setting of the input mode

SYST:CONF:SPH	Sets the phase input mode (Three-phase input/Single-phase input mode).

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Command (Function)

Preset Memory Function

MEM:SAV	Saves to a preset memory.
MEM:RCL	Recalls a preset memory.
MEM:KLOC	Sets the preset memory recall while locked.

Command (Function)

Setting Changes using triggers

Second level node: SEQuence[1] or TRANsient

The same operation is carried out regardless of the node that is used.

-> Tutorial

VOLT:TRIG	Target voltage using a trigger.
CURR:TRIG	Target current using a trigger.
TRIG:SOUR	Sequence 1: Trigger source.
INIT	Sequence 1: Starts the voltage/current setting trigger function.
INIT:NAME	Starts the trigger function.
TRIG	Sequence 1: Software trigger.
ABOR	Aborts the operation of all sequences.

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Command (Function)

Output On/Off Delay

Second level node: SEQuence2 or OUTPut

The same operation is carried out regardless of the node that is used.

-> Tutorial

OUTP:TRIG	Sets whether to turn the output on/off using a trigger.
TRIG:SEQ2:DEL:ON TRIG:OUTP:DEL:ON	Sequence 2: Sets the output on delay.
TRIG:SEQ2:DEL:OFF TRIG:OUTP:DEL:OFF	Sequence 2: Sets the output off delay.
TRIG:SEQ2:SOUR TRIG:OUTP:SOUR	Sequence 2: Trigger source.
INIT:SEQ2	Sequence 2: Starts the output on/off delay trigger function.
INIT:NAME	Starts the trigger function.
TRIG:SEQ2 TRIG:OUTP	Sequence 2: Software trigger.
ABOR	Aborts the operation of all sequences.

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Command (Function)

Measurement

Second level node: SEQuence3 or ACQuire

The same operation is carried out regardless of the node that is used.

-> Tutorial

TRIG:SEQ3:SOUR TRIG:ACQ:SOUR	Sequence 3: Trigger source.
INIT:SEQ3	Sequence 3: Starts the measurement trigger function.
INIT:NAME	Starts the trigger function.
TRIG:SEQ3	Sequence 3: Software trigger.
TRIG:ACQ	
INIT:CONT:SEQ3	Sets the auto continue mode.
INIT:CONT:NAME	
SENS:AVER:CLE	Clears the measured date.
FETC:VOLT	Queries the measured voltage output without starting the measurement operation.
MEAS:VOLT	Queries the measured voltage output after starting a new measurement operation.
FETC:CURR	Queries the measured current output without starting the measurement operation.
MEAS:CURR	Queries the measured current output after starting a new measurement operation.
ABOR	Aborts the operation of all sequences.

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Command (Function)

System

SYST:ERR	Read the error information.
SYST:KLOC	Panel operation lock.
SYST:LOC	Sets to local.
SYST:OPT	Queries the option interface board.
SYST:REM	Sets the operation to remote. Locks the panel keys except the LOCAL switch.
SYST:RWL	Sets the operation to remote. Locks the panel operation.
SYST:VERS	Queries the SCPI specification version with which the PAT-T complies.

Command (Function)

Register

Status byte register

Event status register

OPERation status register.

STAT:OPER	Event.
STAT:OPER:COND	Register status.
STAT:OPER:ENAB	Enable.
STAT:OPER:NTR	Negative transition.
STAT:OPER:PTR	Positive transition.

QUEStionable status register.

STAT:QUES	Event.
STAT:QUES:COND	Register status.
STAT:QUES:ENAB	Enable.
STAT:QUES:NTR	Negative transition.
STAT:QUES:PTR	Positive transition.

Preset Status

STAT:PRES	Resets the enable register.

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Command (Sub-system)

SOURce subsystem

CURR	Sets the current.
CURR:EXT:SOUR	Sets the constant current control mode.
CURR:FINE	Sets the fine adjustment setting for current (Only on the PAT350-22.8T and PAT850-9.4T).
CURR:LIM	Queries the current setting limit.
CURR:LIM:AUTO	Enables/Disables the current setting limit.
CURR:PROT	Sets the OCP.
CURR:TRIG	Target current using a trigger.
VOLT	Sets the voltage.
VOLT:EXT:SOUR	Sets the CV control mode setting.
VOLT:FINE	Sets the fine adjustment setting for voltage. (Only on the PAT350-22.8T and PAT850-9.4T)
VOLT:LIM	Queries the voltage limit setting.
VOLT:LIM:AUTO	Enables/Disables the voltage limit setting.
VOLT:PROT	Sets the OVP.
VOLT:TRIG	Target voltage using a trigger.

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Command (Sub-system)

INPut /OUTPut subsystem

OUTP	Output on/off.
OUTP:TRIG	Sets whether to turn the output on/off using a trigger.
OUTP:EXT	Sets the logic of the output on/off using external contact.
OUTP:PROT:CLE	Clears the alarm.
OUTP:PON:STAT	Output status at power-on.

Command (Sub-system)

MEASure and FETCh subsystem

FETC:CURR	Queries the measured current output without starting the measurement operation.
FETC:VOLT	Queries the measured voltage output without starting the measurement operation.
MEAS:CURR	Queries the measured current output after starting a new measurement operation.
MEAS:VOLT	Queries the measured voltage output after starting a new measurement operation.

Command (Sub-system)

TRIGger subsystem

ABOR	Aborts the operation of all sequences.
INIT:NAME	Sequence 1, 2, and 3: Starts the trigger function.
INIT	Sequence 1: Starts the voltage/current setting trigger function.
INIT:SEQ2	Sequence 2: Starts the output on/off delay trigger function.
INIT:SEQ3	Sequence 3: Starts the measurement trigger function.
INIT:CONT:NAME	Sequence 3: Sets the auto continue mode.
INIT:CONT:SEQ3	Sequence 3: Sets the auto continue mode.
TRIG	Sequence 1: Software trigger.
TRIG:SOUR	Sequence 1: Trigger source.
TRIG:OUTP	Sequence 2: Software trigger.
TRIG:OUTP:DEL:ON	Sequence 2: Sets the output on delay.
TRIG:OUTP:DEL:OFF	Sequence 2: Sets the output off delay.
TRIG:OUTP:SOUR	Sequence 2: Trigger source.
TRIG:SEQ2	Sequence 2: Software trigger.
TRIG:SEQ2:DEL:ON	Sequence 2: Sets the output on delay.
TRIG:SEQ2:DEL:OFF	Sequence 2: Sets the output off delay.
TRIG:SEQ2:SOUR	Sequence 2: Trigger source.
TRIG:ACQ	Sequence 3: Software trigger.
TRIG:ACQ:SOUR	Sequence 3: Trigger source.
TRIG:SEQ3	Sequence 3: Software trigger.
TRIG:SEQ3:SOUR	Sequence 3: Trigger source.

Command (Sub-system)

MEMory subsystem

MEM:KLOC	Sets the preset memory recall while locked.
MEM:RCL	Recalls a preset memory.
MEM:SAV	Saves to a preset memory.

SENSe subsystem

SENS:AVER:CLE	Clears the measured date.

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Command (Sub-system)

SYSTem subsystem

SYST:CONF:BTR	Breaker trip.
SYST:CONF:BTR:PROT	Turns breaker trip on/off when the OCP/OVP activates.
SYST:CONF:BTR:SHUT	Turns the breaker trip on/off when the SD signal is applied.
SYST:CONF:PAR	Setting the number of units in Master-Slave Parallel Operation.
SYST:CONF:PST	Sets the status signal of the power on/off.
SYST:CONF:RSEN	Queries the sensing switch status.
SYST:CONF:MSL	Sets the status during parallel operation.
SYST:CONF:MPR	Sets the output-on startup state. (Only on the PAT350-22.8T and PAT850-9.4T)
SYST:CONF:SPH	Sets the phase input mode (Three-phase input/Single-phase input mode)
SYST:CONF:TRAC	Sets whether to display or hide the communication error.
SYST:ERR	Read the error information.
SYST:KLOC	Panel operation lock.
SYST:LOC	Sets to local.
SYST:OPT	Queries the option interface board.
SYST:REM	Sets the operation to remote. Locks the panel keys except the LOCAL switch.
SYST:RWL	Sets the operation to remote. Locks the panel operation.
SYST:VERS	Queries the SCPI specification version with which the PAT-T complies.

Command (Sub-system)

STATus subsystem

STATus:OPERation	OPERation status register: Event
STATus:OPERation:CONDtion	OPERation status register: Register status
STATus:OPERation:ENABle	OPERation status register: Enable
STATus:OPERation:PTRansition	OPERation status register: Negative transition
STATus:OPERation:NTRansition	OPERation status register: Positive transition
STATus:QUESionable	QUEStionable status register: Event
STATus:QUESionable:CONDtion	QUEStionable status register: Register status
STATus:QUESionable:ENABle	QUEStionable status register: Enable
STATus:QUESionable:PTRansition	QUEStionable status register: Negative transition
STATus:QUESionable:NTRansition	QUEStionable status register: Positive transition
STATus:PRESet	Resets the enable register

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Lists of Messages

SCPI command: Command name in the short form

*RST: 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.

FETCh | MEASure subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
FETC[:SCAL] | MEAS[:SCAL]									
:VOLT			A		NR3		Queries the measured voltage output.	R	1
:CURR			V		NR3		Queries the measured current output.	R	1

MEMory subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
MEM									
:KLOCK	bool			ON	NR1		Sets the preset memory recall while locked.	R/W	3
:RCL	numeric	1 to 3					Recalls a preset memory.	W	3
:SAV	numeric	1 to 3					Saves to a preset memory.	W	3

OUTPut subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
OUTP									
[:STAT]	bool			OFF	NR1	Yes	Output on/off.	R/W	1
[:STAT]:TRIG	bool			OFF	NR1	Yes	Sets whether to turn the output on/off using a trigger.	R/W	3
:EXT	char	NORM | INV		NORM	char	Yes	Sets the logic of the output on/off using external contact.	R/W	3
:PROT:CLE							Clears the alarm.	W	1
:PON:STAT	char	RST | AUTO		RST	char	Yes	Output status at power-on.	W	3

SENSe subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
SENS:AVER:CLE							Clears the measured date.	W	3

SOURce subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
[SOUR]									
:VOLT									
[:LEV][:IMM][:AMPL]	numeric	0 % to 105 % of the rated output voltage	V	0	NR3	Yes	Sets the voltage.	R/W	1
:EXT:SOUR	char	NONE | VOLT | RES | IRES | FVOL*1		NONE	char	Yes	Sets the CV control mode setting.	R/W	3
:FINE*2	NRf	-10000 to 10000		0		Yes	Sets the fine adjustment setting for voltage.	W	3
:LIM									
[:AMPL]			V		NR3	Yes	Queries the voltage limit setting.	R	3
:AUTO	bool			OFF	NR1	Yes	Enables/Disables the voltage limit setting.	R/W	3
:PROT									
[:LEV]	numeric	10 % to 111.5 % of the rated output voltage	V	111.5 % of the rated output voltage	NR3	Yes	Sets the OVP.	R/W	1
:TRIG	numeric	0 % to 105 % of the rated output voltage	V	0	NR3	Yes	Target voltage using a trigger.	R/W	1
:CURR									
[:LEV][:IMM][:AMPL]	numeric	0 % to 105 % of the rated output current	A	105 % of the rated output current	NR3	Yes	Sets the current.	R/W	1
:EXT:SOUR	char	NONE | VOLT | RES | IRES | FVOL*1		NONE	char	Yes	Sets the constant current control mode.	R/W	3
:FINE*2	NRf	-10000 to 10000		0		Yes	Sets the fine adjustment setting for current.	W	3
:LIM									
[:AMPL]			A		NR3		Queries the current setting limit.	R	3
:AUTO	bool			OFF	NR1	Yes	Enables/Disables the current setting limit.	R/W	3
:PROT									
[:LEV]	numeric	10 % to 111.5 % of the rated output current	A	111.5 % of the rated output current	NR3	Yes	Sets the OCP.	R/W	1
:TRIG	numeric	0 % to 105 % of the rated output current	A	105 % of the rated output current	NR3	Yes	Target current using a trigger.	R/W	1

*1. FVOL parameter is available for 8 kW type products only.
*2. The command is available for 8 kW type products only.

STATus subsystem

SCPI Command		Setting	Response	Description	R/W	†
Program header	Parameter					
STAT						
:OPER						
[:EVEN]			NR1	Event.*1	R	1
:COND			NR1	Register status.*1	R	1
:ENAB	NR1	0 to 32767	NR1	Enable.*1	R/W	1
:PTR	NR1	0 to 32767	NR1	Positive transition.*1	R/W	1
:NTR	NR1	0 to 32767	NR1	Negative transition.*1	R/W	1
:PRES				Resets the enable register.	W	1
:QUES						
[:EVEN]			NR1	Event.*2	R	1
:COND			NR1	Register status.*2	R	1
:ENAB	NR1	0 to 32767	NR1	Enable.*2	R/W	1
:PTR	NR1	0 to 32767	NR1	Positive transition.*2	R/W	1
:NTR	NR1	0 to 32767	NR1	Negative transition.*2	R/W	1

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

SYSTem subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
SYST									
:CONF									
:BTR									
[:IMM]							Breaker trip.	W	3
:PROT	bool			OFF	NR1	Yes	Turns breaker trip on/off when the OCP/OVP activates.	R/W	3
:SHUT	bool			OFF	NR1	Yes	Turns the breaker trip on/off when the SD signal is applied.	R/W	3
:PAR	NRf	1 to 5*1		1	NR1		Setting the number of units in Master-Slave Parallel Operation.	R/W	3
:PST	char	NORM | INV		NORM	char		Sets the status signal of the power on/off.	R/W	3
:RSEN					NR1		Queries the sensing switch status.	R	3
:MSL	char	MAST | PAR		MAST	char		Sets the status during parallel operation.	R/W	3
:MPR*2	char	CV | CC		CV	char		Sets the output-on startup state.	R/W	3
:SPH*3	bool			OFF	NR1		Sets the phase input mode.	R/W	3
:TRAC	bool			OFF	NR1		Sets whether to display or hide the communication error.	R/W	3
:ERR[:NEXT]?					string		Read the error information.	R	3
:KLOC	bool				NR1		Panel operation lock.	R/W	1
:LOC							Sets to local.	W	1
:OPT					char		Queries the option interface board.	R	3
: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							Queries the SCPI specification version with which the PAT complies.	R	1

*1. On the PAT850-9.4T, the settings are 1 | 2
*2. The command is available for 8 kW type products only.
*3. The command is available for 4 kW type products only.

TRIGger subsystem

SCPI Command		Setting		Default	Resp.	*RST	Description	R/W	†
Program header	Parameter		Unit						
ABOR							Aborts the operation of all sequences.	W	1
INIT									
[:IMM]									
:NAME	char	TRAN | OUTP| ACQ					Sequence 1, 2, and 3: Starts the trigger function.	W	1
:SEQ1							Sequence 1: Starts the voltage/ current setting trigger function.	W	1
:SEQ2							Sequence 2: Starts the output on/off delay trigger function.	W	1
:SEQ3							Sequence 3: Starts the measurement trigger function.	W	1
:CONT									
:NAME	char	ACQ				Yes	Sequence 3: Sets the auto continue mode.	R/W	1
	bool			OFF	NR1				
:SEQ3	bool			OFF	NR1	Yes			
TRIG[SEQ[1]] | TRIG[:TRAN]									
[:IMM]							Sequence 1: Software trigger.	W	1
:SOUR	char	IMM | BUS		BUS	char	Yes	Sequence 1: Trigger source.	R/W	1
TRIG:SEQ2 | TRIG:OUTP									
[:IMM]							Sequence 2: Software trigger.	W	1
:DEL									
:OFF	numeric	0.0 to 10.0	S	0.0	NR3	Yes	Sequence 2: Sets the output off delay.	R/W	1
:ON	numeric	0.0 to 10.0	S	0.0	NR3	Yes	Sequence 2: Sets the output on delay.	R/W	3
:SOUR	char	IMM | BUS		BUS	char	Yes	Sequence 2: Trigger source.	R/W	3
TRIG:SEQ3 | TRIG:ACQ									
[:IMM]							Sequence 3: Software trigger.	W	1
:SOUR	char	IMM | BUS		IMM	char	Yes	Sequence 3: Trigger source.	R/W	1

IEEE488.2 common commands

IEEE488.2 common command	Parameter	Description	R/W
*CLS		Clears all the event registers.	W
*ESE	NR1	Sets the event status enable register bits.	R/W
*ESR		Queries the event status register.	R
*IDN		Queries the identification string (manufacturer information).	R
*OPC		Causes the device to generate the operation complete message in the event status register when all pending selected device operations have been finished.	R/W
*OPT		Queries the hardware interface board that is installed.	R
*PSC	0 | 1	Initializes *ESE and *SRE.	R/W
*RST		Performs a device reset. Configures the PAT to a known condition independent from the usage history of the device.	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		Executes a self-test	R
*WAI		Prevents the device from executing subsequent commands or queries until the No Operation Pending flag becomes true.	W

[-199,-100] | [-299,-200]
[-399,-300] | [-499,-400]
[-899,-800] | [100-]

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 5) in the event status register to be set.

Error Code		Error Message Description
-100	Command error	This is the generic syntax error
-101	Invalid character	A syntactic element contains a character which is invalid for that type.
-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 recieved than required for the header.
-110	Command header error	An error was detected in the header.
-120	Numeric data error	This error are generated when parsing a data element which apprears to be numeric, including the nondecimal numeric types.
-130	Suffix error	This error are generated when parsing a suffix.
-131	Invalid suffix	The suffix does not follow the syntax or the suffix is inappropriate for this device.
-134	Suffix too long	The suffix contained more than 12 characters.
-138	Suffix not allowed	A suffix was encountered after a numeric element which does not allow suffixes.
-140	Character data error	This error are generated when parsing a character data element.
-141	Invalid character data	Either the character data element contains an invalid character or the particular element received is not valid for the header.
-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 device.
-150	String data error	This error are generated when parsing a string data element.
-160	Block data error	This error are generated when parsing a block data element.
-170	Expression error	This error are generated when parsing an expression data element.
-180	Macro error	This error are generated when defining a macro or executing a macro.

>top

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 4) in the event status register to be set.

Error Code		Error Message Description
-200	Execution error (generic)	This is the generic syntax error for devices that cannot detect more specific errors.
-203	Command protected	Indicates that a legal password-protected program command or query could not be executed because the command was disabled.
-210	Trigger error	Trigger error
-211	Trigger ignored	Indicates that a GET, *TRG, or triggering signal was received and recognized by the device but was ignored because of device timing considerations.
-213	Init ignored	Indicates that a request for a measurement initiation was ignored as another measurement was already in progress.
-214	Trigger deadlock	Indicates that the trigger source for the initiation of a measurement is set to GET and subsequent measurement query is received.
-220	Parameter error	Indicates that a program data element related error occurred.
-221	Settings conflict	Indicates that a legal program data element was parsed but could not be executed due to the current device state
-222	Data out of range	Indicates that a legal program data element was parsed but could not be executed because the interpreted value was outside the legal range as defined by the device.
-223	Too much data	Indicates that a legal program data element of block, expression, or string type was received that contained more data than the device could handle due to memory or related device-specific requirements.
-224	Illegal parameter value	Used where exact value, from a list of possibles, was expected.
-230	Data corrupt or stale	Possibly invalid data; new reading started but not completed since last access.
-241	Hardware missing	Indicates that a legal program command or query could not be executed because of missing device hardware.

>top

Device-specific errors

The occurrence of any error in this class shall cause the Device Dependent Error (bit 3) in the event status register to be set.

Error Code		Error Message Description
-350	Queue overflow	A specific code entered into the queue in lieu of the code that caused the error. This code indicates that there is no room in the queue and an error occurred but was not recorded.
-360	Communication error	Communication error when the flow control is turned off. This error applies when the RS232C is used.
-362	Framing error in program message	Framing error. This error applies when the RS232C is used.
-363	Input buffer overrun	Buffer overrun error. This error applies when the RS232C is used.
-364	Time out error	Time out error. This error applies when the RS232C is used.

>top

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 2) in the event status register to be set.

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: A command such as the following. *IDN?;SYST:ERR?)

>top

Operation complete event errors

An error in the range [-899, -800] is used when the PAT-T wishes to report an IEEE488.2 operation complete event. This event occurs when the instrument?s synchronization protocol, having been enabled by an *OPC command, completes all selected pending operations.

The occurrence of any event error in this class shall cause the Operation Complete (bit 0) in the event status register to be set.

Error Code		Error Message Description
-800	Operation complete	The instrument has completed all selected pending operations in accordance with the IEEE 488.2, 12.5.2 synchronization protocol.

>top

Device-dependent errors

The occurrence of any error in this class shall cause the Device Dependent Error (bit 3) in the event status register to be set.

Error Code		Error Message Description
101	Operation denied while in LOCal state	Operation is denied because the PAT-T 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.
104	Operation denied while in SLAVe mode	Operation is denied because the PAT-T is set to slave mode.

>top

Processing time of Commands

The command processing time is the time until the next command is accepted.
It does not include the response time of the hardware.
The processing times indicated here are typical values.
They are not warranted.

Command	GPIB Processing Time *1 (ms)	USB Processing Time (ms)	RS232C Processing Time *2 (ms)	LAN Processing Time *3 (ms)	Description
VOLT	10	10	8	11	Sets the voltage.
MEAS:VOLT?	30	27	32	27	Queries the measured voltage output.
CURR	10	10	8	11	Sets the current.
MEAS:CURR?	28	27	32	27	Queries the measured current output.
*RST	102	102	100	102	Performs a device reset.

*1 : Using GPIB-USB-B by National Instruments.
*2 : Data rate setting: 19 200 bps, X-Flow control
*3 : 100BASE-TX Ethernet

Tutorial

Turning the Power On and Resetting the Instrument

When the PAT-T is turned on, all panel settings are set to the state when it was turned off the last time. The output state varies depending on the output state setting (OUTPut:PON:STATe) at power-on.

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 PAT-T is turned on. The following commands are implicitly executed at power-on.

```
*CLS
*SRE 0
*ESE 0
:SYSTem:REMote
:OUTPut OFF     'OUTPut ON is executed if OUTP:PON:STAT is set to AUTO.
:OUTPut:PROTection:CLEar
:TRIGger:SEQuence1:SOURce BUS
:TRIGger:SEQuence2:SOURce BUS
:TRIGger:SEQuence3:SOURce IMMediate
:INITiate:CONTinuous:SEQuence3 OFF
```

Reset command

The *RST command is used to initialize the panel settings of the PAT-T.

```
*RST
```

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, the items below must be changed to the initial settings after executing the *RST command.

Communication error display setting

Master-Slave parallel operation setting

Lock function

Remote interface setting

NOTE

Turning on the POWER switch while holding down the SHIFT switch initializes the PAT-T settings to factory default. All the panel settings, panel memory contents, and configuration settings are reset.

>top

Tutorial

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.

```
:VOLTage 13.5     'Set the voltage to 13.5 V
:CURRent 4.5      'Set the current to 4.5 A
:OUTPut ON        'Turn the output on
```

To set the preset current to the maximum value, set the value of the CURRent command to MAXimum.

The current setting limit is set to approximately 95 % of the value specified by the CURRent:PROTection command if the CURRent:LIMit:AUTO command is set to ON (1). The setting limit cannot be set above this value. If the CURRent:LIMit:AUTO command is set to OFF (0), the setting limit is the maximum value of preset range (105 % of the rated output current).

```
:VOLTage 13.5     'Set the voltage to 13.5 V
:CURRent MAXimum     'Set the current to the max.value
```

To set the preset voltage to the maximum value, set the value of the VOLTage command to MAXimum.

The voltage limit setting is set to approximately 95 % of the value specified by the VOLTage:PROTection command if the VOLTage:LIMit:AUTO command is set to ON (1). The setting limit cannot be set above this value. If the VOLTage:LIMit:AUTO command is set to OFF (0), the setting limit is the maximum value of preset range (105 % of the rated output voltage).

```
:CURRent 4.5      'Set the current to 4.5 A
:VOLTage MAXimum     'Set the voltage to the max.value
```

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.

```
:VOLTage? MAXimum
 <Read the response>
:CURRent? MAXimum
 <Read the response>
```

The values that the queries above return may vary depending on the VOLTage:PROTection (OVP) and CURRent:PROTection (OCP) settings.

If a value exceeding the upper limit is specified with the VOLTage or CURRent command, it is interpreted as MAXimum and does not result in an error.

Setting the protection functions

The PAT-T provides overvoltage protection (OVP) and overcurrent (OCP) functions that can be configured. The VOLTage:PROTection and CURRent:PROTection commands are used to set the OVP and OCP, respectively.

```
:VOLTage:PROTection 16.0     'Set the OVP to 16 V
:CURRent:PROTection 7.5      'Set the OCP to 7.5 A
```

If you want to set the OVP or OCP setting to the maximum or minimum value, you can specify MAXimum or MINimum for the parameter.

```
:VOLTage:PROTection MAXimum     'Set the OVP to the max value
:CURRent:PROTection MAXimum     'Set the OCP to the max value
```

The output turns off if an OVP or OCP activates. Whether the breaker is to be tripped at this point can be specified using the SYSTem:CONFigure:BTRip:PROTection command.

```
SYSTem:CONFigure:BTRip:PROTection ON
```

```
'Setting in which the breaker is tripped when the OVP or OCP activates
```

>top

Tutorial

Using Triggers

PAT-T has three different trigger subsystems: TRANsient, OUTPut, and ACQuire. In the normal SCPI specifications, each trigger subsystem is grouped into a numbered trigger sequence. TRANsient, OUTPut, and ACQuire are mapped to SEQuence1, SEQuence2, SEQuence3, respectively.

The functional assignments of each sequence number are specific to the PAT-T. The assignment is not necessarily the same as other models that have the SCPI language implemented.

Sequence 1 (TRANsient) group

A trigger subsystem that changes the output voltage and output current settings.

Sequence 2 (OUTPut) group

A trigger subsystem for the output on/off delay

Sequence 3 (ACQuire) group

A trigger subsystem for measurements

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

```
:ABORt
*RST
Device clear (GPIB and USB) or break signal (RS232)
```

>top

Tutorial

Status Monitoring

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

Register basics

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

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

For example, to check if the PAT-T is being regulated in CV state, check the CV bit (bit 8) on the STATus:OPERation register.

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

STATus:QUEStionable

The STATus:QUEStionable register records events or signals that indicate abnormal operation.

To check if the protection function is working, check the 0V bit (bit 0) on the STATus:QUEStionable register.

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

PON (Power ON) bit

The PON bit (bit 7) in the event status register is set whenever the PAT-T 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 (*PSC 0).
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 (*ESE 128).
3. Set the ESB bit (bit 5) of the status byte enable register.
   Permit the generation of an SRQ caused by a standard event (*SRE 32).

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

When using the RS232C interface, the PON bit cannot be assigned to the service request, because SRQs are not generated.

Though the SRQ feature itself is provided by the USBTMC Interrupt-IN endpoint on the USB interface or LAN interface, a Connection Lost error in the VISA I/O session occurs immediately before the power-on event. It may be difficult to handle PON events when using the USB interface.

>top

Tutorial

Error Checking

Error/event queue

The SCPI specifications define a 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 PAT-T 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 common command is sent, when the last item in the queue is read, or when the PAT-T is turned on. When the error/event queue is empty, the query returns the following:

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

Displaying communication errors

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

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

If the error/event queue is empty, the debug trace function does not display any errors. Sending the *CLS command clears the communication error display.

If in local mode, the debug trace function is temporarily disabled.

The communication error display can be enabled or disabled with the SYSTem:CONFigure:TRACe command.

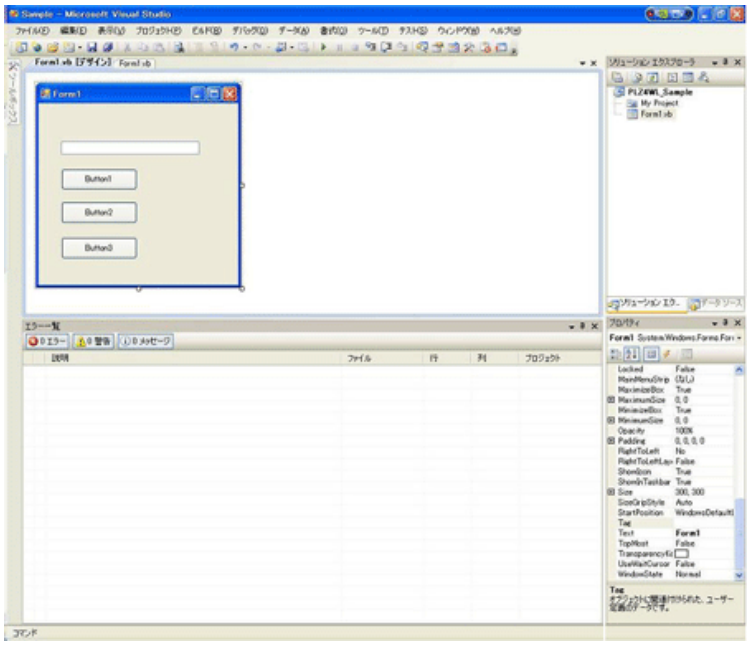
```
SYSTem:CONFigure:TRACe {ON|OFF}
```

>top

Tutorial

Visual Basic 2008

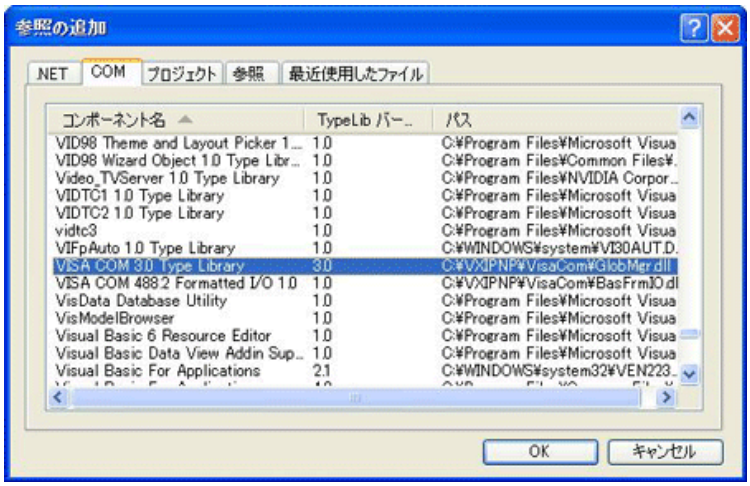
Communicate with the PAT-T series using VISA through GPIB, RS232C, USB, or LAN.



Setting the "Project"

At first, set the communication driver (VISA liabrary) for the "Project".

Click "Project" on the menu bar, then select "Add Reference" to refer "VISA COM 3.0 Type Library".



Communication through GPIB, RS232C, USB, or LAN

After setting the communication driver, it enables to communicate by GPIB, RS232C, USB, or LAN.

The following describes the communication procedure for via VISA.

Open the VISA

To communicate with the device of GPIB, RS232C, USB, or LAN via VISA, it requires to open the VISA first. When opening the VISA, specify the I/O resource.

Example : To open VISA by using USB

```
Set rm = CreateObject("VISA.GlobalRM")
Set msg = rm.Open("USB::0x0B3E::0x100E::00000001::INSTR", NO_LOCK, 0, "")
```

"USB::0x0B3E::0x100E::00000001::INSTR" is the I/O resource.

The I/O resource is specified by the following constructions. The part indicated with [ ] can be abbreviated. Enter the appropriate value in the part specified in oblique characters.

GPIB	GPIB[*board*]::*PrimaryAddress*[::*SecondaryAddress*][::INSTR] Example : The primary address 3 of the measuring instrument connected to GPIB0. GPIB0::3::INSTR
Serial (RS232C)	ASRL[*board*][::INSTR] Example : The measuring instrument connected to the serial port COM1. ASRL1::INSTR
USB	USB[*board*]::*VendorID*::*ProductID*::*SerialNumber*[::*InterfaceNumber*][::INSTR] Example : The USNTMC measuring instrument having with the vendor ID (VID)2878, Product ID(PID)4111 and serial number "00000001". USB0::0x0B3E::0x100E::00000001::INSTR
LAN	TCPIP[*board*]::*LAN divice name*[::inst*0*][::INSTR] Example :The measuring instrument whose IP address (LAN device name) is 169.254.7.8. TCPIP::169.254.7.8::INSTR You can also set the LAN device name using the host name.

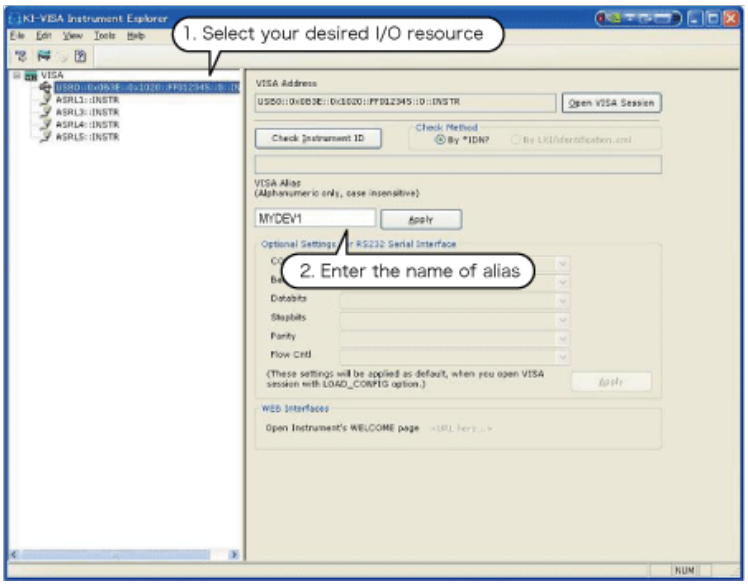
For VISA, the alias can be used for the I/O resource.

When using the alias for the I/O resource, even the alias name to be hard coating directly in the application, it can be easily converted to the appropriate I/O resource name.

Example : When using the alias (MYDEV1) for the I/O resource.

```
Set msg = rm.Open("MYDEV1", NO_LOCK, 0, "")
```

When the alias is used, the actual I/O resource is specified by such an external configuration table. When using the USB (example for KI-VISA)



In case of using VISA other than KI-VISA, please refer to the applied VISA manual.

Controlling the devices

Next, using such a "Read", "Write" to control the devices.

Example:

```
msg.WriteString ("VOLT 13.5")        'Set 13.5 V
msg.WriteString ("CURR 150.0")       'Set 10 A
msg.WriteString ("OUTP 1")           'Output on
```

Closing the VISA.

Close the VISA at the end.

A command for "Open" and "Close" of the VISA is required only once in the program.

```
msg.Close
```

Sample program

```
Imports Ivi.Visa.Interop

Public Class Form1

  Dim rm As ResourceManager
  Dim msg As IMessage

  Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
    rm = CreateObject("VISA.GlobalRM")
    msg = rm.Open("GPIB0::1::INSTR", AccessMode.NO_LOCK, 0, "")    'Example: GPIB
    'msg = rm.Open("MYDEV1", AccessMode.NO_LOCK, 0, "")  'Example: Using a alias
    'msg = rm.Open("USB0::0x0B3E::0x100E::00000001::INSTR", AccessMode.NO_LOCK, 0, "")  'Example: USB
    'msg = rm.Open("TCPIP::169.254.7.8::INSTR", AccessMode.NO_LOCK, 0, "")  'Example: LAN
  End Sub

  'Query the instrument identity
  Private Sub cmdIdn_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles cmdIdn.Click
    msg.WriteString("*IDN?")
    TextBox1.Text = msg.ReadString(256)
  End Sub

  'Set the operation mode and voltage
  Private Sub cmdCurr_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles cmdCurr.Click
    msg.WriteString("OUTP 0")
    msg.WriteString("VOLT 13.5")
    msg.WriteString("CURR 150.0")
    msg.WriteString("OUTP 1")
  End Sub

  'Query the instrument identity
  Private Sub cmdMeas_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles cmdMeas.Click
    msg.WriteString("MEAS:CURR?")
    TextBox1.Text = msg.ReadString(256)
  End Sub

  Private Sub Form1_Disposed(ByVal sender As Object, ByVal e As System.EventArgs) Handles Me.Disposed
    msg.Close()
  End Sub

END CLASS
```

>top

Setup

Interface Setup

RS232C (Standard Equipped)

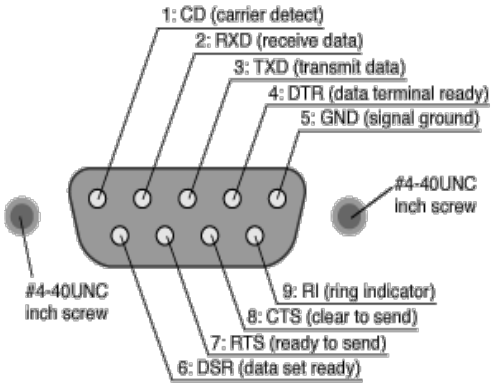
When the PAT-T is shipped from the factory, the RS232C connector has a cover. Keep the cover so that you can attach it to the RS232C connector when the connector is not in use. For safety, always attach the cover to the RS232C connector when the connector is not being used. If the cover is damaged or lost, contact your Kikusui agent or distributor.

RS232C connection

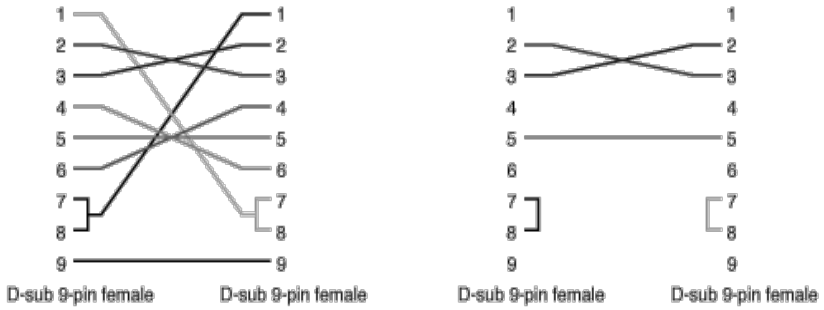
Turn off the POWER switch on the PAT-T and the computer.

Use a D-sub 9-pin female-to-female AT type cross cable for the RS232C cable. Figure shows the connector pin assignments.

The PAT-T does not use hardware handshaking (Cross cable example2).



Facing the KFM2150 rear panel



Cross cable example1 Cross cable example2

9-pin AT type connector

RS232C configuration

1. If an option board is installed, select RS232C in the CONFIG settings (CF54: 232C).

The switch LED illuminates. The ammeter displays the parameter number, and the voltmeter displays the present setting.

2. In the CONFIG settings, set the RS232C data rate (CF40), RS232C data length

(CF41), RS232C stop bit (CF42), and RS232C flow control (CF43).
For the settings, see table of protcol.

Protocol

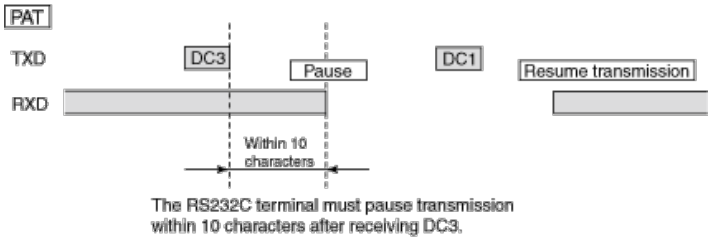
Table shows the RS232C protocol.
Underline indicates factory default condition.

Item	Setting
Connector	9-pin D-sub terminal on the rear panel
Baudrate (CF40)	1 200 bps/ 2 400 bps/ 4 800 bps/ 9 600 bps/ 19 200 bps/ 38 400 bps (1.2/ 2.4/ 4.8/ 9.6/ 19.2/ 38.4)
Data (CF41)	(8 bits/ 7 bits)
Stop (CF42)	(1 bit/ 2 bits)
Parity	Fixed to none
Flow (X-flow control) (CF43)	XFLOW/ None (on/off)

RS232C communication

Use flow control for RS232C communication. DC (device control) codes are used as control codes.
Transmission/reception may not work correctly through unilateral transmission.

Code	Functiom	ASCII code
DC1 (Xon)	Request to send	11H
DC3 (Xoff)	Transmission stop request	13H



Break signal

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

>top

Setup

Interface Setup

GPIB (Optional)

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

GPIB connection

Use a standard IEEE488 cable to connect the PAT-T to the computer.

GPIB configuration

1. Select GPIB (CF54: GPIb) in the CONFIG settings.
2. Set the address (CF51: 1 to 30) in the CONFIG settings.
   The address is set to 1 as factory default setting.

GPIB function

Function	Subset	Description
Source handshaking	SH1	Full capability
Acceptor handshaking	AH1	Full capability
Talker	T6	Function available
Listener	L4	Function available
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.

>top

Setup

Interface Setup

USB (Optional)

This interface valid only when the factory option USB interface board is installed.
A device driver supporting USB T&M Class (USBTMC) is required to control the PAT-T through the USB interface. The USBTMC driver is automatically installed by the VISA library.

USB connection

Use a standard USB cable to connect the PAT-T to the computer.

USB configuration

Select USB (CF54: uSb) in the CONFIG settings.

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)
VID （Vender ID）
0x0B3E
PID （Product ID）
0x100E

>top

Setup

Interface Setup

LAN (Optional)

The LAN interface is a factory option.

To use the LAN interface to control the PAT-T, middleware that supports the VXI-11 protocol must be installed on the controller. The middleware is installed automatically by the VISA library.

There is a Web browser interface to the PAT-T embedded in the LAN interface board. You can configure the LAN interface settings from your PC's Web browser.

For information on topics such as connecting to your corporate LAN, your IP address, your host name, and security, contact your network administrator.

LAN connection

Use a standard LAN cable (category 5 and straight) to connect the PAT-T to a network hub or router. Use a crossover cable when making a direct connection.

LAN setting

Normally, you should set DHCP and AUTO IP to ON to set the IP address automatically.

1. Select LAN (CF54 : LAn) by the CONFIG setting.
2. Select DHCP (CF55 : On) by the CONFIG setting.
3. Select AUTO IP (CF56 : On) by the CONFIG setting.

For direct connections, set DHCP(CF55) to OFF and AUTO IP(CF56) to ON and set the IP address automatically. You cannot set the IP address from the panel. To set a fixed IP address, first set the IP address automatically, and then set a fixed address by accessing the PAT-T through a Web browser.

You can use thee CONFIG settings to check the IP address.

Parameter number	Display	Description
CF57	0 to 255	Display the 1st number of the IP address
CF58	0 to 255	Display the 2nd number of the IP address
CF59	0 to 255	Display the 3rd number of the IP address
CF60	0 to 255	Display the 4th number of the IP address

When you are going to use a fixed IP address over a long period of time or at intervals, we recommend that you specify a host name. To set a host name, access the PAT-T through a Web browser.

Warning

There are possible damage on the equipment or an electric shock. The LAN interface can be accessed from any place on the network. Set the security when it is necessary. Security can be set by the password protection and the host limitation by IP address.
->Setting procedure

NOTE

The LAN interface should be shifted remotely by the command unlike other interfaces. Set it by the SCPI command "SYSTem:REMote" to the remote state. When you do a remote programming, transmit this command to the front of the program.

Service request

The features of service request and serial polling are equipped.

LAN function

The connection to the Internet line may be required by the function according to the operation of the built-in Web site.

Comply with the LXI Class C, Specification 1.2

Comply with VXI-11 protocol

Communication speed: Maximum 100 Mbps (Auto negotiation)

DHCP client function

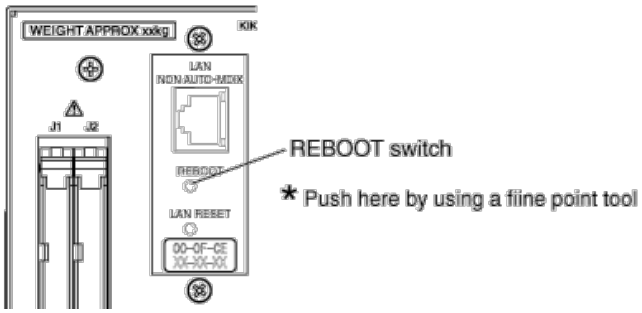
AUTO IP function

Operation of the Web site (Internet Explore 7.0 or later, Mozilla Fire fox 3.0 or later, Opera 9.0 or later, Safari 3.0 or later)

- LAN setting
- Security setting
- Use of temporary control application
- Firmware update

Reboot the LAN interface

When you keep pressing the "REBOOT" switch for more than 2 seconds, the LAN will reboot. However, the setting condition of LAN interface will not be changed.

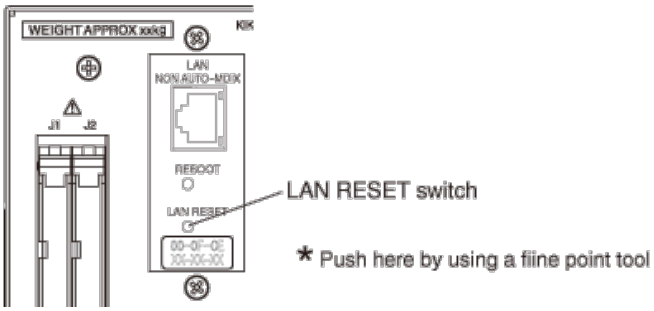


This switch doesn't reflect to the panel setting of the product. In case the product is in the state of remote mode, it can be switched (from the panel operation) to the local mode.

Do not touch the REBOOT switch inadvertently while the automatic measurement system is in operation. It may cause to mis-operation.

Reset the LAN interface

When you keep pressing the "LAN RESET" switch for more than 2 seconds, all of the setting of LAN interface returns to the factory default setting. It can be used when neither the security password nor IP address are forgotten.



This switch doesn't reflect to the panel setting of the product. In case the product is in the state of remote mode, it can be switched (from the panel operation) to the local mode.

Do not touch the LAN RESET switch inadvertently while the automatic measurement system is in operation. It may cause to mis-operation.

>top

Setup

Interface Setup

Accessing and Operating the PAT-T from a Web Browser (LAN interface)

For LAN interface, the detailed setting can be operated from the browser on the PC.

The URL of Web site is defined as adding "http://" in front of the IP address.

The URL can be entered directly on the address bar of the browser by confirming the IP address of the config setting (CF57 to CF60).

Parameter number	Display	Description
CF57	0 to 255	Display the 1st number of the IP address
CF58	0 to 255	Display the 2nd number of the IP address
CF59	0 to 255	Display the 3rd number of the IP address
CF60	0 to 255	Display the 4th number of the IP address

(Example) When the IP address is 169.254.7.8

http://169.254.7.8

When VISA library is used, there is the function to retrieve the VXI-11 measuring instrument by the application program provided by VISA vendors (National Instruments NI-MAX, Agilent Connection Expert, and Kikusui KI-VISA Instrument Explorer, etc.). You can access the PAT-T by clicking on the Web link from the retrieval results.

The following browsers are applied.

Internet Explorer 7.0 or later

Mozilla Firefox 3.0 or later

Opera 9.0 or later

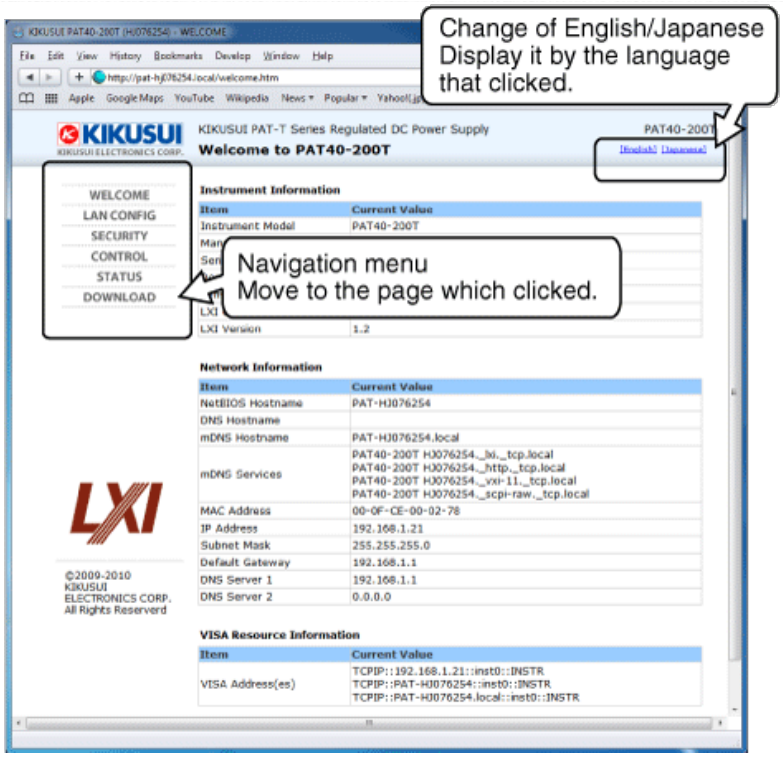
Safari 3.0 or later

WELCOME page

When you access the PAT-T from a Web browser, the WELCOME page is displayed first.

The instrument information, network information, and VISA resource (I/O resource) information appear on the display.

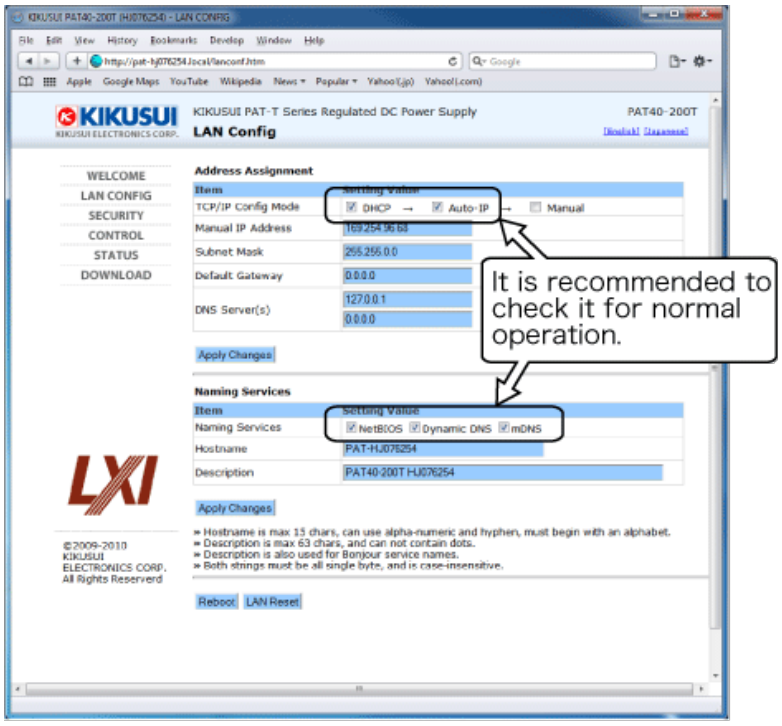
Click the navigation menu to move to the other page.



LAN CONFIG page

Update page for the network settings.

This page can allow you to set the allocation of IP address and the host name, etc. Once you set the host name, you can access to the LAN interface by using the host name instead of IP address. It is recommended to check for the "DHCP", "AUTO IP", "Dynamic DNS", "Net BIOS", and "mDNS" for normal operation.



SECURITY page

This page is for the security setting.

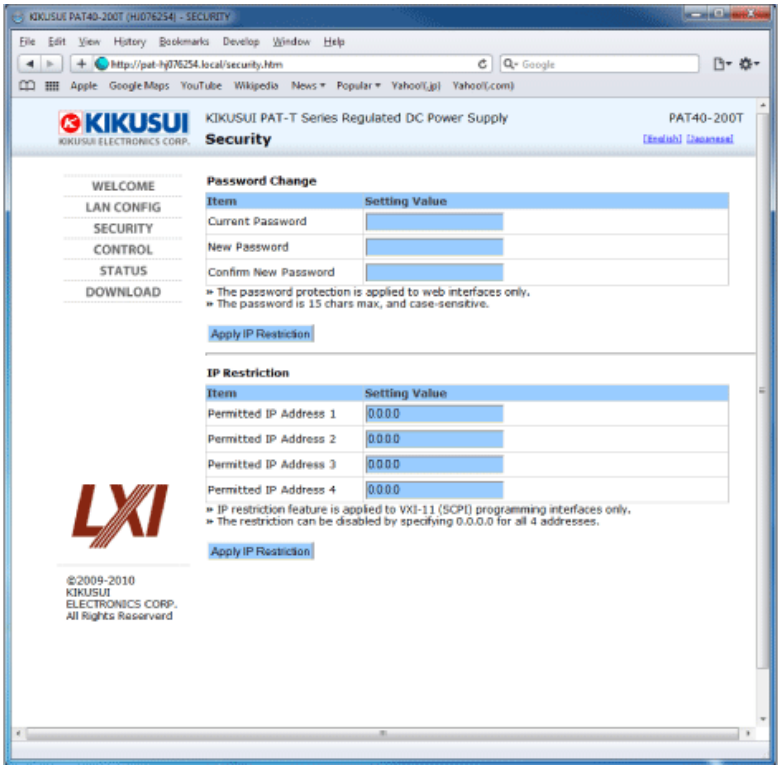
This page can allow you to set the change of the password protection, and the host limit function by the IP address.

The password protection is an effective security features to the Web site. It prevents from being changed inadvertently. The password can be used for any alphanumeric characters, the hyphen, and the underscore. The first character should be an alphabet, with maximum of 15 characters.

The web page which can be set by the password protection are the "LAN CONFIG" page, "SECURITY" page, "CONTROL" page, and "UPDATE" page.

The host limitation by the IP address is an effective security feature for the VXI-11. Having at least one unit is registered, it prevents from being used by non-registered host.

The IP address on the host side can be registered up to 4 units.

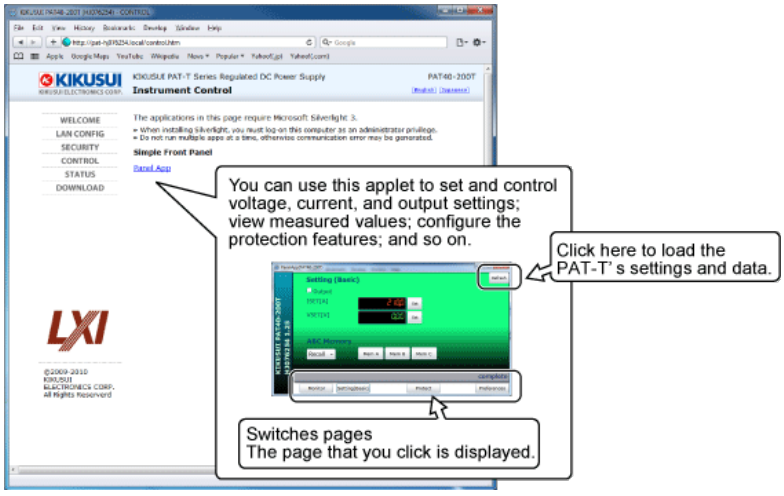


CONTROL page

This page can allow you to set up the simple power supply control application program using the Silverlight.

You can set and control voltage, current, and output settings; view measured values; configure the protection features; and so on. You need to install Microsoft Silverlight before you can use this page.

Click “Refresh” to load the current PAT-T settings. On the Monitor page, the measured values on the PAT-T at the time that you clicked “Refresh” are displayed.



STATUS page

This page is to display the LAN status and for the setting of "identify" display on/off of the product.

Turn the identify display on to identify the PAT-T that is being controlled through the LAN interface. The PAT-T that is being controlled will display “Device Identify” on its front panel.

DOWNLOAD page

Displays the web site link of which down load service of KI-VISA or Microsoft Silverlight.
An internet connection is required to access.

UPDATE page

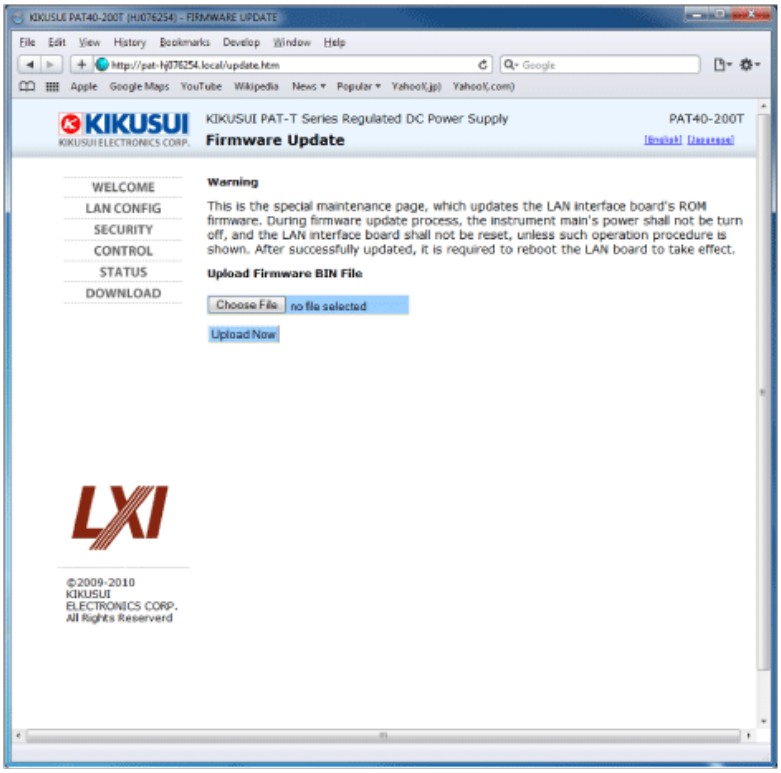
This is firmware update page for the LAN interface.

On this page, you can update by downloading the latest firmware version from the download service of our Web site.

For details of updating firmware, refer to the document in the download module.

To avoid opening the UPDATE page inadvertently, it can not be moved from the navigation menu to the UPDATE page. If you wish to move the navigation menu to the UPDATE page, specify the URL(update.htm) directly.

(Example) When you wish to move to the UPDATE page by the IP address 169.254.7.8
http://169.254.7.8/update.htm



>top

*CLS

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

Command

```
*CLS
```

*ESE

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

Command

```
*ESE <NRf>

*ESE?
```

Parameter
Value：0～255

(Example) 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

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 PAT-T.

Command

```
*IDN?
```

Response

The response to *IDN? is indicated below.

(Example) For PAT20-400T with a serial number AB123456 and firmware version 1.00 Returns

```
KIKUSUI,PAT20-400T,AB123456,1.00
```

*OPC

Sets the OPC bit (bit 0) of the event status register when all of the command processings in stand by have been completed.

Command

```
*OPC

*OPC?
```

Response

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

*OPT

Queries the option interface board that is installed in the PAT-T.

Command

```
*OPT?
```

Response

Returns 0 if there is no option installed in response to *OPT?.

If the factory option GPIB, USB or LAN interface board is installed, "GPIB", "USB" or "LAN" is returned in response to *OPT?.

*PSC

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 <NRf>

*PSC?
```

Parameter

Value	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.

(Example) To enable the power-on SRQ function

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

Response

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

*RST

Aborts the measurement operation and initializes the PAT-T to factory default condition.
->For the commands that are affected by *RST

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 <NRf>

*SRE?
```

Parameter

Value 0～255

(Example) 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

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

Trigger command.

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

If the PAT-T is not in a condition to accept triggers, an SCPI error (-211,"Trigger ignored") occurs.

Command

```
*TRG
```

*TST

This command is to perform the self-test, however, the PAT-T does not equip this feature.
See the IEEE 488.2-1992 Section 10.38.

Command

```
*TST?
```

Response

Returns 0 in response to *TST?.

*WAI

Prevents the PAT-T from executing subsequent commands until all operations in standby are complete.

Command

```
*WAI
```

OUTP

Turn the output on/off. The condition set by the Output on/off Delay function is disabled.

Command

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

OUTPut[:STATe][:IMMediate]?
```

Parameter

Value	ON(1)	Output on
	OFF(0)	Output off (default)

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

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

Value	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.

Response

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

VOLT

Sets the voltage.

Command

```
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]
  {<numeric>|MINimum|MAXimum}

[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]? [{MINimum|MAXimum}]
```

Parameter

Value 0 % to 105 % of the rated output voltage(The default value is 0 % of the rated output voltage.)
An SCPI error (-221, "Settings conflict") occurs if VOLT:EXT:SOUR is not set to NONE.

Unit V

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

Response

Returns the voltage setting in the NR3 form in response to VOLT?. If the voltage value is set using external input, the specified voltage is returned.

VOLT:FINE

Sets the fine adjustment setting for voltage.
This command is available for 8 kW type products only.

Command

```
[SOURce:]VOLTage:FINE <NRf>
```

Parameter

Value -10000 to 10000 (The default value is 0.)

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

CURR

Sets the current.

Command

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

[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]? [{MINimum|MAXimum}]
```

Parameter

Value 0 % to 105 % of the rated output current
(The default value is 105 % of the rated output current.)
An SCPI error (-221, "Settings conflict") occurs if CURR:EXT:SOUR is not set to NONE.

Unit A

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

Response

Returns the current setting in the NR3 form in response to CURR?. If the current value is set using external input, the specified current is returned.

CURR:FINE

Sets the fine adjustment setting for current.
This command is available for 8 kW type products only.

Command

```
[SOURce:]CURRent:FINE <NRf>
```

Parameter

Value -10000 to 10000 (The default value is 0.)

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

CURR:PROT

Sets the overcurrent protection (OCP) value.

Command

```
[SOURce:]CURRent:PROTection[:LEVel] {<numeric>|MINimum|MAXimum}
```

```
[SOURce:]CURRent:PROTection[:LEVel]? [{MINimum|MAXimum}]
```

Parameter

Value 10 % to 111.5 % of the rated output current
(The default value is 111.5 % of the rated output current.)

Unit A

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

Response

Returns the OCP value in the NR3 form in response to CURR:PROT?.

CURR:LIM

Queries the current setting limit. The current setting limit is approximately 95 % of the OCP trip point.

This command is valid when CURR:LIM:AUTO ON is specified.

Command

```
[SOURce:]CURRent:LIMit[:AMPlitude]?
```

Response

Returns the current limit value in the NR3 form in response to CURR:LIM?.

Unit：A

CURR:LIM:AUTO

Sets whether to enable the current setting limit. If enabled, the current setting limit is automatically set to approximately 95 % of the OCP trip point. This cannot be set when the output is on.

Command

```
[SOURce:]CURRent:LIMit:AUTO {ON|OFF|1|0}

[SOURce:]CURRent:LIMit:AUTO?
```

Parameter

Value	ON(1)	Limit the current setting
	OFF(0)	Not limit the current setting (default)

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

Response

Returns whether to enable the current setting limit in the NR1 form in response to CURR:LIM:AUTO?.

VOLT:PROT

Sets the overvoltage protection (OVP).

Command

```
[SOURce:]VOLTage:PROTection[:LEVel] {<numeric>|MINimum|MAXimum}

[SOURce:]VOLTage:PROTection[:LEVel]? [{MINimum|MAXimum}]
```

Parameter

Value 10 % to 111.5 % of the rated output voltage (The default value is 111.5 % of the rated output voltage.)

Unit V

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

Response

Returns the OVP value in the NR3 form in response to VOLT:PROT?.

VOLT:LIM

Queries the voltage limit setting. The voltage limit setting is approximately 95 % of the OVP trip point.

This command is valid when VOLT:LIM:AUTO ON is specified.

Command

```
[SOURce:]VOLTage:LIMit[:AMPLitude]?
```

Response

Returns the voltage limit setting value in the NR3 form in response to VOLT:LIM?.

Unit: V

VOLT:LIM:AUTO

Sets whether to enable the voltage limit setting. If enabled, the voltage limit setting is automatically set to approximately 95 % of the OVP trip point. This cannot be set when the output is on.

Command

```
[SOURce:]VOLTage:LIMit:AUTO {ON|OFF|1|0}

[SOURce:]VOLTage:LIMit:AUTO?
```

Parameter

Value	ON(1)	Limit the voltage setting
	OFF(0)	Not limit the voltage setting (default)

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

Response

Returns whether to enable the voltage limit setting in the NR1 form in response to VOLT:LIM:AUTO?.

SYST:CONF:BTR:PROT

Sets whether to trip the breaker (turn the POWER switch off) when the overvoltage protection (OVP) or overcurrent protection (OCP) is activated.

Command

```
SYSTem:CONFigure:BTRip:PROTection {ON|OFF|1|0}

SYSTem:CONFigure:BTRip:PROTection?
```

Parameter

Value	ON(1)	Trip (turn the POWER switch off)
	OFF(0)	Not trip (turn the output off) (default)

Response

Returns whether to trip the breaker when the OVP or OCP is activated in the NR1 form in response to SYST:CONF:BTR:PROT?.

SYST:CONF:BTR:SHUT

Sets whether to trip the breaker (turn the POWER switch off) when an external shutdown (SD) signal is applied.

Command

```
SYSTem:CONFigure:BTRip:SHUTdown {ON|OFF|1|0}

SYSTem:CONFigure:BTRip:SHUTdown?
```

Parameter

Value	ON(1)	Trip (turn the POWER switch off)
	OFF(0)	Not trip (turn the output off) (default)

Response

Returns whether to trip the breaker when the SD signal is applied in the NR1 form in response to SYST:CONF:BTR:SHUT?.

OUTP:PROT:CLE

Clears the alarm, except for the Fan failure protection (FAN).

Command

```
OUTPut:PROTection:CLEar
```

OUTP:EXT

Sets the logic used to control the output on/off using an external contact (J1 connector). This cannot be set when the output is on.

Command

```
OUTPut:EXTernal {NORMal|INVerted}

OUTPut:EXTernal?
```

Parameter

Value	NORMal	Turn the output on with a high signal (default)
	INVerted	Turn the output on with a low signal

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

Response

Returns the external control logic setting of the output on/off as character data in response to OUTP:EXT?.

SYST:CONF:MPR

Sets the state that the PAT-T starts up in when the output state at power-on is set to on. This cannot be set when the output is on.

This command is available for 8 kW type products only.

Command

```
SYSTem:CONFigure:MPRiority {CV|CC}

SYSTem:CONFigure:MPRiority?
```

Parameter

Value	CV	CV (constant voltage) is prioritized (default)
	CC	CC (constant current) is prioritized

Response

Returns the state that the PAT-T starts up in when the output state at power-on is set to on as character data in response to SYST:CONF:MPR?.

CURR:EXT:SOUR

Sets the constant current control mode. This cannot be set when the output is on.

Command

```
[SOURce:]CURRent:EXTernal:SOURce
  {NONE|VOLTage|RESistance|IRESistance|FVOLtage}

[SOURce:]CURRent:EXTernal:SOURce?
```

Parameter

Value	NONE	Panel control (default)
	VOLTage	External voltage control
	RESistance	External resistance control 10 kW -> MAX OUT
	IRESistance	External resistance control 10 kW -> 0 OUT (FAIL SAFE)
	FVOLtage	External voltage control(FAST)

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

Note: FVOL parameter is available for 8 kW type products only.

Response

Returns the constant current control mode as character data in response to CURR:EXT:SOUR?.

VOLT:EXT:SOUR

Sets the constant voltage control mode. This cannot be set when the output is on.

Command

```
[SOURce:]VOLTage:EXTernal:SOURce
  {NONE|VOLTage|RESistance|IRESistance|FVOLtage}

[SOURce:]VOLTage:EXTernal:SOURce?
```

Parameter

Value	NONE	Panel control (default)
	VOLTage	External voltage control
	RESistance	External resistance control 10 kW -> MAX OUT
	IRESistance	External resistance control 10 kW -> 0 OUT (FAIL SAFE)
	FVOLtage	External voltage control (FAST)

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

Note : FVOL parameter is available for 8 kW type products only.

Response

Returns the constant voltage control mode as character data in response to VOLT:EXT:SOUR?.

SYST:CONF:PAR

Sets the number of units in Master-Slave Parallel Operation. It enables to set only for the Master unit. It can not be set when the output is turned on.

Command

```
SYSTem:CONFigure:PARallel <NRf>
SYSTem:CONFigure:PARallel?
```

Parameter (On models other than the PAT850-9.4T)

Value 1 to 5 (The default value is 1.)

Parameter （PAT850-9.4T）

Value 1 or 2 (The default value is 1.)

Response

Returns the setting numbers of Master-Slave Parallel Operation in the NR1 form in response to SYST:CONF:PAR?.

SYST:CONF:MSL

Sets the PAT-T condition during master-slave parallel operation.

Command

```
SYSTem:CONFigure:MSLave {MASTer|PARallel}

SYSTem:CONFigure:MSLave?
```

Parameter

Value	PARallel	Slave unit
	MASTer	Master unit or independent operation (default)

Response

Returns the PAT-T status under master-slave parallel control as character data in response to SYST:CONF:MSL?.

SYST:CONF:BTR

Sets the breaker trip (turn the POWER switch off).

Command

```
SYSTem:CONFigure:BTRip[:IMMediate]
```

SYST:CONF:PST

Sets whether to output a low level signal at power on status or power off status when monitoring the power on/off status externally (through the J1 connector).

Command

```
SYSTem:CONFigure:PSTatus {NORMal|INVerted}

SYSTem:CONFigure:PSTatus?
```

Parameter

Value	NORMal	Output a low level signal while the power is on (default)
	INVerted	Output a low level signal for 10 s to 15 s when the power is off.

Response

Returns the power on/off status as character data in response to SYST:CONF:PST?.

SYST:CONF:RSEN

Queries the state of the sensing switch on the rear panel.

Command

```
SYSTem:CONFigure:RSENsing?
```

Response

Returns 0 if the sensing switch on the rear panel is set to off (remote sensing disabled) or 1 if set to on (remote sensing enabled) in response to SYST:CONF:RSEN?.

SYST:CONF:TRAC

Sets whether to display communication errors by performing a debug trace. If the debug trace function is turned on, error codes (example: Err-100) are shown on the PAT-T display.

Command

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

SYSTem:CONFigure:TRACe?
```

Parameter

Value	ON(1)	Display communication errors
	OFF(0)	Not display communication errors (default)

Response

Returns whether to display communication errors in the NR1 form in response to SYST:CONF:TRAC?.

SYST:CONF:SPH

Sets the phase input mode (Three-phase input/Single-phase input mode).
This command is available for 4 kW type products only.

Command

```
SYSTem:CONFigure:SPHase {ON|OFF|1|0}

SYSTem:CONFigure:SPHase?
```

Parameter

Value	ON(1)	Select the Single-phase input mode
	OFF(0)	Select the Three-phase input mode (default)

Response

Returns the setting status of phase input mode (Single-phase input/Three-phase input mode) in the NR1 form in response to SYST:CONF:SPH?.

MEM:SAV

Saves the present voltage and current settings of the PAT-T to the preset memory.

Command

```
MEMory:SAV {1|2|3}
```

Parameter

Value	1	Preset memory A
	2	Preset memory B
	3	Preset memory C

MEM:RCL

Recalls a preset memory.

Command

```
MEMory:RCL {1|2|3}
```

Parameter

Value	1	Preset memory A
	2	Preset memory B
	3	Preset memory C

MEM:KLOC

Sets whether preset memory values can be recalled from the panel even when the lock function is enabled. MEM:RCL allows preset memory values to be recalled regardless of this setting.

Command

```
MEMory:KLOCk {ON|OFF|1|0}

MEMory:KLOCk?
```

Parameter

Value ON(1) Unable to recall preset memory values in the locked condition (Default)
OFF(0) Able to recall preset memory values in the locked condition

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

Response

Returns whether recalling of the preset memory is allowed when the keys are locked in the NR1 form in response to MEM:KLOC?.

Tutorial

Using Triggers

Setting changes (Sequence 1: TRANsient)

Using the TRIGger:SEQuence1 (or TRIGger:TRANsient) subsystem allows the VOLTage and CURRent settings to be synchronized using 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:TRIGgered commands.

```
:VOLTage 12.0     'Set the voltage to 12.0 V
:CURRent 1.5      'Set the current to 1.5 A

:VOLTage:TRIGgered 13.5     'Set so that the voltage is 13.5 V when
triggered
:CURRent:TRIGgered 2.5      'Set so that the current is 2.5 A when triggered

:TRIGger:SEQuence1:SOURce BUS     'Set the trigger source to BUS

:INITiate:SEQuence1     'Initiate sequence 1
:TRIGger:SEQuence1      'Apply a software trigger to sequence 1
```

The TRIGger:SEQuence1:SOURce command sets the trigger source to BUS or IMMediate. The INITiate command makes the trigger subsystem leave the IDLE state and go the initiated state. When the Trigger Source is set to IMMediate, the transient action is executed immediately causing the voltage and/or current to change to a new setting. When the Trigger Source is set to BUS, the trigger subsystem goes to the WTG (Waiting For Trigger) state.

If the trigger subsystem is in the WTG state and a software trigger is applied with the TRIGger:SEQuence1 or *TRG common command, the transient action is executed. When the operation is completed, the trigger subsystem returns to the IDLE state again. When an ABORt or an 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. The *TRG command or the IEEE488.1 get (Group Execute Trigger) command applies a software trigger to all sequence groups in which the trigger function is initiated.

Operation using a software trigger

The PAT-T can synchronize the output changes using triggers.

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

Table below shows the responses when the voltage is set to 20 V (VOLT 20) and when the target value to which the voltage is to change using a trigger is set to 10 V (VOLT:TRIG 10).

	Response	
	VOLT?	VOLT:TRIG?
Immediately after the setting	20	10
After a trigger is sent	10	10
After *RST is sent	0	0
ABOR is sent before sending a trigger	20	20 (cancel)
Voltage change VOLT 30 is sent before sending a trigger	30	30 (cancel)

>top

VOLT:TRIG

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

Command

```
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude] {<numeric>|MINimum|MAXimum}
```

```
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [{MINimum|MAXimum}]
```

Parameter

Value 0 % to 105 % of the rated output voltage (The default value is 0 % of the rated output voltage.)

Unit V

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

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 / INIT:NAME TRAN and a software trigger are sent.

Command

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

Parameter

Value	0 % to 105 % of the rated output current (The default value is 105 % of the rated output current.)
Unit	A

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

Response

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

TRIG:SOUR

Sets the condition (trigger source) for actually changing the setting after the sequence 1 group receives INIT / INIT:NAME TRAN.

Command

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

TRIGger[:SEQuence[1]]:SOURce?

TRIGger[:TRANsient]:SOURce {IMMediate|BUS}

TRIGger[:TRANsient]:SOURce?
```

Parameter

Value 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.

Response

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

INIT

Starts the trigger function of the sequence 1 group.

If trigger source 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]]
```

INIT:NAME

Starts the trigger function.

If the trigger source parameter is IMM, the measurement starts immediately. If set to BUS, the measurement starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate]:NAME {TRANsition|OUTPut|ACQuire}
```

Parameter

Value	TRAN	Starts the trigger function of the sequence 1 group.
	OUTP	Starts the trigger function of the sequence 2 group.
	ACQ	Starts the trigger function of the sequence 3 group.

TRIG

Executes a software trigger to the sequence 1 group.

Command

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

ABOR

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

The trigger status immediately after the power is turned on is the same as the condition when the ABOR command is sent. If the ABOR command is sent when the change or measurement is already started, the measured data of the sequence 3 group remains invalid.

If the ABOR command is sent when the sequence 3 group is not initiated and the measured data that is held is valid, the measured data is not discarded.

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

Command

```
ABORt
```

Tutorial

Using Triggers

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

The TRIGger:SEQuence2 (or TRIGger:OUTPut) subsystem allows you to use the output on/off delay function. To reserve the operation of the output change using triggers, use the OUTPut:TRIGgered command.

```
:TRIGger:SEQuence2:SOURce BUS     'Set the trigger source to BU
:TRIGger:SEQuence2:DELay:ON 0.5    'SSet the output on delay 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 (BUS or IMMediate).The :TRIGger:SEQuence2:DELay:ON command sets the delay for turning on the output after the trigger is applied. 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 delay for turning off the output after the trigger is applied.

The INITiate:IMMediate:SEQuence2 command makes the trigger subsystem leave the IDLE state and go 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 a 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 an ABORt or an 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.

If the delay action in progress is aborted by sending an abort command, Device Clear (GPIB/USB), or break signal (RS232), 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.

>top

OUTP:TRIG

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

Command

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

OUTPut[:STATe]:TRIGgered?
```

Parameter

Value	ON(1)	Turn the output on 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.

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

Sets the delay for turning on the output.

Command

```
TRIGger:SEQuence2:DELay:ON {<numeric>|MINimum|MAXimum}

TRIGger:SEQuence2:DELay:ON? [{MINimum|MAXimum}]

TRIGger:OUTPut:DELay:ON {<numeric>|MINimum|MAXimum}

TRIGger:OUTPut:DELay:ON? [{MINimum|MAXimum}]
```

Parameter

Value 0 to 10.0 0 is no delay (The default value is 0.0)

Unit S

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

Response

Returns the delay 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

Sets the delay for turning off the output.

Command

```
TRIGger:SEQuence2:DELay:OFF {<numeric>|MINimum|MAXimum}

TRIGger:SEQuence2:DELay:OFF? [{MINimum|MAXimum}]

TRIGger:OUTPut:DELay:OFF {<numeric>|MINimum|MAXimum}

TRIGger:OUTPut:DELay:OFF? [{MINimum|MAXimum}]
```

Parameter

Value 0 to 10.0 0 is no delay (The default value is 0.0)

Unit S

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

Response

Returns the delay time 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 actually starting the delay action after the sequence 2 group receives INIT:SEQ2 / INIT:NAME OUTP.

The output turns on or off after the delay elapses.

Command

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

TRIGger:SEQuence2:SOURce?

TRIGger:OUTPut:SOURce {IMMediate|BUS}

TRIGger:OUTPut:SOURce?
```

Parameter

Value	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.

Response

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

INIT:SEQ2

Starts the trigger function of the sequence 2 group.

If trigger source set to IMM, the delay action starts immediately. If set to BUS, the delay action starts after waiting for a software trigger.

Command

```
INITiate[:IMMediate]:SEQuence2
```

TRIG:SEQ2
TRIG:OUTP

Executes a software trigger to the sequence 2 group.

Command

```
TRIGger:SEQuence2[:IMMediate]

TRIGger:OUTPut[:IMMediate]
```

Tutorial

Using Triggers

Measurement (sequence 3: ACQuire)

The PAT-T has the capability to return voltage and current measurement values. The easiest way is use the MEASure commands. The trigger function is not used.

The MEASure commands immediately start a new measurement. Simultaneity for multi-item measurements are lost, because each MEASure command starts a new measurement. Advanced measurement allows separate control for measurement initiation and data query.

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

```
:MEASure:VOLTage?     'Query the voltage output
:MEASure:CURRent?     'Query the current output
```

The PAT-T also supports the READ command that initiates a new measurement and queries the data. READ and MEASure are aliases; they operate exactly the same.

Advanced Measurement

The TRIGger:SEQuence3 (or TRIGger:ACQuire) subsystem allows you to control the start of the measurement and the data query separately.

To start a new measurement, set the trigger source to IMMediate and use the INITiate command.

```
:TRIGger:SEQuence3:SOURce IMMediate     'Set the trigger source to IMM
:INITiate:SEQuence3     'Initiate sequence 3
```

If you want the measurement of the sequence3 group to start on a software trigger, change the trigger source to BUS.

```
:TRIGger:SEQuence3:SOURce BUS     'Set the trigger source to BUS
:INITiate:SEQuence3     'Initiate sequence 3
:TRIGger:SEQuence3     'Apply a software trigger to sequence 3
```

When the measurement is completed, measurement data can be queried with the FETCh query commands.

```
:FETCh:VOLTage?     'Query the voltage output
:FETCh:CURRent?     'Query the current output
```

The TRIGger:SEQuence3:SOURce command sets the trigger source to BUS or IMMediate. The INITiate:SEQuence3 command makes the trigger subsystem leave the IDLE state and go the initiated state. If the trigger source is set to IMMediate, the measurement starts immediately. When the Trigger Source is set to BUS, the trigger subsystem goes to the WTG (Waiting For Trigger) state. When a software trigger is applied with the TRIGger:SEQuence3 or *TRG common command, the measurement action is executed. When an ABORt or an equivalent command is sent without executing the trigger, the measurement action is cancelled, and then the trigger subsystem returns to the IDLE state.

The ABORt command and IEEE488.1 sdc/dcl commands simply abort the measurement task that is in progress. It does not have a feature to invalidate any measurement data that has been acquired. On the other hand, the *RST and *RCL common commands not only abort the measurement task, but also invalidate the acquired measurement data. This means that the "*RST;:FETC:VOLT?" command will generate an error, because no measurement data can be fetched and there is no new measurement is scheduled.

The only difference between MEASure (or READ) and FETCh commands is that the MEASure command starts a new measurement while the FETCh command does not. Availability for measurement items is exactly the same for MEASure and FETCh.

Generating and Clearing the measurement data

The measurement data is stored in the measurement data cache for the mean value of the moving average deviations of 64 times measured in every 4 ms. The mean value of the moving average returns after 4 ms counted from the measurement begins upon receipt of the "INIT:SEQ3" command. Despite the setting of the "INIT:CONT:SEQ3" whether on or off,

it will start the measurement in every 4 ms and display the mean value of the moving average deviations of 64 times.

The "INIT:SEQ3/INIT:NAME ACQ" command is a command that invalidates the current measurement data stored in the present measurement data cache and it begins a new measurement. The new measurement data will be established after 4 ms.

The "SENSe:AVERage:CLEar" command clears the measurement data stored in the cache and it does not return the query of "FETC" command until the moving average of 64 times is established. This "SENSe:AVERage:CLEar" command is a command that clears all the measurement data of the mean value of the moving average deviations of 64 times as when the setting of the voltage or the current value changes frequently or to change rapidly to be monitored. Therefore, after transmitting the command, new moving average of another deviations of 64 times will be generated after 256 ms.

Auto continue

To keep the trigger subsystem initiated for multiple actions without having to send an initiate command for each trigger, use the CONTinuous option. This enables measurement data to be automatically refreshed as if the PAT-T is operating in local mode.

```
INITiate:CONTinuous:SEQuence3 ON
```

If the auto continue mode is on, measurement data and the front panel displays are automatically refreshed by the internal trigger loop. In this state, MEASure/READ/FECh query commands work equivalently. New measurements are automatically repeated. This means that sending multiple FETCh queries results in different measurement results, and simultaneity is lost. When the continuous operation is enabled, the ABORt command is ignored because the trigger subsystem automatically exits the IDLE state even if it is aborted.

The *RST command sets CONTinuous to OFF.

Waiting for operation complete

The *OPC common command has a capability to wait for an operation to complete. In case the output on/off delay function is in used, the command will take the delay time (up to 10 s) which is set by this function.

When the *OPC command is sent, the PAT-T goes to Operation Complete Command Active State (OCAS). When the measurement is completed and there is no other operation pending, the PAT-T 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 example starts the output on/off delay action and sends the *OPC command. 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 PAT-T go to Operation Complete Query Active State (OQAS). When the measurement is completed and there is no other operation pending, the PAT-T 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 PAT-T is in the OCIS and OQIS state.

NOTE

When using the RS232C interface, the SRQ function cannot be used. However, the MSS bit of the *STB query can be used in the same manner as the SRQ function.

>top

TRIG:SEQ3:SOUR
TRIG:ACQ:SOUR

Sets the condition (trigger source) for actually starting the measurement after the sequence 3 group receives INIT:SEQ3 / INIT:NAME ACQ.

Command

```
TRIGger:SEQuence3:SOURce {IMMediate|BUS}

TRIGger:SEQuence3:SOURce?

TRIGger:ACQuire:SOURce {IMMediate|BUS}

TRIGger:ACQuire:SOURce?
```

Parameter

Value IMM Start the measurement immediately (default)
BUS Wait for a software trigger (*TRG, TRIG:SEQ3, TRIG:ACQ, or IEEE488.1 get (Group Execute Trigger)) to start the measurement

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

Response

Returns the trigger source of the sequence 3 group as character data in response to TRIG:SEQ3:SOUR? / TRIG:ACQ:SOUR?.

INIT:SEQ3

Clears the present valid measurement data and starts a new measurement.

If the trigger source parameter of the sequence 3 group is IMM, the measurement starts immediately. If set to BUS, the measurement starts after waiting for a software trigger.

New measurement data will be established after 4 ms from the measurement begins. The measured data is stored in the measurement data cache, and it can be queried by "FETC:xxx?"command. The measurement data returns the mean value data (the moving average deviations of 64 times measured in every 4 ms).

Command

```
INITiate[:IMMediate]:SEQuence3
```

TRIG:SEQ3
TRIG:ACQ

Executes a software trigger to the sequence 3 group.

Command

```
TRIGger:SEQuence3[:IMMediate]
```

```
TRIGger:ACQuire[:IMMediate]
```

INIT:CONT:SEQ3
INIT:CONT:NAME ACQ

Sets the measurement conditions of the sequence 3 group in sequence operation auto continue mode.

When the sequence operation auto continue mode is turned on

If the trigger source parameter is set to IMM, the measurement starts immediately. When the operation is complete, a new measurement automatically starts.

If the parameter is set to BUS, the measurement starts after receiving a software trigger. When the operation is complete, the PAT-T waits for the next trigger.

When the sequence operation auto continue mode is turned off

The measurement currently in progress continues unless ABOR is sent. New measurements are not automatically continued.

Command

```
INITiate:CONTinuous:SEQuence3 {ON|OFF|1|0}

INITiate:CONTinuous:SEQuence3?

INITiate:CONTinuous:NAME ACQuire,{ON|OFF|1|0}

INITiate:CONTinuous:NAME?
```

Parameter

Value	ON(1)	Auto continue mode on
	OFF(0)	Auto continue mode off (default)

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

Response

Returns the sequence operation auto continue mode setting in the NR1 form in response to INIT:CONT:SEQ3? / INIT:CONT:NAME ACQ.

SENS:AVER:CLE

It clears all the measurement data (The mean value data: the moving average deviations of 64 times measured in every 4 ms) stored in the measurement data cache, and the measurement data after 256 ms (New moving average created by another 64 times) becomes valid.

When the data is acquired while varying the setting of the voltage or the current, transmit the "SENS:AVER:CLE" command after setting the voltage or the current. The measurement data becomes valid after 256 ms upon receipt of the command.

-> Tutorial

Command

```
SENSe:AVERage:CLEar
```

FETC:VOLT

If FETC? is sent without making a single measurement after resetting the PAT-T (using *RST) or after switching from local mode (panel operation) to remote mode, an SCPI error (-230,"Data corrupt or stale") occurs. This is because there is no valid measured data that is held. Be sure to use this command after the INIT or MEAS command.

Command

```
FETCh[:SCALar]:VOLTage[:DC]?
```

Response

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

If the measurement is not complete, the response data is generated after the measurement for the FETC:VOLT query is complete.

MEAS:VOLT

Queries the measured data after starting a new measurement operation.

MEAS:CURR? is equivalent to combining the INIT command and FETC:CURR? query.

Command

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

Response

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

If the measurement is not complete, the response data is generated after the measurement for the MEAS:VOLT query is complete.

FETC:CURR

Queries the measured data without starting the measurement operation.

If FETC? is sent without making a single measurement after resetting the PAT-T (using *RST) or after switching from local mode (panel operation) to remote mode, an SCPI error (-230,"Data corrupt or stale") occurs. This is because there is no valid measured data that is held. Be sure to use this command after the INIT or MEAS command.

Command

```
FETCh[:SCALar]:CURRent[:DC]?
```

Response

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

If the measurement is not complete, the response data is generated after the measurement for the FETC:CURR query is complete.

MEAS:CURR

Queries the measured data after starting a new measurement operation.

MEAS:CURR? is equivalent to combining the INIT command and FETC:CURR? query.

Command

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

Response

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

If the measurement is not complete, the response data is generated after the measurement for the MEAS:CURR query is complete.

SYST:ERR

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

The error queue is cleared using the *CLS command.

Command

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

Response

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

(Example) When there is no error or event

+0"No error"

(Example) When a command that cannot be executed in the current operating condition is received

-221,"Settings conflict"

SYST:KLOC

Sets/Releases the panel operation lock.

Command

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

SYSTem:KLOCk?
```

Parameter

Value	ON(1)	Lock the panel operation
	OFF(0)	Release the panel operation lock

Response

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

SYST:LOC (RS232C, USB and LAN only)

Sets the PAT-T to local mode (Remote Disable; the RMT LED turns off). This is a substitute command for the IEEE488.1 REN (Remote Disable) command. The Remote Disable state enables both panel operations and commands. Use SYST:REM or SYST:RWL to switch to remote mode (Remote Enable; the RMT LED lights).

Command

```
SYSTem:LOCal
```

SYST:OPT

Queries the hardware interface board that is installed in the PAT-T.

This command is the same as *OPT?.

Command

```
SYSTem:OPTion?
```

Response

Returns 0 if there is no option installed in response to SYST:OPT?.

If the factory option GPIB, USB or LAN interface board is installed, "GPIB", "USB" or "LAN" is returned in response to SYST:OPT?.

SYST:REM (RS232C, USB and LAN only)

Sets the PAT-T operation to remote mode. All panel keys except the LOCAL key are locked. This is a substitute command for the IEEE488.1 REN (Remote Enable) and address designation.

SYST:LOC is used to return to local mode.

Command

```
SYSTem:REMote
```

SYST:RWL (RS232C, USB and LAN only)

Sets the PAT-T operation to remote mode. All panel keys are locked (LOCAL key is also locked). This is a substitute command for the IEEE488.1 llo (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 PAT-T conforms.

Command

```
SYSTem:VERSion?
```

Response

Returns 1999.0 in response to SYST:VERS?.

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

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 PAT-T 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	--

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Event status register

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

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

Check to the SYST:ERR? for the description of the error.

Bit	Bit Wight	Bit Name	Description	Error Code
0	1	Operation Complete(OPC)	Set when an *OPC command is received and all operations in standby are complete.	-800 to -899
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.	-400 to -499
3	8	Device Dependent Error(DDE)	Set when there is a device-specific error.	-300 to -399 100 to 999
4	16	Execution Error(EXE)	Set when the PAT-T evaluates the program data following the header is outside the formal input range or does not match the performance of the PAT-T. This indicates that a valid SCPI command may not be executed correctly depending on the conditions of the PAT-T.	-200 to -299
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 enters the internal IEEE 488.2 SCPI command input buffer.	-100 to -199
6	64	Reserved	Not used	--
7	128	Power ON(PON)	Set when the power is turned on.	--
8-15		Reserved	Not usedv	--

>top

OPERation status register

The OPERation status register is a 16-bit register which contains conditions which are part of the PAT-T normal operation.

Bit	Bit Weight	Bit Name	DEscription
0	1	NOT USED	--
1	2	NOT USED	--
2	4	NOT USED	--
3	8	NOT USED	--
4	16	MEASuring	Indicates whether measurement is in progress on the PAT-T.
5	32	Waiting for TRIGger	Indicates whether the PAT-T is waiting for a trigger (TRIG).
6	64	NOT USED	--
7	128	NOT USED	--
8	256	CV	CV output
9	512	NOT USED	--
10	1024	CC	CC output
11	2048	NOT USED	--
12	4096	ODEL (ON/OFF DELay)	Indicates whether the output delay operation is in progress.
13	8192	ISUM	Not used
14	16384	NOT USED	--
15	32768	NOT USED	--

>top

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 <NR1>

STATus:OPERation:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register setting 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 <NR1>

STATus:OPERation:NTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the negative transition 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 <NR1>

STATus:OPERation:PTRansition?
```

Parameter

Value: 0 to 32767

Response

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

QUEStionable status register

The QUEStionable status register is a 16-bit register that stores information related to the questionable events and status during PAT-T operation.These register bits may indicate problems with the measured data of the PAT-T.

Bit	Bit Weight	Bit Name	Description
0	1	OVP(Over Voltage Protection)	Overvoltage protection activated
1	2	OCP (Over Current Protection)	Overcurrent protection activated
2	4	Not Used	--
3	8	POW(POWER Switch off)	POWER switch off
4	16	OHP (Over Heat Protection)	Over heat protection activated
5	32	Not Used	--
6	64	PHASE(Power-line Phase Protection)	Power-line phase protection activated
7	128	SENS(SENSing Protection)	Incorrect sensing connection protection activated
8	256	FAN(Fan Protection)	Fan failure protection occurred
9	512	BLD(Bleeder Protection)	Bleeder protection
10	1024	UNR(UNRegulated)	Not operating in CV/CC mode
11	2048	SD(Shutdown Alarm)	Shutdown
12	4096	Not Used	--
13	8192	Not Used	--
14	16384	Not Used	--
15	32768	Not Used	--

>top

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 condition 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 <NR1>

STATus:QUEStionable:ENABle?
```

Parameter

Value: 0 to 32767

Response

Returns the enable register setting 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 <NR1>

STATus:QUEStionable:NTRansition?
```

Parameter

Value: 0 to 32767

Response

Returns the negative transition 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 <NR1>

STATus:QUEStionable:PTRansition?
```

Parameter

Value: 0 to 32767

Response

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

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
```

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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.

The SCPI status register structure as shown in the figure below. The character "+" represents the logic sum of the register bits.

Architecture

CONDition register

The transition of the CONDition register is automatic and reflects the condition of the KFM2005 in real-time. Reading this register 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.

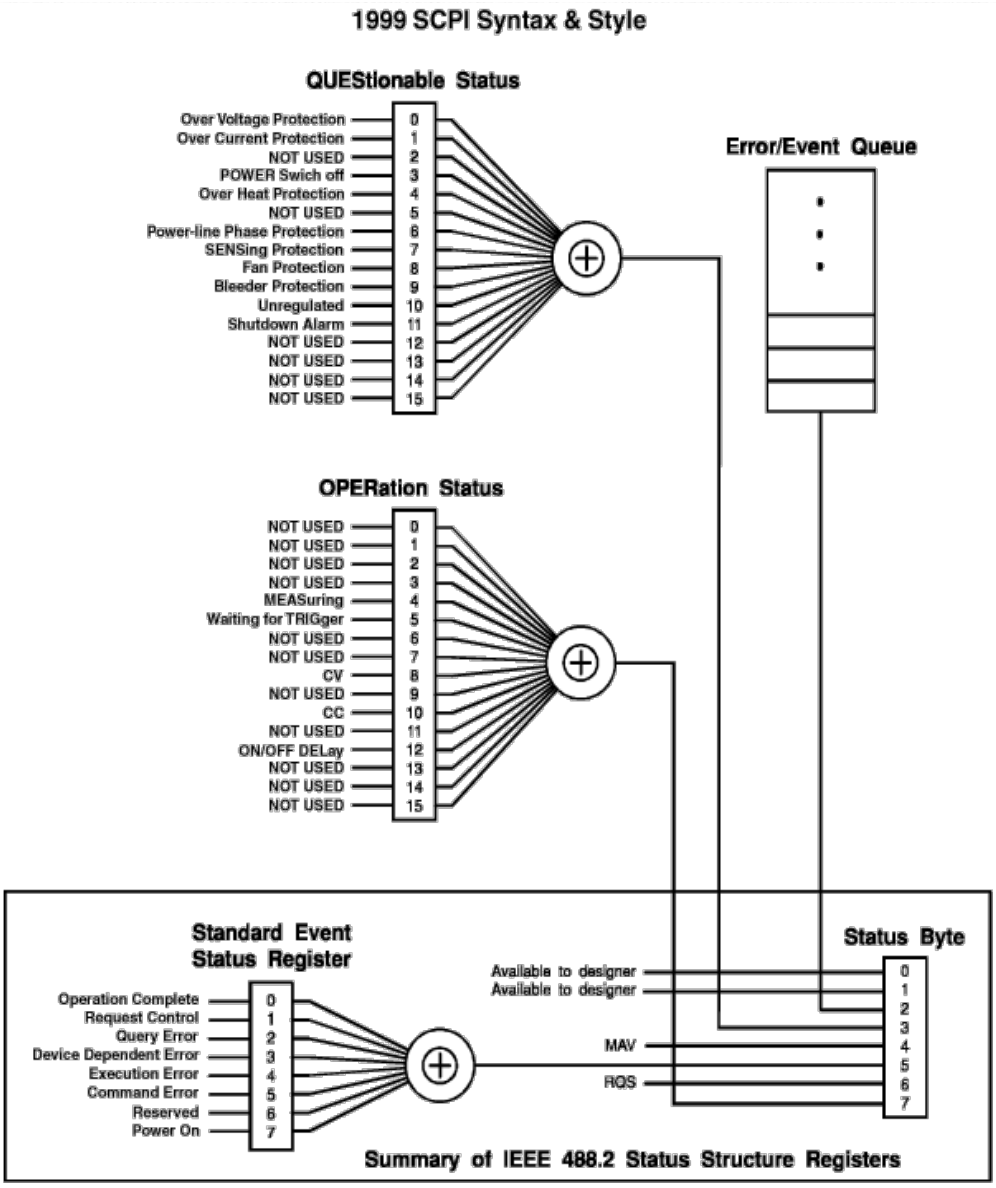
Transition filter

PTRansition (positive transition) filter to report events when the condition changes from false to true.

NTRansition (negative transition) filter to report events when the condition changes from true to false.

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

If both filters are cleared, event reporting is disabled.



Partially changed SCPII Standard 1999.0 Volume1 fiig.9-1.

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CONFIG Settings

1. Press the CONFIG switch.

The switch LED illuminates. The ammeter displays the parameter number, and the voltmeter displays the present setting.

2. Turn the CURRENT knob to select the parameter number.

3. Turn the VOLTAGE knob to change the setting.

If you select a new setting, it blinks.
When the setting is blinking, the new setting is not entered until you press a switch. If you do not want to change the setting, turn the VOLTAGE knob and select the setting that illuminates (not blinking) to return to the original setting.

4. To set or display other parameters, repeat step 2 and step 3 . To exit from the CONFIG settings, proceed to step 5 .

5. Press any of the switch from SET, OVP·OCP, CONFIG or OUTPUT switch. If it is set to the slave unit, press CONFIG switch.

It will exit from the CONFIG setting to reflect the setting conditions.
Even when the POWER switch is turned off, the setting description will be reflected.