



EEZ Programmable PSU SCPI reference guide



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Platform: *EEZ PSU with Arduino Shield r3B4 or latter*

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Table of Contents

Start page.....	1
1.Introduction.....	9
1.1.About SCPI.....	9
2.Syntax and style.....	11
2.1.Root Specifier.....	11
2.2.Command termination.....	11
2.3.Command separators.....	11
2.4.Querying parameter settings.....	11
2.5.Using the MIN, MAX, and DEF Parameters.....	11
2.6.Command and message types.....	12
2.7.Required Commands.....	12
2.7.1.Base functionality for the Power supply instrument class.....	12
2.8.Multiple Commands in a Message.....	13
2.9.Moving Among Subsystems.....	13
2.10.SCPI parameter types.....	14
3.Registers and queues.....	15
3.1.Standard Event Status Register.....	16
3.2.Status Byte Register.....	17
3.3.OPERation Status Register.....	18
3.3.1.Operation INSTRument Status register.....	19
3.3.2.Operation Instrument SUMmary status register.....	19
3.4.QUESTionable Status Register.....	19
3.4.1.Questionable INSTRument Status register.....	20
3.4.2.Questionable Instrument SUMmary status register.....	21
3.5.Error queue.....	22
4.Common command reference.....	23
4.1.*CLS.....	23
4.2.*ESE.....	23
4.3.*ESR?.....	24
4.4.*IDN?.....	24
4.5.*OPC.....	24
4.6.*RCL.....	25
4.7.*RST.....	25
4.8.*SAV.....	26
4.9.*STB?.....	27
4.10.*TRG.....	27
4.11.*TST?.....	27
4.12.*WAI.....	28
5.Subsystem command reference.....	29
5.1.ABORt.....	29
5.2.CALibrate.....	31
5.2.1.CALibration[:MODE].....	31
5.2.2.CALibration:CLEar.....	32
5.2.3.CALibration:CURRent[:DATA].....	32
5.2.4.CALibration:CURRent:LEVel.....	33
5.2.5.CALibration:CURRent:RANGe.....	33
5.2.6.CALibration:PASSword:NEW.....	34
5.2.7.CALibration:REMark.....	34
5.2.8.CALibration:SAVE.....	35

5.2.9.CALibration:STATE.....	35
5.2.10.CALibration:VOLTage[:DATA].....	35
5.2.11.CALibration:VOLTage:LEVel.....	36
5.3.DIAGnostic.....	37
5.3.1.DIAGnostic[:INFOrmation]:ADC?.....	37
5.3.2.DIAGnostic[:INFOrmation]:FAN?.....	37
5.3.3.DIAGnostic[:INFOrmation]:CALibration?.....	37
5.3.4.DIAGnostic[:INFOrmation]:PROTection?.....	38
5.3.5.DIAGnostic[:INFOrmation]:TEST?.....	39
5.4.DISPlay.....	41
5.4.1.DISPlay:BRIGHtness.....	41
5.4.2.DISPlay:VIEW.....	41
5.4.3.DISPlay[:WINdow][::STATE].....	41
5.4.4.DISPlay[:WINdow]:TEXT.....	42
5.4.5.DISPlay[:WINdow]:TEXT:CLEar.....	42
5.5.INITiate.....	43
5.5.1.INITiate.....	43
5.5.2.INITiate:CONTInuous.....	43
5.5.3.INITiate:ELOG.....	44
5.6.INSTrument.....	45
5.6.1.INSTrument[::SElect].....	45
5.6.2.INSTrument:COUPle:TRACking.....	45
5.6.3.INSTrument:DISPlay:TRACe[<n>].....	47
5.6.4.INSTrument:DISPlay:TRACe:SWAP.....	47
5.6.5.INSTrument:DISPlay:YT:RATE.....	48
5.6.6.INSTrument:COUPle:TRIGger.....	48
5.6.7.INSTrument:NSElect.....	49
5.7.MEASure.....	51
5.7.1.MEASure[:SCALar]:CURRent[:DC].....	51
5.7.2.MEASure[:SCALar]:POWEr[:DC].....	51
5.7.3.MEASure[:SCALar]:TEMPerature[:THERmistor][:DC].....	51
5.7.4.MEASure[:SCALar][:VOLTage][:DC].....	52
5.8.MEMory.....	53
5.8.1.MEMory:NSTATes.....	53
5.8.2.MEMory:STATe:CATalog.....	53
5.8.3.MEMory:STATe:DELeTe.....	53
5.8.4.MEMory:STATe:NAME.....	54
5.8.5.MEMory:STATe:RECall:AUTO.....	54
5.8.6.MEMory:STATe:RECall:SElect.....	55
5.8.7.MEMory:STATe:VALid.....	55
5.9.MMEMory.....	57
5.9.1.MMEMory:LOAD:LIST.....	57
5.9.2.MMEMory:STORe:LIST.....	58
5.10.OUTPut.....	59
5.10.1.OUTPut[::STATe].....	59
5.10.2.OUTPut[::STATe]:TRIGgered.....	60
5.10.3.OUTPut:DELay:ON.....	60
5.10.4.OUTPut:DELay:OFF.....	60
5.10.5.OUTPut:DPRog.....	60
5.10.6.OUTPut:MODE?.....	61
5.10.7.OUTPut:PROTection:CLEar.....	61
5.10.8.OUTPut:PROTection:COUPle.....	62

5.10.9.OUTPUT:PROTECTION:MEASURE.....	62
5.10.10.OUTPUT:TRACK[:STATE].....	63
5.11.SENSE.....	65
5.11.1.SENSE:AHOFF:RESET.....	65
5.11.2.SENSE:CURRENT[:DC]:RANGE[:UPPER].....	65
5.11.3.SENSE:CURRENT[:DC]:RANGE:AUTO.....	66
5.11.4.SENSE:ELOG[:DC]:RANGE[:UPPER].....	66
5.11.5.SENSE:ELOG[:DC]:RANGE:AUTO.....	66
5.11.6.SENSE:ELOG:FUNCTION:CURRENT.....	66
5.11.7.SENSE:ELOG:FUNCTION:VOLTAGE.....	66
5.11.8.SENSE:ELOG:PERIOD.....	66
5.11.9.SENSE:WHOFF:RESET.....	66
5.12.SOURCE.....	67
5.12.1.[SOURCE[<n>]]:CURRENT.....	68
5.12.2.[SOURCE[<n>]]:CURRENT:STEP.....	69
5.12.3.[SOURCE[<n>]]:CURRENT:TRIGGERED.....	70
5.12.4.[SOURCE[<n>]]:CURRENT:LIMIT[:POSITIVE][:IMMEDIATE][:AMPLITUDE].....	70
5.12.5.[SOURCE[<n>]]:CURRENT:MODE.....	71
5.12.6.[SOURCE[<n>]]:CURRENT:SLEW:FALLING.....	71
5.12.7.[SOURCE[<n>]]:CURRENT:SLEW:RISING.....	71
5.12.8.[SOURCE[<n>]]:CURRENT:PROTECTION:DELAY[:TIME].....	72
5.12.9.[SOURCE[<n>]]:CURRENT:PROTECTION:STATE.....	72
5.12.10.[SOURCE[<n>]]:CURRENT:PROTECTION:TRIPPED?.....	72
5.12.11.[SOURCE:]DIGITAL:INPUT:DATA.....	73
5.12.12.[SOURCE:]DIGITAL:OUTPUT:DATA.....	73
5.12.13.[SOURCE:]DIGITAL:PIN<n>:FUNCTION.....	73
5.12.14.[SOURCE:]DIGITAL:PIN<n>:POLARITY.....	74
5.12.15.[SOURCE:]DIGITAL:TOUTput:BUS[:ENABLE].....	74
5.12.16.[SOURCE[<n>]]:LIST:COUNT.....	75
5.12.17.[SOURCE[<n>]]:LIST:CURRENT[:LEVEL].....	75
5.12.18.[SOURCE[<n>]]:LIST:DWELL.....	76
5.12.19.[SOURCE[<n>]]:LIST:VOLTAGE[:LEVEL].....	76
5.12.20.[SOURCE[<n>]]:LRIPPLE.....	77
5.12.21.[SOURCE[<n>]]:LRIPPLE:AUTO.....	78
5.12.22.[SOURCE[<n>]]:POWER:LIMIT.....	78
5.12.23.[SOURCE[<n>]]:POWER:PROTECTION[:LEVEL].....	79
5.12.24.[SOURCE[<n>]]:POWER:PROTECTION:DELAY[:TIME].....	79
5.12.25.[SOURCE[<n>]]:POWER:PROTECTION:STATE.....	80
5.12.26.[SOURCE[<n>]]:POWER:PROTECTION:TRIPPED?.....	80
5.12.27.[SOURCE[<n>]]:VOLTAGE.....	80
5.12.28.[SOURCE[<n>]]:VOLTAGE:LIMIT[:POSITIVE][:IMMEDIATE][:AMPLITUDE].....	81
5.12.29.[SOURCE[<n>]]:VOLTAGE:STEP.....	82
5.12.30.[SOURCE[<n>]]:VOLTAGE:TRIGGERED.....	82
5.12.31.[SOURCE[<n>]]:VOLTAGE:MODE.....	83
5.12.32.[SOURCE[<n>]]:VOLTAGE:PROGRAM[:SOURCE].....	83
5.12.33.[SOURCE[<n>]]:VOLTAGE:PROTECTION[:LEVEL].....	84
5.12.34.[SOURCE[<n>]]:VOLTAGE:PROTECTION:DELAY[:TIME].....	85
5.12.35.[SOURCE[<n>]]:VOLTAGE:PROTECTION:STATE.....	85
5.12.36.[SOURCE[<n>]]:VOLTAGE:PROTECTION:TRIPPED?.....	86
5.12.37.[SOURCE[<n>]]:VOLTAGE:SENSE[:SOURCE].....	86
5.12.38.[SOURCE[<n>]]:VOLTAGE:SLEW:FALLING.....	87
5.12.39.[SOURCE[<n>]]:VOLTAGE:SLEW:RISING.....	87

5.13.STATUS.....	89
5.13.1.STATUS:OPERation[:EVENT]?.....	90
5.13.2.STATUS:OPERation:CONDition?.....	90
5.13.3.STATUS:OPERation:ENABLE.....	90
5.13.4.STATUS:OPERation:INSTrument[:EVENT]?.....	91
5.13.5.STATUS:OPERation:INSTrument:CONDition?.....	91
5.13.6.STATUS:OPERation:INSTrument:ENABLE.....	91
5.13.7.STATUS:OPERation:INSTrument:ISUMmary[<n>][:EVENT]?.....	92
5.13.8.STATUS:OPERation:INSTrument:ISUMmary[<n>]:CONDition?.....	92
5.13.9.STATUS:OPERation:INSTrument:ISUMmary<n>:ENABLE.....	92
5.13.10.STATUS:PREset.....	93
5.13.11.STATUS:QUEStionable[:EVENT]?.....	93
5.13.12.STATUS:QUEStionable:CONDition?.....	94
5.13.13.STATUS:QUEStionable:ENABLE.....	94
5.13.14.STATUS:QUEStionable:INSTrument[:EVENT]?.....	94
5.13.15.STATUS:QUEStionable:INSTrument:CONDition?.....	95
5.13.16.STATUS:QUEStionable:INSTrument:ENABLE.....	95
5.13.17.STATUS:QUEStionable:INSTrument:ISUMmary[<n>][:EVENT]?.....	95
5.13.18.STATUS:QUEStionable:INSTrument:ISUMmary[<n>]:CONDition?.....	96
5.13.19.STATUS:QUEStionable:INSTrument:ISUMmary[<n>]:ENABLE.....	96
5.14.SYSTem.....	99
5.14.1.SYSTem:BEEPer.....	101
5.14.2.SYSTem:BEEPer:KEY:STATe.....	101
5.14.3.SYSTem:BEEPer:STATe.....	101
5.14.4.SYSTem:CAPability?.....	101
5.14.5.SYSTem:CHANnel[:COUNT]?.....	101
5.14.6.SYSTem:CHANnel:INfOrmation:CURRent?.....	102
5.14.7.SYSTem:CHANnel:INfOrmation:ONTime:LAST?.....	102
5.14.8.SYSTem:CHANnel:INfOrmation:ONTime:TOTal?.....	102
5.14.9.SYSTem:CHANnel:INfOrmation:POWer?.....	102
5.14.10.SYSTem:CHANnel:INfOrmation:PROGram?.....	103
5.14.11.SYSTem:CHANnel:INfOrmation:VOLTagE?.....	103
5.14.12.SYSTem:CHANnel:MODEl?.....	103
5.14.13.SYSTem:COMMunicate:ENABLE.....	104
5.14.14.SYSTem:COMMunicate:ETHernet :ADDReSS.....	104
5.14.15.SYSTem:COMMunicate:ETHernet:DHCP.....	104
5.14.16.SYSTem:COMMunicate:ETHernet:DNS.....	105
5.14.17.SYSTem:COMMunicate:ETHernet:GATEway.....	105
5.14.18.SYSTem:COMMunicate:ETHernet:HOSTname.....	105
5.14.19.SYSTem:COMMunicate:ETHernet:MAC.....	106
5.14.20.SYSTem:COMMunicate:ETHernet:PORT.....	106
5.14.21.SYSTem:COMMunicate:ETHernet:SMASk.....	107
5.14.22.SYSTem:COMMunicate:NTP.....	107
5.14.23.SYSTem:COMMunicate:RLSTate.....	107
5.14.24.SYSTem:COMMunicate:SERial:BAUD.....	108
5.14.25.SYSTem:COMMunicate:SERial:BITS.....	108
5.14.26.SYSTem:COMMunicate:SERial:PARity.....	108
5.14.27.SYSTem:COMMunicate:SERial:SBITs.....	109
5.14.28.SYSTem:CPU:INfOrmation:ETHernet:TYPE?.....	109
5.14.29.SYSTem:CPU:INfOrmation:ONTime:LAST?.....	109
5.14.30.SYSTem:CPU:INfOrmation:ONTime:TOTal?.....	109
5.14.31.SYSTem:CPU:INfOrmation:TYPE?.....	110

5.14.32.SYSTem:CPU:MODEl?	110
5.14.33.SYSTem:CPU:OPTion?	110
5.14.34.SYSTem:DATE	110
5.14.35.SYSTem:ERRor	111
5.14.36.SYSTem:ERRor:COUNT?	111
5.14.37.SYSTem:KLOCK	111
5.14.38.SYSTem:LOCal	112
5.14.39.SYSTem:PASSword:CALibrate:RESet	112
5.14.40.SYSTem:PASSword:FPANel:RESet	112
5.14.41.SYSTem:PASSword:NEW	112
5.14.42.SYSTem:PON:OUTPut:DISable	113
5.14.43.SYSTem:POWer	113
5.14.44.SYSTem:POWer:PROTection:TRIP	113
5.14.45.SYSTem:REMOte	114
5.14.46.SYSTem:RWLock	114
5.14.47.SYSTem:TEMPerature:PROTection[:HIGH][:LEVel]	114
5.14.48.SYSTem:TEMPerature:PROTection[:HIGH]:CLEAR	115
5.14.49.SYSTem:TEMPerature:PROTection[:HIGH]:DELay[:TIME]	115
5.14.50.SYSTem:TEMPerature:PROTection[:HIGH]:STATe	115
5.14.51.SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?	116
5.14.52.SYSTem:TIME	116
5.14.53.SYSTem:VERSion?	116
5.15.TRIGger	119
5.15.1.TRIGger[:SEQuence][:IMMediate]	119
5.15.2.TRIGger[:SEQuence]:DELay	119
5.15.3.TRIGger[:SEQuence]:SLOPe	119
5.15.4.TRIGger[:SEQuence]:SOURce	120
6.Device-specific (unclassified) commands	121
6.1.1.APPLY	121
6.1.2.DEBUG	121
7.Error messages	123
7.1.Command Error [-199, -100]	123
7.2.Execution Error [-299, -200]	124
7.3.Device-Specific Error [-399, -300], [1, 32767]	125
7.3.1.Self-Test Error Messages	127
8.Parameters and settings	129
8.1.Programming parameters	129
8.1.1.Voltage	129
8.1.2.Current	129
8.1.3.Power	129
8.2.Reset Settings (*RST)	130
8.3.Special modes of operation	132
8.4.Initial settings	132
9.Software simulator	135
9.1.SIMUlator	137
9.1.1.SIMUlator:EXIT	137
9.1.2.SIMUlator:GUI	137
9.1.3.SIMUlator:LOAD	137
9.1.4.SIMUlator:LOAD:STATe	138
9.1.5.SIMUlator:PIN1	138
9.1.6.SIMUlator:PWRGood	139
9.1.7.SIMUlator:RPOL	139

9.1.8.SIMUlator:TEMPerature.....	139
9.1.9.SIMUlator:VOLTage:PROGram:EXTernal.....	140
10.Programming examples.....	141
10.1.Set channel output values and working with the OCP	141
10.2.Voltage and current calibration.....	143
10.3.Working with profiles.....	144
10.4.Get identification info and self-test results.....	145
10.5.Programming output voltage using the list of values.....	146
11.SCPi commands scheduled for upcoming releases.....	147
12.SCPi commands summary.....	149

1. Introduction

This manual contains reference information for programming open hardware/open source EEZ programmable PSU (Power Supply Unit) over the remote interface using the SCPI programming language. The SCPI (*Standard Commands for Programmable Instruments*, often pronounced “skippy”) is an open standard freely available on the [IVI Foundation](#) web pages. Current version is SCPI 1999.0. SCPI is pure software standard and SCPI syntax is ASCII text, and therefore can be attached to any computer language, such as C, C++, etc.

The physical communications link is not defined by SCPI. While originally created for IEEE 488 (GPIB), it can also be used with RS-232 (serial), Ethernet, USB, VXIbus, HiSLIP, etc. The EEZ PSU supports Serial (via USB) and Ethernet communication.

Application software that use SCPI commands is called *Controller* and SCPI enabled device such as PSU is called *Instrument*.

Please note that IEEE 488 standard documents are still not freely available, and if it is mentioned in this manual that is solely for reference purposes for one who wants to conduct a further research for better understanding or possible modification/improvement of the PSU remote control.

1.1. About SCPI

SCPI 1999.0 standard document says (Section 1.3) that the goal of SCPI is to reduce Automatic Test Equipment (ATE) program development time. SCPI accomplishes this goal by providing a consistent programming environment for instrument control and data usage. This consistent programming environment is achieved by the use of defined program messages, instrument responses, and data formats across all SCPI instruments, regardless of manufacturer.

A consistent program environment uses the same commands and parameters to control instruments that have the same functionality.

SCPI programming consistency is both vertical and horizontal. Vertical programming consistency defines program messages within an instrument class. An example of vertical consistency is using the same command for reading DC voltage from several different multimeters. Horizontal consistency is using the same command to control similar functions across instrument classes. For example, the trigger command would be the same for an identical trigger function found among counters, oscilloscopes, function generators, etc.

A key to consistent programming is the reduction of multiple ways to control similar instrument functions. The philosophy of SCPI is for the same instrument functions to be controlled by the same SCPI commands. To simplify learning, SCPI uses industry-standard names and terms that are manufacturer and customer supported.

SCPI is designed to be expanded with new defined commands in the future without causing programming problems. As new instruments are introduced, the intent is to maintain program compatibility with existing SCPI instruments.

Additional links:

- Wikipedia [SCPI](#)
- Technopedia [Standard Commands For Programmable Instruments \(SCPI\)](#)
- Wikipedia [IEEE-488](#)
- Keysight (Agilent) [Developing a SCPI command set](#)
- NI [GPIB Hardware and Software Specifications](#)

Implementation links:

- [Open source SCPI device](#) library
- Keysight (Agilent) [Application Note 1465-29](#)
- Keysight (Agilent) [Command Expert](#)

2. Syntax and style

Throughout this document, the following conventions are used for the SCPI command syntax:

- Square brackets ([]) indicate optional keywords or parameters. The braces are not sent with the command string.
- Braces ({}) enclose parameters within a command string.
- Triangle brackets (<>) indicate that you must substitute a value or a code for the enclosed parameter.
- A vertical bar (|) separates one of two or more alternative parameters.

2.1. Root Specifier

When it precedes the first header of a message unit, the colon becomes the root specifier. It tells the command parser that this is the root or the top node of the command tree.

2.2. Command termination

A command string sent to the PSU must terminate with a <new line>character. A <carriage return> followed by a <new line>is also accepted. Command string termination will always reset the current SCPI command path to the root level.

2.3. Command separators

A colon (:) is used to separate a command keyword from a lower-level keyword as shown below:

```
SOURce1:CURRent:PROTection:STATe
```

A semicolon (;) is used to separate two commands within the same subsystem, and can also minimize typing. For example, sending the following command string,

```
SOURce1:VOLTagE 20;CURRent 300mA
```

is the same as sending the following two commands:

```
SOURce1:VOLTagE 20  
SOURce1:CURRent 1.5
```

Use a colon and a semicolon to link commands from different subsystems. For example, in the following command string, an error is generated if you do not use the colon and semicolon:

```
SYSTem:BEEP;:SOURce1:CURRent 2.5
```

2.4. Querying parameter settings

You can query the value of most parameters by adding a question mark (?) to the command. For example, the following command sets the output voltage to 45.5V:

```
VOLTagE 45.5
```

You can query the value by executing:

```
VOLTagE?
```

If error is occurred use [SYSTem:ERRor\[:NEXT\]?](#) to get more information about error.

2.5. Using the MIN, MAX, and DEF Parameters

For many commands, you can substitute "MIN" or "MAX" in place of a parameter. In some cases you may also substitute "DEF". For example, consider the following command:

```
[SOURce[<n>]]:VOLTagE[:LEVel][:IMMediate][:AMPLitude] {<voltage>|MIN|DEF|MAX|UP|DOWN}
```

Instead of selecting a specific value for the <voltage> parameter, you can substitute MIN to set the voltage to its minimum value, MAX to set the voltage to its maximum value, or DEF to set the voltage to its default value. For list of parameter values see [Section 8.1](#)

2.6. Command and message types

SCPI commands can be divided to **common** and **subsystem** commands.

- Common commands are defined by the IEEE 488.2 standard to perform common interface functions. They begin with an * and consist of three letters (command) or three letters and a ? (query). Description of supported common commands can be found in [Section 4](#)
- Subsystem commands are specific to instrument (PSU in this case) functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. See [Section 5](#) for commands that is created in accordance to the SCPI 1999.0 standard. Commands that is not defined by SCPI 1999.0 is labeled "unclassified" and are presented in [Section 6](#)

There are two types of SCPI messages, **program** and **response**.

- A program message consists of one or more properly formatted SCPI commands sent from the controller to the instrument. The message, which may be sent at any time, requests the instrument to perform some action.
- A response message consists of data in a specific SCPI format sent from the instrument to the controller. The instrument sends the message only in response to a **query** header.

2.7. Required Commands

The following commands are required in all SCPI instruments (see SCPI 1999.0 Section 4.2.1):

Mnemonic	SCPI 1999.0 Command Reference Section	SCPI 1999.0 Syntax and Style Section
:SYSTem		
:ERRor	21.8	
[:NEXT]?	21.8.3e	1996
:VERSion?	19.16	1991
:STATus	18	5
:OPERation		
[:EVENT]?		
:CONDition?		
:ENABle		
:ENABle?		
:QUESTionable		
[:EVENT]?		
:CONDition?		
:ENABle		
:ENABle?		
:PRESet		

2.7.1. Base functionality for the Power supply instrument class

SCPI Command	Description
OUTPut	
[:STATe] <bool>	Enables the specified output channel(s)
[SOURce[<n>]]	
CURRent	

```

[:LEVel]
    [:IMMediate][:AMPLitude] <current>    Sets the output current
VOLTage
    [:LEVel]
    [:IMMediate][:AMPLitude] <voltage>    Sets the output voltage

```

All SCPI power supplies shall implement the status reporting structure. STATUS Subsystem defines the commands which shall be used to control the status reporting structure. For a power supply, the bits of interest in the QUESTIONable status structure are VOLTage and CURRENT. When a power supply is operating as a voltage source, bit 1 (CURRENT) shall be set. When a power supply is operating as a current source, bit 0 (VOLTage) shall be set. When the output is unregulated, both bits shall be set (for example, while the output is changing to a new programmed value).

2.8. Multiple Commands in a Message

Multiple SCPI commands can be combined and sent as a single message with one message terminator. There are two important considerations when sending several commands within a single message:

- Use a semicolon to separate commands within a message.
- There is an implied header path that affects how commands are interpreted by the PSU.

The header path can be thought of as a string that gets inserted before each command within a message. For the first command in a message, the header path is a null string. For each subsequent command the header path is defined as the characters that make up the headers of the previous command in the message up to and including the last colon separator. An example of a message with two commands is:

```
OUTPut:STATe ON,CH1;PROTection:CLEAr CH1
```

which shows the use of the semicolon separating the two commands, and also illustrates the header path concept. Note that with the second command, the leading header OUTPut was omitted because after the OUTPut:STATe ON command, the header path became defined as OUTPut and thus the instrument interpreted the second command as:

```
OUTPut:PROTection:CLEAr CH1
```

In fact, it would have been syntactically incorrect to include the OUTPut explicitly in the second command, since the result after combining it with the header path would be:

```
OUTPut:OUTPut:PROTection:CLEAr CH1
```

which is incorrect.

You can combine common commands (IEEE488) with subsystem commands in the same message. Treat the common command as a message unit by separating it with a semicolon (the message unit separator). Common commands do not affect the header path; you may insert them anywhere in the message.

```
*TST?;SYSTem:ERRor?
```

2.9. Moving Among Subsystems

In order to combine commands from different subsystems, you need to be able to reset the header path to a null string within a message. You do this by beginning the command with a colon (:), which discards any previous header path. For example, you could clear the output protection and check the status of the Operation Condition register in one message by using a root specifier as follows:

```
OUTPut:PROTection:CLEAr CH1;;STATus:OPERation:CONDition? CH1
```

The following message shows how to combine commands from different subsystems as well as within the same subsystem:

```
VOLTage:LEVel 7.5,CH1;PROTection 10,CH1;;CURRENT:LEVel 0.5,CH1
```

Note the use of the optional header LEVel to maintain the correct path within the subsystems, and the

use of the root specifier to move between subsystems.

2.10. SCPI parameter types

The SCPI language defines several different data formats to be used in program messages and response messages:

Numeric Commands that require numeric parameters will accept all commonly used representations of numbers like integer (also known as NR1 format specified in ANSI X3.42-1990) or decimal representations of numbers including optional signs, decimal points (NR2 format), and scientific notation (i.e. 10E3 or NR3 format). Special values for numeric parameters like MINimum, MAXimum, and DEFault are also accepted. You can also send engineering unit suffixes (V, A, or SEC) with numeric parameters. If only specific numeric values are accepted, the PSU will automatically round the input numeric parameters. The following command uses a numeric parameter:

```
VOLT:STEP {<step>}
```

Discrete Used to program settings that have a limited number of values such as BUS and IMM or CH1 and CH2. Query responses will always return the short form in all uppercase letters. The following command uses discrete parameters:

```
CAL:CURREN:LEV {MIN|MID|MAX}
```

Boolean Represent a single binary condition that is either true or false. For a false condition, the PSU will accept OFF or 0. For a true condition, the PSU will accept ON or any nonzero value (i.e. 1 but also 2.34 or -3). When you query a Boolean setting, the PSU will always return 0 or 1. The following command uses a Boolean parameter:

```
OUTP {OFF|ON}
```

String Can contain virtually any set of ASCII characters. A string must begin and end with matching quotes, either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

```
CAL:REM <quoted string>
```

3. Registers and queues

SCPI requires the status mechanism described in Section 11 of IEEE 488.2, including full implementation of the status register structure. Summary of implemented registers structure for the PSU is shown on Fig. 1. (commands used to access registers are written in parentheses).

All SCPI instruments have to implement status registers in the same way. The status system records various instrument conditions in the following register groups:

- the Status Byte register,
- the Standard Event register,
- the QUEStionable Status register group, and
- the OPERation Status register group.

The Status Byte register records high-level summary information reported in the other register groups. Message interchanging between Controller and Instrument is accomplished by using input buffer and Output queue and Error queue. The length of the Input buffer is 48 characters. Both Output and Error queue can handle up to 20 messages.



Fig. 1: Summary of status structure registers

3.1. Standard Event Status Register

An status register group is consist of Condition, Event and Enable registers (see Fig. 1):

- The Condition register is a read-only register, which holds the live (unlatched) operational status of the instrument. Reading the Condition register does not clear it.
- The Event register is a read-only that reports defined conditions within the PSU. Bits in an event register are latched. Once an event bit is set, subsequent state changes are ignored. Bits in the Event register are automatically cleared by a query of that register (such as *ESR? or STATus:QUESTionable:EVENT?) or by sending the *CLS (clear status) command. A reset (*RST) or device clear will *not* clear bits in event registers (See [Section 8.2](#)). Querying an event register returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.
- The ENABLE register is used to define which bits of the Event Status register will latch ESB (bit 5) of the Status byte register.

An error status (bit 2, 3, 4 or 5) records one or more errors in the PSU error queue. The SYSTEM:ER-Ror? command can be used to read the error queue.

Implementation of the Standard Event Status register follows IEEE 488.2 Section 11.5.1.1:

Bit	Decimal value	Description
0	1	Operation Complete (OPC) – This event bit is generated in response to the *OPC command. It indicates that the PSU has completed all selected pending operations (including *OPC).
1	2	Not used
2	4	Query ERROR (QYE) – Query Errors are detected by the Output Queue Control. This event bit indicates that either <ul style="list-style-type: none"> • An attempt is being made to read data from the Output Queue when no output is either present or pending, or • Data in the Output Queue has been lost. Events that generate Query Errors do not generate Execution Errors, Command Errors, or Device-Specific Errors.
3	8	Device-Specific ERROR (DDE) – This event bit indicates that an error has occurred that is neither a Command Error, a Query Error, nor an Execution Error. A Device-Specific Error is any executed device operation that did not properly complete due to some condition, such as over-range, a self-test or calibration error. Following a Device-Specific Error, the PSU will continue to process the input stream. Events that generate Device-Specific Errors do not generate Command Errors, Query Errors, or Execution Errors.
4	16	Execution ERROR (ERR) – This event bit indicates that: <ul style="list-style-type: none"> • A <PROGRAM DATA> element following a header was evaluated by the PSU as outside of its legal input range or is otherwise inconsistent with the PSU's capabilities. • A valid program message could not be properly executed due to some PSU condition. Following an Execution Error, the PSU will continue parsing the input stream. Execution Errors will be reported by the PSU after rounding and expression evaluation operations have taken place. Rounding a numeric data element, for example, will not be reported as an Execution Error. Events that generate Execution Errors do not generate Command Errors, Query Errors, or Device-Specific Errors.
5	32	Command ERROR (CME) – Command Errors are detected by the parser. This

event bit indicates that one of the following events has occurred:

- An IEEE 488.2 syntax error has been detected by the parser. That is, a controller-to-device message was received that is in violation of this standard. Possible violations include a data element that violates the device listening formats or whose type is unacceptable to the device (see also IEEE 488.2 Section 7.1.2.2).
- A semantic error has occurred indicating that an unrecognized header was received. Unrecognized headers include incorrect device-specific headers and incorrect or unimplemented common commands described in [Section 4](#)

When the PSU detects a Command Error, parser synchronization may be lost.

When a Command Error is detected, any prior parsable elements of the same <PROGRAM MESSAGE> will be executed. That is also true for all parsable elements that follows after detected Command Error.

The Command Error bit not be set to report any other device-specific condition. Events that are reported as Command Errors cannot be reported as Execution Errors, Query Errors, or Device-Specific Errors.

6	64	User Request (URQ) – This event bit indicates that the PSU input device (TFT Touch screen) has been for any reason activated. The setting of this event-bit occur regardless of the IEEE 488.1 Remote/Local state of the device (not supported in M1)
7	128	Power On (PON) – This event bit indicates that an off-to-on transition has occurred in the device's power supply. See also SYSTem:POWer.
8-15	–	Not used, always zero

3.2. Status Byte Register

The Status Byte summary register reports conditions from the other status registers (see Fig. 1). Query data that is waiting in the PSU's output buffer is immediately reported through the "Message Available" (MAV) bit (bit 4) of the Status Byte register. Bits in the summary register are NOT latched. Clearing an event register will clear the corresponding bits in the Status Byte summary register. Reading all messages in the output buffer, including any pending queries, will clear the message available bit (MAV).

The Status Byte summary register is cleared when the *CLS (clear status) command has been executed.

The Status Byte enable register (request service) is cleared when the *SRE 0 command has been executed.

Querying the Standard Event register (*ESR? command) will clear only bit 5 (ESR) in the Status Byte summary register. For example, 24 (8 + 16) is returned when you have queried the status of the Status Byte register, QUES and MAV conditions have occurred.

Bit	Decimal value	Description
0-1	–	Not used, always zero
2	4	ERR – Error queue bit indicates that one or more errors have been stored in the Error queue.
3	8	QUES – One or more bits are set in the QUEStionable Status register (bits must be enabled in the enable register).
4	16	MAV – The Message Available bit indicates whether or not the Output Queue is empty. Whenever the device is ready to accept a request by the controller to output data bytes, the MAV is TRUE. The MAV is FALSE when the Output Queue is empty. This bit is used to synchronize information exchange with the controller. The controller can, for example, send a query command to the device and then wait for MAV to become TRUE.
5	32	ESB – One or more bits are set in the Standard Event register (bits must be en-

abled in the enable register, see *ESE command).

- | | | |
|---|-----|--|
| 6 | 64 | MMS – Master Status summary bit indicates that one or more bits are set in the Status Byte Register (bits must be enabled, see *SRE command). Also used to indicate a request for service (RQS). |
| 7 | 128 | OPER – One or more bits are set in the OPERation Status register. |

3.3. OPERation Status Register

The OPERation status register contains conditions which are part of the instrument's normal operation. Each channel of the PSU is considered as separate "instrument". The two logical outputs (channels) of the PSU include an INSTRument summary status register and an individual instrument ISUMmary register for each logical output.

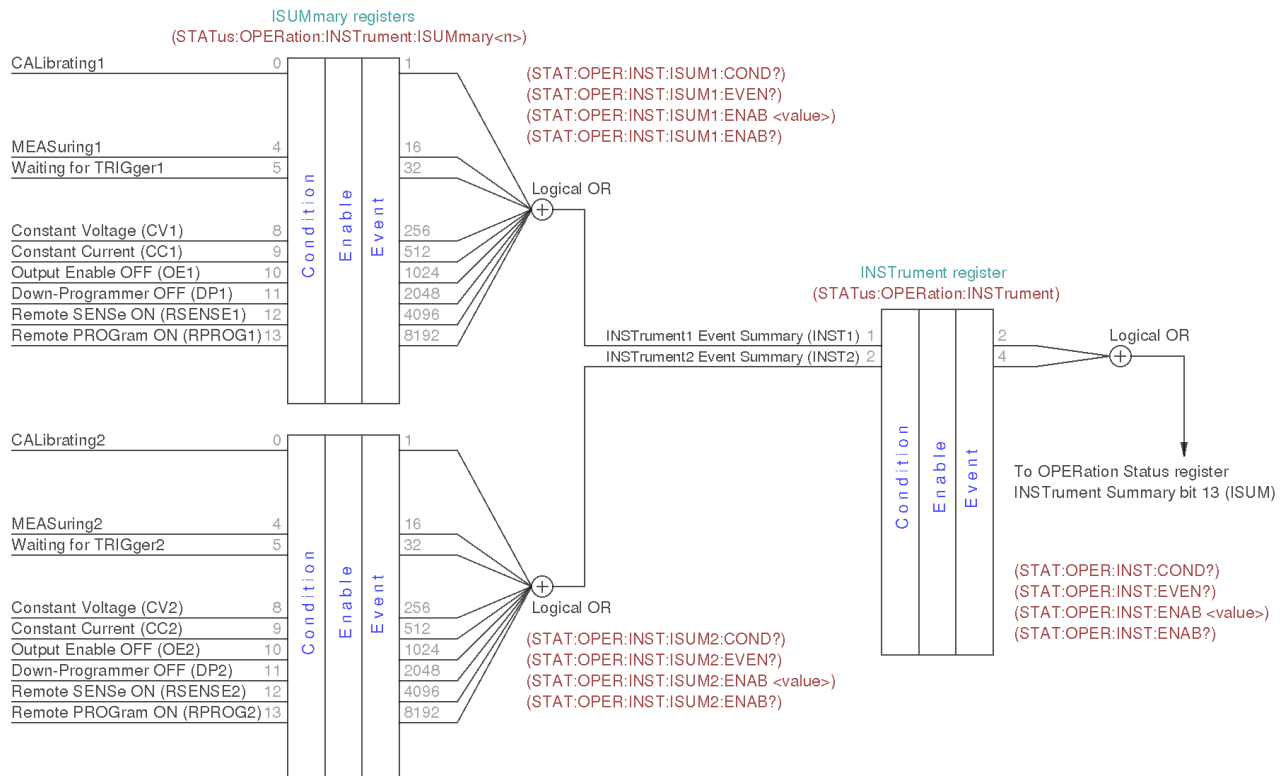


Fig. 2: OPERation Status registers summary

The bit definition of OPERation Status register shown on Fig.1.:

Bit	Decimal value	Description
0-7	–	Not used, always zero
8	256	GROUp PARAllel indicate that PSU's channels are connected in parallel.
9	512	GROUp SERial indicate that PSU's channels are connected in serial.
10-12	–	Not used, always zero
13	8192	INSTRument Summary Bit – One of n multiple logical instruments is reporting OPERational status.
14-15	–	Not used, always zero

The Event Status Enable register is cleared when the STAT:EVEN:ENAB 0 command is executed. The *CLS command can be also used to clear the register.

3.3.1. Operation INSTRument Status register

The bit definition of OPERation INSTRument Status register shown on Fig.2.:

Bit	Decimal value	Description
0	–	Not used, always zero
1	2	INST1 – Instrument1 summary bit indicate that one or more bits are changed in the Channel 1 OPERation INSTRument Summary register
2	4	INST2 – Instrument2 summary bit indicate that one or more bits are changed in the Channel 2 OPERation INSTRument Summary register
3-15	–	Not used, always zero

3.3.2. Operation Instrument SUMmary status register

The ISUMmary registers report to the INSTRument register, which in turn reports to bit 13 of the Operation Status register. This is illustrated on Fig. 2. Using such a status register configuration allows a status event to be cross- referenced by output channel and type of event. The INSTRument register indicates which channel(s) have generated an event. The ISUMmary register represent a pseudo-operation Status register for a particular logical output.

The bit definition of OPERation INSTRument ISUMmary Status register shown on Fig.2.:

Bit	Decimal value	Description
0	1	CALibrating – Channel is performing calibration
1-3	–	Not used, always zero
4	16	MEASuring – Channel is performing measurement (not supported in M1)
5	32	Waiting for TRIGger – Channel is waiting for the trigger event (not supported in M1)
6-7	–	Not used, always zero
8	256	CV – Channel is entered CV operation mode
9	512	CC – Channel is entered CC operation mode
10	1024	OE – Output is switched off
11	2048	DP – Down-programmer is switched off
12	4096	RSENSE – Remote voltage sense is switched on
13	8192	RPROG – Remote voltage programming is switched on
14-15	–	Not used, always zero

3.4. QUEStionable Status Register

The Questionable Status register provides information about unexpected operations of the PSU. Each channel of the PSU is considered as separate "instrument". The two logical outputs (channels) of the PSU include an INSTRument summary status register and an individual instrument ISUMmary register for each logical output.

The ISUMmary registers report to the INSTRument register, which in turn reports to bit 13 of the Questionable Status register. This is illustrated on Fig. 3. Using such a status register configuration allows a status event to be cross-referenced by output channel and type of event. The INSTRument register indicates which channel(s) have generated an event. The ISUMmary register represent a pseudo-Questionable Status register for a particular logical output.

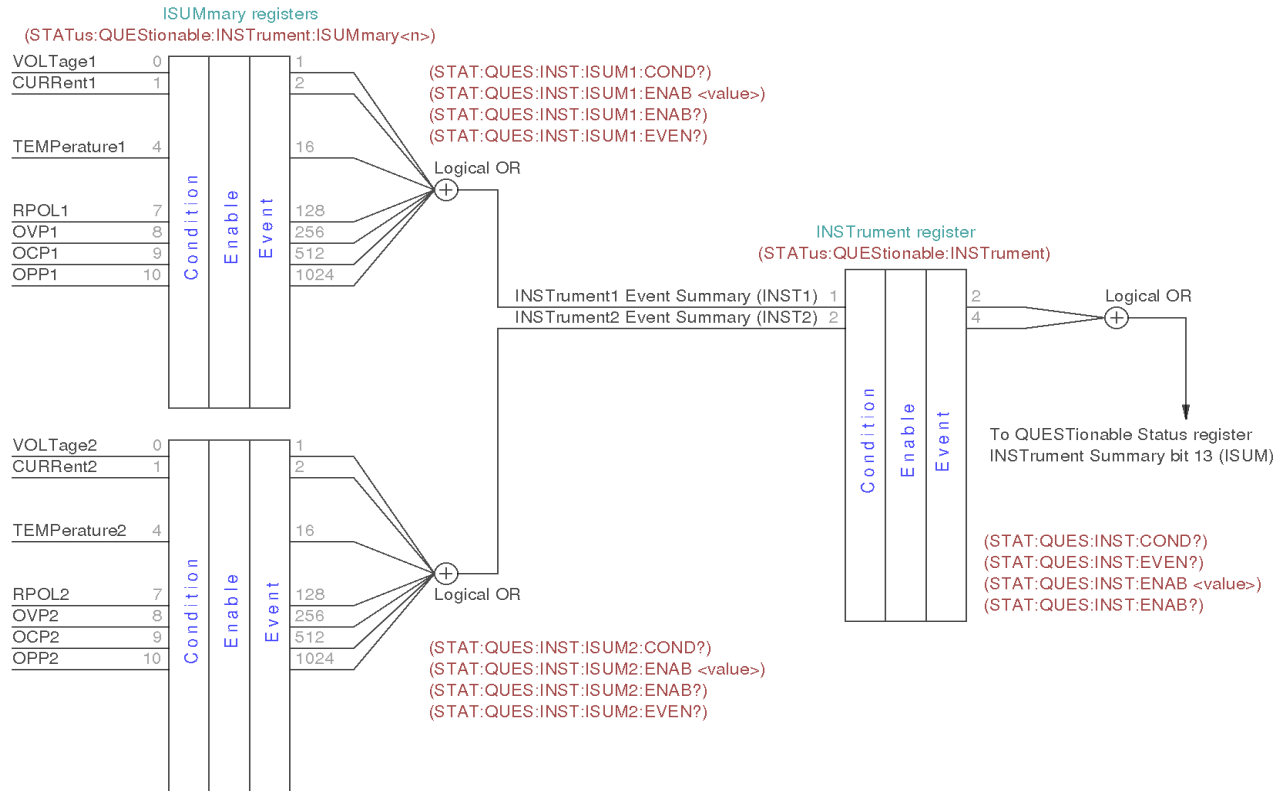


Fig. 3: QUESTIONable INSTRument registers summary

For example, if one of the two channels is in constant voltage (CV) mode and due to an overload loses regulation, bit 13 is set (latched). To read the register, the command `STATus:QUESTIONable?` is required. To make use of bit 13 (ISUM), enable register must be correctly set. The command `STAT:QUES:INST:ENAB 6 (2 + 4)` has to be sent to enable the Questionable instrument register, followed by the command `STAT:QUES:INST:ISUM<n>:ENAB 19` for each channel to enable the QUESTIONable INSTRument SUMmary register, where n is 1 or 2.

Bit definition for QUESTIONable Status register shown on Fig.1.:

Bit	Decimal value	Description
0-2	–	Not used, always zero
3	8	TIME – indicate abnormal time/date situation due to RTC failure or conflict between current and time/date retrieved from the stored configuration.
4	16	TEMPerature – temperature measurement that use the AUX temperature sensor on the Arduino Shield board require attention (i.e. over-temperature condition is detected, sensor is not functional, etc.). <i>Do not confuse this sensor with that are connected to a PSU channels.</i>
5-11	–	Not used, always zero
12	4096	FAN – cooling fan failure is detected
13	8192	INSTRument summary, is described later in this chapter in association with multiple logical instruments.
14-15	–	Not used, always zero

The Questionable Status Enable register is cleared when the `STAT:QUES:ENAB 0` command is executed. The `*CLS` command can be also used to clear the register.

3.4.1. Questionable INSTRument Status register

Bit definition for QUESTIONable INSTRument register:

Bit	Decimal value	Description
0	–	Not used, always zero
1	2	INST1 – Instrument1 summary bit indicate that one or more bits are changed in the Channel 1 OPERation INSTRument Summary register.
2	4	INST2 – Instrument2 summary bit indicate that one or more bits are changed in the Channel 2 OPERation INSTRument Summary register.
3-15	–	Not used, always zero

3.4.2. Questionable Instrument SUMmary status register

There are two questionable instrument summary registers, one for each PSU output. These registers provide information about voltage and current regulation.

Bit definition for QUESTionable INSTRument SUMmary register:

Bit	Decimal value	Description
0	1	VOLTage – This bit is set when the voltage becomes unregulated, therefore a channel enters CC operation mode. <i>If the over-voltage protection (OVP) is activated (see VOLTage:PROTection:STATe) channel output will be switched off.</i>
1	2	CURRent – This bit is set when the current becomes unregulated, therefore a channel enters CV operation mode. <i>If the over-current protection (OCP) is activated (see CURRent:PROTection:STATe) channel output will be switched off.</i>
2-3	–	Not used, always zero
4	16	TEMPerature – the temperature sensor on the channel power board require attention (i.e. over-temperature condition is detected, sensor is not functional, etc.). <i>Do not confuse this sensor with one that is connected to the Arduino shield board.</i>
5-6	–	Not used, always zero
7	128	RPOL – Remote sense reverse polarity is detected.
8	256	OVP – Over-voltage protection is activated. The query VOLT:PROT:TRIP? returns value of this bit. See also STAT:QUES.
9	512	OCP – Over-current protection is activated. The query CURR:PROT:TRIP? returns value of this bit. See also STAT:QUES.
10	1024	OPP – Over-power protection is activated. The query POW:PROT:TRIP? returns value of this bit. See also STAT:QUES.
11	2048	FAN – cooling fan failure is detected. See also STAT:QUES.
12-15	–	Not used, always zero

Please note here that CURRent bit is use for questionable Voltage operating mode and vice versa.

If 0 and 1 bits is true that indicate neither the voltage nor the current is regulated (so-called unregulated or UR mode), and both bits false indicate the PSU channel are off.

To read the register for each PSU channel, the command STAT:QUES:INST:ISUM[<n>]? has to be send, where [<n>] is 1 or 2. If [<n>] is not specified the currently selected channel is used.

Use STAT:QUES:INST:ISUM<n>:COND? to determine operating mode (CV or CC) for the PSU channel (where n is 1 or 2 depending on the output).

The Questionable Status event register is cleared with:

- the *CLS (clear status) command or
- the event register is queried using the STAT:QUES? (status questionable event register)

command.

3.5. Error queue

The error queue contains items that include a numerical and textual description of the error or event. The <Error/event_number> is a unique integer in the range [-32 768, 32 767]. All positive numbers are instrument-dependent. All negative numbers are reserved by the SCPI standard with certain standard error/event codes. The value, zero, is also reserved to indicate that no error or event has occurred. The second parameter of the full response is a quoted string containing an <Error/event_description>. Each <Error/event_number> has a unique and fixed <Error/event_description> associated with it. An example:

```
-113, "Undefined header"
```

The maximum string length of <Error/event_description> plus <Device-dependent_info> is 255 characters. List of all error/event messages can be found in [Section 7](#) of this document.

As errors and events are detected, they are placed in a queue. This queue is first in, first out. If the queue overflows, the last error/event in the queue is replaced with error:

```
-350, "Queue overflow"
```

Any time the queue overflows, the least recent errors/events remain in the queue, and the most recent error/event is discarded. Reading an error/event from the head of the queue removes that error/event from the queue, and opens a position at the tail of the queue for a new error/event, if one is subsequently detected.

If the error queue is not empty, bit 2 of the Instrument Summary Status Register is set. A query returns only the oldest error code and associated error description information from the error queue. To return all error codes and associated description information, use repetitive queries until an error value of zero is returned, or until bit 2 of the status register is 0.

The error queue is cleared when any of the following occur (IEEE 488.2, section 11.4.3.4):

- Upon power up
- Upon receipt of a *CLS command
- Upon reading the last error message from the queue

4. Common command reference

This section summarizes the mandatory subset of IEEE 488.2 commands that is a requirement for any SCPI compliant instrument.

Common command	Description
*CLS	Clears all status data structures
*ESE {<value>}	Programs the Standard Event Status Enable register bits
*ESR?	Reads the Standard Event Status Register
*IDN?	Returns the UNIQUE identification of the PSU
*OPC	Operation Complete Command used for program synchronization
*RCL {<profile>}	Recalls the PSU state stored in the specified storage location
*RST	Reset PSU to the initial state
*SAV {<profile>}	Stores the current PSU state in the specified storage location
*STB?	Reads the Status Byte register
*TRG	Generates a software trigger
*TST?	Returns Self-Test results
*WAI	Waits until all pending commands are completed

4.1. *CLS

Syntax	*CLS
Description	<p>Clear Status Command. This command clears all status data structures in the PSU:</p> <ul style="list-style-type: none">• Standard Event Status Register• OPERation Event Status Register• QUEStionable Event Status Register• Error/Event Queue <p>The corresponding condition and enable registers are unaffected. If *CLS immediately follows a program message terminator (<NL>), then the output queue and the MAV bit are also cleared.</p>
Return	None
Related Commands	*ESR? STATus:OPERation[:EVENT] STATus:OPERation:INSTRument[:EVENT] STATus:OPERation:INSTRument:ISUMmary[<n>][:EVENT] STATus:QUEStionable[:EVENT] STATus:QUEStionable:INSTRument[:EVENT] STATus:QUEStionable:INSTRument:ISUMmary[<n>][:EVENT] SYSTem:ERRor

4.2. *ESE

Syntax	*ESE {<value>} *ESE?
Description	<p>Standard Event Status Enable Command. This command programs the Standard Event Status Enable register bits. The programming determines which events of the Standard Event Status Event register (see *ESR?) are allowed to set the ESB (Event Summary Bit) of the Status Byte register. A 1 in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Event Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set.</p> <p>A STATus:PRESet command does not clear the bits in the Status Byte register.</p>

See also [Section 3.1](#) in this document.

Parameters	Name	Type	Range	Default
	<value>	Numeric	0 – 255 (A decimal value which corresponds to the binary-weighted sum of the bits in the register. See also table in Section 3.1).	None
Return	The query reads the enable register and returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.			
Usage example	To enable bit 2 (decimal value = 4), bit 3 (decimal value = 8), and bit 7 (decimal value = 128), the corresponding decimal value would be 140 (4 + 8 + 128): *ESE 140 Read value of the Standard Event Status Enable register: *ESE? 140			
Errors	-200, "Execution error"			
Related Commands	*CLS *RST STATus:PRESet			

4.3. *ESR?

Syntax	*ESR?
Description	Standard Event Status Register (see Section 3.2) Query. Reading the Standard Event Status Event register clears it.
Return	The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register.
Usage example	If ERRor (bit 2) is set: ESR? 4

4.4. *IDN?

Syntax	*IDN?
Description	Identification query for the UNIQUE identification of the PSU. (see also IEEE 488.2 10.14).
Return	The following system parameters will be displayed: <vendor>, <model>, <serial number>, <firmware>. The <model> include information about used CPU in brackets and could be Mega, Due or Simulator. More information about simulator could be found in Section 9 .
Usage example	*IDN? EEZ, PSU 2/50/03 (Due), 00001, M1.0.96

4.5. *OPC

Syntax	*OPC *OPC?
Description	Operation Complete Command. The command is mainly used for program synchronization. It causes the PSU to set the OPC bit (bit 0) of the Standard Event Status register when the PSU has completed all pending operations sent before *OPC. Pending operations are complete when:

- All commands sent before *OPC, including paralleled commands, have been completed. Most commands are sequential and are completed before the next command is executed. Commands that affect output voltage, current, or state, relays, and trigger actions are executed in parallel with subsequent commands. *OPC provides notification that all parallel commands have completed.
- All triggered actions are completed.

Query whether the current operation is completed and the query returns 1.
See also IEEE 488.2 Section 12.5 – 12.8.

Return Query causes the PSU to place a 1 in the output buffer when all pending operations are completed. *OPC? does not suspend processing of commands.

Usage example *OPC?
1

if current operation is not completed:

*OPC?
0

4.6. *RCL

Syntax *RCL {<profile>}

Description This command recalls the PSU state stored in the specified storage location. The PSU has ten storage locations in non-volatile memory to store PSU states. It is not possible to recall the PSU state from a storage location that is empty or was deleted. When the firmware is started for the first time, storage locations 1 through 9 are empty (location 0 has the power-on state).

The PSU uses location 0 to automatically hold the state of the PSU at power down.

Parameters	Name	Type	Range	Default
	<profile>	Numeric	0 – 9	None
Return	None			
Usage example	*RCL 2			
Errors				
Related Commands	*SAV MEMory:STATe:DELeTe MEMory:STATe:RECall:AUTO MEMory:STATe:RECall:SELeCt SYSTem:POWeR			

4.7. *RST

Syntax *RST

Description Reset Command. Restore the PSU to initial state (as predefined in the PSU firmware, see [Section 8.2](#)) and clear the error queue. The reset command explicitly will NOT affect calibration data nor any of saved configuration profiles (0 to 9). When *RST is issued all output are set to OFF, and voltage and current are programmed to 0. Power up sequence is started. All SPI peripherals are reinitialize except Ethernet controller if an active Ethernet connection exists.

Return None

Usage example *RST
MEMory:RECall:AUTO
SYSTem:POWeR

Related Commands *RST
 *SAV
 MEMory:STATe:CATalog?

4.8. *SAV

Syntax *SAV {<profile>}

Description This command stores the current instrument state in the specified storage location. Any state previously stored in the same location is overwritten without generating any errors. The PSU has nine storage locations in non-volatile memory available to user to store current PSU states. The following channel and system parameters will be stored in the non-volatile memory:

- Calibration status ([CALibration:STATe](#))
- Output enable state ([OUTPut\[:STATe\]](#))
- Output track state ([OUTPut:TRACk\[:STATe\]](#))
- Channel coupling state ([INSTrument:COUPle:TRACking](#))
- Low ripple state ([\[SOURce\[<n>\]\]:LRIPple](#))
- Low ripple auto mode ([\[SOURce\[<n>\]\]:LRIPple:AUTO](#))
- Remote sense state ([\[SOURce\[<n>\]\]:VOLTage:SENSe\[:SOURce\]](#))
- Output voltage ([\[SOURce\[<n>\]\]:VOLTage](#))
- Output voltage limit ([\[SOURce\[<n>\]\]:VOLTage:LIMit](#))
- Output voltage step ([\[SOURce\[<n>\]\]:VOLTage:STEP](#))
- OVP status ([\[SOURce\[<n>\]\]:VOLTage:PROTection:STATe](#))
- OVP delay ([\[SOURce\[<n>\]\]:VOLTage:PROTection:DELAy](#))
- Output current ([\[SOURce\[<n>\]\]:CURRent](#))
- Output current limit ([\[SOURce\[<n>\]\]:CURRent:LIMit](#))
- Output current step ([\[SOURce\[<n>\]\]:CURRent:STEP](#))
- OCP status ([\[SOURce\[<n>\]\]:CURRent:PROTection:STATe](#))
- OCP delay ([\[SOURce\[<n>\]\]:CURRent:PROTection:DELAy](#))
- Output power limit ([\[SOURce\[<n>\]\]:POWER:LIMit](#))
- OPP level ([\[SOURce\[<n>\]\]:POWER:PROTection\[:LEVel\]](#))
- OPP status ([\[SOURce\[<n>\]\]:POWER:PROTection:STATe](#))
- OPP delay ([\[SOURce\[<n>\]\]:POWER:PROTection:DELAy](#))
- OTP level ([\[SYSTem:TEMPerature:PROTection\[:HIGH\]\]:LEVel](#))
- OTP status ([\[SYSTem:TEMPerature:PROTection\[:HIGH\]\]:STATe](#))
- OTP delay ([\[SYSTem:TEMPerature:PROTection\[:HIGH\]\]:DELAy](#))
- Power on state ([\[SYSTem:POWER\]](#))
- Simulator load value ([\[SIMUlator:LOAD\]](#))
- Simulator load connection ([\[SIMUlator:LOAD:STATe\]](#))

You can assign a user-defined name to each of locations 1 through 9 using the [MEMory:STATe:NAME](#) command.

A reset ([*RST](#) command) does not affect the configurations stored in memory. Once a state is stored, it remains until it is overwritten using this command or specifically deleted using the [MEMory:STATe:DELeTe](#) command.

The PSU uses location 0 to automatically hold the state of the PSU at power down.

Parameters	Name	Type	Range	Default
	<profile>	Numeric	1 – 9	None
Return	None			
Usage example	*SAV 2			
Related Commands	*RCL *RST MEMory:STATe:CATalog?			

MEMory:STATe:NAME
MEMory:STATe:DELeTe

4.9. *STB?

Syntax	*STB?
Description	Read Status Byte Query. This query reads the Status Byte register (see Section 3.2), which contains the status summary bits and the Output Queue MAV bit. The Status Byte is a read-only register and the bits are not cleared when it is read. A serial poll also returns the value of the Status Byte register, except that bit 6 returns Request for Service (RQS) instead of Master Status Summary (MSS). A serial poll clears RQS, but not MSS. When MSS is set, it indicates that the PSU has one or more reasons for requesting service.
Return	The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register.
Usage example	If OPER (bit 7) is set: *STB? 128
Related Commands	*SRE

4.10. *TRG

Syntax	*TRG
Description	This command generates a trigger to the trigger subsystem that has selected a bus (software) trigger as its source (TRIGger[:SEQuence]:SOURce BUS).
Return	None
Usage example	Generate a trigger operation after 5 seconds: TRIG:SOUR BUS TRIG:DEL 5 INIT *TRG
Errors	-211, "Trigger ignored" 304, "Incompatible transient modes" 307, "List lengths are not equivalent"
Related Commands	*WAI ABORt INITiate TRIGger[:SEQuence]:DELay TRIGger[:SEQuence]:SOURce

4.11. *TST?

Syntax	*TST?
Description	Self-Test Query. The self-test query causes an internal self-test and places a response into the Output Queue indicating whether or not the PSU completed the self-test without any detected errors. <i>Ensure that all terminal connections are removed while the internal self-test is being performed.</i> <i>If an active Ethernet connection exists, testing of Ethernet controller will be skipped. You can use DIAGnostic[:INFormation]:TEST? for query detailed report of the latest self-test.</i>

If fan is installed and not running this command will start it for the short time to obtain speed information.

Return 0 or 1 depends of the self-test results. See also [DIAGnostic\[:INFormation\]:TEST?](#).

Usage example If all tests passed:

```
*TST?
0
```

If one or more tests failed:

```
*TST?
1
```

Related Commands DIAGnostic[:INFormation]:TEST?
SYSTem:BEEP:STATE

4.12. *WAI

Syntax [*WAI](#)

Description Wait-to-Continue Command causes the PSU to wait until all pending commands are completed, before executing any other commands.

Pending operations are as defined under the *OPC command.

Return None

Usage example For example, the *WAI command can be used to make a voltage measurement after an OUTPut ON command has completed:

```
OUTPut ON;*WAI;:MEASure:VOLTage?
```

Related Commands *OPC

5. Subsystem command reference

This section summarizes the Standard Commands for Programmable Instruments (SCPI) available to program the PSU over the remote interface.

- [ABORt](#)
- [CALibrate](#)
- [DIAGnostic](#)
- [DISPlay](#)
- [INITiate](#)
- [INSTrument](#)
- [MEASure](#)
- [MEMory](#)
- [MMEMory](#)
- [OUTPut](#)
- [SENSe](#)
- [SOURce](#)
- [STATus](#)
- [SYSTem](#)
- [TRIGger](#)

5.1. *ABORt*

Syntax [ABORt](#)

Description The ABORt command resets the trigger system and places all trigger sequences in the IDLE state. Any actions related to the trigger system that are in progress will be also aborted as quickly as possible. As a result, subsequent triggers have no effect on the input level.

Return None

Usage
example `ABORt`

Related
Commands `INITiate`
`[SOURce[<n>]]:CURRent:TRIGgered`
`[SOURce[<n>]]:VOLTage:TRIGgered`
`[SOURce[<n>]]:LIST:COUNT`

5.2. CALibrate

This subsystem provides commands for the PSU calibration. Only one channel can be calibrated at a time. If calibration mode has not been enabled with CALibrate:STATE, the calibration commands will generate an error. Use CALibrate:SAVE to save any changes, otherwise all changes will be lost on exit from calibration mode. Within the same calibration session both output voltage and current can be calibrated for the currently selected channel.

Calibration cannot start if channel output is not enabled (OUTPut[:STATE] ON). During calibration process three points has to be entered: MIN, MID and MAX. But in practice two point calibration is performed to re-scale the output programmed and measured values by correcting both slope and offset errors. MID point is used only as an additional validation that between entered MIN and MAX values it's possible to "draw" a line within allowed minor tolerance.

SCPI Command	Description
CALibrate[:MODE] {<bool>, <password>}	Enables/disables calibration mode
:CLEar {<password>}	Clears all calibration parameters
:CURRent	
[:DATA] {<new value>}	Enters the calibration value
:LEVel {<level>}	Calibrates the output current programming
:RANGe {range}	Sets current range for multiple current range model
:PASSword	
:NEW {<old>, <new>}	Changes calibration password
:REMark {<string>}	Saves calibration information
:SAVE	Saves the new cal constants in non-volatile memory
:STATe {<bool>, <password>}	Enables calibration parameters
:VOLTage	
[:DATA] {<new value>}	Enters the calibration value
:LEVel {<level>}	Calibrates the output voltage programming

5.2.1. CALibration[:MODE]

Syntax [CALibration\[:MODE\] {<bool> <password>}](#)
[CALibration\[:MODE\]?](#)

Description This command enables or disables calibration mode. Calibration mode must be enabled for the channel to accept any calibration commands. The first parameter specifies the ON (1) or OFF (0) state. The second parameter is the password. Successful execution of this command set both output VOLTage and CURRent of the selected channel to the MINi-
mum value (see [Section 8.1](#)).
Execution of this command also affects bit 0 (CALibrating) of the Operation Instrument
Isummary register (see [Section 3.3.2](#)).

*If both voltage and current calibration parameters exists on calibration mode exit (CALi-
bration[:MODE] OFF) the CALibration:STATe ON command will automatically follows.*

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
	<password>	Quoted string	4 to 16 characters	"eezpsu"
Return	The returned parameter is 0 (OFF) or 1 (ON).			
Usage example	See Section 10.2			
Errors	102, "Invalid cal password" 104, "Bad sequence of calibration commands"			

312,"Cannot execute when the channels are coupled"

Related CALibration:STATe
 Commands DIAGnostic[:INfOrmation]:OTIme?
 INSTRument:COUPle:TRACking

5.2.2. CALibration:CLEar

Syntax CALibration:CLEar {<password>}

Description Clear all calibration parameters stored in the non-volatile memory for the currently selected channel. After successful execution of this command CALibration:STATe will be set to OFF (0) and further usage of the calibration data will be disabled. This command will be also filled calibration remark with the date and note that calibration data has been cleared.

Parameters	Name	Type	Range	Default
	<password>	Quoted string	4 to 16 characters	"eezpsu"

Return None

Usage example DIAG:CAL?

```
"remark=20170331 new
cal","u_cal_params_exists=1","u_min_level=0.150V","u_min_data=0.1
06V","u_min_adc=0.165V","u_mid_level=19.100V","u_mid_data=19.056V
","u_mid_adc=18.500V","u_max_level=38.000V","u_max_data=37.956V",
"u_max_adc=36.791V","u_min_range=0.000V","u_max_range=40.000V","i
_5A_cal_params_exists=1","i_5A_min_level=0.050A","i_5A_min_data=0
.057A","i_5A_min_adc=0.050A","i_5A_mid_level=2.425A","i_5A_mid_da
ta=2.438A","i_5A_mid_adc=2.368A","i_5A_max_level=4.800A","i_5A_ma
x_data=4.811A","i_5A_max_adc=4.686A","i_5A_min_range=0.000A","i_5
A_max_range=5.000A","i_500mA_cal_params_exists=1","i_500mA_min_le
vel=0.0050A","i_500mA_min_data=0.0060A","i_500mA_min_adc=0.0051A"
,"i_500mA_mid_level=0.2425A","i_500mA_mid_data=0.2617A","i_500mA
_mid_adc=0.2368A","i_500mA_max_level=0.4800A","i_500mA_max_data=0.
5170A","i_500mA_max_adc=0.4686A","i_500mA_min_range=0.0000A","i_5
00mA_max_range=0.0000A"
```

CAL:STAT?

1

CAL:CLE "eezpsu"

CAL:STAT?

0

DIAG:CAL?

```
"remark= Not
calibrated","u_cal_params_exists=0","i_cal_params_exists=0"
```

Errors 102,"Invalid cal password"

Related CALibration:STATe
 Commands DIAGnostic[:INfOrmation]:CALibration?

5.2.3. CALibration:CURRent[:DATA]

Syntax CALibration:CURRent[:DATA] {<new value>}

Description This command can only be used when calibration is enabled and the output state of the currently selected channel is ON. It enters a current value that is obtained by reading an external meter. The minimum calibration level (CAL:CURR:LEV MIN) has to be selected first for the value being entered, then the middle and maximum calibration levels (CAL:CURR:LEV MID and CAL:CURR:LEV MAX) for the value being entered. Three

successive values must be selected and entered. Data values are expressed in base units – either volts or amperes, depending on which function is being calibrated.

Parameters	Name	Type	Range	Default
	<new value>	numeric (NR2)	-0.2A to MAX + 0.2A The maximum value is dependent on the PSU current rating. See Section 8.1	–
Return	None			
Usage example	See Section 10.2			
Errors	104, "Bad sequence of calibration commands" 107, "Cal value out of range"			

5.2.4. CALibration:CURRent:LEVel

Syntax [CALibration:CURRent:LEVel {<level>}](#)

Description This command can only be used when calibration is enabled and the output state of the currently selected channel is ON. It sets the PSU to a calibration point that is entered with the CAL:CURR command. During calibration, three points must be entered and the low-end point (MIN) must be selected and entered first.

This command will set output voltage to MAXimum / 2 (for example 25V for the PSU model with 0-50V).

When calibration LEVel is set it's possible to override its default value using the CURRent command. That could be especially useful when LOW range is calibrating with average 3½-digit multimeter with full scale of 200 mA that is not enough to measure MID and MAX level. Therefore instead of predefined 242.5 mA and 480 mA one can set e.g. 100 mA and 200 mA to stay within multimeter's low current range (next one is usually 10 A or 20 A that cannot be used to get satisfactory results).

Parameters	Name	Type	Range	Default
	<level>	Discrete	MIN MID MAX (see also Section 8.1)	–
Return	None			
Usage example	See Section 10.2			
Errors	101, "Calibration state is off" 104, "Bad sequence of calibration commands"			
Related Commands	CALibration:STATe INSTrument:NSElect INSTrument[:SElect] [SOURce[<n>]]:CURRent			

5.2.5. CALibration:CURRent:RANGe

Syntax [CALibration:CURRent:RANGe {<range>}](#)

Description When PSU is equipped with Power boards that has multiple current range (e.g. r5B12 that can be find out with the SYSTem:CHANnel:MODEl? command) it's recommended to perform calibration of both range. Use this command to select current range on which calibration will be accomplished.

Parameters	Name	Type	Range	Default
	<range>	Discrete	HIGH LOW 5 0.5	HIGH 5

Return	None
Usage example	See Section 10.2
Errors	101, "Calibration state is off" 302, "Option not installed"
Related Commands	CALibration:CURRent:LEVel CALibration:STaTe SYSTem:CHANnel:MODEl?

5.2.6. CALibration:PASSword:NEW

Syntax	CALibration:PASSword:NEW {<old>, <new>}			
Description	Enter a new calibration password. To change the password, first unsecure the PSU using the old password. Then, the new code has to be entered. The calibration code may contain up to 16 characters over the remote interface. Minimum length is 4 characters. The new password is automatically stored in non-volatile memory and does not have to be stored with CALibrate:SAVE.			
Parameters	Name	Type	Range	Default
	<old>	Quoted string	4 to 16 characters	eezpsu
	<new>	Quoted string	4 to 16 characters	–
Return	None			
Usage example	CAL:PASS:NEW "eezpsu", "mycal1234"			
Errors	102, "Invalid cal password" 105, "Cal password too long" 106, "Cal password too short"			

5.2.7. CALibration:REMark

Syntax	CALibration:REMark {<user remark>} CALibration:REMark?			
Description	Record calibration information about the PSU. The calibration message is consist of two parts: <ul style="list-style-type: none"> • datetime stamp in format <i>yyyymmdd</i> and • up to 32 characters. <p>The PSU should be in calibration mode before sending a calibration message.</p>			
Parameters	Name	Type	Range	Default
	<user remark>	Quoted string	0 to 32 characters	"Calibration passed"
Return	Query the calibration message.			
Usage example	When CAL:REM with text "Calibrated by EEZ" is executed at 2015-09-14: CAL:REM "Calibrated by EEZ" CAL:REM? "20150904 Calibrated by EEZ" See also Section 10.2			
Errors	The following errors could be generated by command but not query: 101, "Calibration state is off" 104, "Bad sequence of calibration commands"			
Related Commands	CALibration:STaTe			

5.2.8. CALibration:SAVE

Syntax **CALibration:SAVE**

Description This command saves calibration constants in non-volatile memory after the calibration procedure has been completed. If calibration mode is exited by programming CALibration:STaTe OFF without first saving the new constants, the previous constants are re-stored. Execution of this command also affects bit 0 (CALibrating) of the Operation Instrument Isummary register (see [Section 3.3.2](#)).

Return None

Usage example See [Section 10.2](#)

Errors
 -340,"Calibration failed"
 101,"Calibration state is off"
 104,"Bad sequence of calibration commands"
 111,"No new cal data exists"

5.2.9. CALibration:STaTe

Syntax **CALibration:STaTe {<bool>}**
CALibration:STaTe?

Description This command enables or disables usage of calibration parameters if they exists.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	OFF ON 0 1	ON

Return The returned parameter is 0 (OFF) or 1 (ON).

Usage example CAL:STAT OFF

Errors 110,"Cal params missing or corrupted"

Related Commands DIAGnostic[:INfOrmation]:OTIme?

5.2.10. CALibration:VOLTage[:DATA]

Syntax **CALibration:VOLTage[:DATA] {<new value>}**

Description This command can only be used when calibration is enabled and the output state of the currently selected channel is ON. It enters a voltage value that you obtained by reading an external meter. You must first select the minimum calibration level (CAL:VOLT:LEV MIN) for the value being entered. You must then select the middle and maximum calibration levels (CAL:VOLT:LEV MID and CAL:VOLT:LEV MAX) for the value being entered. Three successive values must be selected and entered. The PSU then computes new voltage calibration constants. These constants has to be stored in non-volatile memory with CALibration:SAVE command.

Parameters	Name	Type	Range	Default
	<new value>	numeric (NR2)	-0.5V to MAX + 0.5V The maximum value is dependent on the PSU voltage rating. See Section 8.1	–

Return None

Usage example See Section [Section 10.2](#)

Errors
 104,"Bad sequence of calibration commands"
 107,"Cal value out of range"

Related CALibration:SAVE

Commands CALibration:STATe
 INSTRument:NSElect
 INSTRument[:SElect]

5.2.11. CALibration:VOLTage:LEVel

Syntax CALibration:VOLTage:LEVel {<level>}

Description This command can only be used when calibration is enabled and the output state of the currently selected channel is ON. It sets the PSU to a calibration point that is entered with the CAL:VOLT[:DATA] command. During calibration, three points must be entered and the low-end point (MIN) must be selected and entered first.

This command will set output current to 50mA.

When calibration LEVel is set it's possible to override its default value using the VOLTage command.

Parameters	Name	Type	Range	Default
	<level>	Discrete	MIN MID MAX (see also Section 8.1)	–
Return	None			
Usage example	See Section Section 10.2			
Errors	101, "Calibration state is off" 104, "Bad sequence of calibration commands"			
Related Commands	CALibration:STATe INSTRument:NSElect INSTRument[:SElect] [SOURce[<n>]]:VOLTage			

5.3. DIAGnostic

The purpose of the DIAGnostic subsystem is to provide a tree node for all of the PSU service and diagnostic routines used in routine maintenance and repair.

SCPI command	Description
DIAGnostic	
[:INfOrMation]	
:ADC?	Returns the latest values acquired by ADC
:CALibration?	Returns a list of the calibration parameters
:FAN?	Returns status of the cooling fan.
:PROtection?	Returns the information about all protections.
:TEST?	Returns results of the most recent self-test

5.3.1. DIAGnostic[:INfOrMation]:ADC?

Syntax	DIAGnostic[:INfOrMation]:ADC? [<channel>]			
Description	This query returns the latest values acquired by ADC (Analog-to-Digital Converter) of the currently selected channel.			
Return	Return a list of quoted strings. The U_SET and I_SET are values measure on DAC outputs, and U_MON and I_SET on the channel output binding posts.			
Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	n/a
Usage example	DIAG:ADC? CH2 "U_SET=10.1202", "U_MON=10.12", "I_SET=3.00", "I_MON=1.23"			
Related Commands	MEASure[:SCALar]:CURRent[:DC] MEASure[:SCALar][:VOLTage][:DC] [SOURce[<n>]]:CURRent[:LEVel][:IMMediate][:AMPLitude] [SOURce[<n>]]:VOLTage[:LEVel][:IMMediate][:AMPLitude]			

5.3.2. DIAGnostic[:INfOrMation]:FAN?

Syntax	DIAGnostic[:INfOrMation]:FAN?			
Description	Use this query to obtain information about cooling fan state.			
Return	Returns -1 if cooling fan is not installed (see SYSTem:CPU[:INfOrMation]?), 0 if fan is stalled (fault condition) or measured fan speed in rpm. Cooling fan is periodically tested while it's working (that depends of measured channel's temperature sensor value). When it does not passed the test, programmed output current is automatically limited to value defined with <code>ERR_MAX_CURRENT</code> constant (<code>conf_advanced.h</code>). If load that draws more current then <code>ERR_MAX_CURRENT</code> value output current will be set to zero.			
Usage example	DIAG:FAN? 1205.00			
Related Commands	MEASure[:SCALar]:TEMPerature[:THERmistor][:DC] SYSTem:CPU[:INfOrMation]			

5.3.3. DIAGnostic[:INfOrMation]:CALibration?

Syntax	DIAGnostic[:INfOrMation]:CALibration? [<channel>]
--------	---

Description This query returns a list of calibration parameters for the currently selected channel. If the selected channel is in the calibration mode (CALibration[:MODE] ON) then all calibration information collected to the current calibration step will be returned. Otherwise the calibration data stored in non-volatile memory will be returned.

Return The information will be returned as a list of quoted strings.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	n/a

Usage example Calibration parameters for H24005 PSU model when the channel 1 is not in the calibration mode:

```
DIAG:INFO:CAL? CH1
```

```
"remark=20161211
```

```
he2","u_cal_params_exists=1","u_min_level=0.15V","u_min_data=0.13
V","u_min_adc=0.11V","u_mid_level=19.10V","u_mid_data=19.07V","u_
mid_adc=18.75V","u_max_level=38.00V","u_max_data=37.90V","u_max_a
dc=37.35V","u_min_range=0.019735V","u_max_range=39.997578V","i_ca
l_params_exists=1","i_min_level=0.05A","i_min_data=0.04A","i_min_
adc=0.04A","i_mid_level=2.42A","i_mid_data=2.42A","i_mid_adc=2.42
A","i_max_level=4.80A","i_max_data=4.81A","i_max_adc=4.79A","i_mi
n_range=0.012135A","i_max_range=4.999954A"
```

The query results when a channel is just entered the calibration mode:

```
DIAG:INFO:CAL?
```

```
"u_level=none", "i_level=none"
```

The query results when a channel is at the step MIDdle of the voltage calibration:

```
DIAG:INFO:CAL?
```

```
"u_min=0.11V", "u_level=mid", "u_level_value=24.05V",
"u_adc=24.14V", "i_level=none"
```

Related CALibration:REMark

Commands CALibration:SAVE

5.3.4. DIAGnostic[:INFOrmation]:PROTection?

Syntax [DIAGnostic\[:INFOrmation\]:PROTection?](#)

Description This query returns information about all supported output protection mechanisms.

Return The information will be returned as a list of quoted strings.

Usage example DIAG:PROT?

```
"CH1 u_tripped=0","CH1 u_state=0","CH1 u_delay=5.00 ms","CH1
u_level=39.99 V","CH1 i_tripped=0","CH1 i_state=1","CH1
i_delay=20.00 ms","CH1 p_tripped=0","CH1 p_state=1","CH1
p_delay=10.00 s","CH1 p_level=155.00 W","CH2 u_tripped=0","CH2
u_state=0","CH2 u_delay=5.00 ms","CH2 u_level=39.99 V","CH2
i_tripped=1","CH2 i_state=1","CH2 i_delay=20.00 ms","CH2
p_tripped=0","CH2 p_state=1","CH2 p_delay=10.00 s","CH2
p_level=155.00
W","temp_AUX_tripped=0","temp_AUX_state=0","temp_AUX_delay=10.00
s","temp_AUX_level=55.00
oC","temp_CH1_tripped=0","temp_CH1_state=1","temp_CH1_delay=30.00
s","temp_CH1_level=75.00
oC","temp_CH2_tripped=0","temp_CH2_state=1","temp_CH2_delay=30.00
s","temp_CH2_level=75.00 oC"
```

Related [SOURce[<n>]]:CURRent:PROTection:DELAy[:TIME]

Commands [SOURce[<n>]]:CURRent:PROTection:STATE

[SOURce[<n>]]:CURRent:PROTection:TRIPped?

[SOURce[<n>]]:POWEr:PROTection

```
[SOURce[<n>]]:POWer:PROTection:DELAy[:TIME]
[SOURce[<n>]]:POWer:PROTection:STATe
[SOURce[<n>]]:POWer:PROTection:TRIPped?
[SOURce[<n>]]:VOLTage:PROTection:DELAy[:TIME]
[SOURce[<n>]]:VOLTage:PROTection:STATe
[SOURce[<n>]]:VOLTage:PROTection:TRIPped?
SYSTem:TEMPerature:PROTection[:HIGH][:LEVel]
SYSTem:TEMPerature:PROTection[:HIGH]:DELAy[:TIME]
SYSTem:TEMPerature:PROTection[:HIGH]:STATe
SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?
```

5.3.5. DIAGnostic[:INFOrmation]:TEST?

Syntax **DIAGnostic[:INFOrmation]:TEST?**

Description This query returns results of the most recent self-test (see [*TST?](#) command).

Return The information will be returned in the following format: "<return code, device name, installed, return message>" where the return code could be one of the following values:

- 0 – failed
- 1 – passed
- 2 – skipped

This information format will repeat with as many iterations as the number of devices found in configuration parameters of the PSU. While in the Stand-by mode this command will return only test results for the Arduino shield devices.

Return code for the BP option will always be 2 (skipped).

Usage example Return self-test results when SD card is not found:

```
DIAG:TEST?
```

```
"1, EEPROM, installed, passed","0, SD card, installed,
failed","2, Ethernet, installed, skipped","1, RTC, installed,
passed","1, DateTime, installed, passed","2, BP option,
installed, skipped","1, Fan, installed, passed","1, AUX temp,
installed, passed","1, CH1 temp, installed, passed","1, CH2 temp,
installed, passed","1, CH1 IOEXP, installed, passed","1, CH1 DAC,
installed, passed","1, CH1 ADC, installed, passed","1, CH2 IOEXP,
installed, passed","1, CH2 DAC, installed, passed","1, CH2 ADC,
installed, passed"
```

Return self-test results while PSU is in the Stand-by mode:

```
DIAG:TEST?
```

```
"1, EEPROM, installed, passed","1, SD card, installed,
passed","2, Ethernet, installed, skipped","1, RTC, installed,
passed","1, DateTime, installed, passed","2, BP option,
installed, skipped","1, Fan, installed, passed","1, AUX temp,
installed, passed","1, CH1 temp, installed, passed","1, CH2 temp,
installed, passed","1, CH1 IOEXP, installed, passed","1, CH1 DAC,
installed, passed","1, CH1 ADC, installed, passed","1, CH2 IOEXP,
installed, passed","1, CH2 DAC, installed, passed","1, CH2 ADC,
installed, passed"
```

Related ***TST?**

Commands **SYSTem:POWer**

5.4. DISPlay

The DISPlay commands are used to set the display mode, turn on or off the front panel TFT display, select main page appearance, display and clear the text sent using a controller application. DISPlay is independent of, and does not modify, how data is returned to the controller application.

SCPI command	Description
DISPlay	
:BRIGhtness {<value>}	Sets the intensity of the front panel TFT display
:VIEW {<mode>}	Sets the front panel TFT display main page appearance
[:WINdow]	
[:STATe] {<bool>}	Sets the front panel TFT display state
:TEXT {<message>}	Displays a message on the front panel TFT display
:CLEar	Clear a message on the front panel TFT display

5.4.1. DISPlay:BRIGhtness

Syntax [DISPlay:BRIGhtness {<brightness>}](#)
[DISPlay:BRIGhtness?](#)

Description Controls the intensity of the front panel TFT display. The range of the parameter is 0 to 255, where 255 is full intensity and 0 is fully blanked.

Parameters	Name	Type	Range	Default
	<value>	Numeric	0 – 255	200

Return This query returns set front panel's TFT display brightness value.

Usage example
DISP:BRIG?
200

Related Commands
*RST

5.4.2. DISPlay:VIEW

Syntax [DISPlay:VIEW {<mode>}](#)
[DISPlay:VIEW?](#)

Description Use this command to set front panel TFT display main page appearance. Starting with firmware M2 the following modes are available:

- 1 – Digits
- 2 – Bar graph horizontal
- 3 – Bar graph vertical
- 4 – YT view

Parameters	Name	Type	Range	Default
	<mode>	Numeric	1 – 3 DEFAult	DEFAult

Return This query returns set front panel's TFT display main page appearance numeric value.

Usage example
DISP:VIEW 2

Related Commands
*RST

5.4.3. DISPlay[:WINdow][:STATe]

Syntax [DISPlay\[:WINdow\]\[:STATe\] {<bool>}](#)

DISPlay[:WINDow][:STATe]?

Description Turn the front panel TFT display off or on. When the display is turned off, outputs are not sent to the display and all indicators are disabled except the Event view indicator. The display state is automatically turned on when you return to the local mode. Press and hold the display for about a second to return to the LOCAL from the REMote control.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
Return	DISPlay? query the front panel TFT display state. Returns 0 (OFF) or 1 (ON).			
Usage example	DISP ON			
Related Commands	SYSTem:LOCal SYSTem:REMote			

5.4.4. DISPlay[:WINDow]:TEXT

Syntax **DISPlay[:WINDow]:TEXT {<text message>}**
DISPlay[:WINDow]:TEXT?

Description Display a message on the front panel TFT display. The PSU will display up to 32 characters in a message.

Parameters	Name	Type	Range	Default
	<text message>	Quoted string	–	–
Return	Query the message sent to the front panel TFT display and returns a quoted string.			
Usage example	Send "Hello world" textual message: DISP:TEXT "Hello world"			

5.4.5. DISPlay[:WINDow]:TEXT:CLEAr

Syntax **DISPlay[:WINDow]:TEXT:CLEAr**

Description Clear the message displayed on the front panel TFT display.

Return None

Usage example DISP:TEXT:CLE

5.5. FETCh

Fetch commands return measurement data that has been previously acquired. FETCh queries do not generate new measurements, but allow additional measurement calculations from the same acquired data.

SCPI command	Description
FETCh	
:AHOu?	Returns the accumulated energy in amp-hours
WHOu?	Returns the accumulated energy in watt-hours

5.5.1. FETCh:AHOu?

Not implemented yet

5.5.2. FETCh:WHOu?

Not implemented yet

5.6. INITiate

INITiate commands initialize the trigger system. This enables the trigger system to receive triggers.

SCPI command	Description
INITiate	
[:IMMediate]	Completes one full trigger cycle
:CONTInuous {<bool>}	Enables/disables continuous transient triggers
:ELOG	Enables external data log measurements

5.6.1. INITiate

Syntax **INITiate[:IMMediate]**

Description The INITiate command is used to initialize the trigger system of the PSU. This command completes one full trigger cycle when the trigger source is an IMMediate and initiates the trigger subsystem when the trigger source is BUS.

For example, when the IMMediate is selected as a trigger source, an INITiate command immediately transfers the VOLTage:TRIGgered[:AMPLitude] and CURRent:TRIGgered[:AMPLitude] values to VOLTage[:LEVel][:IMMediate][:AMPLitude] and CURRent[:LEVel][:IMMediate][:AMPLitude] values. Any delay is ignored.

Return None

Usage example Generate a trigger operation after 5 seconds:

```
TRIG:SOUR BUS
TRIG:DEL 5
INIT
*TRG
```

Errors -213,"Init ignored"
307,"List lengths are not equivalent"
308,"Cannot be changed while transient trigger is initiated"
309,"Cannot initiate while in fixed mode"

Related *TRG

Commands INSTRument:COUPle:TRIGger

5.6.2. INITiate:CONTInuous

Syntax **INITiate:CONTInuous {<Bool>}**
INITiate:CONTInuous?

Description This command is used to select whether the trigger system is continuously initiated or not. With CONTInuous set to OFF, the trigger system remain in the IDLE state until CON-TInuous is set to ON or INITiate:IMMediate is received.

Once CONTInuous is set to ON, the trigger system will be initiated and exit the IDLE state. On completion of each trigger cycle, with CONTInuous ON, the trigger system immediately commence another trigger cycle without entering the IDLE state.

When INITiate:CONTInuous is set to OFF, the current trigger cycle will be completed before entering the IDLE state. The return to IDLE also occur as the result of an ABORt or *RST command.

The ABORt command force the trigger system to the IDLE state; however, the value of INITiate:CONTInuous is unaffected.

If INITiate:CONTInuous was set to ON prior to receiving ABORt, it remains ON and the trigger system immediately exit the IDLE state.

Parameters	Name	Type	Range	Default
	<bool>	Boolean	OFF ON 0 1	OFF

Return	The query command returns 0 if continuous transients are disabled (OFF), and 1 if continuous transients are enabled (ON).
Usage example	INIT:CONT ON
Related Commands	*RST ABORt

5.6.3. INITiate:ELOG

Not implemented yet

5.7. INSTRument

Each channel of the PSU is considered as separate (logical) instrument, which is required by the SCPI standard. The INSTRument subsystem provides a mechanism to identify and select instruments and establish coupling to simplify programming of more channels at once.

SCPI command	Description
INSTRument	
[:SElect] {<channel>}	Selects the output to be programmed
:COUPle	
:TRACking {<type>}	Selects independent, parallel-tracking, or series-tracking mode
:TRIGger {<mode>}	Selects a coupling between channels trigger systems
:DISPlay	
:TRACe[<n>] {<value>}	Selects output value on the specified display trace
:SWAP	Swaps positions of selected output values
:YT	
:RATE {<duration>}	Selects YT view sample duration
:NSElect {<channel>}	Selects the output to be programmed

5.7.1. INSTRument[:SElect]

Syntax [INSTRument\[:SElect\] {<channel>}](#)
[INSTRument\[:SElect\]?](#)

Description This command selects the output to be programmed by the output identifier. The outputs of the PSU are considered as two logical instruments. The INSTRument command provides a mechanism to identify and select an output. When one output is selected, the other output is unavailable for programming until selected. The following commands are affected by the INSTRument command: SOURce, MEASure, and CALibration.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Return	Query returns the currently selected output by the INSTRument[:SElect] or INSTRument:NSElect command. The returned value is CH1 or CH2.			
Usage example	INST? CH1 INST:SEL? CH1			
Related Commands	INSTRument:NSElect			

5.7.2. INSTRument:COUPle:TRACking

Syntax [INSTRument:COUPle:TRACking {<type>}](#)
[INSTRument:COUPle:TRACking?](#)

Description This command selects how channel's outputs will be internally connected:

- independent (NONE)
- parallel-tracking (PARallel) controls K_PAR power relay state when max. output current is doubled (e.g. 10 A instead of 5 A), or
- series-tracking (SERies) that controls K_SER power relay state and max. output voltage is doubled (e.g. 80 V instead of 40 V).

When channels are coupled, resulting output will be present on different binding posts as indicated with LED_SP (red) instead of LED_OUT1 (green) and/or LED_OUT2 (green). Coupled channels will be seen as single channel. Therefore the following commands will affect the both channel regardless of which channel is currently selected using the INSTRument[:SElect] or INSTRument:NSElect command):

- OUTPut[:STATe], OUTPut:DPRog, OUTPut:PROTection:CLEar
- MEASure[:SCALar]:CURRent[:DC], MEASure[:SCALar]:POWER[:DC], MEASure[:SCALar]:VOLTage[:DC]
- SIMULator:LOAD, SIMULator:LOAD:STATe
- [SOURce[<n>]]:CURRent, [SOURce[<n>]]:CURRent:STEP, [SOURce[<n>]]:CURRent:TRIGgered, [SOURce[<n>]]:CURRent:LIMit, [SOURce[<n>]]:CURRent:MODE, [SOURce[<n>]]:CURRent:PROTection:DELay, [SOURce[<n>]]:CURRent:PROTection:STATe, [SOURce[<n>]]:CURRent:PROTection:TRIPped?, [SOURce[<n>]]:LIST:COUNT, [SOURce[<n>]]:LIST:CURRent, [SOURce[<n>]]:LIST:DWELI, [SOURce[<n>]]:LIST:VOLTage[:LEVel], [SOURce[<n>]]:LRIPple, [SOURce[<n>]]:LRIPple:AUTO, [SOURce[<n>]]:POWER:LIMit, [SOURce[<n>]]:POWER:PROTection[:LEVel], [SOURce[<n>]]:POWER:PROTection:DELay[:TIME], [SOURce[<n>]]:POWER:PROTection:STATe, [SOURce[<n>]]:POWER:PROTection:TRIPped?, [SOURce[<n>]]:VOLTage, [SOURce[<n>]]:VOLTage:LIMit, [SOURce[<n>]]:VOLTage:STEP, [SOURce[<n>]]:VOLTage:TRIGgered, [SOURce[<n>]]:VOLTage:MODE, [SOURce[<n>]]:VOLTage:PROTection[:LEVel], [SOURce[<n>]]:VOLTage:PROTection:DELay, [SOURce[<n>]]:VOLTage:PROTection:STATe, [SOURce[<n>]]:VOLTage:PROTection:TRIPped?
- TRIGger[:SEquence][:IMMediate], TRIGger[:SEquence]:DELay, TRIGger[:SEquence]:SLOPe, TRIGger[:SEquence]:SOURce

The following channel specific commands will generate a device specific error 312 when channels are coupled:

- CALibrate,
- OUTPut:TRACk[:STATe],
- SIMULator:RPOL, SIMULator:VOLTage:PROGram,
- [SOURce[<n>]]:LRIPple, [SOURce[<n>]]:LRIPple:AUTO
- [SOURce[<n>]]:VOLTage:PROGram,
- [SOURce:]VOLTage:SENSe (series-tracking only)

Channels coupled in parallel could have only one down-programmer circuit active that is on the channel 1. State of the channel 2 down-programmer will always be off regardless of what is set with the OUTPut:DPRog command.

If channels are calibrated (CAL:STAT? 1) a max. value of the channel that has lower calibrated value will be used as a reference and multiplied by two. For example, if channel 1 max. voltage is 39.98 and channel 2 max. voltage is 40.00 the new max. value for the SERIES-tracking will become 79.96 V instead of 80.00 V.

Two conditions requires special attention: that is entering CC mode while channels are coupled in SERIES or entering CV mode when PARAllel coupling is active.

For example when coupled in SERIES and output voltage is set to 60 V and current to 1.7 A with connected load of 1 Ω the PSU will enter the CC mode of operation (see OUTPut:MODE?) and output voltage will drop to 1.7 V. Coupling mechanism will set both channels to 30 V (initial value divided by two) but that value cannot be maintained on any output and there is no warranty that new voltage will be equally shared between channels (i.e. $1.7 / 2 = 1.35$ V per channel). It's even possible that outputs become unbalanced in a way that one of the channels becomes negative like -0.6 V on one channel and +2.3 V on another that still resulting in required +1.7 V limited by max. current. To

avoid such situation coupling mechanism also include *balancing* to ensure that such deviation when one channel is pushed to sink instead of source power is rectified. That is accomplished by calculating and set more appropriate output voltage values during the CC mode of operation. The measured output voltage (using the MEASure[:SCALar][:VOLTage][:DC]? Command) will return that newly programmed value, that could be e.g. 30.93 V instead of 60 V. When output come back to CV mode of operation (e.g. load is disconnected), initial set 60 V will be measured again.

At *RST, channels will be uncoupled (NONE).

Parameters	Name	Type	Range	Default
	<type>	Discrete	NONE PARAllel SERies	NONE
Return	Query returns the currently selected output coupling state.			
Usage example	<pre>INST:COUP:TRAC SER VOLT 70 VOLT? 70.00 INST:COUP:TRAC PAR CURR 9 CURR? 9.00</pre>			
Errors	312, "Cannot execute when the channels are coupled"			
Related Commands	<pre>*SAV MEASure[:SCALar]:CURRent[:DC] MEASure[:SCALar][:VOLTage][:DC] OUTPut:DPRog OUTPut:MODE? OUTPut:TRACk[:STATe]</pre>			

5.7.3. INSTRument:DISPlay:TRACe[<n>]

Syntax	<pre>INSTRument:DISPlay:TRACe[<n>] {<value>} INSTRument:DISPlay:TRACe[<n>]?</pre>			
Description	<p>This command sets the output value that will be displayed on the display position (trace) defined with [<n>]. This command affects only display modes 2, 3 and 4 (see the DISPlay:VIEW command).</p> <p>An attempt to select the same value on both positions (traces) will generate an execution error.</p>			
Parameters	Name	Type	Range	Default
	<value>	Discrete	VOLTage CURRent POWER	–
Return	Query returns the currently selected displayed output value on the selected display position (trace).			
Usage example	<pre>INST:DISP:TRAC2? CURR</pre>			
Errors	-200, "Execution error"			
Related Commands	<pre>DISPlay:VIEW INSTRument:DISPlay:TRACe:SWAP INSTRument:DISPlay:YT:RATE</pre>			

5.7.4. INSTRument:DISPlay:TRACe:SWAP

Syntax	INSTRument:DISPlay:TRACe:SWAP
--------	-------------------------------

Description Use this command to swap output values display positions.

Usage example

```
INST:DISP:TRAC1?
VOLT

INST:DISP:TRAC2?
CURR

INST:DISP:TRAC:SWAP
INST:DISP:TRAC1?
CURR

INST:DISP:TRAC2?
VOLT
```

Related Commands DISPlay:VIEW
INSTrument:DISPlay:TRACe[<n>] {<value>}
INSTrument:DISPlay:YT:RATE

5.7.5. INSTrument:DISPlay:YT:RATE

Syntax [INSTrument:DISPlay:YT:RATE {<duration>}](#)
[INSTrument:DISPlay:YT:RATE?](#)

Description This command sets the sample duration in seconds when YT (mode 4, see the DISPlay:VIEW command) display view is selected.

Parameters	Name	Type	Range	Default
	<duration>	Numeric	0.02 – 300	0.1

Return The query command returns the programmed sample duration in seconds.

Usage example

```
INST:DISP:YT:RATE 10
```

Related Commands DISPlay:VIEW
INSTrument:DISPlay:TRACe[<n>] {<value>}
INSTrument:DISPlay:TRACe:SWAP

5.7.6. INSTrument:COUPle:TRIGger

Syntax [INSTrument:COUPle:TRIGger {<mode>}](#) (not implemented in M3)
[INSTrument:COUPle:TRIGger?](#)

Description This command defines a coupling between channels trigger systems. Use ALL parameter to couple or NONE to remove coupling.

At *RST, trigger systems are uncoupled.

Parameters	Name	Type	Range	Default
	<mode>	Discrete	NONE, ALL	NONE

Return This query returns the currently coupled output.

Usage example

```
INST:SEL CH1
VOLT:TRIG 12
CURR:TRIG 1.5
INST:SEL CH2
VOLT:TRIG 5
CURR:TRIG MAX
INST:COUP:TRIG ALL
TRIG:SOUR IMM
INIT
```

Related Commands *RST
INSTrument:COUPle:TRACking

5.7.7. INSTRument:NSElect

Syntax `INSTRument:NSElect {<channel>}`
 `INSTRument:NSElect?`

Description This command is used in conjunction with the SElect command. It serves the same purpose, except that it uses a numeric value instead of the identifier used in the SElect command.

Parameters	Name	Type	Range	Default
	<channel>	Numeric	1 2	–

Return When queried it returns the logical instrument number of the currently selected PSU channel. Note that the numbering used for logical instruments directly corresponds to the numbers used in status reporting for multiple instruments; specifically the STATus:QUESTIONable:INSTRument and STATus:OPERation:INSTRument commands.

Usage
example `INST:NSEL 2`
 `INST:NSEL?`
 2

Related
Commands `STATus:QUESTIONable:INSTRument`
 `STATus:OPERation:INSTRument`

5.8. MEASure

Measure commands measure the output voltage, current, power or temperature. They trigger the acquisition of new data before returning the reading. Measurements are performed by digitizing the instantaneous output voltage, current or temperature. Output power is calculated as product of measured voltage and current. Keyword [:DC] is optional since all measurement are by default of the DC level of the signal.

SCPI command	Description
MEASure	
[:SCALar]	
:CURRent	
[:DC]? [<channel>]	Takes a measurement; returns the average current
:POWer	
[:DC]? [<channel>]	Takes a measurement; returns the average power
:TEMPerature	
[:DC]? {<sensor>}	Takes a measurement; returns the average temperature
[:VOLTage]	
[:DC]? [<channel>]	Takes a measurement; returns the average voltage

5.8.1. MEASure[:SCALar]:CURRent[:DC]

Syntax **MEASure[:SCALar]:CURRent[:DC]? [<channel>]**

Description Query the current measured across the current sense resistor inside the PSU.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Return	Returns the average output current in amperes as decimal number (NR2).			
Usage example	Measure current on the currently selected channel (CH1) and CH2: MEAS:CURR?;:MEAS:CURR? CH2 1.23;0.12			
Related Commands	INSTrument:COUPle:TRACking			

5.8.2. MEASure[:SCALar]:POWer[:DC]

Syntax **MEASure[:SCALar]:POWer[:DC]? [<channel>]**

Description Query the output power calculated as product of measured voltage and current value.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	n/a
Return	Returns the average output power in watts as decimal number (NR2).			
Usage example	MEAS:POW? CH2 80.44			
Related Commands				

5.8.3. MEASure[:SCALar]:TEMPerature[:THERmistor][:DC]

Syntax **MEASure[:SCALar]:TEMPerature[:THERmistor][:DC]? {<sensor>}**

Description Query the temperature measured using the specified temperature sensors as follows:

- AUX – auxiliary temperature sensor connected to Arduino Shield board (can be used to monitor e.g. “ambient” or chassis temperature)
- CH1, CH2 – temperature sensor connected to channel power board used to regulate fan speed (if installed)
- BATT – isolated V/F (Voltage-to-frequency converter) temperature sensor connected to Arduino Shield board (can be used to monitor e.g. connected battery temperature during the charging cycle)

All installed sensors are periodically tested. When sensor does not passed the test, programmed output current is automatically limited to value defined with `ERR_MAX_CURRENT` constant (`conf_advanced.h`). If load that draws more current then `ERR_MAX_CURRENT` value output current will be set to zero.

BATT sensor is still not supported in the Firmware M3.

Return Returns the average temperature value in degrees Celsius (°C) as decimal number (NR2). If self-test detect selected temperature sensor failure or sensor is not installed a -240 or -241 error will be generated.

Parameters	Name	Type	Range	Default
	<sensor>	Discrete	{[AUX] CH1 CH2 BATT}	AUX
Usage example	MEAS:TEMP? AUX 39.50			
Errors	-240, "Hardware error" -241, "Option not installed"			
Related Commands	DIAGnostic[:INFOrmation]:FAN? SYSTem:CPU:OPTion? SYSTem:TEMPerature:PROTection[:HIGH][:LEVel] SYSTem:TEMPerature:PROTection[:HIGH]:DELay[:TIME] SYSTem:TEMPerature:PROTection[:HIGH]:STATe SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?			

5.8.4. MEASure[:SCALar][:VOLTage][:DC]

Syntax **MEASure[:SCALar][:VOLTage][:DC]? [<channel>]**

Description Query the voltage measured at the sense terminals of the selected channel.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	n/a
Return	Returns the average output voltage in volts as decimal number (NR2).			
Usage example	MEAS:VOLT? CH1 43.25 Query voltage of the channel 2 that is currently selected: INST CH2 MEAS? 12.40			
Related Commands	INSTrument:COUPle:TRACking			

5.9. MEMory

The MEMory subsystem works with PSU state files that are saved to ([*SAV](#)) and recalled from ([*RCL](#)) non-volatile storage locations numbered 0 through 9. The storage location 0 named "Power down state" is used to store the current PSU parameters.

SCPI command	Description
MEMory	
:NSTates?	Returns total number of state storage memory locations
:STATe	
:CATalog?	Lists the names associated with all ten state storage locations
:DElete {<profile>}	Deletes the contents of a state storage location
:ALL	Deletes the contents of all state storage locations
:NAME {<profile>, <name>}	Assigns a custom name to a state storage locations
:RECall	
:AUTO {<bool>}	Specifies whether the power-down state is recalled from location 0 on power-on
:SElect {<profile>}	Specifies which PSU state will be used at power on
:VALid? {<profile>}	Determines whether a storage location contains a valid state

5.9.1. MEMory:NSTates

Syntax	MEMory:NSTates?
Description	Returns the total number of *SAV/*RCL states available in the PSU.
Return	Returns numeric value which is one greater than the maximum that can be sent as a parameter to the *SAV and *RCL commands.
Usage example	MEM:NST? 10
Errors	
Related Commands	

5.9.2. MEMory:STATe:CATalog

Syntax	MEMory:STATe:CATalog?
Description	This query requests a list of defined names in the MEMory:STATe subsystem.
Return	The PSU returns a list of defined <name>'s in a comma separated list. Each <name> is returned in a quoted string.
Usage example	MEM:STAT:CAT? "Power down state", "All outputs on", "dual 15V/300mA", "Power protection at 100W", "--Not used--", "--Not used--", "--Not used--", "--Not used--", "--Not used--", "--Not used--"
Errors	
Related Commands	MEMory:STATe:NAME

5.9.3. MEMory:STATe:DElete

Syntax	MEMory:STATe:DElete {<profile>} MEMory:STATe:DElete:ALL
--------	--

Description When used with a profile number this command deletes the contents of the specified storage location. The MEMory:STATe:DELeTe:ALL deletes the contents of storage locations 1 through 9.

An error is generated on an attempt to recall a deleted state.

Parameters	Name	Type	Range	Default
	<profile>	Numeric	1 – 9	–
Return	None			
Usage example	MEM:STAT:DEL 2			
Errors				
Related Commands	*RCL *SAV			

5.9.4. MEMory:STATe:NAME

Syntax MEMory:STATe:NAME {<profile>, <name>}
MEMory:STATe:NAME? {<profile>}

Description This command associates a <name> with a *SAV/*RCL register number. May assign same name to different locations and state names are unaffected by [*RST](#). Deleting a storage location's contents MEMory:STATe:DELeTe resets associated name to "--Not used--"

Parameters	Name	Type	Range	Default
	<profile>	Numeric	1 – 9	–
	<name>	Quoted string	0 to 32 characters	–
Return	Returns a *SAV/*RCL register number associates with profile number.			
Usage example	MEM:STAT:DEF, 2, "All outputs on" MEM:STAT:DEF? 2 "All outputs on"			
Errors				
Related Commands	MEMory:STATe:DELeTe			

5.9.5. MEMory:STATe:RECall:AUTO

Syntax MEMory:STATe:RECall:AUTO {<bool>}
MEMory:STATe:RECall:AUTO?

Description This command disables or enables the automatic recall of a specific stored PSU state selected using the MEMory:STATe:RECall:SELection command when power is turned on. Select ON to automatically recall one of the ten stored states or the "power-down" state (location 0) when power is turned on. Select OFF to issue a reset ([*RST](#)) when power is turned on.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
Return	The query command returns 0 (OFF) or 1 (ON).			
Usage example	MEM:STAT:REC:AUTO? 1			
Errors				
Related	*SAV			

Commands MEMory:STATe:RECall:SElect
SYSTem:POWer

5.9.6. MEMory:STATe:RECall:SElect

Syntax MEMory:STATe:RECall:SElect {<profile>}
MEMory:STATe:RECall:SElect?

Description This command selects which PSU state will be used at power on if the automatic recall mode is enabled (see MEMory:STATe:RECall:AUTO ON command). If the automatic recall mode is disabled (MEMory:STATe:RECall:AUTO OFF), then a “factory reset” (return to the default values) is issued when power is turned on.

Parameters	Name	Type	Range	Default
	<profile>	Numeric	0 – 9	–

Return The query command returns numeric value for 0 to 9 indicating which instrument state will be used at power on.

Usage example MEM:STAT:REC:SEL?
2

Errors

Related *SAV
Commands MEMory:STATe:RECall:AUTO
SYSTem:POWer

5.9.7. MEMory:STATe:VALid

Syntax MEMory:STATe:VALid? {<profile>}

Description This command queries the specified storage location to determine if a valid state is currently stored in this location.

*Use this command before sending the [*RCL](#) command to determine if a valid state has been previously stored on queried location.*

Parameters	Name	Type	Range	Default
	<profile>	Discrete	0 – 9	–

Return Returns 0 if no state has been stored or if it has been deleted. It returns 1 if a valid state is stored in this location.

Usage example MEM:STAT:VAL? 2
1

Errors

Related *RCL
Commands *SAV

5.10. MMEMory

The MMEMory commands are used to store, read or delete file in the PSU's SD card. It can also query SD card information. In addition it is used for storing and recalling values used by [SOURce[<n>]]:LIST subsystem.

SCPI command	Description
MMEMory	
:CATalog?	Outputs a list of the files from the SD card storage
:CDIRectory <directory>	Changes the current directory (folder)
:COPY <filename1>, <filename2>	Copies <filename1> to <filename2>
:DATE? <filename>	
:DELeTe <filename>	Removes file on the SD card
:DOWNload	http://rfmw.em.keysight.com/spdhelpfiles/33500/webhelp/US/Content/___I_SCPI/MMEMory_Subsystem.htm#MMEMory_LOAD_LIST
:DATA	
:FNAMe	
:LOAD	
:LIST[<n>] <filename>	Loads stored LIST from the SD card to the specified channel
:MDIRectory <directory>	Makes a new directory (folder)
:MOVE <filename1>, <filename2>	Renames <filename1> to <filename2>
:RDIRectory <directory>	Removes the specified directory (folder)
:STORe	
:LIST[<n>] <filename>	Stores specified channel LIST to the SD card
:TIME? <filename>	
TRANsfer <filename>, <datablock>	http://na.support.keysight.com/pna/help/latest/Programming/GPIB_Command_Finder/Memory.htm
:UPLoad	http://rfmw.em.keysight.com/spdhelpfiles/33500/webhelp/US/Content/___I_SCPI/MMEMory_Subsystem.htm#MMEMory_LOAD_LIST

5.10.1. MMEMory:LOAD:LIST

Syntax	MMEMory:LOAD:LIST[<n>] {<filename>}			
Description	Load stored LIST program from SD card location defined by <filename> to the channel defined with [<n>].			
Return	None			
Parameters	Name	Type	Range	Default
	<filename>	Quoted string	1 to 32 characters	—
Usage example	MMEM:LOAD:LIST1 "DC/DC conv testing"			
Errors				
Related Commands	MMEMory:STORe:LIST[<n>]			

5.10.2. MMEMory:STORe:LIST

Syntax **MMEMory:STORe:LIST[<n>] {<filename>}**

Description Store channel defined with [<n>] LIST program to SD card location defined by <filename>.

Return None

Parameters	Name	Type	Range	Default
	<filename>	Quoted string	1 to 32 characters	–

Usage example
MMEM:STOR:LIST1 "DC/DC conv testing"

Errors

Related Commands
MMEMory:LOAD:LIST[<n>]

5.11. OUTPut

The OUTPut subsystem controls the output state, coupling outputs and protections, protection clear and tracking state.

SCPI command	Description
OUTPut	
[:STATe] {<bool>}	Controls the specified channel output state
TRIGgered	Controls channel output state with trigger
:DELay	
:ON {<time>}	Sets the delay time for turning the output on
:OFF {<time>}	Sets the delay time for turning the output off
:DPRog {<bool>}	Controls down-programmer circuit
:MODE?	Returns the channel mode of operation
:PROTection	
:CLEar	Resets latched protection
:COUPlE {<bool>}	Enables channel coupling for protection faults
:MEASure {<bool>}	Enables measuring of output voltage before channel output is turned on
:TRACk[:STATe] {<bool>}	Enables channels to operate in the track mode

5.11.1. OUTPut[:STATe]

Syntax [OUTPut\[:STATe\] {<bool>} \[, <channel>\]](#)
[OUTPut\[:STATe\]? \[<channel>\]](#)

Description This command enables or disables the specified output channel(s). The enabled state is ON (1); the disabled state is OFF (0). The state of a disabled output is a condition of zero output voltage and zero source current. Execution of this command also affects bit 10 (OE) and bit 11 (DP) of the Operation Instrument Summary register (see [Section 3.3.2](#)). Self-test operation initiated by [*TST?](#) command will put all PSU channels into disable state. When the BP_OPTION is enabled and the channels are not grouped together (SYSTem:GROup commands scheduled for M3) this command sets LED indicators above binding posts in the following manner:

- Turn on/off Out1 green indicator (LED_O1) when CH1 is selected
- Turn on/off Out2 indicator (LED_O2) when CH2 is selected

Execution of the OUTP ON command on the channel with tripped one or more protection (OCP, OVP, OPP or OTP) will generate error 201. Use OUTPut:PROTection:CLEar command to clear all tripped protections.

This command also affects Sense+/Sense- indicators (LED_S1+, LED_S1-, LED_S2+, LED_S2-) controlled by the [SOURce:]VOLTage:SENSe[:SOURce] command.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
	<channel>	Discrete	CH1 CH2	–
Return	The query command returns 0 if the output is OFF, and 1 if the output is ON.			
Usage example	OUTP ON, CH1 OUTP? CH1 1			

Errors	108, "Cal output disabled" 201, "Cannot execute before clearing protection"
Related	*TST
Commands	OUTPut:PROTection:CLEar [SOURce:]VOLTage:SENSe[:SOURce]

5.11.2. OUTPut[:STATe]:TRIGgered

Syntax	OUTPut[:STATe]:TRIGgered {<bool>} [, <channel>] OUTPut[:STATe]:TRIGgered? [<channel>]			
Description	This command programs the pending triggered channel's output state. The pending triggered current level is a stored value that is transferred to the output terminals when a trigger occurs.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
	<channel>	Discrete	CH1 CH2	–
Return	Query the triggered output state presently programmed. If no triggered level is programmed, the OUTPut? state is returned.			
Usage example	OUTP? 0 OUTP:TRIG ON TRIG:SOUR IMM INIT OUTP? 1			
Errors	108, "Cal output disabled" 201, "Cannot execute before clearing protection"			
Related	*TST			
Commands	OUTPut:PROTection:CLEar [SOURce:]VOLTage:SENSe[:SOURce]			

5.11.3. OUTPut:DELaY:ON

Not implemented yet

5.11.4. OUTPut:DELaY:OFF

Not implemented yet

5.11.5. OUTPut:DPRog

Syntax	OUTPut:DPRog {<bool>} (not implemented yet) OUTPut:DPRog?
Description	<p>A down-programmer is a circuit built into the channel's output of a PSU that actively pulls the output voltage down when the PSU's channel is moving from a higher setting to a lower setting.</p> <p>The down-programmer circuit is active by default and only rare situation requires to be turned off. One such situation is when battery is connected as a load. Another one is connecting two channel in parallel when only one down-programmer circuit is enough for actively pulls the output voltage down while lower voltage is set.</p> <p>Execution of this command also affects bit 11 (DP) of the Operation Instrument Summary register (see Section Section 3.3.2).</p>

Despite of the down-programmer state programmed by this command, it will be deactivated when the channel output is turned off (i.e. OUTPut[:STATe] OFF) after `DP_OFF_DELAY_PERIOD` seconds). When the channel output is turned on again, down-

programmer will be set back to the state programmed with this command.

If negative output power (`DP_NEG_LEV`) is measured and last more then `DP_NEG_DELAY` seconds the down-programmer will be switched off and an error 500 will be generated.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	ON
Return				
Usage example	OUTP:DPR? 1			
Errors	500, "Down-programmer on CH1 switched off" 501, "Down-programmer on CH2 switched off"			
Related Commands	OUTPut[:STATe]			

5.11.6. OUTPut:MODE?

Syntax `OUTPut:MODE? [, <channel>]`

Description This command simplify resolving a results that can be obtained reading the bit 8 (CV) and 9 (CC) of the read-only Instrument Isummary Operation Status register for a specific channel (see table in the [Section 3.3.2](#)). The PSU can works in one of the three output modes:

- CV (Constant Voltage), when the output voltage equals the voltage setting value and the output current is determined by the load
- CC (Constant Current), when the output current equals the current setting value and the output voltage is determined by the load and
- UR (Unregulated) that is critical mode between CV and CC modes that could be noticed when the output voltage is close to the one end of the full scale (i.e. somewhere below 2 V and above 48 V for the 50 V model that depends of the connected load).

The UR mode is not supported in [software simulator](#).

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Return	The query returns CV, CC or UR.			
Usage example	Set output voltage to 20 V and max. current, check that output voltage is as defined that indicate the constant voltage mode of operation: VOLT 20; CURR MAX MEAS:VOLT? 20.0 OUTP:MODE? CV			
Related Commands	STATus:OPERation:INSTrument:ISUMmary[<n>][:EVENT] STATus:OPERation:INSTrument:ISUMmary[<n>]:CONDition STATus:OPERation:INSTrument:ISUMmary[<n>]:ENABle			

5.11.7. OUTPut:PROTectio:n:CLEar

Syntax `OUTPut:PROTectio:n:CLEar [<channel>]`

Description This command clears the latched protection status that disables the output when an over-voltage, over-current or a power-limit condition is detected. All conditions that generate the fault must be removed before the latched status can be

cleared. The output is restored to the state it was in before the fault condition occurred.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Return	None			
Usage example	The following command clears the latched protection status on all channels: <code>OUTP:PROT:CLE</code>			
Related Commands	[SOURce[<n>]]:CURRent:PROTection:STATe [SOURce[<n>]]:POWEr:PROTection:STATe [SOURce[<n>]]:VOLTage:PROTection:STATe			

5.11.8. OUTPut:PROTection:COUPle

Syntax	<code>OUTPut:PROTection:COUPle {<bool>}</code> <code>OUTPut:PROTection:COUPle?</code>			
Description	This command enables or disables output coupling for protection faults. When enabled, all output channels are disabled when a protection fault occurs on any output channel. When disabled, only the affected output channel is disabled when a protection fault is triggered.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Return	The query command returns 0 if the protection coupling is OFF (disabled), and 1 if the protection coupling is ON (enabled).			
Usage example	<code>OUTP:PROT:COUP ON</code> <code>OUTP:PROT:COUP?</code> 1			
Related Commands	<code>OUTPut:PROTection:CLEar</code>			

5.11.9. OUTPut:PROTection:MEASure

Syntax	<code>OUTPut:PROTection:MEASure {<bool>}</code> <code>OUTPut:PROTection:MEASure?</code>			
Description	This command enables or disables measuring of output voltage before channel output will be enabled. If non-zero voltage is present on the output due to e.g. intentionally connected battery or wrong wiring that brings some other power source to the output terminals an error message will be generated.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Return	The query command returns 0 if the voltage measuring is disabled (OFF) before output is going to be enabled, and 1 if voltage measuring is ON (enabled).			
Usage example	<code>OUTP:PROT:MEAS ON</code>			
Errors	505, "External voltage on CH1 detected" 506, "External voltage on CH2 detected"			
Related Commands	<code>OUTPut[:STATe]</code>			

5.11.10. OUTPut:TRACk[:STATe]

Syntax **OUTPut:TRACk[:STATe] {<bool>}**
OUTPut:TRACk[:STATe]?

Description This command enables or disables the PSU to operate in the track mode. When the track mode is first enabled, the CH2 output will be set to the same voltage level as the CH1 output. Once enabled, any change of the programmed voltage level in either CH1 or CH2 will be reflected in the other channel. The TRACK OFF command returns the PSU to the non-track mode.

A device-specific error 312 will be generated if this command is tried to executed when channels are in any of coupled mode.

The following commands will affect the both channel regardless of which channel is currently selected using the INSTrument[:SElect] or INSTrument:NSElect command):

- OUTPut:PROTection:CLEar
- [SOURce[<n>]]:CURRent, [SOURce[<n>]]:CURRent:STEP,
[SOURce[<n>]]:CURRent:TRIGgered, [SOURce[<n>]]:CURRent:LIMit,
[SOURce[<n>]]:CURRent:PROTection:DELAy,
[SOURce[<n>]]:CURRent:PROTection:STATe,
[SOURce[<n>]]:CURRent:PROTection:TRIPped?, [SOURce[<n>]]:LIST:COUNT,
[SOURce[<n>]]:LIST:CURRent, [SOURce[<n>]]:LIST:DWELI,
[SOURce[<n>]]:LIST:VOLTage[:LEVel], [SOURce[<n>]]:LRIPple:AUTO,
[SOURce[<n>]]:POWer:LIMit, [SOURce[<n>]]:POWer:PROTection[:LEVel],
[SOURce[<n>]]:POWer:PROTection:DELAy[:TIME],
[SOURce[<n>]]:POWer:PROTection:STATe,
[SOURce[<n>]]:POWer:PROTection:TRIPped?, [SOURce[<n>]]:VOLTage,
[SOURce[<n>]]:VOLTage:LIMit, [SOURce[<n>]]:VOLTage:STEP,
[SOURce[<n>]]:VOLTage:TRIGgered, [SOURce[<n>]]:VOLTage:MODE,
[SOURce[<n>]]:VOLTage:PROTection[:LEVel],
[SOURce[<n>]]:VOLTage:PROTection:DELAy,
[SOURce[<n>]]:VOLTage:PROTection:STATe,
[SOURce[<n>]]:VOLTage:PROTection:TRIPped?
- TRIGger[:SEquence][:IMMediate], TRIGger[:SEquence]:DELAy,
TRIGger[:SEquence]:SLOPe, TRIGger[:SEquence]:SOURce

The following channel specific commands will generate a device-specific error 313 when channels are in tracking mode:

- CALibrate,
- INSTrument:COUPle:TRACking,
- OUTPut:TRACk[:STATe],
- SIMUlator:RPOL, SIMUlator:VOLTage:PROGram,
- [SOURce[<n>]]:LRIPple, [SOURce[<n>]]:LRIPple:AUTO
- [SOURce[<n>]]:VOLTage:PROGram,

At *RST, the tracking mode is disabled.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Return	Query the tracking mode state of the PSU. The returned value is 0 (OFF) or 1 (ON).			
Usage example	<pre>OUTP:TRAC ON VOLT 12 MEAS? 12.00 MEAS? CH2 12.00</pre>			

EEZ PSU SCPI reference M5 PRELIMINARY

Errors	312, "Cannot execute when the channels are coupled"
	313, "Cannot execute in tracking mode"
Related	*RST
Commands	INSTRument:COUPle:TRACking

5.12. SENSE

The SENSE control the current measurement range, energy counting/window, and the data acquisition sequence.

SCPI command	Description
SENSe	
:AHOuR	
:RESet	Resets the amp-hour (Ah) measurement to zero
:CURRent	
[:DC]	
RANGe[:UPPer] {<range>}	Selects a DC current measurement range
AUTO {<bool>}	Enables/disables seamless measurement auto ranging
:ELOG	
:CURRent	
[:DC]	
:RANGe[:UPPer] {<value>}	Selects the Elog current measurement range
:AUTO {<bool>}	Enables/disables Elog seamless measurement autoranging
:FUNction	
:CURRent {<bool>}	Enables/disables current data logging
:VOLTage {<bool>}	Enables/disables voltage data logging
:PERiod {<time>}	Sets the integration time of an Elog measurement
:WHOUr	
:RESet	Resets the watt-hour (Wh) measurement to zero

5.12.1. SENSE:AHOuR:RESet

Not implemented yet

5.12.2. SENSE:CURRent[:DC]:RANGe[:UPPer]

Syntax	SENSe:CURRent[:DC]:RANGe[:UPPer] {<range>} SENSe:CURRent[:DC]:RANGe[:UPPer]?			
Description	This command selects a DC current measurement range when Power board with multiple current ranges is installed (e.g. r5B12 that can be find out with the SYSTem:CHANnel:MODEl? command). The entered value must be higher than the maximum current that you expect to measure. Units are in amperes.			
	If selected range is lower then measured current, when load is connected, an error -220 will be generated.			
Return	The query command returns the maximum DC current that can be measured on the range that is presently set.			
Parameters	Name	Type	Range	Default
	<range>	Numeric (NR2), discrete	0.5, 5, MIN MAX	MAX
Usage example	SENS:CURR:RANG? 0.5			
Errors	-220, "Cannot set range"			
Related Commands	SENSe:CURRent[:DC]:RANGe:AUTO SYSTem:CHANnel:MODEl?			

5.12.3. SENSE:CURRENT[:DC]:RANGE:AUTO

Syntax `SENSe:CURRent[:DC]:RANGe:AUTO {<bool>}`
`SENSe:CURRent[:DC]:RANGe:AUTO?`

Description This command enables/disables current measurement autoranging. Autoranging provides seamless measurement ranging, which results in a wide dynamic range with no data being lost across ranges.

When enabled, this command overrides the SENSE:CURRent[:DC]:RANGe setting.

Return The query command returns 0 if current measurement autoranging is OFF, and 1 if current measurement autoranging is ON.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Usage example	<code>SENS:CURR:RANG?</code> 0.5			

Errors

Related Commands `SENSe:CURRent[:DC]:RANGe`
`SYSTem:CHANnel:MODEl?`

5.12.4. SENSE:ELOG[:DC]:RANGE[:UPPer]

Not implemented yet

5.12.5. SENSE:ELOG[:DC]:RANGE:AUTO

Not implemented yet

5.12.6. SENSE:ELOG:FUNCTION:CURRent

Not implemented yet

5.12.7. SENSE:ELOG:FUNCTION:VOLTage

Not implemented yet

5.12.8. SENSE:ELOG:PERiod

Not implemented yet

5.12.9. SENSE:WHOur:RESet

Not implemented yet

5.13. SOURce

The SOURce commands are used to set the output voltage and current values, remote voltage sensing, and implemented protection mechanisms on the specified channel. Although the [APPLy](#) command provides the most straightforward method to program the PSU over the remote interfaces, the SOURce commands give you more flexibility to change individual parameters.

SCPI command	Description
[SOURce[<n>]]	
:CURRent	
[:LEVel]	
[:IMMediate][:AMPLitude] {<current>}	Sets the output current
:STEP[:INCRement] {<step>}	Sets the step of the current change
:TRIGgered[:AMPLitude] {<current>}	Sets the triggered output current
:LIMit	
[:POSitive][:IMMediate][:AMPLitude] {<current>}	Sets the output current limit
:MODE {<mode>}	Sets the current trigger mode
:PROTection	
:DELay	
[:TIME] {<time>}	Sets the over-current protection (OCP) programming delay
:STATe {<bool>}	Enables/disables over-current protection on the selected channel
:TRIPped?	Returns status of over-current protection activation
:SLEW	
:FALLing	Sets the falling current slew rate
:RISing	Sets the rising current slew rate
:RANGe	Sets current range for dual current range model
:DIGital	
:INPut:DATA? [<pin>]	Reads the state of the digital port pins
:OUTPut:DATA [<pin>] {<state>}	Sets the state of the digital port pins
:PIN<n>	
:FUNCTion {<function>}	Sets the selected pin's function
:POLarity {<polarity>}	Sets the selected pin's polarity
:TOUTput	
:BUS[:ENABLE] {<Bool>}	Enables/disables BUS-generated triggers on digital pins
:LIST	
:COUNT	Sets the number of times that the list is executed
:CURRent[:LEVel]	Specifies the current setting for each list step
:DWELl	Specifies the dwell time for each list step
:VOLTage[:LEVel]	Specifies the voltage setting for each list step
:LRIPple {<bool>}	Sets low output ripple (noise) mode of operation
:AUTO {<bool>}	Sets automatic changing to the low output ripple (noise) mode of operation

:POWer	
:LiMit {<power>}	Sets the output power limit
:PROTection[:LEVel]	Sets the over-power protection (OPP) level
:DELaY	
[:TIME] {<time>}	Sets the over-power protection programming delay
:STATe {<bool>}	Enables/disables over-power protection on the selected channel
:TRIPped?	Returns status of over-power protection activation
:VOLTage	
[:LEVel]	
[:IMMediate][:AMPLitude] {<voltage>}	Sets the output voltage
:STEP[:INCRement] {<step>}	Sets the step of the voltage change
:TRIGgered[:AMPLitude] {<voltage>}	Sets the triggered output voltage
:LiMit	
[:POSitive][:IMMediate][:AMPLitude] {<voltage>}	Sets the output voltage limit
:MODE {<mode>}	Sets the voltage trigger mode
:PROGram[:SOURce] {<source>}	Sets voltage programming source
:PROTection[:LEVel]	Sets the over-voltage protection (OVP) level
:DELaY	
[:TIME] {<time>}	Sets the over-voltage protection (OVP) programming delay
:STATe {<bool>}	Enables/disables over-voltage protection on the selected channel
:TRIPped?	Returns status of over-voltage protection activation
:SENSe[:SOURce] {<source>}	Sets voltage sense inputs source
:SLEW	
:FALLing	Sets the falling voltage slew rate
:RISing	Sets the rising voltage slew rate

5.13.1. [SOURce[<n>]]:CURRent

Syntax	[SOURce[<n>]]:CURRent[:LEVel][:IMMediate][:AMPLitude] {<current> MIN DEF MAX UP DOWN} [SOURce[<n>]]:CURRent[:LEVel][:IMMediate][:AMPLitude]? [MIN DEF MAX]
Description	This command sets the immediate current level of the channel. Units are in amperes. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command.

This command also increases or decreases the immediate current level using the 'UP' or DOWN parameter by a predetermined amount. The command CURRent:STEP sets the amount of increase or decrease. A new increment setting will *not* cause an execution error -222,"Data out of range" when the maximum or the minimum rated current is exceeded – the output value will be set to the maximum or the minimum value instead.

At [*RST](#), the signal being sourced will be set to a "safe" condition. This is achieved by setting the amplitude to its MINimum value (see [Section 8.1](#)).

Return The query command returns the programmed current level. CURR? MIN, CURR? DEF and CURR? MAX can be used to obtain minimum, default and maximum current level on the currently selected channel. For actual output current value use MEASure:CURRent command.

Parameters	Name	Type	Range	Default
	<current>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX UP DOWN The maximum value is dependent on the PSU current rating. See Section 8.1	–

Usage example A 10 ohm load is connected and voltage is set to 20 V. With MAX current set measured current will be 2 A. When new current value is set to 1.2 A, voltage will drop to 12 V (the channel enters the CC mode of operation):

```
INST CH1
VOLT 20
CURR MAX
MEAS:VOLT?
```

```
20.00
```

```
CURR 1.2
MEAS:VOLT?
```

```
12.00
```

Query that returns maximum current of the currently selected channel:

```
CURR? MAX
```

```
5.00
```

Errors 150, "Power limit exceeded"
-222, "Data out of range"

Related Commands *SAV
*RST
APPLY
MEASure[:SCALar]:CURRent[:DC]?
[SOURce[<n>]]:CURRent[:LEVel][:IMMediate]:STEP[:INCRement]

5.13.2. [SOURce[<n>]]:CURRent:STEP

Syntax [SOURce[<n>]]:CURRent[:LEVel][:IMMediate]:STEP[:INCRement] {<step>|DEFault}
[SOURce[<n>]]:CURRent[:LEVel][:IMMediate]:STEP[:INCRement]? [DEFault]

Description Set the step of the current change of the channel. When [SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command. Step change is performed by using UP and DOWN as parameter for the [SOURce[<n>]]:CURRent command.

Return The query returns the step of the current change of the specified channel.

Parameters	Name	Type	Range	Default
	<step>	Numeric (NR2)	0.01 to 1 DEFault	0.05

Usage example Return default step value:

```
CURR:STEP? DEF
```

```
0.05
```

When a 10 ohm load is connected with voltage set to 20 V and current to 1 A the first channel enters CC mode of operation. Current is then increased from 1 A in two steps to 1.2 A:

```

APPL CH1, 20,1
MEAS:VOLT?

10.00

CURR:STEP 0.1
CURR UP
MEAS:CURR?

1.10

CURR UP
MEAS:CURR?

1.20

MEAS:VOLT?

12.00

```

Related Commands *SAV
[SOURce[<n>]]:CURRent

5.13.3. [SOURce[<n>]]:CURRent:TRIGgered

Syntax	[SOURce[<n>]]:CURRent[:LEVel]:TRIGgered[:AMPLitude] {<current> MINimum DEFault MAXimum} [SOURce[<n>]]:CURRent[:LEVel]:TRIGgered[:AMPLitude]? [MINimum MAXimum]			
Description	This command programs the pending triggered current level. The pending triggered current level is a stored value that is transferred to the output terminals when a trigger occurs. <i>A pending triggered level is not affected by subsequent CURRent commands.</i>			
Return	Query the triggered current level presently programmed. If no triggered level is programmed, the CURRent level is returned. CURR:TRIG? MIN and CURR:TRIG? MAX return the lowest and highest programmable triggered current levels.			
Parameters	Name	Type	Range	Default
	<current>	Numeric (NR2), discrete	0 to maximum, MIN DEF MAX The MAXimum value is dependent on the PSU current rating. See Section 8.1	0.00
Usage example	On the currently selected channel voltage will be set to 3.3 V and current to 1 A when INITiate command is executed: VOLT:TRIG 3.3 CURR:TRIG 1 TRIG:SOUR IMM INIT			
Related Commands	ABORT			

5.13.4. [SOURce[<n>]]:CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude]

Syntax	[SOURce[<n>]]:CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude] {<current>} [SOURce[<n>]]:CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MINimum MAXimum]			
Description	This command sets the channel's output current limit. Units are in amperes. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command. This command could be used as mean of protection against incidental programming of too high output current that can be set for example with [SOURce[<n>]]:CURRent:STEP			

command.

Maximum limit value will be affected with detected failure of cooling fan or channel's temperature sensor. Use CURR:LIM? MAX to query actual value.

Return The query returns the max. allowed output current of the specified channel. Querying MAX on an output channel returns the maximum current limit.

Parameters	Name	Type	Range	Default
	<current>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX The MAXimum value is dependent on the PSU current rating. See Section 8.1	MAXimum

Usage example Normal mode of operation for 5 A model:

```
CURR:LIM MAX?
```

```
5.00
```

Max. allowable current with faulty cooling fan or temperature sensor:

```
CURR:LIM MAX?
```

```
1.00
```

Related Commands *SAV
[SOURce[<n>]]:CURRent:STEP
[SOURce[<n>]]:POWer:LIMit
[SOURce[<n>]]:VOLTag:e:LIMit[:POSitive][:IMMediate][:AMPLitude]

5.13.5. [SOURce[<n>]]:CURRent:MODE

Syntax [SOURce[<n>]]:CURRent:MODE {<mode>}
[SOURce[<n>]]:CURRent:MODE?

Description This command determines what happens to the output current when the transient system is initiated and triggered:

- FIXEd – the output current remains at the immediate value
- LIST – the output follows the list values when a trigger occurs.
- STEP – the output goes to the triggered level when a trigger occurs.

Return The query command returns the current mode of the currently selected channel.

Parameters	Name	Type	Range	Default
	<mode>	Discrete	FIXEd LIST STEP	FIXEd

Usage example CURR:MODE?

```
FIX
```

Related Commands [SOURce[<n>]]:LIST:CURRent[:LEVel]
[SOURce[<n>]]:VOLTag:e:MODE

5.13.6. [SOURce[<n>]]:CURRent:SLEW:FALLing

Not implemented yet

5.13.7. [SOURce[<n>]]:CURRent:SLEW:RISing

Not implemented yet

5.13.8. [SOURce[<n>]]:CURRent:PROTection:DELaY[:TIME]

Syntax [SOURce[<n>]]:CURRent:PROTection:DELaY[:TIME] {<time>|DEFault}
[SOURce[<n>]]:CURRent:PROTection:DELaY[:TIME]? [DEFault]

Description This command sets the over-current protection delay. The over-current protection function will not be triggered on the selected output channel during the delay time. After the delay time has expired, the over-current protection function will be active. This prevents momentary changes in output status from triggering the over-current protection function. Programmed values can range from 0 to 10 seconds. See also [Section 8.1](#)

Return The query command returns the programmed delay time.

Parameters	Name	Type	Range	Default
	<time>	Numeric, discrete	0 – 10 DEFault	20 ms

Usage example Get default OCP delay of 20 milliseconds:

```
CURR:PROT:DEL? DEF
0.02
```

Related *SAV
Commands OUTPut:PROTection:CLEAr

5.13.9. [SOURce[<n>]]:CURRent:PROTection:STATe

Syntax [SOURce[<n>]]:CURRent:PROTection:STATe {<bool>}
[SOURce[<n>]]:CURRent:PROTection:STATe?

Description This command enables or disables the over-current protection (OCP) function. The enabled state is ON (1); the disabled state is OFF (0). Since the PSU do not have a dedicated over-current protection circuit that can be programmed independently of output current level, entering the CC (constant current) mode of operation is used as a trigger to start OCP sequence. When delay time specified with the [SOURce[<n>]]:CURRent:PROTection:DELaY[:TIME] command expired the output turns off and the Questionable Condition status register OCP bit 9 is set. An error tone will also follow if beeper is enabled (see SYSTem:BEEPer:STATe). [SOURce[<n>]]:CURRent:PROTection:TRIPped? command can be used to query whether over-current protection occurred on the selected channel.

Return The query command returns 0 if the current protection state is OFF, and 1 if the current protection state is ON.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage example CURR:PROT:STAT?
0

Related *SAV
Commands OUTPut:PROTection:CLEAr
OUTPut:PROTection:COUPle
[SOURce[<n>]]:CURRent:PROTection:DELaY[:TIME]
[SOURce[<n>]]:CURRent:PROTection:TRIPped
SYSTem:BEEPer:STATe

5.13.10. [SOURce[<n>]]:CURRent:PROTection:TRIPped?

Syntax [SOURce[<n>]]:CURRent:PROTection:TRIPped?

Description Query whether OCP occurred on the currently selected channel. When protection is tripped bit 9 (OCP) of the Questionable Instrument Isummary register will be set (see [Section 3.4.2](#)).

The [OUTPut:PROTection:CLEAr](#) command can be send to clear OCP condition on the

	selected channel.
Return	This query returns a 1 if the protection circuit is tripped and a 0 if it is untripped.
Usage example	CURR:PROT:TRIP? 1
Related Commands	OUTPut:PROTection:CLEar

5.13.11. [SOURce:]DIGital:INPut:DATA

Syntax	[SOURce:]DIGital:INPut:DATA? [<pin>] (not implemented in M4)			
Description	This query reads the state of the digital control port. <i>Applies only to pin 1.</i>			
Return	The query returns the value of the state of input pin.			
Parameters	Name	Type	Range	Default
	<pin>	Numeric	1	1
Usage example	DIG:INP:DATA? 1			
Related Commands	[SOURce:]DIGital:PIN<n>:FUNctIon [SOURce:]DIGital:PIN<n>:POLarity			

5.13.12. [SOURce:]DIGital:OUTPut:DATA

Syntax	[SOURce:]DIGital:OUTPut:DATA [<pin>] {<state>} (not implemented in M4) [SOURce:]DIGital:OUTPut:DATA? [<pin>]			
Description	This command sets the output data on the digital output pin. <i>Applies only to pin 2 and pin 3. This command is supported on Arduino Shield r5B11 or newer revision.</i>			
Return	The query returns the last programmed value on the selected pin.			
Parameters	Name	Type	Range	Default
	<pin>	Numeric	2 – 3	–
	<state>	Discrete	ON OFF	–
Usage example	DIG:OUTP:DATA 0			
Related Commands	[SOURce:]DIGital:PIN<n>:FUNctIon [SOURce:]DIGital:PIN<n>:POLarity			

5.13.13. [SOURce:]DIGital:PIN<n>:FUNctIon

Syntax	[SOURce:]DIGital:PIN<n>:FUNctIon {<function>} (not implemented in M4) [SOURce:]DIGital:PIN<n>:FUNctIon?			
Description	Use this command to set function of the selected digital port pin. The pin function is saved in non-volatile memory. <ul style="list-style-type: none"> DINPut – The pin is in digital input mode. <i>Applies only to pin 1.</i> DOUTput – The pin is in digital output mode. <i>Applies only to pin 2 and pin 3.</i> FAULt – Setting FAULt means that pin functions as an isolated fault output. The fault signal is true when any output is in a protected state (from OCP, OVP, OTP, OPP or INH). <i>Applies only to pin 2.</i> INHibit – When pin is configured as an inhibit input, a true signal at the pin will disable all output channels. <i>Applies only to pin 1.</i> ONCouple – output pin synchronize channel On state 			

- OFFCouple – output pin synchronize channel Off state
- TINPut – The pin is configured as a trigger input. When configured as a trigger input, the pin can be selected as the source for trigger signals. See TRIGger[:SEQuence]:SOURce. *Applies only to pin 1.*
- TOUTput – This allows a BUS trigger to be sent to any digital port pin that has been configured as a trigger output. A trigger out pulse is generated when the state is on and a bus trigger is received. A BUS trigger is generated using the *TRG command.

Return The query command returns DINP, DOUT, FAUL, INH or TINP.

Parameters	Name	Type	Range	Default
	<n>	Numeric	1 – 3	–
	<function>	Discrete	DINP DOUT FAUL INH ONC OFFC TINP TOUT	–
Usage example	DIG:PIN1:INH DIG:PIN2:FAUL			
Related Commands	TRIGger[:SEQuence]:SOURce [SOURce:]DIGital:INPut:DATA [SOURce:]DIGital:OUTPut:DATA			

5.13.14. [SOURce:]DIGital:PIN<n>:POLarity

Syntax [SOURce:]DIGital:PIN<n>:POLarity {<polarity>}
[SOURce:]DIGital:PIN<n>:POLarity?

Description This command sets the polarity of the selected digital port pin. The pin polarity is saved in non-volatile memory.

- POSitive – Setting a polarity to POSitive means that a logical true signal is a voltage high at the pin. For trigger inputs and outputs, POSitive means a rising edge.
- NEGative – Setting the polarity NEGative means that a logical true signal is a voltage low at the pin. For trigger inputs and outputs, NEGative means a falling edge.

Return The query command returns POS or NEG.

Parameters	Name	Type	Range	Default
	<n>	Numeric	1 – 2	–
	<polarity>	Discrete	POSitive NEGative	–
Usage example	DIG:PIN1:POL POS DIG:PIN2:POL NEG			
Related Commands	TRIGger[:SEQuence]:SOURce [SOURce:]DIGital:INPut:DATA [SOURce:]DIGital:OUTPut:DATA			

5.13.15. [SOURce:]DIGital:TOUTput:BUS[:ENABLE]

Syntax [SOURce:]DIGital:TOUTput:BUS[:ENABLE] {<Bool>} (not implemented in M4)
[SOURce:]DIGital:TOUTput:BUS[:ENABLE]?

Description This command allows a BUS trigger to be sent to any digital port pin that has been configured as a trigger output. The state is either ON (1) or OFF (0). A trigger is generated when the state is True (ON). A BUS trigger is generated using the *TRG command.

Return The query command returns 0 (OFF) if the trigger signal will NOT be generated when a BUS trigger command occurs, and 1(ON) if a trigger signal will be generated when a

BUS trigger command occurs.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Usage example	DIG:TOUT:BUS ON			
Related Commands	*TRG [SOURce:]DIGital:PIN<n>:FUNctIon [SOURce:]DIGital:PIN<n>:POLarity			

5.13.16. [SOURce[<n>]]:LIST:COUNT

Syntax	[SOURce[<n>]]:LIST:COUNT {<count> INFinity} [SOURce[<n>]]:LIST:COUNT?			
Description	This command sets the number of times that the list is executed before it is completed. The list count range is 1 through 255. Use the INFinity parameter or 0 to execute a list continuously. Use ABORt to stop the list at any time. When the list is aborted, the output returns to the settings that were in effect before the list started.			
Return	The query command returns the list count. Multiple responses are separated by commas. If a repeat count of 0 is returned, it means the list is set to repeat continuously.			
Parameters	Name	Type	Range	Default
	<count>	Numeric, discrete	0 1 – 65535 INFinity	1
Usage example	LIST:COUN? 10			
Related Commands	ABORt MMEMory:LOAD:LIST[<n>]			

5.13.17. [SOURce[<n>]]:LIST:CURRENT[:LEVEL]

Syntax	[SOURce[<n>]]:LIST:CURRENT[:LEVEL] {<current>}[, <current>] [SOURce[<n>]]:LIST:CURRENT[:LEVEL]?			
Description	This command specifies the current setting for each list step in amperes. A comma-delimited list of up to 256 steps may be programmed. The order in which the current values are entered determines the sequence when the list executes. To create a valid list, the VOLTage, CURRent and DWELl lists must either all be the same length, or have a length of 1, which is interpreted as having the same length as the list with the maximum length. This command overwrites any previously programmed current list; it does not append to the previous list.			
Return	The query command returns the programmed current level. Multiple responses are separated by commas.			
Parameters	Name	Type	Range	Default
	<current>	<numeric> (NR2)	0 to maximum, MIN DEF MAX UP DOWN The MAXimum value is dependent on the PSU current rating. See Section 8.1	–
Usage example	LIST:CURR 0.25			
Errors	306, "Too many list points"			

Related Commands MMEMory:LOAD:LIST[<n>]
[SOURce[<n>]]:CURRent:MODE
[SOURce[<n>]]:LIST:COUNt

5.13.18. [SOURce[<n>]]:LIST:DWELI

Syntax [SOURce[<n>]]:LIST:DWELI {<time>}[,<time>]
[SOURce[<n>]]:LIST:DWELI?

Description This command specifies the dwell time for each list step. A comma-delimited list of up to 256 steps may be programmed. Dwell time is the time that the output will remain at a specific step. Dwell times can be programmed from 0 through 65535 seconds.

Note that min. dwell time that can be achieved during the list execution depends of MCU activity and waveform shape. Therefore one have to find that out experimentally while list is executed on desired number of channels (one or two). Usage of oscilloscope is recommended for fast transitions since e.g. YT view resolution cannot be set to less then 20 ms. The expected usable min. dwell time goes well below 10 ms (down to 1 ms).

Return The query command returns the programmed dwell times. Multiple responses are separated by commas.

Parameters	Name	Type	Range	Default
	<time>	numeric	0 – 65535	–
Usage example	LIST:DWEL 20ms,10ms,10ms,50ms			
Errors	306, "Too many list points"			
Related Commands	MMEMory:LOAD:LIST[<n>] [SOURce[<n>]]:LIST:COUNt			

5.13.19. [SOURce[<n>]]:LIST:VOLTage[:LEVel]

Syntax [SOURce[<n>]]:LIST:VOLTage[:LEVel] {<voltage>}[,<voltage>]
[SOURce[:LEVel]]:LIST:VOLTage[:LEVel]?

Description This command specifies the voltage setting for each list step in volts. A comma-delimited list of up to 256 steps may be programmed.
The order in which the voltage values are entered determines the sequence when the list executes.
To create a valid list, the VOLTage, CURRent and DWELI lists must either all be the same length, or have a length of 1, which is interpreted as having the same length as the list with the maximum length.
This command overwrites any previously programmed voltage list; it does not append to the previous list.

Return The query command returns the programmed voltage level. Multiple responses are separated by commas.

Parameters	Name	Type	Range	Default
	<voltage>	<numeric> (NR2)	0 to maximum, MIN DEF MAX UP DOWN The maximum value is dependent on the PSU voltage rating. See Section 8.1	–

Usage example Programming the list that contain 4 steps and will be executed 20 times on the channel 2. Execution will start by receiving remote command (*TRG) since BUS is selected as a trigger source:

```
INST CH2
LIST:COUN 20
```

```

LIST:VOLT 0,1.5,3,4.5
LIST:CURR 0.25
LIST:DWEL 20ms,10ms,10ms,50ms
OUTP ON
*OPC?

0

TRIG:SOUR BUS
INIT
*TRG

```

Errors 306, "Too many list points"

Related Commands MMEMory:LOAD:LIST[<n>]
[SOURce[<n>]]:LIST:COUNt
[SOURce[<n>]]:VOLTage:MODE

5.13.20. [SOURce[<n>]]:LRIPple

Syntax [SOURce[<n>]]:LRIPple {<bool>}
[SOURce[<n>]]:LRIPple?

Description This command enables or disables low output ripple (noise) mode of operation when it's supported by installed channel board (use the SYSTem:CHANnel[:INFORMation]:PROGram? to query channel functionality).

When low ripple mode of operation is selected the power pre-regulator is bypassed by setting so-called [Duty cycle](#) of the SMPS controller to 100 %. That will disable switching frequency and therefore that otherwise hard to filter component disappear entirely from the channel output. In that case the remaining noise mainly comes from the low power bias switching pre-regulator.

The maximum output power in this mode of operation is limited to stay within [SOA](#) (Safe operating area) of the pre-regulator and post-regulator regulation elements. The maximum output power is limited by the first of the following conditions that is met:

- The pre-regulator regulation element (switching mosfet) capability is limited with max. allowed continuous current (SOA_PREG_CURR value) for the applied input voltage (SOA_VIN value). The set output current cannot exceeds this value in *any* moment.
- The post-regulator regulation element (pass mosfet) could dissipate finite power ($SOA_POSTREG_PTOT$ value) while load is connected. Therefore output power cannot exceed product of voltage difference (SOA_VIN and output voltage) and output current.

For example, when output voltage is set to 12 V and $SOA_VIN = 50$ V, $SOA_PREG_CURR = 0.8$ A and $SOA_POSTREG_PTOT = 20$ W, the max. output current in low ripple mode cannot exceed 0.526 A because $SOA_VIN - VOLT = 50 - 12 = 38$ V and $I_{max} = SOA_POSTREG_PTOT / 38 = 20 / 38 = 0.526$ A.

If output voltage is set to 36 V with the same SOA values as in example above the max. output current cannot exceed 0.8 A (limited by SOA_PREG_CURR) regardless of the fact that max. power dissipation of 20 W allows output current of up to 1.428 A or $20 / (50 - 36)$.

If low ripple mode is set an error will be generated when any of the limits are exceeded. The AUTOMatic mode should be used to avoid error conditions. Also if AUTOMatic mode disables low ripple, an attempt to enable it using the [SOURce[<n>]]:LRIPple ON command will generate an execution error.

An attempt to enter low ripple mode while remote (EXTernal) voltage programming is active ([SOURce[<n>]]:VOLTage:PROGram[:SOURce]) will generate -221 error.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Return	The query command returns 1 if the low ripple mode is active, and 0 if the low ripple mode is not active.
Usage example	VOLT:LRIP? 0
Errors	-200, "Execution error" -221, "Settings conflict" 302, "Option not installed"
Related Commands	*SAV [SOURce[<n>]]:LRIPple:AUTO SYSTem:CHANnel:INFOrmation:PROGram?

5.13.21. [SOURce[<n>]]:LRIPple:AUTO

Syntax	[SOURce[<n>]]:LRIPple:AUTO {<bool>} [SOURce[<n>]]:LRIPple:AUTO?			
Description	Use this command to allows automatic changing to the low ripple (noise) mode of operation. If AUTOMATIC mode of operation is enabled, the channel will stay in low ripple mode of operation as long as output power does not exceed calculated limitations allowed for that mode of operation. The [SOURce[<n>]]:LRIPple? query can be used to determine current status.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF
Return	The query command returns 1 if the low ripple automatic mode is active, and 0 if the low ripple automatic mode is not active.			
Usage example	VOLT:LRIP:AUTO 1 VOLT:LRIP? 1			
Errors	302, "Option not installed" 312, "Cannot execute when the channels are coupled"			
Related Commands	*SAV INSTrument:COUPle:TRACking SOURce[<n>]:LRIPple SYSTem:CHANnel:INFOrmation:PROGram?			

5.13.22. [SOURce[<n>]]:POWer:LIMit

Syntax	[SOURce[<n>]]:POWer:LIMit {<power>} [SOURce[<n>]]:POWer:LIMit? [MINimum MAXimum]			
Description	This command sets the channel's output power limit. Units are in Watts. Such limitation is required if main transformer (or AC/DC adapter if DC power input is used) <i>cannot</i> provide the same power as connected channel power module. For example if power module can deliver 200 W but main transformer offer only 160 W then MAXimum allowable continuous power is only 160 W.			
Return	The query returns the max. allowed output power of the specified channel. Querying MAX on an output channel returns the maximum rated power limit.			
Parameters	Name	Type	Range	Default
	<power>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX The MAXimum value is dependent on the PSU power rating.	MAXimum

See [Section 8.1](#)

Usage example
 POW:LIM DEF
 POW:LIM?
 150.00

Related Commands *SAV
 [SOURce[<n>]]:CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude]
 [SOURce[<n>]]:VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude]

5.13.23. [SOURce[<n>]]:POWer:PROTectio[n]:LEVel]

Syntax [SOURce[<n>]]:POWer:PROTectio[n]:LEVel {<power>|DEFault}
 [SOURce[<n>]]:POWer:PROTectio[n]:LEVel?

Description Set the over-power protection (OPP) value of the channel. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command. When the over-power protection function of the specified channel is enabled ([SOURce[<n>]]:POWer:PROTectio[n]:STATe), the output turns off automatically when the output power exceeds the over-power protection value currently set. [SOURce[<n>]]:POWer:PROTectio[n]:TRIPped? command can be used to query whether over-power protection occurred on the selected channel.

Return Query the over-power protection (OPP) value of the selected channel.

Parameters	Name	Type	Range	Default
	<power>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX The maximum value is dependent on the PSU power rating. See Section 8.1	DEFault

Usage example Set power protection to 50 W on the channel 2:
 SOUR2:POW:PROT 50

Related Commands *SAV
 OUTPut:PROTectio[n]:COUPLe
 [SOURce[<n>]]:POWer:PROTectio[n]:TRIPped?
 [SOURce[<n>]]:POWer:PROTectio[n]:STATe

5.13.24. [SOURce[<n>]]:POWer:PROTectio[n]:DELay[:TIME]

Syntax [SOURce[<n>]]:POWer:PROTectio[n]:DELay[:TIME] {<time>|DEFault}
 [SOURce[<n>]]:POWer:PROTectio[n]:DELay[:TIME]? [DEFault]

Description This command sets the over-power protection (OPP) delay. The over-power protection function will not be triggered on the selected output channel during the delay time. After the delay time has expired, the over-power protection function will be active. This prevents momentary changes in output status from triggering the over-power protection function. Programmed values can range from 0 to 300 seconds. See also [Section 8.1](#)

Return The query command returns the programmed delay time.

Parameters	Name	Type	Range	Default
	<time>	Numeric	0 – 300 DEFault	10

Usage example Get default OPP delay of 10 seconds:
 POW:PROT:DEL? DEF
 10

Related Commands *SAV
 OUTPut:PROTectio[n]:CLEAr

5.13.25. [SOURce[<n>]]:POWer:PROTection:STATe

Syntax [SOURce[<n>]]:POWer:PROTection:STATe {<bool>}
[SOURce[<n>]]:POWer:PROTection:STATe?

Description This command enables or disables the over-power protection (OPP) function. The enabled state is ON (1); the disabled state is OFF (0). If the over-power protection function is enabled and the measure output power reach value set by [SOURce[<n>]]:POWer:PROTection[:LEVel] the output is disabled and the Questionable Condition status register OPP bit 10 is set.

Return The query command returns 0 if the current protection state is OFF, and 1 if the current protection state is ON.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage example
 POW:PROT:STAT ON
 POW:PROT:STAT?
 1

Related Commands *SAV
 OUTPut:PROTection:CLEar
 [SOURce[<n>]]:POWer:PROTection[:LEVel]

5.13.26. [SOURce[<n>]]:POWer:PROTection:TRIPped?

Syntax [SOURce[<n>]]:POWer:PROTection:TRIPped?

Description Query whether OPP occurred on the currently selected channel. When protection is tripped bit 10 (OPP) of the Questionable Instrument Isummary register will be set (see [Section 3.4.2](#)).
 The [OUTPut:PROTection:CLEar](#) command can be send to clear OPP condition on the selected channel.

Return This query returns a 1 if the protection circuit is tripped and a 0 if it is untripped.

Usage example
 POW:PROT:TRIP?
 0

Related Commands OUTPut:PROTection:CLEar

5.13.27. [SOURce[<n>]]:VOLTage

Syntax [SOURce[<n>]]:VOLTage[:LEVel][:IMMediate][:AMPLitude] {<voltage>|MINimum|DEFAULT|MAXimum|UP|DOWN}
 [SOURce[<n>]]:VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MINimum|DEFAULT|MAXimum]

Description This command sets the immediate voltage level of the output channel. Units are in volts. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command.

This command also increases or decreases the immediate voltage level using the 'UP' or DOWN parameter by a predetermined amount. The command VOLTage:STEP sets the amount of increase or decrease. A new increment setting will *not* cause an execution error -222,"Data out of range" when the maximum or the minimum rated current is exceeded – the output value will be set to the maximum or the minimum value instead.

At *RST, the signal being sourced will be set to a "safe" condition. This is achieved by setting the amplitude to its MINimum value (see [Section 8.1](#)).

Return The query command returns the programmed voltage level. VOLT? MIN, VOLT? DEF and VOLT? MAX can be used to obtain minimum, default and maximum voltage level on

the currently selected channel. For actual output voltage value use MEASure:VOLTage? command.

Parameters	Name	Type	Range	Default
	<voltage>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX UP DOWN The maximum value is dependent on the PSU voltage rating. See Section 8.1	–
Usage example	<p>A 10 ohm load is connected and current is set to 1 A. With MAX voltage set measured voltage will be 10 V. When new voltage value is set to 5 V, current will drop to 0.5 A (the channel enters the CV mode of operation):</p> <pre>INST CH1 VOLT MAX CURR 1 MEAS:CURRE? 1.00 VOLT 5 MEAS:CURRE? 0.50</pre> <p>Query that returns maximum current of the currently selected channel:</p> <pre>CURRE? MAX 5.00</pre>			
Errors	<pre>150, "Power limit exceeded" -222, "Data out of range"</pre>			
Related Commands	<pre>*SAV *RST APPLY MEASure[:SCALar]:VOLTage[:DC]? [SOURce[<n>]]:VOLTage[:LEVel][:IMMediate]:STEP[:INCRement]</pre>			

5.13.28. [SOURce[<n>]]:VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude]

Syntax	<pre>[SOURce[<n>]]:VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude] {<voltage>} [SOURce[<n>]]:VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MINimum MAXimum]</pre>			
Description	<p>This command sets the channel's output voltage limit. Units are in volts. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command.</p> <p>This command could be used as mean of protection against incidental programming of too high output voltage that can be set for example with [SOURce[<n>]]:VOLTage:STEP command.</p>			
Return	<p>The query returns the max. allowed output voltage of the specified channel. Querying MAX on an output channel returns the maximum voltage limit.</p>			
Parameters	Name	Type	Range	Default
	<voltage>	Numeric (NR2), discrete	0 to MAXimum, MIN DEF MAX The MAXimum value is dependent on the PSU current rating. See Section 8.1	MAXimum
Usage	<pre>VOLT:LIM 20</pre>			

example

Related *SAV

Commands [SOURce[<n>]]:CURRent:STEP
 [SOURce[<n>]]:POWer:LIMit
 [SOURce[<n>]]:VOLTage:LIMit[:POSitive][:IMMEDIATE][:AMPLitude]

5.13.29. [SOURce[<n>]]:VOLTage:STEP

Syntax [SOURce[<n>]]:VOLTage[:LEVel][:IMMEDIATE]:STEP[:INCRement] {<step>|DEFault}
 [SOURce[<n>]]:VOLTage[:LEVel][:IMMEDIATE]:STEP[:INCRement]? [DEFault]

Description Set the step of the voltage change of the channel. When [SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command. Step change is performed by using UP and DOWN as parameter for the [SOURce[<n>]]:VOLTage command.

Return The query returns the step of the voltage change of the specified channel.

Parameters	Name	Type	Range	Default
	<step>	Numeric (NR2), discrete	0.01 to 10 DEFault	0.1

Usage example Return default step value:

```
VOLT:STEP? DEF
```

```
0.10
```

By connecting a 10 ohm load and current set to 2 A and voltage to 10 V the first channel enters the CV mode of operation. Voltage is then decreased from 10 V in two steps to 6 V:

```
APPL CH1, 10, 2
```

```
MEAS:CURR?
```

```
1.0
```

```
VOLT:STEP 2
```

```
VOLT DOWN
```

```
VOLT DOWN
```

```
MEAS:VOLT?
```

```
6.0
```

```
MEAS:CURR?
```

```
0.60
```

Related *SAV

Commands [SOURce[<n>]]:VOLTage

5.13.30. [SOURce[<n>]]:VOLTage:TRIGgered

Syntax [SOURce[<n>]]:VOLTage[:LEVel]:TRIGgered[:AMPLitude] {<voltage>|MINimum|DEFault|MAXimum}
 [SOURce[<n>]]:VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [MINimum|MAXimum]

Description This command programs the pending triggered voltage level. The pending triggered current level is a stored value that is transferred to the output terminals when a trigger occurs.

A pending triggered level is not affected by subsequent VOLTage commands.

Return Query the triggered voltage level presently programmed. If no triggered level is programmed, the VOLTage level is returned. VOLT:TRIG? MIN and VOLT:TRIG? MAX return the lowest and highest programmable triggered voltage levels.

Parameters	Name	Type	Range	Default
	<voltage>	Numeric (NR2), discrete	0 to maximum, MIN DEF MAX	0.00

The maximum value is dependent on the PSU voltage rating.
See [Section 8.1](#)

Usage example On the currently selected channel voltage will be set to 3.3V and current to 1A when INITiate command is executed:

```
VOLT:TRIG 3.3
CURR:TRIG 1
TRIG:SOUR IMM
INIT
```

Related Commands ABORT

5.13.31. [SOURce[<n>]]:VOLTage:MODE

Syntax [SOURce[<n>]]:VOLTage:MODE {<mode>}
[SOURce[<n>]]:VOLTage:MODE?

Description This command determines what happens to the output voltage when the transient system is initiated and triggered:

- **FIXed** – the output current remains at the immediate value
- **LIST** – the output follows the list values when a trigger occurs.
- **STEP** – the output goes to the triggered level when a trigger occurs.

Return The query command returns the voltage mode of the currently selected channel.

Parameters	Name	Type	Range	Default
	<mode>	Discrete	FIXed LIST STEP	FIXed

Usage example VOLT:MODE?
LIST

Related Commands [SOURce[<n>]]:LIST:VOLTage[:LEVel]
[SOURce[<n>]]:CURRent:MODE

5.13.32. [SOURce[<n>]]:VOLTage:PROGram[:SOURce]

Syntax [SOURce:]VOLTage:PROGram[:SOURce] {INTernal|EXTernal}
[SOURce:]VOLTage:PROGram[:SOURce]?

Description Use this command to define source for output voltage programming if channel support this option (use the SYSTem:CHANnel[:INfOrmation]:PROGram? to query channel programming capability).

A channel's D/A converter controlled by CPU is used by default for voltage output programming. That source can be calibrated (see the CALibrate subsystem) and provide output within safe limits.

The external voltage programming could be used when fast interaction with an external process is required. For example if tracking output of the connected D.U.T. (i.e. a power supply) is needed the PSU effectively becomes a pre-regulator keeping its output voltage in relation with changes of the D.U.T. output keeping constant difference between connected D.U.T input and output and in that way its max. power dissipation.

Max. D/A converter programmed voltage of 2.5 V would results with MAXimal voltage output regardless of the channel's voltage range (see [Section 8.1](#)). Therefore if EXTernal programming source is selected, any voltage value higher then 2.5 V could produce unexpected results and eventually damage the PSU and/or connected load.

To limit possible damage when programming source is set to EXTernal, the over-voltage protection (OVP) will be activated and set to MAXimum ([SOURce[<n>]]:VOLTage:PROTection[:LEVel]) with protection delay time set to zero ([SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME]). Further adjustment of OVP level and delay is also allowed (e.g. to decrease OVP level or increase delay time).

The enabled state is EXTERNAL (1); the disabled state is INTERNAL (0). Execution of this command also affects bit 13 (RPROG) of the Operation Instrument Summary register (see [Section 3.3.2](#)).

Self-test operation initiated by [*TST?](#) command will reset voltage programming on all PSU channels to the internal/local source.

If external programming source is selected the DIAGnostic[:INfOrmation]:ADC? Query returns 0.00 value for U_SET.

Parameters	Name	Type	Range	Default
	<source>	Discrete	INTERNAL EXTERNAL	INTERNAL
Return	The query command returns 0 if the local (internal) voltage programming is selected, and 1 if the remote (external) sense is selected.			
Usage example	VOLT:PROG EXT VOLT:PROG? 1			
Errors	302, "Option not installed" 312, "Cannot execute when the channels are coupled"			
Related Commands	*TST DIAGnostic[:INfOrmation]:ADC? INSTRument:COUPle:TRACking OUTPut[:STATe] [SOURce[<n>]]:VOLTage:PROTection[:LEVel] [SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME] [SOURce[<n>]]:VOLTage:PROTection:TRIPped? SYSTem:CHANnel[:INfOrmation]:PROGram?			

5.13.33. [\[SOURce\[<n>\]\]:VOLTage:PROTection\[:LEVel\]](#)

Syntax	[SOURce[<n>]]:VOLTage:PROTection[:LEVel] {<voltage> MINimum DEFAULT MAXimum} [SOURce[<n>]]:VOLTage:PROTection[:LEVel]?			
Description	Set the over-voltage protection (OVP) value of the channel. When [:SOURce[<n>]] or [<n>] is omitted, the currently selected channel will be affected by this command. When the over-voltage protection function of the specified channel is enabled ([SOURce[<n>]]:VOLTage:PROTection:STATe), the output turns off automatically when the output voltage exceeds the over-voltage protection value currently set. [SOURce[<n>]]:VOLTage:PROTection:TRIPped? command can be used to query whether over-voltage protection occurred on the selected channel. An execution error -222, "Data out of range" will be generated when output voltage is controlled internally ([SOURce[<n>]]:VOLTage:PROGram[:SOURce]) and OVP value is set below programmed output voltage ([SOURce[<n>]]:VOLTage).			
Return	Query the over-voltage protection (OVP) value of the selected channel.			
Parameters	Name	Type	Range	Default
	<voltage>	Numeric (NR2), discrete	0 to maximum, MIN DEF MAX The maximum value is dependent on the PSU voltage rating. See Section 8.1	—
Usage example	Set voltage protection to 10.2 V on the channel 1: SOUR1:VOLT:PROT 10.2			
Errors	-222, "Data out of range"			
Related	*SAV			

Commands `OUTPut:PROTection:COUPle`
`[SOURce[<n>]]:VOLTage`
`[SOURce[<n>]]:VOLTage:PROGram[:SOURce]`
`[SOURce[<n>]]:VOLTage:PROTection:TRIPped?`
`[SOURce[<n>]]:VOLTage:PROTection:STATe`

5.13.34. `[SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME]`

Syntax `[SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME] {<time>|DEFAult}`
`[SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME]? [DEFAult]`

Description This command sets the over-voltage protection delay. The over-voltage protection function will not be triggered on the selected output channel during the delay time. After the delay time has expired, the over-voltage protection function will be active. This prevents momentary changes in output status from triggering the over-voltage protection function. Programmed values can range from 0 to 10 seconds. See also [Section 8.1](#)

Return The query command returns the programmed delay time.

Parameters	Name	Type	Range	Default
	<time>	Numeric	0 – 10 DEFAult	5 ms

Usage example Get default OVP delay of 50 milliseconds:

```
VOLT:PROT:DEL? DEF
0.050
```

Related *SAV
 Commands `OUTPut:PROTection:CLEAr`

5.13.35. `[SOURce[<n>]]:VOLTage:PROTection:STATe`

Syntax `[SOURce[<n>]]:VOLTage:PROTection:STATe {<bool>}`
`[SOURce[<n>]]:VOLTage:PROTection:STATe?`

Description This command enables or disables the over-voltage protection (OVP) function. The enabled state is ON (1); the disabled state is OFF (0). Since the PSU do not have a dedicated over-voltage protection circuit that can be programmed independently of output current level, entering the CV (constant voltage) mode of operation is used as a trigger to start OVP sequence. When delay time specified with the `[SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME]` command expired the output turns off and the Questionable Condition status register OCP bit 8 is set. An error tone will also follow if beeper is enabled (see `SYSTEM:BEEPer:STATe`). `[SOURce[<n>]]:VOLTage:PROTection:TRIPped?` command can be used to query whether over-voltage protection occurred on the selected channel.

Return The query command returns 0 if the voltage protection state is OFF, and 1 if the voltage protection state is ON.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage example `VOLT:PROT:STAT?`
 0

Related *SAV
 Commands `OUTPut:PROTection:CLEAr`
`[SOURce[<n>]]:VOLTage:PROTection:DELay[:TIME]`
`[SOURce[<n>]]:VOLTage:PROTection:TRIPped`
`SYSTEM:BEEPer:STATe`

5.13.36. [SOURce[<n>]]:VOLTage:PROtection:TRIPped?

Syntax [SOURce[<n>]]:VOLTage:PROtection:TRIPped?

Description Query whether OVP occurred on the currently selected channel. When protection is tripped bit 8 (OVP) of the Questionable Instrument Summary register will be set (see [Section 3.4.2](#)).
When channel's output voltage is controlled remotely ([SOURce[<n>]]:VOLTage:PROGram[:SOURce]) this protection will change voltage control back to INTERNAL source.
The [OUTPut:PROtection:CLEar](#) command can be send to clear OVP condition on the selected channel.

Return This query returns a 1 if the protection circuit is tripped and a 0 if it is untripped.

Usage example VOLT:PROT:TRIP?

0

VOLT:PROG?

0

Related Commands OUTPut:PROtection:CLEar
[SOURce[<n>]]:VOLTage:PROGram[:SOURce]

5.13.37. [SOURce[<n>]]:VOLTage:SENSe[:SOURce]

Syntax [SOURce:]VOLTage:SENSe[:SOURce] {INTERNAL|EXTERNAL}
[SOURce:]VOLTage:SENSe[:SOURce]?

Description This command enables or disables remote sensing. The enabled state is EXTERNAL (1); the disabled state is INTERNAL (0). Execution of this command also affects bit 12 (RSENSE) of the Operation Instrument Summary register (see [Section 3.3.2](#)).
Self-test operation initiated by [*TST?](#) command will put remote sense on all PSU channels into disable state.
When the BP_OPTION is enabled and the channels are not grouped together (SYSTEM:GROUp commands scheduled for M3) this command sets LED indicators above binding posts and sense relays in the following manner:

- Turn on/off Sense1 indicator (LED_S1) and sense relay K_S1 when CH1 is selected
- Turn on/off Sense2 indicators (LED_S2) and sense relay K_S2 when CH2 is selected

Remote sensing has no effect during CC (Constant Current) operation. Sense+/Sense-indicators (LED_S1, LED_S2) will not be affected if output state is off (OUTPut OFF command).

Parameters	Name	Type	Range	Default
	<source>	Discrete	INTERNAL EXTERNAL	INTERNAL
Return	The query command returns 0 if the internal sense is selected, and 1 if the remote (external) sense is selected.			
Usage example	VOLT:SENS EXT VOLT:SENS? 1			
Errors	302,"Option not installed" 312,"Cannot execute when the channels are coupled"			
Related Commands	*SAV *TST INSTrument:COUPle:TRACking OUTPut[:STATe] SYSTem:CHANnel[:INformation]:PROGram?			

5.13.38. [SOURce[<n>]:VOLTage:SLEW:FALLing

Not implemented yet

5.13.39. [SOURce[<n>]:VOLTage:SLEW:RISing

Not implemented yet

5.14. STATus

Status register programming lets you determine the operating condition of the instrument at any time. This subsystem controls the SCPI-defined status-reporting structures. SCPI defines, in addition to those in IEEE 488.2, QUEStionable, OPERation, INSTRument SUMmary and INSTRument registers. These registers conform to the IEEE 488.2 specification and each may be comprised of a condition register, an event register, an enable register. The purpose and definition of the SCPI-defined registers is described in "Volume 1: Syntax and Style". SCPI also defines an IEEE 488.2 queue for status. The queue provides a human readable record of instrument events. The application programmer may individually enable events into the queue.

STATus:PRESet enables errors and disables all other events.

SCPI command	Description
STATus	
:OPERation	
[:EVENT]?	Returns the value of the Operation Event register
:CONDition?	Returns the value of the Operation Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Event register
:INSTRument[<n>]	
[:EVENT]?	Returns the value of the Operation Instrument Event register
:CONDition?	Returns the value of the Operation Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Instrument Event register
:ISUMmary<n>	
[:EVENT]?	Returns the value of the Operation Instrument Isummary Event register
:CONDition?	Returns the value of the Operation Instrument Isummary Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Instrument Isummary Event register
:PRESet	Presets all enable registers to power-on state
:QUEStionable	
[:EVENT]?	Returns the value of the Questionable Event register
:CONDition?	Returns the value of the Questionable Condition register
:ENABLE {<value>}	Enables specific bits in the Questionable Event register
:INSTRument[<n>]	
[:EVENT]?	Returns the value of the Questionable Instrument Event register
:CONDition?	Returns the value of the Questionable Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Questionable Instrument Event register
:ISUMmary<n>	
[:EVENT]?	Returns the value of the Questionable Instrument Isummary Event register
:CONDition?	Returns the value of the Questionable Instrument Isummary Condition register

:ENABLe {<value>}

Enables specific bits in the Questionable Instrument Summary Event register

5.14.1. STATus:OPERation[:EVENT]?**Syntax** **STATus:OPERation[:EVENT]?****Description** This query returns the value of the read-only Operation Status Event register. The bits are latched and reading the register will clear it. The *CLS command can be also used to clear the register.**Return** The value returned is the binary-weighted sum of all bits set in the register. For example, if bit 9 (decimal value = 512) and bit 13 (decimal value = 8192) are set, this command will return 8704. See table in the [Section 3.3](#) for bits description.**Usage example** If GROUp PARAllel (bit 8) is set (next query returns 0 since the first query clears the event register):

STAT:OPER?

256

STAT:OPER?

0

Errors**Related** *CLS**Commands** *STB?

STATus:OPERation:ENABLe

5.14.2. STATus:OPERation:CONDition?**Syntax** **STATus:OPERation:CONDition?****Description** This query returns the value of the read-only Operation Status Condition register.**Return** The value returned is the binary-weighted sum of all bits set in the register. For example, if bit 9 (decimal value = 512) and bit 13 (decimal value = 8192) are set, this command will return 8704. See table in the [Section 3.3](#) for bits description.**Usage example** If GROUp PARAllel (bit 8) is set:

STAT:OPER:COND?

256

Errors**Related** STATus:OPERation:ENABLe**Commands****5.14.3. STATus:OPERation:ENABLe****Syntax** **STATus:OPERation:ENABLe {<value>}**
STATus:OPERation:ENABLe?**Description** This command and its query set and read the value of the Operation Status Enable register. The Enable register is a mask for enabling specific bits from the Operation Event register to set the operation summary bit 7 (OPER) of the Status Byte register. This bit is the logical OR of all the Operational Event register bits that are enabled by the Operation Status Enable register.**Return** Query the Operation Status Enable register. The PSU returns a binary-weighted decimal representing the bits set in the enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to	PREset=0

the binary-weighted sum of the bits in the register (see the table in [Section 3.3](#))

Usage example	Enable ISUM (bit 13): <code>STAT:OPER:ENAB 8192</code>
Errors	
Related Commands	*CLS *STB? <code>STATus:OPERation[:EVENT]?</code>

5.14.4. STATus:OPERation:INSTrument[:EVENT]?

Syntax	<code>STATus:OPERation:INSTrument[:EVENT]?</code>
Description	This query returns the value of the read-only Instrument Operation Status Event register. The bits are latched and reading the register will clear it. The *CLS command can be also used to clear the register.
Return	The value returned is the binary-weighted sum of all bits set in the register. For example, if bit 1 (decimal value = 2) and bit 2 (decimal value = 4) are set, this command will return 6. See table in the Section 3.3.1 for bits description.
Usage example	If bit 2 (INST2) is set: <code>STAT:OPER:INST?</code> 4
Errors	
Related Commands	*CLS <code>STATus:PREset</code>

5.14.5. STATus:OPERation:INSTrument:CONDition?

Syntax	<code>STATus:OPERation:INSTrument:CONDition?</code>
Description	This query returns the value of the read-only Instrument Operation Status Condition register.
Return	The value returned is the binary-weighted sum of all bits set in the register. For example, if bit 1 (decimal value = 2) and bit 2 (decimal value = 4) are set, this command will return 6. See table in the Section 3.3.1 for bits description.
Usage example	If bit 2 (INST2) is set: <code>STAT:OPER:INST:COND?</code> 4
Errors	
Related Commands	<code>STATus:PREset</code>

5.14.6. STATus:OPERation:INSTrument:ENABLE

Syntax	<code>STATus:OPERation:INSTrument:ENABLE {<value>}</code> <code>STATus:OPERation:INSTrument:ENABLE?</code>
Description	Enable bits in the Instrument Operation Status Enable register. The selected bits are then reported to the Operation Status Event register.
Return	Query the Instrument Operation Status Enable register. The PSU returns a binary-weighted decimal representing the bits set in the enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to the binary-weighted sum of the bits in the register (see the table in Section 3.3.1)	PREset=0
Usage example	Enable INST1 (bit 1) and INST2 (bit 2): STAT:OPER:INST:ENAB 6			
Errors				
Related Commands	*CLS STATus:PREset			

5.14.7. STATus:OPERation:INSTrument:ISUMmary[<n>][:EVENT]?

Syntax	STATus:OPERation:INSTrument:ISUMmary[<n>][:EVENT]?			
Description	This query returns the value of the read-only Instrument Isummary Operation Status Event register for a specific channel of the PSU represented by numeric value [<n>]. When [<n>] is omitted, the system queries the Instrument Isummary Operation Status Event register of the current channel. The bits are latched and reading the register will clear it. The *CLS command can be also used to clear the register.			
Return	The value returned is the binary-weighted sum of all bits set in the register. See table in the Section 3.3.2 for bits description.			
Usage example	If bit 8 (CV1) and bit 10 (OE1) on the channel 1 are set (256+1024=1280): STAT:OPER:INST:ISUM1? 1280			
Errors				
Related Commands	*CLS OUTPut:MODE?			

5.14.8. STATus:OPERation:INSTrument:ISUMmary[<n>]:CONDition?

Syntax	STATus:OPERation:INSTrument:ISUMmary[<n>]:CONDition?			
Description	This query returns the value of the read-only Instrument Isummary Operation Status Condition register for a specific channel of the PSU represented by numeric value [<n>]. When [<n>] is omitted, the system queries the Instrument Isummary Operation Status Condition register of the current channel.			
Return	The value returned is the binary-weighted sum of all bits set in the register. See table in the Section 3.3.2 for bits description.			
Usage example	If bit 8 (CV1) and bit 10 (OE1) on the channel 1 are set (256+1024=1280): STAT:OPER:INST:ISUM1:COND? 1280			
Errors				
Related Commands	OUTPut:MODE?			

5.14.9. STATus:OPERation:INSTrument:ISUMmary<n>:ENABLE

Syntax	STATus:OPERation:INSTrument:ISUMmary[<n>]:ENABLE {<value>} STATus:OPERation:INSTrument:ISUMmary[<n>]:ENABLE?			
Description	Enable bits in the Instrument Isummary Operation Status Enable register for a specific			

channel of the PSU represented by numeric value [n]. When [n] is omitted, the system queries the Instrument Isummary Operation Status Enable register of the current channel. The selected bits are then reported to the Status Byte.

This command and its query set and read the value of the Operation Status Enable register. The Enable register is a mask for enabling specific bits from the Operation Event register to set the operation summary bit (OPER) of the Status Byte register. This bit (bit 7) is the logical OR of all the Operational Event register bits that are enabled by the Operation Status Enable register

Return Query the Instrument Isummary Operation Status Enable register. The PSU returns a binary-weighted decimal representing the bits set in the enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to the binary-weighted sum of the bits in the register (see the table in Section 3.3.2)	PREset=0

Usage example The query returns that VOLT1 (bit 0), CURR1 (bit 1) and TEMP1 (bit 4) are set (1+2+16=19):

```
INST?
CH2

INST CH1
STAT:OPER:INST:ISUM:ENABLE?

19
```

Errors

Related Commands *CLS
STATus:PREset

5.14.10. STATus:PREset

Syntax STATus:PREset

Description This command clears all bits in the Enable registers.

Return None

Usage example STAT:PRE

Errors

Related Commands *CLS

5.14.11. STATus:QUEStionable[:EVENT]?

Syntax STATus:QUEStionable[:EVENT]?

Description Query the Questionable Status event register. The bits are latched and reading the register will clear it. The *CLS command can be also used to clear the register.

Return The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register. See table in the [Section 3.4](#) for bits description.

Usage example If the error is detected in RTC (Real-time clock) circuit, the bit 3 (TIME) is set and this command returns 8:

```
STAT:QUES?

8
```

Errors

Related *CLS
Commands

5.14.12. STATus:QUEStionable:CONDition?Syntax **STATus:QUEStionable:CONDition?**

Description Query the Questionable Status condition register.

Return The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register. See table in the [Section 3.4](#) for bits description.

Usage example If the error is detected in RTC (Real-time clock) circuit, the bit 3 (TIME) is set and this command returns 8:

STAT:QUES:COND?

8

Errors

Related
Commands

5.14.13. STATus:QUEStionable:ENABle

Syntax **STATus:QUEStionable:ENABle {<value>}**
STATus:QUEStionable:ENABle?

Description Enable bits in the Questionable Status Enable register. The selected bits are then reported to the Status Byte.
When <enable value> is set to 0, executing this command will clear the Questionable Status Enable register.

Return Query the Questionable Status Enable register. The PSU returns a binary-weighted decimal representing the bits set in the enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to the binary-weighted sum of the bits in the register (see table in Section 3.4)	PREset=0

Usage example The query returns that TIME (bit 3), TEMPerature (bit 4) and ISUM (bit 13) are enabled (8+16+8192=8216):

STAT:QUES:ENAB?

8216

Errors

Related *CLS
Commands STATus:PREset

5.14.14. STATus:QUEStionable:INSTrument[:EVENT]?Syntax **STATus:QUEStionable:INSTrument[:EVENT]?**

Description Query the questionable instrument event register. The bits are latched and reading the register will clear it. The *CLS command can be also used to clear the register.

Return The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register and clears the register. See table in the [Section 3.4.1](#) for bits description.

Usage example Result of the query when INST1 (bit 1) and INST2 (bit 2) are set (2+4=6):
 STAT:QUES:INST?
 6

Errors

Related Commands *CLS

5.14.15. STATus:QUEStionable:INSTrument:CONDition?

Syntax STATus:QUEStionable:INSTrument:CONDition?

Description Query the questionable instrument condition register.

Return The PSU returns a decimal value which corresponds to the binary-weighted sum of all bits in the register and clears the register. See table in the [Section 3.4.1](#) for bits description.

Usage example Result of the query when INST1 (bit 1) and INST2 (bit 2) are set (2+4=6):
 STAT:QUES:INST:COND?
 6

Errors

Related Commands

5.14.16. STATus:QUEStionable:INSTrument:ENABLE

Syntax STATus:QUEStionable:INSTrument:ENABLE {<value>}
 STATus:QUEStionable:INSTrument:ENABLE?

Description Set the value of the questionable instrument enable register. This register is a mask for enabling specific bits from the questionable instrument event register to set the instrument summary bit 13 (ISUM) of the Questionable Status register. The ISUM bit of the Questionable Status register is the logical OR of all the questionable instrument event register bits that are enabled by the questionable instrument enable register.

Return Query the Questionable Instrument Enable register. The PSU returns a binary-weighted decimal representing the bits set in the enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to the binary-weighted sum of the bits in the register (see table in Section 3.4.1)	PREset=0

Usage example Set INST1 (bit 1) and INST2 (bit 2):
 STAT:QUES:INST:ENAB 6

Errors

Related Commands *CLS

5.14.17. STATus:QUEStionable:INSTrument:ISUMmary[<n>][:EVENT]?

Syntax STATus:QUEStionable:INSTrument:ISUMmary[<n>][:EVENT]?

Description Return the value of the Questionable Instrument Isummary Event register for a specific channel of the PSU represented by numeric value [<n>]. When [<n>] is omitted, the system queries the questionable instrument Isummary enable register of the current chan-

nel. The event register is a read-only register which holds (latches) all events. Reading the Questionable Instrument Isummary Event register clears it. The *CLS command can be also used to clear the register.

When the PSU is operating as a voltage source, bit 1 (CURRENT) is set. When the PSU is operating as a current source, bit 0 (VOLTage) is set. When the output is unregulated (UR), both bits are set (for example, while the output is changing to a new programmed value or when the PSU is sinking instead of sourcing because down-programmer is active with battery with higher voltage then set output is connected).

Return The PSU returns a binary-weighted decimal representing the bits set in the enable register. See table in the [Section 3.4.2](#) for bits description.

Usage example Result of the query when over-current protection (OCP) condition is detected (bit 9):

```
STAT:QUES:INST:ISUM1?
512
```

Errors

Related Commands *CLS

5.14.18. **STATus:QUESTIONable:INSTrument:ISUMmary[<n>]:CONDition?**

Syntax **STATus:QUESTIONable:INSTrument:ISUMmary[<n>]:CONDition?**

Description Return the value of the Questionable Instrument Isummary Condition register for a specific channel of the PSU represented by numeric value [<n>]. When [<n>] is omitted, the system queries the questionable instrument Isummary enable register of the current channel.

When the PSU is operating as a voltage source, bit 1 (CURRENT) is set. When the PSU is operating as a current source, bit 0 (VOLTage) is set. When the output is unregulated (UR), both bits are set (for example, while the output is changing to a new programmed value or when the PSU is sinking instead of sourcing because down-programmer is active with battery with higher voltage then set output is connected).

Return The PSU returns a binary-weighted decimal representing the bits set in the enable register. See table in the [Section 3.4.2](#) for bits description.

Usage example Result of the query when over-current protection (OCP) condition is detected (bit 9):

```
STAT:QUES:INST:ISUM1:COND?
512
```

Errors

Related Commands

5.14.19. **STATus:QUESTIONable:INSTrument:ISUMmary[<n>]:ENABle**

Syntax **STATus:QUESTIONable:INSTrument:ISUMmary[<n>]:ENABle {<value>}**
STATus:QUESTIONable:INSTrument:ISUMmary[<n>]:ENABle?

Description Set the value of the Questionable Instrument Isummary Enable register for a specific channel of the PSU represented by numeric value [<n>]. When [<n>] is omitted, the system queries the Questionable Instrument Isummary Enable register of the current channel. The *CLS command can be used to clear the register.

This register is a mask for enabling specific bits from the Questionable Instrument Isummary Event register to set the Instrument Summary bit (bits 1 and 2) of the Questionable Instrument register. These bits are the logical OR of all the Questionable Instrument Isummary Event register bits that are enabled by the Questionable Instrument Isummary Enable register.

Return Query the value of the Questionable Instrument Isummary Enable register.

Parameters	Name	Type	Range	Default
	<value>	Numeric	A decimal value which corresponds to the binary-weighted sum of the bits in the register (see table in Section 3.4.2)	PREset=0

Usage example Enable bits for all events on channel 2 – VOLT2 (bit 0, value=1), CURR (bit 1, decimal value=2), TEMP2 (bit 4, value 16), OVP1 (bit 8, value=256), OCP2 (bit 9, value=512), OPP2 (bit 10, value=1024), therefore the enable value is 1+2+16+256+512+1024=1811:

```
STAT:QUES:INST:ISUM2:ENAB 1811
```

Errors

Related *CLS

Commands STATus:PREset

5.15. SYSTem

System commands control system functions that are not directly related to output control, measurement, or status functions.

SCPI command	Description
SYSTem	
:BEEPer[:IMMediate]	Issues a single beep immediately
:KEY	
:STATe {<bool>}	Enables click tone for local control
:STATe {<bool>}	Enables beeper function
:CAPability?	Returns an <instrument_specifier>
CHANnel	
[:COUNT]?	Returns the number of output channels
INFOrmation	
:CURRent?	Returns output current capability
:ONTime	
LAST?	Returns time passed after last output enable
TOTal?	Returns channel's total active time
:POWer?	Returns output power capability
:PROGram?	Returns programmable features of the channel
:VOLTAge?	Returns output voltage capability
:MODEl?	Returns the channel model identification
COMMunicate	
:ENABLE {<bool>, <interface>}	Enables the remote interface
ETHernet	
:ADDRess {<ip_address>}	Sets the static LAN (IP) address
:CONTRol? (Not implemented in M4)	Returns the control connection port
:DHCP {<bool>}	Enables the use of the Dynamic Host Configuration Protocol (DHCP)
:DNS <ip_address>	Sets the IP address of the DNS server.
:GATEWay {<ip_address>}	Sets the IP address of the default gateway
:HOSTname {<name>}	Sets the host name
:MAC?	Returns the MAC address
:PORT {<number>}	Sets the port number
:SMASk {<mask>}	Sets the static subnet mask
:NTP {<server>}	Set s NTP service server address
:RLSTate {<state>}	Places the instrument in remote or local mode
SERial	
:BAUD {<speed>}	Sets the baud rate (speed)
:BITS {<number>}	Sets the data bit number
:PARity {<parity>}	Sets the parity mode
:SBITs {<number>}	Sets the stop bit
CPU	

:INfOrmatIOn	
:ETHeRnet	
:TYPE?	Returns the type of Ethernet controller
:ONtime	
LAST?	Returns time passed after last power on
TOTal?	Returns PSU's total active time
:TYPE?	Returns the type of CPU
:MODEl?	Returns the control board model identification
:OPTIon?	Returns information about installed options on the control board
:DATE {<year>,<month>,<day>}	Sets the date of the system clock
:ERRor	
[:NEXT]?	Queries and clears errors from the error queue
:COUNT?	Queries the error/event queue for the number of unread items
:KLOCK	Disables front panel [lock/unlock] icon
:LOCAL	Places the PSU in the local mode
:PASSword	
:CALibration	
:RESet	Resets the calibration password to initial value
:FPANel	
:RESet	Resets the front panel lock password to initial value
:NEW {<old>,<new>}	Changes system password
:PON:OUTPut:DISable {<bool>}	Sets output state on power up
:POWER {<bool>}	Enters the PSU into the Stand-by mode
:PROTection:TRIP {<bool>}	Enters the PSU into the Stand-by mode in case of protection trip
:REMote	Places the PSU in the remote mode
:RWLock	Places the PSU in the remote mode and disables front panel [lock/unlock] icon
:TEMPerature	
:PROTection	
[:HIGH]	
[:LEVel] {<temperature>[,<sensor>]}	Sets the OTP value
:CLEar[,<sensor>]}	Clears the latched protection status of the over-temperature protection (OTP)
:DElay	
[:TIME] {<delay>[,<sensor>]}	Sets the OTP programming delay
:STATe {<bool>[,<sensor>]}	Enables/disables OTP on the selected temperature sensor
:TRIPped? [<sensor>]	Returns status of OTP activation
:TIME {<hours>,<minutes>,<seconds>}	Sets the time of the system clock
:VERSion?	Returns the SCPI version number

5.15.1. SYSTem:BEEPer

Syntax `SYSTem:BEEPer[:IMMEDIATE]`

Description This command issues a single beep immediately.

Usage example `SYST:BEEP`

5.15.2. SYSTem:BEEPer:KEY:STATe

Syntax `SYSTem:BEEPer:KEY:STATe {<bool>} (not implemented in M3)`
`SYSTem:BEEPer:KEY:STATe?`

Description Use this command to enable or disable generation of audible “click” sound when front panel option is selected.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage example `SYST:BEEP:KEY:STAT ON`

Related Commands `SYSTem:BEEPer[:IMMEDIATE]`
`SYSTem:BEEPer:STATe`

5.15.3. SYSTem:BEEPer:STATe

Syntax `SYSTem:BEEPer:STATe {<bool>}`
`SYSTem:BEEPer:STATe?`

Description When the beeper is enabled, the PSU generates audible sound in any of the following situations:

- the power is turns on or off (see `SYSTem:POWer`),
- when error occurs during front panel operation or remote operation (see [Section 7](#) for the list of error messages),
- self-test is failed and
- any of the protection function is “tripped”

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	ON

Usage example `SYST:BEEP:STAT ON`
`SYST:BEEP:STAT?`
1

Related Commands `SYSTem:BEEPer[:IMMEDIATE]`
`SYSTem:POWer`

5.15.4. SYSTem:CAPability?

Syntax `SYSTem:CAPability?`

Description This query returns the PSU’s capabilities and outputs the appropriate specifiers. See also SCPI Volume 4: Section 7.1, 1.4.1, 7.2.1, 7.2.2, and 7.2.3

Usage example `SYSTem:CAPability?`
`DCSUPPLY WITH (MEASURE|MULTIPLE|TRIGGER)`

5.15.5. SYSTem:CHANnel[:COUNT]?

Syntax `SYSTem:CHANnel[:COUNT]?`

Description This query returns the number of output channels in a mainframe.

Usage example `SYSTem:CHANnel?`
2

Related Commands `INSTRument[:SElect]`
`INSTRument:NSElect`

5.15.6. SYSTem:CHANnel:INFOrmation:CURRent?

Syntax `SYSTem:CHANnel:INFOrmation:CURRent? [<channel>]`

Description Use this query to get currently selected channel output current capability.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	—
Usage example	<code>SYST:CHAN:INFO:CURR?</code> 5.00			

5.15.7. SYSTem:CHANnel:INFOrmation:ONTime:LAST?

Syntax `SYSTem:CHANnel:INFOrmation:ONTime:LAST? [<channel>]`

Description This query returns time passed after last activation of the currently selected channel. Resolution is 1 minute and this information is stored every 10 minutes in non-volatile memory. Therefore it's possible that up to 10 minutes is lost after restart caused with power outage or system reset.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	—
Usage example	<code>SYST:CHAN:INFO:ONT:LAST?</code> 15m			

5.15.8. SYSTem:CHANnel:INFOrmation:ONTime:TOTal?

Syntax `SYSTem:CHANnel:INFOrmation:ONTime:TOTal? [<channel>]`

Description This query returns total active time of the currently selected channel. Resolution is 1 minute and this information is stored every 10 minutes in non-volatile memory. Therefore it's possible that up to 10 minutes is lost after restart caused with power outage or system reset.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	—
Usage example	<code>SYST:CHAN:INFO:ONT:TOT?</code> 1h 45m			

5.15.9. SYSTem:CHANnel:INFOrmation:POWEr?

Syntax `SYSTem:CHANnel:INFOrmation:POWEr? [<channel>]`

Description Use this query to get currently selected channel output power capability.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	—
Usage example	<code>SYST:CHAN:INFO:POW?</code> 160.00			

5.15.10. SYSTem:CHANnel:INFOrmation:PROGram?

Syntax **SYSTem:CHANnel:INFOrmation:PROGram? [<channel>]**

Description This query returns names of all channel board functionality that can be controlled by firmware. Depending of the board model (see the SYSTem:CHANnel:MODEl? query) various combination of the following features can be returned:

- Volt – program the output voltage while channel is in the CV mode of operation (see [SOURce[<n>]]:VOLTage and APPLy commands)
- Current – program the output current while channel is in the CC mode of operation (see [SOURce[<n>]]:CURRent and APPLy commands)
- Power – set max. allowed output power regardless of the channel mode of operation (see [SOURce[<n>]]:POWer:LIMit)
- OE – set channel power output (see OUTPut[:STATe])
- Dprog – control down-programmer circuit (see OUTPut:DPRog)
- LRipple – set low power mode of operation when SMPS pre-regulator is switched off (see OUTPut:LRIPple)
- Rprog – control output voltage programming source (see [SOURce[<n>]]:VOLTage:PROGram[:SOURce])

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Usage example	SYST:CHAN:INFO:PROG? CH1 "Volt", "Current", "Power", "OE", "DProg", "LRipple", "Rprog"			
Related Commands	APPLy OUTPut:DPRog OUTPut:MODE? OUTPut[:STATe] OUTPut:LRIPple [SOURce[<n>]]:CURRent [SOURce[<n>]]:POWer:LIMit [SOURce[<n>]]:VOLTage [SOURce[<n>]]:VOLTage:PROGram[:SOURce] SYSTem:CHANnel:MODEl?			

5.15.11. SYSTem:CHANnel:INFOrmation:VOLTage?

Syntax **SYSTem:CHANnel:INFOrmation:VOLTage? [<channel>]**

Description Use this query to get currently selected channel output voltage capability.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Usage example	SYST:CHAN:INFO:VOLT? 40.00			

5.15.12. SYSTem:CHANnel:MODEl?

Syntax **SYSTem:CHANnel:MODEl? [<channel>]**

Description This query returns the model identification string of the specified channel.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	–
Usage example	SYST:CHAN:MOD? "Power_r5B6b", "Postreg_r4B43a"			

```
SYST:CHAN:MOD? CH2
```

```
"Postreg_r4B43a"
```

5.15.13. SYSTem:COMMunicate:ENABLE

Syntax `SYSTem:COMMunicate:ENABLE {<bool>, <interface>}`
`SYSTem:COMMunicate:ENABLE? {<bool>, <ininterface>}`

Description Enables or disables the remote interface Serial (via USB), Ethernet, NTP service, or the remote service Sockets. The setting is effective after rebooting the PSU. This command setting is not changed by power off or the *RST command.

Remote service Sockets is not supported in M4

Return This query returns the status of the selected interface that could be 0 (OFF) or 1 (ON).

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
	<interface>	Discrete	SERial ETHernet NTP SOCKets	–

Usage example `SYST:COMM:ENAB 1, ETH`
`SYST:COMM:ENAB 0, SER`

Errors

Related Commands

5.15.14. SYSTem:COMMunicate:ETHernet :ADDRess

Syntax `SYSTem:COMMunicate:ETHernet:ADDRess {<ip_address>}`
`SYSTem:COMMunicate:ETHernet:ADDRess?`

Description Set the IP address of the system manually if the DHCP mode is not enabled. If the DHCP mode is enabled setting the IP address using this command will be ignored.

Return The query returns the current IP address sets manually or assigned by the DHCP server.

Parameters	Name	Type	Range	Default
	<ip_address>	Quoted string	15 characters max. formatted as four groups of up to 3 digits (range 0–255), separated by "."	–

Usage example `SYST:COMM:ETH:ADDR?`
`192.168.5.55`

Errors

Related Commands `SYSTem:COMMunicate:ETHernet:DHCP`

5.15.15. SYSTem:COMMunicate:ETHernet:DHCP

Syntax `SYSTem:COMMunicate:ETHernet:DHCP {<bool>}`
`SYSTem:COMMunicate:ETHernet:DHCP?`

Description Enable or disable the DHCP mode. In DHCP mode, the DHCP server in the current network assigns network parameters (IP Address, DNS address, GATEway address and the Subnet MASK) for the PSU.

Return Query the status of the DHCP mode.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	ON

Usage example `SYST:COMM:ETH:DHCP?`
 1

Errors

Related
 Commands

5.15.16. **SYSTem:COMMunicate:ETHernet:DNS**

Syntax `SYSTem:COMMunicate:ETHernet:DNS {<ip_address>}`
 `SYSTem:COMMunicate:ETHernet:DNS?`

Description Set the DNS (Domain Name Service) address if the DHCP mode is not enabled. If the DHCP mode is enabled setting the DNS address using this command will be ignored.

Return The query returns the DNS address sets manually or assigned by the DHCP server.

Parameters	Name	Type	Range	Default
	<ip_address>	Quoted string	15 characters max. formatted as four groups of up to 3 digits (range 0–255), separated by "."	–

Usage example `SYST:COMM:ETH:DNS "192.168.1.200"`

Errors

Related `SYSTem:COMMunicate:ETHernet:DHCP`
 Commands

5.15.17. **SYSTem:COMMunicate:ETHernet:GATEway**

Syntax `SYSTem:COMMunicate:ETHernet:GATEway {<ip_address>}`
 `SYSTem:COMMunicate:ETHernet:GATEway?`

Description Set the network gateway address if the DHCP mode is not enabled. If the DHCP mode is enabled setting the network gateway address using this command will be ignored.

Return The query returns the network gateway address sets manually or assigned by the DHCP server.

Parameters	Name	Type	Range	Default
	<ip_address>	Quoted string	15 characters max. formatted as four groups of up to 3 digits (range 0–255), separated by "."	–

Usage example `SYST:COMM:ETH:GATE?`
 `"192.168.1.1"`

Errors

Related `SYSTem:COMMunicate:ETHernet:DHCP`
 Commands

5.15.18. **SYSTem:COMMunicate:ETHernet:HOSTname**

Syntax `SYSTem:COMMunicate:ETHernet:HOSTname {<name>}`
 `SYSTem:COMMunicate:ETHernet:HOSTname?`

Description Set and query the PSU host name. The default host name is EEZ-PSU<serial_no>; where serial_no is the PSU Serial Number. If you set an empty host name (""), the host name will be set to its default value.

The Internet standards ([RFC 1123](#)) mandate that component host name labels may contain only the ASCII letters 'a' through 'z' (in a case-insensitive manner), the digits '0' through '9', and the hyphen ('-')

Return The query returns the PSU host name as a quoted string.

Parameters	Name	Type	Range	Default
------------	------	------	-------	---------

	<name>	quoted string	0 to 16 characters	EEZ-PSU<serial_no>
--	--------	---------------	--------------------	--------------------

Usage example The *IDN? command is used to see that PSU's serial number (16.0002) is present in default host name. Then the new host name is defined (BENCHPSU1):

```
*IDN?
EEZ,PSU 2/40/05 (Due),16.0002,M4
SYST:COMM:ETH:HOST?
"EEZ-PSU16.0002"
SYST:COMM:ETH:HOST "BENCHPSU1"
SYST:COMM:ETH:HOST?
"BENCHPSU1"
```

Errors

Related Commands *IDN?

5.15.19. SYSTem:COMMunicate:ETHernet:MAC

Syntax SYSTem:COMMunicate:ETHernet:MAC?

Description Query the MAC (Media Access Control) address of the Ethernet interface.

The Media Access Control (MAC) number is a unique number associated with each network adapter.

Return The query returns the MAC address as a quoted string (hexadecimal value without a prefix or separators).

Usage example

```
SYST:COMM:ETH:MAC?
"01020314AEB8"
```

Errors

Related Commands

5.15.20. SYSTem:COMMunicate:ETHernet:PORT

Syntax SYSTem:COMMunicate:ETHernet:PORT {<number>}
SYSTem:COMMunicate:ETHernet:PORT?

Description Use this command to change default (5025) Ethernet communication port for SCPI.

Return The query returns the Ethernet communication port number.

Parameters	Name	Type	Range	Default
------------	------	------	-------	---------

	<number>	Numeric	1-65535	5025
--	----------	---------	---------	------

Usage example

```
SYST:COMM:ETH:PORT?
5025
```

Errors

Related Commands SYSTem:COMMunicate:ENABLE
SYSTem:COMMunicate:ETHernet:CONTrol? (Not implemented in M4)

5.15.21. SYSTem:COMMunicate:ETHernet:SMASk

Syntax `SYSTem:COMMunicate:ETHernet:SMASk {<mask>}`
`SYSTem:COMMunicate:ETHernet:SMASk?`

Description Set the subnet mask if the DHCP mode is not enabled. If the DHCP mode is enabled setting the network gateway address using this command will be ignored.

Return The query returns the subnet mask sets manually or assigned by the DHCP server.

Parameters	Name	Type	Range	Default
	<mask>	Quoted string	15 characters max. formatted as four groups of up to 3 digits (range 0–255), separated by "."	–

Usage example `SYST:COMM:ETH:SMAS "255.255.255.0"`

Errors

Related Commands `SYSTem:COMMunicate:ETHernet:DHCP`

5.15.22. SYSTem:COMMunicate:NTP

Syntax `SYSTem:COMMunicate:NTP {<server>}`
`SYSTem:COMMunicate:NTP?`

Description Use this command to set the NTP service server network address.

Return The query command returns the NTP service server network address.

Parameters	Name	Type	Range	Default
	<server>	Quoted string	IP address or NTP server host name up to 32 characters	europe.pool.ntp.org

Usage example `SYST:COMM:ENAB NTP`
`SYST:COMM:NTP "ntp.ubuntu.com"`

Related Commands `SYSTem:COMMunicate:ENABLE`
`SYSTem:DATE`
`SYSTem:TIME`

5.15.23. SYSTem:COMMunicate:RLState

Syntax `SYSTem:COMMunicate:RLState {<state>}`
`SYSTem:COMMunicate:RLState?`

Description This command configures the remote/local state of the PSU according to the following settings:

- **LOCAL** – The PSU is set to front panel and remote interface control.
- **REMOTE** – The PSU is set to front panel and remote interface control.
- **RWLock** – The front panel keys are disabled. The PSU can only be controlled via the remote interface. This programmable setting is completely independent from the front panel lock/unlock function that is available from the front panel menu. If you use this command to lock the front panel, the front panel will be unlocked when AC power is cycled.

The **LOCAL** parameter is the same as `SYSTem:LOCAL`, the **REMOTE** parameter is the same as `SYSTem:REMOTE`, and the **RWLock** parameter is the same as `SYSTem:RWLock`.

The remote/local state is unaffected by `*RST` or any SCPI commands other than `SYS-`

	Tem:COMMunicate:RLState.			
Return	The query command returns control state of the PSU that could be LOC, REM, or RWL.			
Parameters	Name	Type	Range	Default
	<state>	Discrete	LOCa REMOte RWLock	LOCa
Usage example	SYST:COMM:RLST? "LOC"			
Related Commands	*RST SYSTem:LOCa SYSTem:REMOte SYSTem:RWLock			

5.15.24. SYSTem:COMMunicate:SERial:BAUD

Syntax	SYSTem:COMMunicate:SERial:BAUD {<speed>} SYSTem:COMMunicate:SERial:BAUD			
Description	Set the baud rate of the serial (via USB) interface and the unit is Baud.			
Return	Query the baud rate of the serial interface.			
Parameters	Name	Type	Range	Default
	<speed>	Numeric	4800 7200 9600 14400 19200 38400 57600 115200	9600
Usage example	SYST:COMM:SER:BAUD 38400 SYST:COMM:SER:BAUD? 38400			
Errors				
Related Commands	SYSTem:COMMunicate:ENABLE			

5.15.25. SYSTem:COMMunicate:SERial:BITS

Syntax	SYSTem:COMMunicate:SERial:BITS {<number>} SYSTem:COMMunicate:SERial:BITS?			
Description	Set the data bit number of the serial (via USB) interface.			
Return	Query the data bit number of the serial interface.			
Parameters	Name	Type	Range	Default
	<number>	Numeric	5 6 7 8	8
Usage example	SYST:COMM:SER:BITS? 7			
Errors				
Related Commands				

5.15.26. SYSTem:COMMunicate:SERial:PARity

Syntax	SYSTem:COMMunicate:SERial:PARity {<parity>} SYSTem:COMMunicate:SERial:PARity?			
Description	Set the parity mode of the serial (via USB) interface.			
Return				
Parameters	Name	Type	Range	Default

	<parity>	Discrete	NONE ODD EVEN	NONE
Usage example	SYST:COMM:SER:PAR?			
	NONE			
Errors				
Related Commands				

5.15.27. SYSTem:COMMunicate:SERial:SBITs

Syntax [SYSTem:COMMunicate:SERial:SBITs {<number>}](#)
[SYSTem:COMMunicate:SERial:SBITs?](#)

Description Set the stop bit of the serial (via USB) interface.

Return Query the current stop bit.

Parameters	Name	Type	Range	Default
	<number>	Numeric	1 2	1

Usage example `SYST:COMM:SER:SBIT?`
 1

Errors

Related Commands

5.15.28. SYSTem:CPU:INFOrmation:ETHernet:TYPE?

Syntax [SYSTem:CPU:INFOrmation:ETHernet:TYPE?](#)

Description This query returns the name of Ethernet controller installed on the control board (Arduino shield). If simulator is used it returns "Simulator".

Return The information will be returned as a list of quoted strings.

Usage example `SYST:CPU:INFO:ETH:TYPE?`
 "W5500"

5.15.29. SYSTem:CPU:INFOrmation:ONTime:LAST?

Syntax [SYSTem:CPU:INFOrmation:ONTime:LAST? \[<channel>\]](#)

Description This query returns time passed after last activation of the PSU. Resolution is 1 minute and this information is stored every 10 minutes in non-volatile memory. Therefore it's possible that up to 10 minutes is lost after restart caused with power outage or system reset.

Parameters	Name	Type	Range	Default
	<channel>	Discrete	CH1 CH2	—

Usage example `SYST:CPU:INFO:ONT:LAST?`
 15m

5.15.30. SYSTem:CPU:INFOrmation:ONTime:TOTal?

Syntax [SYSTem:CPU:INFOrmation:ONTime:TOTal? \[<channel>\]](#)

Description This query returns total active time of the PSU. Resolution is 1 minute and this information is stored every 10 minutes in non-volatile memory. Therefore it's possible that up to 10 minutes is lost after restart caused with power outage or system reset.

Parameters	Name	Type	Range	Default
------------	------	------	-------	---------

	<channel>	Discrete	CH1 CH2	—
Usage example	SYST:CPU:INFO:ONT:TOT? 1h 45m			
5.15.31.	SYSTem:CPU:INfOrmation:TYPE?			
Syntax	SYSTem:CPU:INfOrmation:TYPE?			
Description	This query returns the name of CPU installed on the control board (Arduino shield). If simulator is used it returns "Simulator".			
Usage example	SYST:CPU:TYPE? "Due"			
Related Commands	*IDN?			
5.15.32.	SYSTem:CPU:MODeI?			
Syntax	SYSTem:CPU:MODeI?			
Description	This query returns the name of the control board (Arduino shield). If simulator is used it returns "Simulator" and its version.			
Usage example	If revision 1 Arduino shield is detected: SYST:CPU:MODeI? "Arduino", "r5B12" If firmware is running on simulator: SYST:CPU:MODeI? "Simulator", "M4.0"			
Related Commands	SYSTem:CPU:OPTion?			
5.15.33.	SYSTem:CPU:OPTion?			
Syntax	SYSTem:CPU:OPTion?			
Description	This query returns a list of all installed options on the control board.			
Return	The information will be returned as a list of quoted strings.			
Usage example	SYST:CPU:MODeI? "BPost", "EEPROM", "RTC", "SDcard", "Ethernet", "USB", "Ext_trig", "Ext_prog", "Watchdog", "Fan"			
Related Commands	SYSTem:CPU:MODeI?			
5.15.34.	SYSTem:DATE			
Syntax	SYSTem:DATE {<year>,<month>,<day>} SYSTem:DATE?			
Description	Sets the date of the system clock (RTC). Specify the year, month, and day. The self-test procedure compare date and time stored in RTC registers with values stored in the non-volatile memory (EEPROM). When the later is greater then former or any of them lost integrity (i.e. any of value is outside allowed range: for example seconds are higher then 60 or months are higher then 12, etc.) self-test will failed. The *TST? will return 1 and detailed report could be queried using the DIAGnostic:TEST? command.			

The bit 3 (TIME) of the Questionable Status register will be set (see [Section 3.4](#)) if date-

time self-test failed or datetime was never set.

Return Query the current date of the system clock in YYYY, MM, DD format.

Parameters	Name	Type	Range	Default
	<year>	Numeric	2000 – 2099	–
	<month>	Numeric	1 – 12	–
	<day>	Numeric	1 – 31	–

Usage example
SYST:DATE?
2015, 10, 24

Related Commands
*TST?
DIAGnostic[:INFormation]:TEST?
SYSTem:TIME

5.15.35. SYSTem:ERRor

Syntax SYSTem:ERRor[:NEXT]?

Description This query command reads and clear errors from the error queue. A record of up to 20 errors can be stored in the PSU's error queue. See also "Error Messages" in [Section 7](#). Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. The PSU beeps once each time an error is generated. The error queue is cleared when power has been off or after a *CLS command.

Return SYSTem:ERRor[:NEXT]? queries and clears the error messages in the error queue. The query returns the number and content of the error message.

Usage example
SYST:ERR?
-113,"Undefined header"

Errors If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with:

-350,"Queue overflow"

No additional errors are stored until you remove errors from the queue.

Related Commands
*CLS
*RST
SYSTem:ERRor:COUNT

5.15.36. SYSTem:ERRor:COUNT?

Syntax SYSTem:ERRor:COUNT?

Description This query command queries the error/event queue for the number of unread items. As errors and events may occur at any time, more items may be present in the queue at the time it is actually read.

Usage example
SYST:ERR:COUNT?
10

Related Commands
*CLS
*RST
SYSTem:ERRor[:NEXT]

5.15.37. SYSTem:KLOCK

Syntax SYSTem:KLOCK

Description This command similar to the SYSTem:REMOte command disables all front-panel options except for [Lock/Unlock] icon. You can push and hold the [Lock/Unlock] for a few seconds to unlock the front panel. The system password may be needed if it is set.

Lock state is saved in non-volatile memory. Therefore, the front panel remains locked even after AC power is cycled.

Usage example `SYST:LOC`

Related Commands `SYSTem:COMMunicate:RLState`
 `SYSTem:REMOte`

5.15.38. **SYSTem:LOCal**

Syntax **`SYSTem:LOCal`**

Description This command places the PSU in the local mode during remote operation. All options on the front panel are fully functional.

Usage example `SYST:LOC`

Related Commands `SYSTem:COMMunicate:RLState`
 `SYSTem:REMOte`
 `SYSTem:RWLock`

5.15.39. **SYSTem:PASSword:CALibrate:RESet**

Syntax **`SYSTem:PASSword:CALibrate:RESet`**

Description This command resets the calibration password to the firmware default setting, which is "eezpsu". This command does not reset the system password.

Usage example `SYST:PASS:CAL:RES`

Related Commands `CALibration[:MODE]`
 `CALibration:PASSword:NEW`

5.15.40. **SYSTem:PASSword:FPANel:RESet**

Syntax **`SYSTem:PASSword:FPANel:RESet`**

Description This command resets the front panel lockout password to the firmware default setting, which is empty space (""). This command does not reset the calibration password.

Usage example `SYST:PASS:FPAN:RES`

Related Commands `SYSTem:KLOCK`
 `SYSTem:PASSword:NEW`

5.15.41. **SYSTem:PASSword:NEW**

Syntax **`SYSTem:PASSword:NEW {<old code>, <new>}`**

Description Enter a new system password. To change the password, first unsecure the PSU using the old password. Then, the new code has to be entered. The calibration code may contain up to 16 characters over the remote interface. Minimum length is 4 characters. The new password is automatically stored in non-volatile memory

Parameters	Name	Type	Range	Default
	<old>	Quoted string	0 to 16 characters	–
	<new>	Quoted string	4 to 16 characters	–

Usage example `SYST:PASS:NEW "", "mypass2016"`

Errors `122, "Invalid sys password"`
 `125, "Sys password too long"`

```
126,"Sys password too short"
```

Related
Commands SYSTem:KLOCK

5.15.42. SYSTem:PON:OUTPut:DISable

Syntax [SYSTem:PON:OUTPut:DISable {<bool>}](#)
[SYSTem:PON:OUTPut:DISable?](#)

Description This command controls status off all channel outputs on power up. If enabled (ON), all outputs will be disabled regardless of what is stored in user profile selected for auto recall.

Return Query returns status of forced output disabling on power up.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage
example OUTP?
1
SYST:PON:OUTP 1
(Restart)
OUTP?
0

Related
Commands MEMory:STATe:RECall:AUTO
SYSTem:POWer

5.15.43. SYSTem:POWer

Syntax [SYSTem:POWer {<bool>}](#)
[SYSTem:POWer?](#)

Description This command controls powering down and powering up sequence of the AC power inputs. The “Stand-by” indicator (LED_PWR, TLC5925 Out15) will be switched on when the PSU enters the Stand-by mode.

Return Query returns PSU power Stand-by status.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage
example SYST:POW ON
SYST:POW?
1

Related
Commands *RST
*TST?
SYSTem:BEEP:STATe

5.15.44. SYSTem:POWer:PROTection:TRIP

Syntax [SYSTem:POWer:PROTection:TRIP {<bool>}](#)
[SYSTem:POWer:PROTection:TRIP?](#)

Description Use this command to shut down (stand-by) the PSU when any of channel's protection tripped. The SYSTem:POWer command has to be used to power the PSU on again.

Return Query returns status of shutdown when tripped mode.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	OFF

Usage example `SYST:POW:PROT:TRIP?`
1

Related Commands `SYSTem:POWer`

5.15.45. **SYSTem:REMOte**

Syntax `SYSTem:REMOte`

Description Use this command to place the PSU into remote mode for serial (via USB) or Ethernet remote control. All front-panel options are disabled except for [Lock/Unlock] icon. You can push and hold the [Lock/Unlock] for a few seconds to unlock the front panel. The system password may be needed if it is set.

Usage example `SYST:REM`

Related Commands `SYSTem:COMMunicate:RLState`
`SYSTem:LOCal`
`SYSTem:RWLock`

5.15.46. **SYSTem:RWLock**

Syntax `SYSTem:RWLock`

Description Places the PSU in the remote mode for serial (via USB) or Ethernet remote control. This command is the same as `SYSTem:REMOte`, except that all front panel options are disabled, including the [Lock/Unlock] icon.

Usage example `SYST:RWL`

Related Commands `SYSTem:COMMunicate:RLState`
`SYSTem:LOCal`
`SYSTem:REMOte`

5.15.47. **SYSTem:TEMPerature:PROTection[:HIGH][:LEVel]**

Syntax `SYSTem:TEMPerature:PROTection[:HIGH][:LEVel] {<temperature>, <sensor>}`
`SYSTem:TEMPerature:PROTection[:HIGH][:LEVel]? <sensor>`

Description Set the over-temperature protection (OTP) value in degrees Celsius (°C) of the selected temperature sensor. When the over-temperature protection function of the specified temperature sensor is enabled (`SYSTem:TEMPerature:PROTection[:HIGH]:STATE`), one of the following action will be performed when the temperature exceeds the over-temperature protection value currently set:

- AUX – Switch off power of the main transformer and set bit 4 of the Questionable Status register
- CH1, CH2 – Disable channel output (OUTPut OFF) and set bit 4 of the Questionable Instrument Summary register. If any of above mentioned temperature sensors cause over-temperature condition an error tone will also follow if beeper is enabled (see `SYSTem:BEEPer:STATE`).

`SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?` command can be used to query whether over-temperature protection occurred on the selected temperature sensor.

Return Query the over-temperature protection (OTP) value of the selected temperature sensor.

Parameters	Name	Type	Range	Default
	<temperature>	Numeric (NR2)	0 – 100	70
	<sensor>	Discrete	{[AUX] CH1 CH2}	AUX

Usage example
 TEMP:PROT:50.5, AUX
 TEMP:PROT?
 50.50

Related Commands
 *RST
 SYSTem:TEMPerature:PROTection[:HIGH]:STATe
 SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?

5.15.48. SYSTem:TEMPerature:PROTection[:HIGH]:CLEar

Syntax SYSTem:TEMPerature:PROTection[:HIGH]:CLEar[, {<sensor>}]

Description This command clears the latched protection status when an over-temperature is detected.
 All conditions that generate the fault must be removed before the latched status can be cleared. The output is restored to the state it was in before the fault condition occurred.

Return None

Name	Type	Range	Default
<sensor>	Discrete	{[AUX]CH1 CH2}	AUX

Usage example
 TEMP:PROT:CLE

Related Commands
 SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped

5.15.49. SYSTem:TEMPerature:PROTection[:HIGH]:DELay[:TIME]

Syntax SYSTem:TEMPerature:PROTection[:HIGH]:DELay[:TIME] {<delay>[, <sensor>]}
 SYSTem:TEMPerature:PROTection[:HIGH]:DELay[:TIME]?[, {<sensor>}]

Description This command sets the over-temperature protection delay. The over-temperature protection function will not be triggered during the delay time. After the delay time has expired, the over-temperature protection function will be active.
 Programmed values can range from 0 to 300 seconds. See also [Section 8.1](#)

Return The query returns programmed over-temperature protection delay.

Parameters	Name	Type	Range	Default
	<delay>	Numeric	0 – 300 seconds	10
	<sensor>	Discrete	{[AUX]CH1 CH2}	AUX

Usage example
 TEMP:PROT:DEL 30, S2

Related Commands
 *RST
 SYSTem:TEMPerature:PROTection[:HIGH][:LEVel]

5.15.50. SYSTem:TEMPerature:PROTection[:HIGH]:STATe

Syntax SYSTem:TEMPerature:PROTection[:HIGH]:STATe {<bool>[, <sensor>]}
 SYSTem:TEMPerature:PROTection[:HIGH]:STATe?[, {<sensor>}]

Description This command enables or disables the over-temperature protection (OTP) function. The enabled state is ON (1); the disabled state is OFF (0). If the over-temperature protection function is enabled and the measured output power reach value set by [SOURce[<n>]]:POWER:PROTection[:LEVel] the output is disabled and the Questionable Condition status register OPP bit 10 is set.

Return The query command returns 0 if the current protection state is OFF, and 1 if the current protection state is ON.

Parameters	Name	Type	Range	Default
------------	------	------	-------	---------

	<bool>	Discrete	ON OFF 0 1	OFF
	<sensor>	Discrete	{[AUX] CH1 CH2}	AUX
Usage example	TEMP:PROT:STAT? CH1 0			
Related Commands	*RST SYSTem:TEMPerature:PROTection[:HIGH]:CLEar			

5.15.51. SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?

Syntax	SYSTem:TEMPerature:PROTection[:HIGH]:TRIPped?[, {<sensor>}]			
Description	Query whether OTP occurred on the selected temperature sensor. When protection is tripped bit 4 (TEMPerature) of the Questionable Status register will be set (see Section 3.4). The SYSTem:TEMPerature:PROTection[:HIGH]:CLEar command can be send to clear OTP condition caused by the selected temperature sensor.			
Return	This query returns a 1 if the protection circuit is tripped and a 0 if it is untripped.			
Parameters	Name	Type	Range	Default
	<sensor>	Discrete	{[AUX] CH1 CH2}	AUX
Usage example	TEMP:PROT:TRIP? 0			
Related Commands	SYSTem:TEMPerature:PROTection[:HIGH]:CLEar SYSTem:TEMPerature:PROTection[:HIGH]:STATE			

5.15.52. SYSTem:TIME

Syntax	SYSTem:TIME {<hours>,<minutes>,<seconds>} SYSTem:TIME?			
Description	Sets the time of the system clock (RTC). Specify the hours, minutes, and seconds. The self-test procedure compare date and time stored in RTC registers with values stored in the non-volatile memory (EEPROM). When the later is greater then former or any of them lost integrity (i.e. any of value is outside allowed range: for example seconds are higher then 60 or months are higher then 12, etc.) self-test will failed. The *TST? will return 1 and detailed report could be queried using the DIAGnostic:TEST? command. <i>The bit 3 (TIME) of the Questionable Status register will be set (see Section 3.4) if date-time self-test failed or datetime was never set.</i>			
Return	Query the current time of the system clock in HH, MM, SS format.			
Parameters	Name	Type	Range	Default
	<hours>	Numeric	0 – 23	–
	<minutes>	Numeric	0 – 59	–
	<seconds>	Numeric	0 – 59	–
Usage example	SYST:TIME? 15, 10, 33			
Related Commands	*TST? DIAGnostic[:INFormation]:TEST? SYSTem:DATE			

5.15.53. SYSTem:VERSion?

Syntax	SYSTem:VERSion?
--------	-----------------

Description	This command returns the version of the SCPI (Standard Commands for Programmable Instruments) standard with which the instrument is in compliance
Return	The command returns a string in the form “YYYY.V”, where YYYY represents the year of the version and V represents a version for that year.
Usage example	<pre>SYST:VERS? 1999.0</pre>

5.16. TRIGger

The PSU's triggering system allows a change in output voltage and current when receiving a trigger, to select a trigger source, and to insert a trigger. Triggering the PSU is a multi-step process, for example:

- An output has to be selected (the INSTRument:SElect command) following by configuring the PSU for the triggered output level by using CURRent:TRIGgered and VOLTage:TRIGgered commands.
- The source from which the PSU will accept the trigger must be specified. The PSU could accept e.g. a BUS (software) trigger or an IMMEDIATE trigger from the remote interface.
- The time delay between the detection of the trigger on the specified trigger source and the start of any corresponding output change can be programmed if needed. Such time delay is valid only for the BUS trigger source.
- Trigger programming is completed by providing an INITiate[:IMMEDIATE] command. If the IMMEDIATE source is selected, the selected output is set to the triggered level immediately. But if the trigger source is the BUS, the PSU is set to the triggered level after receiving the *TRG command.

SCPI command	Description
TRIGger	
[:SEquence]	
[:IMMEDIATE]	
:DELay {<delay>}	Sets the time delay between the detection of a trigger event and the start of any corresponding trigger action
:SLOPe {polarity}	Sets the polarity of the EXternal trigger signal
:SOURce {<source>}	Sets the trigger source

5.16.1. TRIGger[:SEquence][:IMMEDIATE]

Syntax TRIGger[:SEquence][:IMMEDIATE]

Description This event command causes a defined LIST to immediately start without the selected trigger occurring.

Usage example TRIG

Related Commands *TRG

5.16.2. TRIGger[:SEquence]:DELay

Syntax TRIGger[:SEquence]:DELay {<time>}
TRIGger[:SEquence]:DELay?

Description This command sets the time delay between the detection of an event on the specified trigger source and the start of any corresponding trigger action on the PSU output.

Parameters	Name	Type	Range	Default
	<delay>	Numeric	0 – 3600 MIN MAX	MIN

Return The query command returns the programmed delay in seconds.

Usage example TRIG:DEL 10

Related Commands

5.16.3. TRIGger[:SEquence]:SLOPe

Syntax	TRIGger[:SEQuence]:SLOPe {<polarity>} TRIGger[:SEQuence]:SLOPe?			
Description	This command sets the polarity of the signal present at the Channel 1 Digital IN pin (applicable if the TRIGger[:SEQuence]:SOURce EXTernal command is executed). The slope type is edge not level, hence transition from one state to another will be used for triggering.			
Parameters	Name	Type	Range	Default
	<polarity>	Discrete	POSitive NEGative	POSitive
Return	The query command returns the programmed trigger subsystem source.			
Usage example				
Related Commands	TRIGger[:SEQuence]:SOURce			

5.16.4. TRIGger[:SEQuence]:SOURce

Syntax	TRIGger[:SEQuence]:SOURce {<source>} TRIGger[:SEQuence]:SOURce?			
Description	<p>This command selects the source from which the PSU will accept a trigger.</p> <ul style="list-style-type: none"> BUS – enables LAN and serial (via USB) triggering using the *TRG command. IMMEDIATE – the PSU executes a complete trigger operation immediately after executing the INITiate command without delay. MANual – enables triggering by selecting the encoder knob switch. PIN<n> – selects a digital port pin configured as a trigger input. <n> specifies the pin number (it's always 1). <p>When the trigger source is set to BUS, the *WAI command can ensure the synchronization. After executing the *WAI command, the PSU will only execute new command when all the pending operations are completed.</p> <p>Also when the trigger source is set to BUS, you can use the *OPC command to report that the operation is completed. The *OPC? command will return “1” to the output buffer and the *OPC command will set the bit 0 (OPC bit, operation complete) in the standard event register when the operation is finished.</p> <p>The wait for the BUS, EXTernal, or KEY trigger can be bypassed by sending the TRIGger[:SEQuence][:IMMEDIATE] command.</p> <p>The APPLy command automatically sets the source to IMMEDIATE.</p>			
Parameters	Name	Type	Range	Default
	<source>	Discrete	BUS IMM MAN PIN1	–
Return	The query command returns the programmed trigger subsystem source.			
Usage example	TRIG:SOUR BUS TRIG:SOUR? BUS			
Related Commands	*OPC *RST *TRG *WAI ABORt APPLy INITialize TRIGger[:SEQuence][:IMMEDIATE]			

6. Device-specific (unclassified) commands

The commands in this section are device-specific to the PSU. They are not included in the 1999.0 version of the SCPI standard. However, these commands are designed with the SCPI standard in mind, and they follow all of the command syntax rules defined by the standard.

6.1.1. APPLy

The APPLy command provides the most straightforward method to program the PSU over the remote interface.

Syntax	APPLy {<channel> [,<voltage> MINimum MAXimum DEF[,<current> MINimum MAXimum DEFault]] APPLy? {<channel>}[, <param>]			
Description	This command is a combination of INSTRument:SElect (or INSTRument:NSElect), [SOURce[<n>]]:VOLTage and [SOURce[<n>]]:CURRent commands. The APPLy changes the PSU's output to the newly programmed values only if the programmed values are valid within the presently selected range. An execution error will occur if the programmed values are not valid within the selected range. You can substitute MINimum, MAXimum, or DEFault in place of a specific value for the voltage and current parameters (see table below).			
Parameters	Name	Type	Range	Default
	{<channel>}	Discrete	CH1 CH2	–
	<voltage>	Numeric	0 to MAXimum, MIN DEF MAX UP DOWN The MAXimum value is dependent on the PSU voltage rating. See Section 8.1	–
	<current>	Numeric	0 to MAXimum, MIN DEF MAX UP DOWN The MAXimum value is dependent on the PSU current rating. See Section 8.1	–
	<param>	Discrete	CURR VOLT	–
Return	APPLy? query the voltage/current of the specified channel.			
Usage example	Set the voltage and current of CH1 to 35.5V and 0.5A respectively: APPL CH1,35.5,0.5 Query the voltage and current settings of the first channel: APPL? CH1 CH1:50V/3A, 35.500, 0.500 Query only current setting of the second channel: APPL? CH2, CURR 0.25			
Errors	-221,"Power limit exceeded" -222,"Data out of range"			
Related Commands	INSTRument:NSElect INSTRument[:SElect] [SOURce[<n>]]:VOLTage[:LEVel][:IMMediate][:AMPLitude] [SOURce[<n>]]:CURRent[:LEVel][:IMMediate][:AMPLitude] TRIGger[:SEQUence]:SOURce			

6.1.2. DEBUG

Syntax	DEBUG?
Description	

Usage	DEBUG?
example	CH1 U_DAC = 0 CH2 U_DAC = 32768 CH1 U_MON = 0 CH2 U_MON = 4095 CH1 U_MON_DAC = 0 CH2 U_MON_DAC = 16383 CH1 I_DAC = 39321 CH2 I_DAC = 6554 CH1 I_MON = 0 CH2 I_MON = 3276 CH1 I_MON_DAC = 19660 CH2 I_MON_DAC = 3276 MAIN_LOOP_DURATION = 15998 16696 17409 / 0 0 0 / 1844 346805388 ADC_COUNTER = 120 / 0 / 296
Related Commands	DIAGnostic[:INFormation]:ADC?

7. Error messages

The system-defined error/event numbers are chosen on an enumerated ("1 of N") basis. The SCPI-defined error/event numbers and the <error/event_description> portions of the full queue item are listed here. The first error/event described in each class (for example, -100, -200, -300, -400) is a "generic" error.

7.1. Command Error [-199, -100]

An <error/event number> in the range [-199, -100] indicates that a syntax error has been detected by the PSU's parser. The occurrence of any error in this class causes the command error bit (CME, bit 5) in the Standard Event Status Register (see [Section 3.1](#)) to be set.

Return string	Description
0, "No error"	The queue is completely empty. Every error/event in the queue has been read or the queue was purposely cleared by power-on, *CLS, etc.
-100, "Command error"	Generic syntax error.
-101, "Invalid character"	An invalid character was found in the command string. You may have inserted a character such as #, \$, or % in the command keyword or within a parameter. Example: OUTP:STAT #ON
-103, "Invalid separator"	An invalid separator was found in the command string. You may have used a comma instead of a colon, semicolon, or blank space, or you may have used a blank space instead of a comma. Example: TRIG:SOUR,BUS
-104, "Data type error"	The wrong parameter type was found in the command string. You may have specified a number where a string was expected, or vice versa. Example (password is not a quoted string): CAL ON, 123
-108, "Parameter not allowed"	More parameters were received than expected for the command. You may have entered an extra parameter, or added a parameter to a command that does not accept a parameter. Example: INST CH1, CH2
-109, "Missing parameter"	Fewer parameters were received than expected for the command. You omitted one or more parameters that are required for this command. Example: APPL
-113, "Undefined header"	A command was received that is not valid for this PSU. You may have misspelled the command or it may not be a valid command. If you are using the short form of the command, remember that it may contain up to four letters. Example: MEASU:CURR?
-114, "Header suffix out of range"	The numeric suffix attached to a command header is not one of the allowable values.

Example:

```
STAT:QUES:INST:ISUM3?
```

-131, "Invalid suffix"

A suffix was incorrectly specified for a numeric parameter. You may have misspelled the suffix.
Example (use A instead of V):

```
VOLT 3A
```

-138, "Suffix not allowed"

A suffix was received following a numeric parameter which does not accept a suffix.
Example (SEC is not a valid suffix):

```
STAT:QUES:ENAB 10 SEC
```

-151, "Invalid string data"

An invalid character string was received. Check to see if you have enclosed the character string in single or double quotes.
Example:

```
DISP:TEXT 'ON
```

7.2. Execution Error [-299, -200]

An <error/event number> in the range [-299, -200] indicates that an error has been detected by the PSU's execution control block. The occurrence of any error in this class cause the execution error bit (EXE, bit 4) in the Standard Event Status Register (see [Section 3.1](#)) to be set. One of the following events has occurred:

- A <PROGRAM DATA> element following a header was evaluated by the device as outside of its legal input range or is otherwise inconsistent with the PSU's capabilities.
- A valid program message could not be properly executed due to some PSU condition.

Execution errors will be reported by the PSU after rounding and expression evaluation operations have taken place. Rounding a numeric data element, for example, will not be reported as an execution error. Events that generate execution errors will not generate Command Errors, device-specific errors, or Query Errors; see the other error definitions in this section.

Return string	Description
-200, "Execution error"	This is the generic execution error when more specific error is not assigned in the case that command execution failed.
-221, "Settings conflict"	Indicates that a legal program data element was parsed but could not be executed due to the current device state. Example (an attempt to enter low ripple mode while remote programming is activated): VOLT:PROG EXT LRIP ON
-222, "Data out of range"	A numeric parameter value is outside the valid range for the command. Example: VOLT 166
-223, "Too much data"	A character string was received but could not be executed because the string length was more than 32 characters. This error can be generated by the CALibration:REMark command.
-224, "Illegal parameter value"	A discrete parameter was received which was not a valid choice for the command. You may have used an invalid parameter choice. Example:

VOLT ON

-240, "Hardware error"	Command or query could not be executed because failure is detected during power-up self-test. Use *TST? command to query self-test results. See also Section 7.3.1
-241, "Option not installed"	Command or query could not be executed because of missing PSU hardware. Example (remote sense cannot be activated when BP_OPTION is false): OUTP:SENS ON
-242, "CH1 fault detected"	POWERGOOD signal failure is detected on channel 1. If such condition is happened the PSU will be immediately put into the stand-by mode.
-243, "CH2 fault detected"	POWERGOOD signal failure is detected on channel 2. If such condition is happened the PSU will be immediately put into the stand-by mode.
-245, "CH1 output fault detected"	A prohibited state is detected on the channel 1 output (e.g. negative power is measured for extended period of time). The channel output will be turned off.
-246, "CH2 output fault detected"	A prohibited state is detected on the channel 2 output (e.g. negative power is measured for extended period of time). The channel output will be turned off.

7.3. Device-Specific Error [-399, -300], [1, 32767]

An <error/event number> in the range [-399, -300] or [1, 32767] indicates that the PSU has detected an error which is not a command error, a query error, or an execution error; some PSU operations did not properly complete, possibly due to an abnormal hardware or firmware condition. These codes are also used for self-test response errors. The occurrence of any error in this class cause the device-specific error bit (DDE, bit 3) in the Standard Event Status Register (see [Section 3.1](#)) to be set.

Events that generate device-specific errors do not generate command errors, execution errors, or query errors; see the other error definitions in this section.

Return string	Description
-211, "Trigger ignored"	A *TRG was received but the trigger was ignored. The trigger source should be selected to the BUS and the trigger subsystem should be initiated by the INITiate[:IMMdate] command.
-213, "Init ignored"	An INITiate command was received but could not be executed because a measurement was already in progress.
-220, "Cannot set range"	Measurement range cannot be set because currently measured value is higher than range max value. Example: CURR? 2.33 SENS:CURR:RANG 0.5
-310, "System error"	Internal firmware error.
-330, "Self-test failed"	The PSU's complete self-test failed from the remote interface (*TST? command). In addition to this error, more specific self-test errors are also reported. See also Section 7.3.1
-350, "Queue overflow"	The error queue is full because more than 16 errors have occurred. No additional errors are stored until you remove errors from the queue. The error queue is cleared when power has been turned off, or after a *CLS (clear status) command has

	been executed.
-363,"Input buffer overrun"	Input buffer overrun. Serial or Ethernet port input buffer overflows with data.
100,"Channel not found"	Non existing channel number is specified. Example: SOUR3:VOLT?
101,"Calibration mode is off"	Calibration is not enabled. The PSU will not accept calibration commands.
102,"Invalid cal password"	The calibration password is incorrect.
104,"Bad sequence of cal commands"	Calibration commands have not been entered in the proper sequence.
105,"Cal password too long"	A calibration password was received which contained more than 16 characters.
106,"Cal password too short"	A calibration password was received which contained less than 4 characters.
107,"Cal value out of range"	The specified calibration value (CALibration:CURRent:DATA or CALibration:VOLTage:DATA) is not valid for the present measurement function and range.
108,"Cal output disabled"	Calibration is aborted by sending the OUTPut OFF command during an output calibration.
109,"Invalid cal data"	One or more calibration data have value that prohibit calibration parameters calculation. For example MID value is lower then MIN, or MIN is higher then MAX, or MID value is out of accepted tolerance that it cannot be predicted with newly calculated calibration parameters.
110,"Cal params missing or corrupted"	Calibration parameters activation initiated by CALibration:STATe ON, "<password>" failed because calibration has never been conducted or existing parameters are corrupted.
111,"No new cal data exists"	Attempt to save calibration data with the CALibration:SAVE command while no new calibration data are entered.
122,"Invalid sys password"	The system password is incorrect.
125,"Sys password too long"	A system password was received which contained more than 16 characters.
126,"Sys password too short"	A system password was received which contained less than 4 characters.
150,"Power limit exceeded"	Product of voltage and current exceeds channel power limitation. For example if channel power limit is 160 W and the following sequence is executed: VOLT 38 CURR 4.4
201,"Cannot execute before clearing protection"	Command such as OUTP ON cannot be executed on the channel where one or more protections are tripped.
270,"CH1 ADC timeout detected"	Channel is switched off after 3 consecutive ADC timeouts are detected.
304,"Incompatible transient modes"	VOLTage and CURRent cannot be in STEP and LIST mode at the same time (see [SOURce[<n>]]:CURRent:MODE and [SOURce[<n>]]:VOLTage:MODE)
306,"Too many list points"	Too many list points have been specified.

307, "List lengths are not equivalent"	One or more lists are not the same length. For example, number of CURRent steps is not equal to one or number of VOLTage steps LIST:VOLT 0, 5, 10, 15, 20 LIST:CURR 1, 2
308, "Cannot be changed while transient trigger is initiated"	Setting cannot be changed while the instrument is waiting for or executing a trigger sequence.
309, "Cannot initiate while in fixed mode"	Cannot initiate transient generator. Either the VOLTage or CURRent function is set to FIXEd mode.
310, "List exceed set limits or maximum values"	List cannot be executed because one or more VOLTage or CURRent value exceed set limits or maximum values. For example if channels are not coupled in series and the following list are used: LIST:VOLT 50, 60, 70
312, "Cannot execute when the channels are coupled"	Cannot execute command when the channel outputs are coupled.
313, "Cannot execute in tracking mode"	Cannot execute command when tracking mode is active.
320, "Firmware update error"	An attempt to upload firmware via LAN is failed due to communication error, checksum error, etc.
400, "Cannot load empty profile"	An attempt to recall empty or erased user profile with *RCL command.
500, "Down-programmer on CH1 switched off"	Down programmer is switched off because negative output power (DP_NEG_LEV) is measured on CH1 that lasts more then DP_NEG_DELAY seconds.
501, "Down-programmer on CH2 switched off"	Down programmer is switched off because negative output power (DP_NEG_LEV) is measured on CH2 that lasts more then DP_NEG_DELAY seconds.
505, "External voltage on CH1 detected"	External voltage is measured (e.g. a battery or other power source is intentionally or mistakenly connected) on channel 1 while output is switched from off to on.
506, "External voltage on CH2 detected"	External voltage is measured (e.g. a battery or other power source is intentionally or mistakenly connected) on channel 2 while output is switched from off to on.
615, "External EEPROM save failed"	If non-volatile memory (an external EEPROM) is not installed, damaged or not responsive and OPTION_EXT_EEPROM is set to 1 (conf.h) this error will occurred.

7.3.1. Self-Test Error Messages

During power-up the PSU will start self-test sequence when communication with all SPI devices that is marked as installed will be established. Scope of self-test depends of device capability and it could vary from simple reading device registers and waiting for expecting response to more complex operation such as set DAC registers and read back set values using ADC (if ADC test passed). Every test failure will be announced by error beep, and one error message per failed test will be inserted into error queue. That also cause the device-specific error bit (DDE, bit 3) in the Standard Event Status Register (see [Section 3.1](#)) to be set.

Return string	Description
210, "CH1 IOEXP test failed"	Communication with Channel 1 I/O expander is not possible. I/O expander is not functional or SPI 10-pin ribbon cable is not connected.

211, "CH2 IOEXP test failed"	Communication with Channel 2 I/O expander is not possible. I/O expander is not functional or SPI 10-pin ribbon cable is not connected.
220, "CH1 ADC test failed"	Communication with Channel 1 ADC is not possible. Values written into various registers are not equal to the returned values or SPI 10-pin ribbon cable is not connected.
221, "CH2 ADC test failed"	Communication with Channel 2 ADC is not possible. Values written into various registers are not equal to the returned values or SPI 10-pin ribbon cable is not connected.
230, "CH1 DAC test failed"	Channel 1 DAC is not functional, communication is failed or difference between set and acquired DAC output value is too high when CPU sends a test voltage data to the DAC and converts the DAC output to digital data (using ADC I_SET input).
231, "CH2 DAC test failed"	Channel 2 DAC is not functional, communication is failed or difference between set and acquired DAC output value is too high when CPU sends a test voltage data to the DAC and converts the DAC output to digital data (using ADC I_SET input).
240, "External EEPROM test failed"	Non-volatile memory on the Arduino board checksum test failed.
250, "RTC test failed"	RTC on the Arduino board is not present or date or time values are not valid or last datetime stored into non-volatile memory is greater than RTC datetime.
260, "Ethernet test failed"	Ethernet controller on the Arduino Shield board test failed.
630, "Fan test failed"	Measured fan speed during self-test procedure is not within expected range.

For example, if SPI-bus cable is incidentally not connected or wrongly wired on channel 1 two errors will be generated and placed into error queue what can be checked using the following command sequence:

```

SYST:ERR:COUN?
2

SYST:ERR?
210, "CH1 IOEXP test failed"

SYST:ERR?
220, "CH1 ADC test failed"

```

8. Parameters and settings

8.1. Programming parameters

The PSU firmware could be used to control channels with various characteristics. For example voltage range could be from 0 to 30 V, 0 to 40 V or 0 to 50 V and current range could vary from 0 to 3.12 A, 0 to 4.16 A or 0 to 5 A. It's also possible to mix two channels with different voltage and current ranges e.g. 0 – 40 V/0 – 5 A and 0 – 50 V/0 – 3.12 A. Use [*IDN?](#) command to find out what channels are defined in the firmware.

8.1.1. Voltage

Programming range or model	0 – 30 V	EEZ PSU H24005	0 – 50 V
MAXimum [V]	30	40	50
MINimum [V]	0	0	0
DEFault [V]	0	0	0
Value after *RST or *TST?	0	0	0
STEP MINimum [V]	10m	10m	10m
STEP MAXimum [V]	5	5	5
STEP DEFault [V]	100m	100m	100m
PROtection DELay MINimum [s]	0	0	0
PROtection DELay MAXimum [s]	10	10	10
PROtection DELay DEFault [s]	5m	5m	5m
CALibration VALue MINimum[V]	0.15	0.15	0.15
CALibration VALue MIDdle[V]	14.1	19.1	24.1
CALibration VALue MAXimum[V]	28	38	48

8.1.2. Current

Programming range or model	0 – 3.12 A	EEZ PSU H24005
MAXimum [A]	3.12	5
MINimum [A]	0	0
DEFault [A]	0	0
Value after *RST or *TST?	0	0
STEP and STEP MINimum [A]	10m	10m
STEP MAXimum [A]	1	1
STEP DEFault [A]	50m	50m
PROtection DELay MINimum [s]	0	0
PROtection DELay MAXimum [s]	10	10
PROtection DELay DEFault [s]	20m	20m
CALibration VALue MINimum[A]	50m	50m
CALibration VALue MIDdle[A]	1.525	2.425
CALibration VALue MAXimum[A]	3	4.8

8.1.3. Power

The total number of possible combinations for power parameters are 6 of which two typical examples are stated below:

Programming range or model	0 – 50 V, 0 – 3.12 A	EEZ PSU H24005
MINimum [W]	0	0
DEFault [W]	100	155
MAXimum [W]	150	160
PROTection LEVeL DEFault [W]	100	155
PROTection DELay MINimum [s]	1	1
PROTection DELay MAXimum [s]	300	300
PROTection DELay DEFault [s]	10	10

8.2. Reset Settings (*RST)

At power-on or after execution of the [*RST](#) common command, device settings will be set to states that are listed in the table that follows. See also the [MEMory:STATe:RECall:AUTO](#) command.

Command	Power on	*RST
<i>*ESE</i>	0	<i>Not affected</i>
<i>*ESR</i>	0	<i>Not affected</i>
<i>*SRE</i>	0	<i>Not affected</i>
<i>*STB?</i>	0	???
<i>CAL[:MODE]</i>	OFF	
<i>CAL:STAT</i>	ON if valid calibrating data for both voltage and current exists in the non-volatile memory, otherwise OFF.	
<i>DISP:BRIG</i>	Power down state	20
<i>DISP:MODE</i>	Power down state	1
<i>DISP[:STAT]</i>	Power down state	Not affected
<i>INST:NSEL</i>	Power down state	Not affected
<i>INST:SEL</i>	Power down state	Not affected
<i>MEMM:CDIR</i>	Power down state	C:\
<i>OUTP[:STAT]</i>	Power down state	OFF
<i>OUTP:PROT:COUP</i>	Power down state	OFF
<i>OUTP:TRAC</i>	Power down state	OFF
<i>SENS:CURRE:RANG</i>	Power down state	MAX
<i>SENS:CURRE:RANG:AUTO</i>	Power down state	OFF
<i>[SOUR[n]]:CURR</i>	Power down state	DEF (see Section 8.1)
<i>[SOUR[n]]:CURR:PROT:DEL</i>	Power down state	DEF (see Section 8.1)
<i>[SOUR[n]]:CURR:PROT:STAT</i>	Power down state	OFF
<i>[SOUR[n]]:CURR:PROT:TRIP?</i>	0	
<i>[SOUR[n]]:CURR:STEP</i>	Power down state	DEF (see Section 8.1)
<i>[SOUR[<n>]]:LRIP:AUTO</i>	Power down state	Not affected
<i>[SOUR[n]]:POW:PROT[:LEV]</i>	Power down state	DEF (see Section 8.1)
<i>[SOUR[n]]:POW:PROT:DEL</i>	Power down state	DEF (see Section 8.1)
<i>[SOUR[n]]:POW:PROT:STAT</i>	Power down state	ON
<i>[SOUR[n]]:POW:PROT:TRIP?</i>	0	
<i>[SOUR[n]]:VOLT</i>	Power down state	DEF (see Section 8.1)

[SOUR[<n>]]:VOLT:PROG[:SOUR]	INT	
[SOUR[n]]:VOLT:PROT:DEL	Power down state	DEF (see Section 8.1)
[SOUR[n]]:VOLT:PROT:STAT	Power down state	OFF
[SOUR[n]]:VOLT:PROT:TRIP?	0	
[SOUR[n]]:VOLT:STEP	Power down state	DEF (see Section 8.1)
[SOUR[<n>]]:VOLT:SENS[:SOUR]	Power down state	OFF
STAT:OPER[:EVEN]	0	Not affected
STAT:OPER:COND	0	Not affected
STAT:OPER:ENAB	0	Not affected
STAT:OPER:INST[:EVEN]	0	Not affected
STAT:OPER:INST:COND	0	Not affected
STAT:OPER:INST:ENAB	0	Not affected
STAT:OPER:INST:ISUM[:EVEN]	0	Not affected
STAT:OPER:INST:ISUM:COND	0	Not affected
STAT:OPER:INST:ISUM:ENAB	0	Not affected
STAT:QUES[:EVEN]	0	Not affected
STAT:QUES:COND	0	Not affected
STAT:QUES:ENAB	0	Not affected
STAT:QUES:INST[:EVEN]	0	Not affected
STAT:QUES:INST:COND	0	Not affected
STAT:QUES:INST:ENAB	0	Not affected
STAT:QUES:INST:ISUM[:EVEN]	0	Not affected
STAT:QUES:INST:ISUM:COND	0	Not affected
STAT:OPER:INST:ISUM:ENAB	0	Not affected
SYST:CHAN:INFO:ONT:LAST?	0	
SYST:CHAN:INFO:ONT:TOT?	Power down state	Not affected
SYST:CPU:INFO:ONT:LAST?	0	
SYST:CPU:INFO:ONT:TOT?	Power down state	Not affected
SYST:ERR:COUN?	0	
SYST:POW	Power down state	ON
SYST:TEMP:PROT [AUX]	Power down state	50
SYST:TEMP:PROT:DEL [AUX]	Power down state	10
SYST:TEMP:PROT:STAT [AUX]	Power down state	ON
SYST:TEMP:PROT CH1 CH2	Power down state	75
SYST:TEMP:PROT:DEL CH1 CH2	Power down state	30
SYST:TEMP:PROT:STAT CH1 CH2	Power down state	ON
TRIG:DEL	Power down state	0
TRIG:SLOP	Power down state	POS
TRIG:SOUR	Power down state	IMM

8.3. Special modes of operation

Operations with channels will differ when tracking or any of coupling mode is selected. Please note that some of features have to be disabled because it cannot be accomplish due to the nature of the feature or electronic circuits design. The following table shows how special modes of operation affects features that is in question:

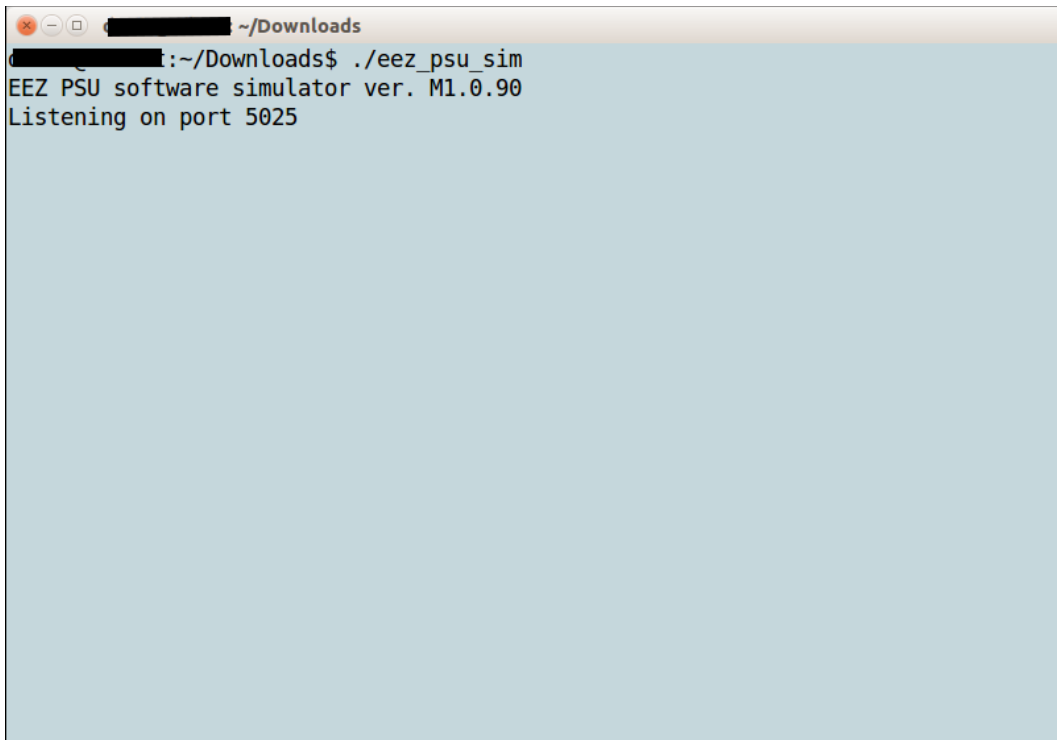
	Calibration (CAL)	Low ripple (LRIP, LRIP:AUTO)	Remote sensing (VOLT:SENS)	Voltage programming (VOLT:PROG)	Tracking control (OUTP:TRAC)	Coupling (INST:COUP: TRAC)
TRACKing	Disabled			Disabled		Disabled
Coupled in PARallel	Disabled			Disabled	Disabled	
Coupled in SERies	Disabled	Disabled	Disabled	Disabled	Disabled	

8.4. Initial settings

Function	State / Value	SCPI command reference
Over-current protection (OCP)	OFF	CURR:PROT:STAT
Over-voltage protection (OVP)	OFF	VOLT:PROT:STAT
Over-power protection (OPP)	ON	POW:PROT:STAT
OPP trip level	155.00 W	POW:PROT:TRIP
OPP delay	10 s	POW:PROT:DEL
Channel Over-temperature protection (OTP)	ON	SYST:TEMP:PROT:STAT {<channel>}
Channel OTP trip level	75.00 °C	SYST:TEMP:PROT:TRIP {<channel>}
Channel OTP delay	30 s	SYST:TEMP:PROT:DEL {<channel>}
AUX sensor OTP	ON	SYST:TEMP:PROT:STAT AUX
AUX sensor OTP trip level	50 °C	SYST:TEMP:PROT:TRIP AUX
AUX sensor OTP delay	10 s	SYST:TEMP:PROT:DEL AUX
Shutdown when protection tripped	OFF	SYST:POW:PROT:TRIP
Switch off all outputs when protection tripped	OFF	OUTP:PROT:COUP
Low ripple mode	OFF	LRIP
Remote voltage programming	OFF	VOLT:PROG
Remote voltage sense	OFF	VOLT:SENS
Coupling mode	NONE	INST:COUP:TRAC
Tracking mode	OFF	OUTP:TRAC
Calibration password	eezpsu	CAL:PASS:NEW
System password	Not defined	
Communication mode	Local	
Front panel lock	OFF	SYST:KLOC
Front panel display	ON	
Ethernet communication	Disabled	
Force disabling of all outputs on power up	OFF	SYST:PON:OUTP:DIS
Beeper	ON	SYST:BEEP:STAT
“Key pressed” click tone	OFF	SYST:BEEP:KEY:STAT

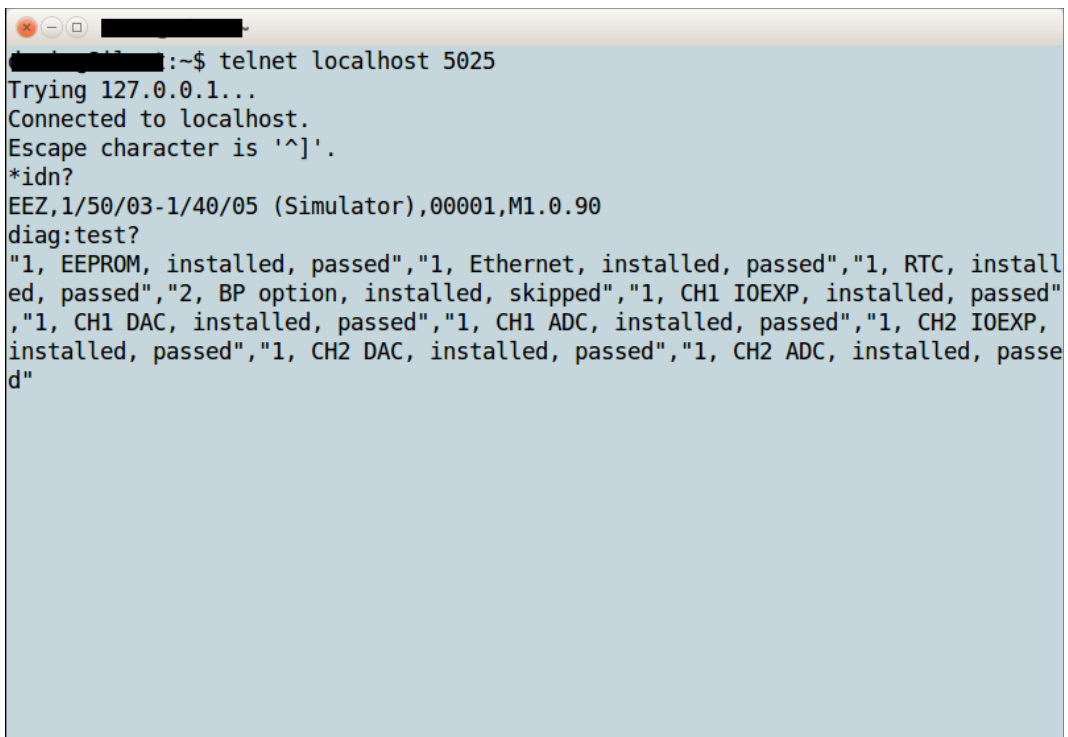
9. Software simulator

The PSU firmware can be also compiled and executed as a Windows, Linux or OS X application. The software simulator is a terminal application that can respond to any currently supported SCPI command described in this document. SCPI commands could be entered directly in the simulator's terminal window (Fig. 4) or remotely by using the e.g. a [Telnet](#) client (Fig. 5).

A terminal window titled "~/Downloads" with a light blue background. The text inside shows the command to run the simulator and its output.

```
~/Downloads$ ./eez_psu_sim
EEZ PSU software simulator ver. M1.0.90
Listening on port 5025
```

Fig. 4: Simulator welcome screen

A terminal window showing a telnet connection to the simulator. The text includes the telnet command, connection status, escape character, and a diagnostic test result.

```
telnet localhost 5025
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
*idn?
EEZ,1/50/03-1/40/05 (Simulator),00001,M1.0.90
diag:test?
"1, EEPROM, installed, passed","1, Ethernet, installed, passed","1, RTC, installed, passed",
"2, BP option, installed, skipped","1, CH1 IOEXP, installed, passed",
"1, CH1 DAC, installed, passed","1, CH1 ADC, installed, passed","1, CH2 IOEXP, installed, passed",
"1, CH2 DAC, installed, passed","1, CH2 ADC, installed, passed"
"
```

Fig. 5: Remote connection using a telnet client

The simulator also has a GUI part when started open a separate window with the picture of the PSU front panel. The GUI depends of what revision is used that can be set in `conf_user_revision.h` file before simulator compilation.

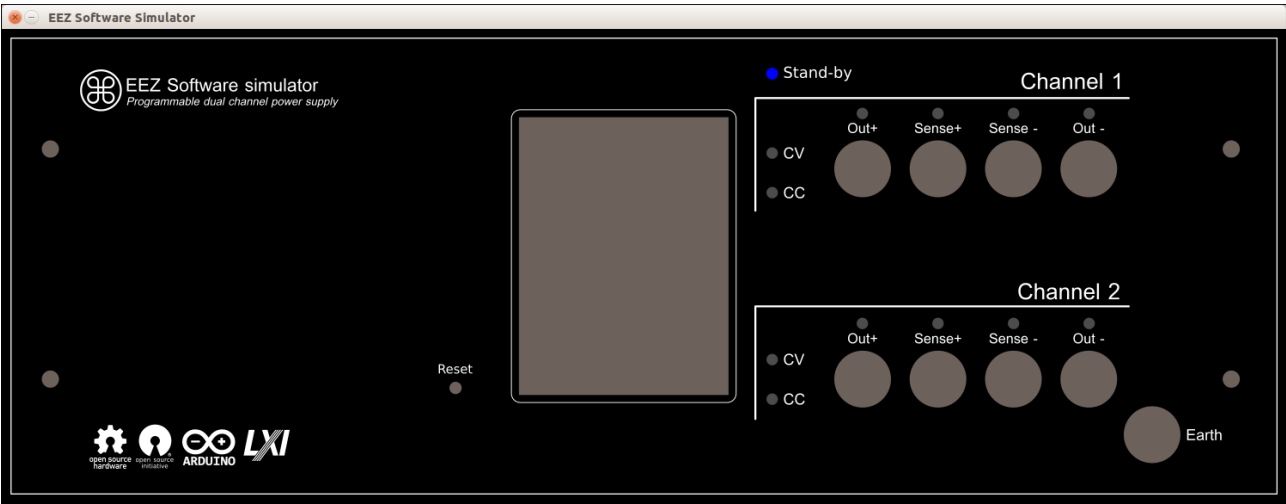


Fig. 6: Simulator GUI for portrait front panel (r1B9)

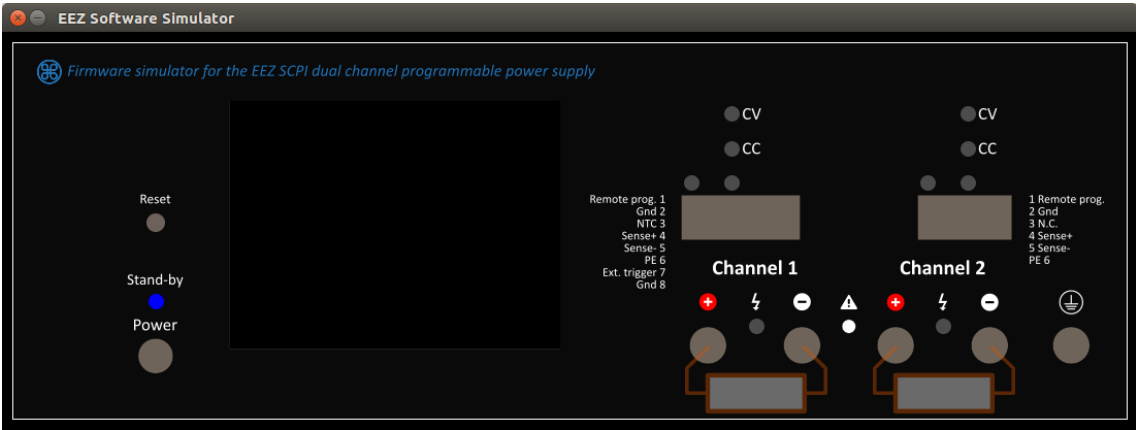


Fig. 7: Simulator GUI for landscape front panel (r3B4)

The GUI simulator front panel currently displays only changes in LED indicators and indicates if load is applied on the output terminals or not. For example if 8.2 Ohm load is connected to the channel 2 and cause that channel enters CC mode the GUI front panel will indicate that in the following way:

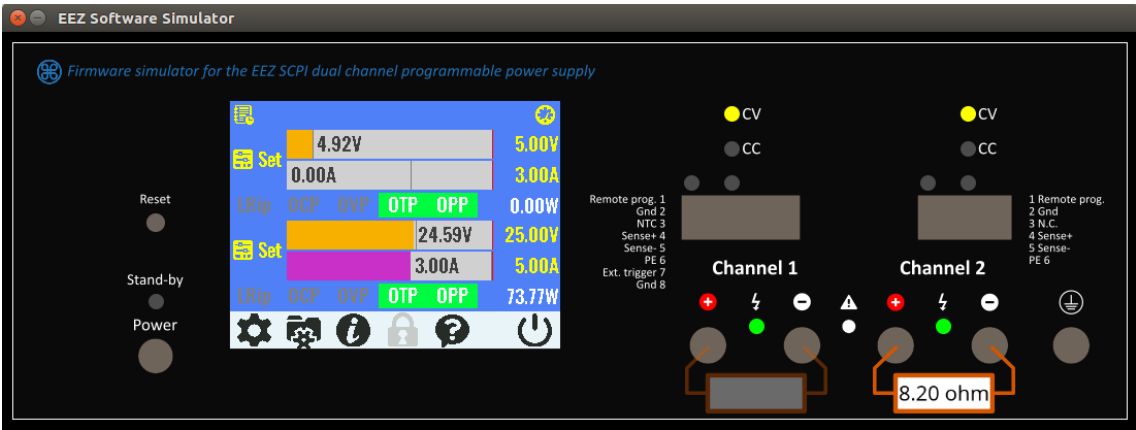


Fig. 8: Simulator GUI with connected load on the channel 2

9.1. SIMUlator

The SIMUlator subsystem represent a set of unclassified SCPI commands that can be used to manage external parameters and events such as load impedance, connection and disconnection of the load, sensor temperature or the PSU control circuit power supply state. Thanks to them e.g. simulation of the measuring and protection commands that depends of external events become more meaningful.

For example MEASure:CURRent? without connected load will always returns zero, or activation of the VOLTage:PROTection:STATe will automatically trip the OVP since channel cannot starts in CC mode of operation when output is switched on, etc.

SCPI command	Description
SIMUlator	
:EXIT	Closes simulator
:GUI	Starts simulator's GUI
:LOAD {<resistance>}	Sets value of the virtual load
:STATe {<bool>}	"Connects" virtual load to the channel output
:PIN1 {<bool>}	Sets value of the PIN1 input
:PWRGood {<bool>}	Sets the PWRGOOD signal state
:RPOL {<bool>}	Sets the RPOL signal state
:TEMP {<temperature>}	Sets the temperature sensor value
:VOLT:PROG:EXT {<voltage>}	Sets the output voltage when channel is in external programming mode

9.1.1. SIMUlator:EXIT

Syntax [SIMUlator:EXIT](#)

Description This command close all Software simulators windows (terminal and GUI if started).

Return None

Usage example `SIMU:EXIT`

9.1.2. SIMUlator:GUI

Syntax [SIMUlator:GUI](#)

Description Use this command to start the GUI simulator in the new window (see Fig. 6 and Fig. 7).

Return None

Usage example `SIMU:GUI`

Related Commands [SIMUlator:EXIT](#)

9.1.3. SIMUlator:LOAD

Syntax [SIMUlator:LOAD {<resistance>}](#)
[SIMUlator:LOAD?](#)

Description This command is used to define impedance of the virtual load that is connected to the channel output. Units are in ohms. With load connected it is possible to simulate e.g. CC mode of operation, current and power measurement, OCP and OPP functionality, etc.

Load value can be also changed by click and drag on the load's image. Move cursor to

the left to decrease, or to the right to increase value in increments of 1 Ω .

The simulator currently cannot emulate the “UR” mode of operation (see the [OUTPut:MODE?](#) command).

Parameters	Name	Type	Range	Default
	<resistance>	Numeric	0 – 9999999 INFinite	–
Return	The query command returns the programmed load value.			
Usage example	SIMU:LOAD 8.2			
Related Commands	OUTPut:MODE?			

9.1.4. SIMULator:LOAD:STATe

Syntax	SIMULator:LOAD:STATe {<bool>} SIMULator:LOAD:STATe?			
Description	This command is used to “connect” or “disconnect” the virtual load to the channel output. If the GUI simulator is started (the SIMULator:GUI command) load symbol with selected value in Ohms will be displayed (See Fig. 8).			
	Another possibility to connect (or disconnect) a load is by click on its image.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
Return	The query command returns the load state.			
Usage example	SIMU:LOAD:STAT? 0 MEAS:CURRE? 0.00 SIMU:LOAD:STAT ON MEAS:CURRE? 1.50			
Related Commands	OUTPut:MODE? SIMULator:GUI SIMULator:LOAD			

9.1.5. SIMULator:PIN1

Syntax	SIMULator:PIN1 {<bool>} SIMULator:PIN1?			
Description	This command can be used to simulate state on the PIN1 input on the PSU front panel push-in connector that can be used for initiate trigger.			
Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	–
Return	The query command returns the simulated PIN1 input state.			
Usage example	VOLT:TRIG 12.00 CURR:TRIG 2.50 TRIG:SOUR PIN1 OUTP 1 INIT SIMU:PIN1			

Related Commands
 ABORT
 INITiate[:IMMediate]
 TRIGger[:SEquence]:DELay
 TRIGger[:SEquence]:SLOPe
 TRIGger[:SEquence]:SOURce

9.1.6. SIMUlator:PWRGood

Syntax `SIMUlator:PWRGood {<bool>}`
`SIMUlator:PWRGood?`

Description This command can be used to simulate detection of an internal power supply failure. When PWRGOOD signal is changed from 1 to 0 the PSU is going to the Stand-by mode (equal to the command SYSTem:POW OFF). The PSU mode cannot be changed until PWRGOOD is not changed to 1.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	ON

Return The query command returns the PWRGOOD signal state.

Usage example
`SYST:POW?`
 1
`SIMU:PWRG 0`
`SYST:POW?`
 0

Related Commands
 SYSTem:POWer

9.1.7. SIMUlator:RPOL

Syntax `SIMUlator:RPOL {<bool>}`
`SIMUlator:RPOL?`

Description This command can be used to simulate detection of remote sensing reverse polarity condition.

Parameters	Name	Type	Range	Default
	<bool>	Discrete	ON OFF 0 1	ON

Return The query command returns the RPOL signal state.

Usage example
`STAT:QUES:INST:ISUM2?`
 0
`SIMU:RPOL 1`
`STAT:QUES:INST:ISUM2?`
 128

Errors 312, "Cannot execute when the channels are coupled"

Related Commands
 INSTRument:COUPle:TRACking
 [SOURce[<n>]]:VOLTage:SENSe[:SOURce]
 STATus:QUEStionable:INSTRument[:EVENT]?

9.1.8. SIMUlator:TEMPerature

Syntax `SIMUlator:TEMPerature {<temperature>}[, {<sensor>}]`
`SIMUlator:TEMPerature? [{<sensor>}]`

Description Use this command to set temperature in degrees Celsius (°C) that will "sense" temperature sensor.

Parameters	Name	Type	Range	Default
	<temperature>	Numeric	0 – 100	–
	<sensor>	Discrete	AUX CH1 CH2	AUX
Return	The query command returns the set temperature value.			
Usage example	SIMU:TEMP 45, CH2 MEAS:TEMP? CH2 45.00			
Related Commands	MEASure[:SCALar]:TEMPerature[:THERmistor][:DC]			

9.1.9. SIMUlator:VOLTage:PROGram:EXternal

Syntax	SIMUlator:VOLTage:PROGram:EXternal {<voltage>} SIMUlator:VOLTage:PROGram:EXternal?			
Description	Use this command to set voltage that will be used for output voltage programming when channel is in external / remote programming mode (see [SOURce[<n>]]:VOLTage:PROGram[:SOURce]). For full range apply 2.5 V and if higher value is entered channel's OVP will trip.			
Parameters	Name	Type	Range	Default
	<voltage>	Numeric	Positive value	0.00
Return	The query command returns the external output voltage programming value.			
Usage example	VOLT:PROG EXT SIMU:VOLT:PROG:EXT 1.25 MEAS? 20.00			
Errors	312, "Cannot execute when the channels are coupled"			
Related Commands	INSTrument:COUPle:TRACking [SOURce[<n>]]:VOLTage:PROGram[:SOURce] [SOURce[<n>]]:VOLTage:PROTection:TRIPped?			

10. Programming examples

10.1. Set channel output values and working with the OCP

This is a SCPI commands sequence that sets a voltage, current, and the over-current protection (OCP) on the channel two:

INST?	<i>Check currently selected output</i>
1	
INST CH2	<i>Select channel two as current channel</i>
VOLT 10	<i>Set output voltage</i>
CURR	<i>Set output current</i>
CURR:PROT:STAT?	<i>Check OCP status</i>
0	
CURR:PROT:STAT 1	<i>Enable OCP</i>
CURR:PROT:DEL 100ms	<i>Set OCP delay</i>
OUTP 1	<i>Enable output</i>
MEAS?	<i>Measure output voltage</i>
10.00	
MEAS:CURR?	<i>Measure output current</i>
0.00	<i>Current is zero since no load is connected</i>

If [software simulator](#) is used, connection of the load can be also simulated:

SIMU:LOAD 20	<i>Define connected load impedance</i>
MEAS?	<i>Measure voltage once again</i>
10.00	
MEAS:CURR?	<i>Measure current once again</i>
0.50	<i>Measured current</i>

The following command sequence could be used to test channel mode with load previously defined and after the load impedance is lowered enough that output current reach programmed value. The OCP has to be disabled because previously defined 100ms delay does not give us enough time to execute the whole sequence for testing channel mode and output voltage and current values:

OUTP:MODE?	<i>Check mode of operation</i>
"CV"	<i>The channel is in constant-voltage mode since output current is below previously programmed level</i>
SIMU:LOAD?	<i>Check load value</i>
10	
CURR:PROT:STAT?	<i>Check OCP status</i>
1	
CURR:PROT:STAT OFF	<i>Disable OCP</i>
SIMU:LOAD 4	<i>Decrease load impedance</i>
OUTP:MODE?	<i>Check once again mode of operation</i>
"CC"	<i>Channel enters constant-current mode since $I_{max} = U / R = 10 / 4 = 2.5A$ and current is limited to the 1A</i>

EEZ PSU SCPI reference M5 PRELIMINARY

MEAS:CURR?	Measure output current
1.00	
MEAS?	Measure output voltage
4.00	Output voltage is decreased since $U = I * R = 1 * 4 = 4V$

The OCP will “trip” when output current reach programmed value and channel stay in the CC mode for more then programmed OCP delay time. To test that with e.g. the [software simulator](#) we’ll disable channel output first, enable OCP and when change channel output back to enabled state:

OUTP OFF	Disable channel output
CURR:PROT:TRIP?	Check OCP status
0	OCP is not activated
CURR:PROT:STAT ON	Enable OCP
VOLT?	Check programmed output voltage
10.00	
CURR?	Check programmed output current
1.00	
SIMU:LOAD?	Check simulated load value
4	
OUTP ON	Enable channel output
CURR:PROT:TRIP?	Check OCP status once again
1	OCP has been tripped
OUTP?	Check channel output state
0	Channel output is changed to OFF stated by the OCP

The channel output state cannot be changed to enabled until any of protection is active. We have to clear protection first. If the same load that caused the first protection trip is still connected the channel output will be disabled immediately after the protection programmed delay time expired. Therefore we also have to disconnect load or disable protection. The later method will be used in the command sequence that follows:

OUTP ON	First attempt to enable channel output
OUTP?	
0	This attempt failed, the channel output remain disabled
OUTP:PROT:CLE	Channel protections reset
OUTP ON	Second to enable channel output
0	Channel output was enabled for a short time (100ms) and returns back to OFF state
CURR:PROT:TRIP?	Check OCP status
1	OCP has been tripped
OUTP:PROT:CLE	Reset channel protections once again
CURR:PROT:STAT OFF	Disable OCP
OUTP ON	Third attempt to enable channel output
OUTP?	
1	Output is finally enabled
OUTP:MODE?	

"CC"

Channel enters CC mode of operation

10.2. Voltage and current calibration

For optimum calibration results the following condition are recommended:

- the calibration ambient temperature is stable and between 20 °C and 30 °C.
- ambient relative humidity is less than 80%.
- Allow a one hour warm-up period before verification or calibration (use e.g. SYST:CHAN:INFO:ONT:LAST? or SYST:CPU:INFO:ONT:LAST? to get that info).
- Use short and thick cables to connect test setups.

Step	Commands	Description
1	*RST	
2	SYST:RWL	Make sure that PSU is in remote mode and cannot be unlock from local console (TFT display)
3	INST {CH1 CH2}; OUTP ON	Select the channel to be calibrated and enable the channel output.
4	VOLT:PROT:STAT OFF CURR:PROT:STAT OFF POW:PROT:STAT OFF	Disable if required the voltage, current and power protections.
5	CAL ON, "<password>"	PSU enters calibration mode on the channel selected in step 1. Both voltage and current on the selected channel are set to the MINimum value. The VOLT? and CURR? commands can be optionally used here to test channel output values.
6		For voltage calibration, connect a digital voltmeter (DVM) across the PSU's output terminals.
7	CAL:VOLT:LEV MIN	Set the channel to the low-end (MIN) calibration point.
8	CAL:VOLT 81.8MV	Enter the reading you obtained from the external DVM.
9	CAL:VOLT:LEV MID	Set the channel to the middle (MID) calibration point.
10	CAL:VOLT 19.68	Enter the reading you obtained from the DVM.
11	CAL:VOLT:LEV MAX	Set the channel to the high (MAX) calibration point.
12	CAL:VOLT 39.2	Enter the reading you obtained from the DVM.
13		For current calibration, connect current monitoring resistor (shunt) across the output terminals and connect the DVM across the shunt resistor. Its resistance has to be less then 5 Ω and rated for 25 W or more for measuring MAX current level.
14		Repeat step 7 through step 12 by substituting CURR for VOLT for current calibration. For example, CAL:CURR:LEV MIN.
15	CAL_CURR:RANG LOW	Power board r5B12 only: for low current range (i.e. 0 – 500 mA) calibration use this command to change the range and repeat once again procedure mentioned in step 14.
16	CAL:REM "<string>"	Record calibration information such as next calibration due date for future reference. The calibration string may contain up to 40 characters. You don't need to enter current date and time since that information will be recorded automatically.
17	CAL:SAVE	Save to non-volatile memory new calibration data.
18	CAL OFF, "<password>"	PSU exit calibration mode. Both voltage and current on the selected channel are again set to the MINimum value.
19	SYST:REM	Enable local console unlock. Alternatively SYST:LOC can be executed to make local console enabled again.

10.3. Working with profiles

The following command sequence could be used to store current set of parameters to the profile location 4 in the non-volatile memory:

MEM:STAT:VAL? 4	<i>Check to see if profile selected location is empty</i>
0	
MEM:STAT:NAME? 4	<i>We can also check that by querying profile location name</i>
--Not used--	
INST CH1	<i>Examine currently programmed output values of the first channel</i>
VOLT?;:CURR?;:OUTP?	
0.00;0.00;0	
INST CH2	<i>Examine currently programmed output values of the second channel</i>
VOLT?;:CURR?;:OUTP?	
0.00;0.00;0	
VOLT 12;:CURR 300mA	<i>Reprogram both channel output values that will be stored as a new profile</i>
INST CH1	
VOLT 12;:CURR 300mA	
OUTP 1;:OUTP 1, CH2	
*SAV 4	<i>All profile parameters is now storing on the selected location</i>
MEM:STAT:NAME? 4	<i>Check profile name</i>
" "	
MEM:STAT:NAME 4, "Dual 12V/300mA, Output ON"	<i>Set the profile name (only ASCII characters are allowed!)</i>
MEM:STAT:NAME? 4	<i>Check the profile name once again</i>
"Dual 12V/300ma, Output ON"	

We can now turn the PSU off (when it enters the Stand-by mode) turn it on again and check some of the programmed parameters:

SYST:POW 0	<i>The PSU enters the Stand-by mode</i>
SYST:POW 1	<i>Returns back from the Stand-by mode. Please note that this command can be executed with the minimum of 5 seconds delay otherwise a -200,"Execution error" will be generated (you can check that with the SYST:ERR? command)</i>
VOLT?;:CURR?;:OUTP?	<i>Query programmed voltage, current and output state of the currently selected channel</i>
0.00;0.00;0	<i>Returned data indicate that previously saved values in profile number 4 were not used</i>
*RCL 4	<i>Recall parameters from desired location and execute query once again</i>
VOLT?;:CURR?;:OUTP?	
12.00;0.30;1	<i>The channel output values are now programmed using the selected profile</i>

We can automate above mentioned process that channel profile parameters stored in non-volatile memory are using on power up. First we'll check what is a current status of automatic recall and what profile will be used in the case of automatic recall:

MEM:STAT:REC:AUTO?	<i>Query status of automatic profile recall during power on sequence</i>
0	<i>Automatic recall is turned off</i>

MEM:STAT:REC:AUTO ON	<i>Turn on automatic recall</i>
MEM:STAT:REC:SEL?	<i>Query which profile will be used when automatic recall is turned on</i>
0	<i>Selected profile was 0</i>
MEM:STAT:REC:SEL 4	<i>Change power on profile to 4</i>
SYST:POW 0	<i>Switch the PSU to the Stand-by mode once again</i>
SYST:POW 1	<i>Returns back from the Stand-by mode. Again wait at least 5 seconds before enters this command</i>
VOLT?;:CURR?;:OUTP?	<i>Query programmed voltage, current and output state of the currently selected channel</i>
12.00;0.30;1	<i>The channel output values are programmed using the selected profile</i>

10.4. Get identification info and self-test results

The PSU's identification information could be beneficial when more than one instrument are controlled. Additionally in the following example information about self-test will be queried:

*IDN?	<i>Query identification string</i>
EEZ,1/50/03-1/40/05 (Due),00001,M1.0.93	<i>PSU with two different channels is identified, the first channel is 0-50V/3A and the second is 0-40V/5A. Serial number is 00001, and firmware version M1.0.93</i>
*TST?	<i>Execute self-test and query result</i>
0	<i>Self-test is passed</i>
DIAG:TEST?	<i>Query additional information about self-test</i>
"1, EEPROM, installed, passed", "1, Ethernet, installed, passed", "1, RTC, installed, passed", "1, DateTime, installed, passed", "2, BP option, installed, skipped", "1, CH1 IOEXP, installed, passed", "1, CH1 DAC, installed, passed", "1, CH1 ADC, installed, passed", "1, CH2 IOEXP, installed, passed", "1, CH2 DAC, installed, passed", "1, CH2 ADC, installed, passed"	

The self-test could be performed even when the PSU is in the Stand-by mode. We'll first switch the PSU into the Stand-by mode. At the end of this example we are using additional diagnostic command that allows us to query information about channel's ADC measurements.

SYST:POW 0	<i>The PSU enters the Stand-by mode</i>
DIAG:TEST?	<i>Query additional information about self-test</i>
"1, EEPROM, installed, passed", "1, Ethernet, installed, passed", "1, RTC, installed, passed", "1, DateTime, installed, passed", "2, BP option, installed, skipped"	<i>Only Arduino Shield +BP module diagnostic information is returned</i>
SYST:POW 1	<i>Returns back from the Stand-by mode</i>
DIAG:ADC?	<i>Additional information about currently selected channel ADC inputs</i>

```
"U_SET=12.02 V", "U_MON=12.00
V", "I_SET=0.30 A", "I_MON=0.00 A"
```

U_SET and I_SET are measured values of the DAC outputs, U_MON and I_MON are actual output values. I_MON is 0 because no load is connected. A small difference between set and actual output voltage exists because calibration data are currently in use.

10.5. Programming output voltage using the list of values

The PSU comes with simple “arbitrary waveform generator” functionality that can be accomplished using the LIST commands. The following example changes in the loop output voltage between five output values each half a second long while current is set to 3 A.

INST CH1	<i>Select the channel that has to be programmed</i>
VOLT:MODE LIST	<i>Set voltage programming mode to the list of values</i>
LIST:VOLT 5, 10, 20, 40, 0	<i>Define sequence of output voltage (could be up to 256 steps)</i>
CURR:MODE LIST	<i>Set current programming mode to the list of values.</i>
LIST:CURR 3	<i>Only one output current value is defined. Single value or number of values equivalent to other parameters (LIST:VOLT and LIST:DWEL) is allowed.</i>
LIST:DWEL 0.5	<i>Only one value for the duration of each step is chosen. Single value or number of values equivalent to other parameters (LIST:VOLT and LIST:CURR) is allowed.</i>
LIST:COUN INF	<i>Repeat continuously LIST sequence</i>
TRIG:SOUR IMM	<i>Define type of trigger. In this case the list execution will start immediately after INIT command is received.</i>
INIT	<i>Start the trigger.</i>

Resulting output voltage and current waveform with connected load of 15 Ω is shown on the picture below.



11. SCPI commands scheduled for upcoming releases

Please note that the following list is preliminary.

SCPI command	Description
DCL	Requires the client (controller) to send a "DCL\n" string
*SRE	Sets the value of the Service Request Enable register
ABORt	
:ELOG	
CALibration	
:TEMPerature	
[:DATA] {<new value>}	Enters the calibration value
INITiate	
:ELOG	
SENSe	
:AHOur	
:RESet	Resets the amp-hour (Ah) measurement to zero
:ELOG	
:CURRent	
[:DC]	
:RANge[:UPPer] {<value>}	Selects the Elog current measurement range
:AUTO {<bool>}	Enables/disables Elog seamless measurement autoranging
:FUNCTION	
:CURRent {<bool>}	Enables/disables current data logging
:VOLTage {<bool>}	Enables/disables voltage data logging
:PERiod {<time>}	Sets the integration time of an Elog measurement
:WHOur	
:RESet	Resets the watt-hour (Wh) measurement to zero
OUTPut	
:DELAy	
:ON {<time>}	Sets the delay time for turning the output on
:OFF {<time>}	Sets the delay time for turning the output off
[SOURce[<n>]]	
:CURRent	
:SLEW	
:FALLing	Sets the falling current slew rate
:RISing	Sets the rising current slew rate
:VOLTage	
:SLEW	

:FALLing	Sets the falling voltage slew rate
:RISing	Sets the rising voltage slew rate
SYSTem	
:COMMunicate	
:ETHernet	Ethernet communication parameters
:CONTrol?	Queries communication port for SRQ handling
:DHCP {<bool>}	Enables the DHCP mode
:DNS {<ip_address>}	Sets the DNS (Domain Name Service) address
:GATEway {<ip_address>}	Sets the network gateway address
:HOSTname {<name>}	Sets the Ethernet communication host name
:IPAdDress {<ip_address>}	Sets the IP address
:MAC {<mac_address>}	Returns the Ethernet device MAC address
:PORT {<number>}	Sets the Ethernet communication port
:SMASk {<mask>}	Sets the subnet mask
:NTP {<ip_address>}	Sets NTP (Network Time Protocol) server
:SERial	Serial (via USB) communication parameters
:BAUD {<speed>}	Sets the baud rate
:BITS {<number>}	Sets the number of data bits
:PARity {<parity>}	Sets parity bit
SBITs {<number>}	Sets the number of stop bits
:ERRor	
:ALL?	Queries the error/event queue for all the unread items
:CODE[:NEXT]?	Queries the error/event queue for the next item code
:TIME	
:TIMer	
[:STATe]	Sets the internal timer state
:COUNT	Queries the current value of the internal timer
:TZONe <hour>	Sets time zone

12. SCPI commands summary

Common command	Description
*CLS	Clears all status data structures
*ESE {<value>}	Programs the Standard Event Status Enable register bits
*ESR?	Reads the Standard Event Status Register
*IDN?	Returns the UNIQUE identification of the PSU
*OPC	Operation Complete Command used for program synchronization
*RCL {<profile>}	Recalls the PSU state stored in the specified storage location
*RST	Reset PSU to the initial state
*SAV {<profile>}	Stores the current PSU state in the specified storage location
*STB?	Reads the Status Byte register
*TRG	Generates a software trigger
*TST?	Returns Self-Test results
*WAI	Waits until all pending commands are completed

SCPI Command	Description
ABORt	Resets the trigger system
CALibrate[:MODE] {<bool>, <password>}	Enables/disables calibration mode
:CLEar {<password>}	Clears all calibration parameters
:CURRent	
[:DATA] {<new value>}	Enters the calibration value
:LEVel {<level>}	Calibrates the output current programming
:RANGe {<range>}	Sets current range for multiple current range model
:PASSword	
:NEW {<old>, <new>}	Changes calibration password
:REMark {<string>}	Saves calibration information
:SAVE	Saves the new cal constants in non-volatile memory
:STATe {<bool>, <password>}	Enables calibration parameters
:VOLTage	
[:DATA] {<new value>}	Enters the calibration value
:LEVel {<level>}	Calibrates the output voltage programming
DIAGnostic	
[:INFORmation]	
:ADC?	Returns the latest values acquired by ADC
:CALibration?	Returns a list of the calibration parameters
:FAN?	Returns status of the cooling fan.
:PROTection?	Returns the information about all protections.
:TEST?	Returns results of the most recent self-test
DISPlay	
:BRIGhtness {<value>}	Sets the intensity of the front panel TFT display

:MODE {<mode>}	Sets the main page appearance
[:WINDow]	
[:STATe] {<bool>}	Sets the front panel TFT display state
:TEXT {<message>}	Displays a message on the front panel TFT display
:CLEar	Clear a message on the front panel TFT display
<hr/>	
INITiate	
[:IMMediate]	Completes one full trigger cycle
:CONTinuous {<bool>}	Enables/disables continuous transient triggers
<hr/>	
INSTrument	
[:SElect] {<channel>}	Selects the output to be programmed
:COUPle	
:TRACking {<type>}	Selects independent, parallel-tracking, or series-tracking mode
:TRIGger {<mode>}	Selects a coupling between channels trigger systems
:DISPlay	
:TRACe[<n>] {<value>}	Selects output value on the specified display trace
:SWAP	Swaps positions of selected output values
:YT	
:RATE {<duration>}	Selects YT view sample duration
:NSElect {<channel>}	Selects the output to be programmed
<hr/>	
MEASure	
[:SCALar]	
:CURRent	
[:DC]? [<channel>]	Takes a measurement; returns the average current
:POWer	
[:DC]? [<channel>]	Takes a measurement; returns the average power
:TEMPerature	
[:DC]? {<sensor>}	Takes a measurement; returns the average temperature
[:VOLTage]	
[:DC]? [<channel>]	Takes a measurement; returns the average voltage
<hr/>	
MEMory	
:NSTATes?	Returns total number of state storage memory locations
:STATe	
:CATalog?	Lists the names associated with all ten state storage locations
:DELeTe {<profile>}	Deletes the contents of a state storage location
:ALL	Deletes the contents of all state storage locations
:NAME {<profile>, <name>}	Assigns a custom name to a state storage locations
:RECall	
:AUTO {<bool>}	Specifies whether the power-down state is recalled from location 0 on power-on

:SElect {<profile>}	Specifies which PSU state will be used at power on
:VALid? {<profile>}	Determines whether a storage location contains a valid state
MMEMory	
:LOAD	
:LIST[1 2] <filename>	Loads stored LIST from the SD card to the specified channel
:STORe	
:LIST[1 2] <filename>	Stores specified channel LIST to the SD card
<hr/>	
OUTPut	
[:STATe] {<bool>}	Enables the specified output channel(s)
:DPRog {<bool>}	Controls down-programmer circuit
:MODE?	Returns the channel mode of operation
:PROTection	
:CLEar	Resets latched protection
:COUPle {<bool>}	Enables channel coupling for protection faults
:TRACk[:STATe] {<bool>}	Enables channels to operate in the track mode
<hr/>	
SIMUlator	
:EXIT	Closes simulator
:GUI	Starts simulator's GUI
:LOAD {<value>}	Sets value of the virtual load
:STATe {<bool>}	"Connects" virtual load to the channel output
:PIN1 {<bool>}	Sets value of the PIN1 input
:PWRGood {<bool>}	Sets the PWRGOOD signal state
:RPOL {<bool>}	Sets the RPOL signal state
:TEMP {<value>}	Sets the temperature sensor value
:VOLT:PROG:EXT {<voltage>}	Sets the output voltage when channel is in external programming mode
<hr/>	
SENSe	
:CURRent	
[:DC]	
RANGe[:UPPer] {<range>}	Selects a DC current measurement range
AUTO {<bool>}	Enables/disables seamless measurement auto ranging
<hr/>	
[SOURce[<n>]]	
:CURRent	
[:LEVel]	
[:IMMediate][:AMPLitude] {<current>}	Sets the output current
:STEP[:INCRement] {<step>}	Sets the step of the current change
:TRIGgered [:AMPLitude] {<current>}	Sets the triggered output current
:LIMit	
[:POSitive][:IMMediate][:AMPLitude]	Sets the output current limit

{<current>}	
:PROTection	
:DELaY	
[:TIME] {<time>}	Sets the over-current protection (OCP) programming delay
:STATe {<bool>}	Enables/disables over-current protection on the selected channel
:TRIPped?	Returns status of over-current protection activation
:DIGital	
:INPut:DATA? [<pin>]	Reads the state of the digital port pins
:OUTPut:DATA [<pin>] {<state>}	Sets the state of the digital port pins
:PIN<n>	
:FUNCTion {<function>}	Sets the selected pin's function
:POLarity {<polarity>}	Sets the selected pin's polarity
:TOUTput	
:BUS[:ENABLE] {<Bool>}	Enables/disables BUS-generated triggers on digital pins
:LIST	
:COUNT	Sets the number of times that the list is executed
:CURRent[:LEVel]	Specifies the current setting for each list step
:DWELl	Specifies the dwell time for each list step
:VOLTage[:LEVel]	Specifies the voltage setting for each list step
:LRIPple {<bool>}	Sets low output ripple (noise) mode of operation
:AUTO {<bool>}	Sets automatic changing to the low output ripple (noise) mode of operation
:POWEr	
:LIMit {<power>}	Sets the output power limit
:PROTection[:LEVel]	Sets the over-power protection (OPP) level
:DELaY	
[:TIME] {<time>}	Sets the over-power protection programming delay
:STATe {<bool>}	Enables/disables over-power protection on the selected channel
:TRIPped?	Returns status of over-power protection activation
:VOLTage	
[:LEVel]	
[:IMMediate][:AMPLitude] {<voltage>}	Sets the output voltage
:STEP[:INCRement] {<step>}	Sets the step of the voltage change
:TRIGgered [:AMPLitude] {<voltage>}	Sets the triggered output voltage
:LIMit	
[:POSitive][:IMMediate][:AMPLitude] {<voltage>}	Sets the output voltage limit
:PROGrama[:SOURce] {<source>}	Sets voltage programming source

:PROTection[:LEVel]	Sets the over-voltage protection (OVP) level
:DELay	
[:TIME] {<time>}	Sets the over-voltage protection (OVP) programming delay
:STATe {<bool>}	Enables/disables over-voltage protection on the selected channel
:TRIPped?	Returns status of over-voltage protection activation
:SENSe[:SOURce] {<source>}	Sets voltage sense inputs source

STATus

:OPERation	
[:EVENT]?	Returns the value of the Operation Event register
:CONDition?	Returns the value of the Operation Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Event register
:INSTrument[<n>]	
[:EVENT]?	Returns the value of the Operation Instrument Event register
:CONDition?	Returns the value of the Operation Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Instrument Event register
:ISUMmary<n>	
[:EVENT]?	Returns the value of the Operation Instrument Isummary Event register
:CONDition?	Returns the value of the Operation Instrument Isummary Condition register
:ENABLE {<value>}	Enables specific bits in the Operation Instrument Isummary Event register
:PREset	Presets all enable registers to power-on state
:QUEStionable	
[:EVENT]?	Returns the value of the Questionable Event register
:CONDition?	Returns the value of the Questionable Condition register
:ENABLE {<value>}	Enables specific bits in the Questionable Event register
:INSTrument[<n>]	
[:EVENT]?	Returns the value of the Questionable Instrument Event register
:CONDition?	Returns the value of the Questionable Instrument Condition register
:ENABLE {<value>}	Enables specific bits in the Questionable Instrument Event register
:ISUMmary<n>	
[:EVENT]?	Returns the value of the Questionable Instrument Isummary Event register
:CONDition?	Returns the value of the Questionable Instrument

	Isystem Condition register
:ENABLE {<value>}	Enables specific bits in the Questionable Instrument Isystem Event register
<hr/>	
SYSTem	
:BEEPer[:IMMediate]	Issues a single beep immediately
:STATe {<bool>}	Enables beeper function
:KEY	
:STATe {<bool>}	Enables click tone for local control
:CAPability?	Returns an <instrument_specifier>
:CHANnel	
[:COUNT]?	Returns the number of output channels
:INFOrmation	
:CURRent?	Returns output current capability
:ONtime	
LAST?	Returns time passed after last output enable
TOTal?	Returns channel's total active time
:POWer?	Returns output power capability
:PROGram?	Returns programmable features of the channel
:VOLTage?	Returns output voltage capability
:MODEl?	Returns the channel model identification
:COMMunicate	
:RLSTate {<state>}	Places the instrument in remote or local mode
CPU	
:INFOrmation	
:ETHernet	
:TYPE?	Returns the type of Ethernet controller
:ONtime	
LAST?	Returns time passed after last power on
TOTal?	Returns PSU's total active time
:TYPE?	Returns the type of CPU
:MODEl?	Returns the control board model identification
:OPTion?	Returns information about installed options on the control board
:DATE {<yyyy>,<mm>,<dd>}	Sets the date of the system clock
:ERRor	
[:NEXT]?	Queries and clears errors from the error queue
:COUNT?	Queries the error/event queue for the number of unread items
:KLOCK	Disables front panel [lock/unlock] icon
:LOCAL	Places the PSU in the local mode
:PASSword	
:CALibration	

:RESet	Resets the calibration password to initial value
:FPANel	
:RESet	Resets the front panel lock password to initial value
:NEW {<old>, <new>}	Changes system password
:POWer {<bool>}	Enters the PSU into the Stand-by mode
:PROTection:TRIP {<bool>}	Enters the PSU into the Stand-by mode in case of protection trip
:REMote	Places the PSU in the remote mode
:RWLock	Places the PSU in the remote mode and disables front panel [lock/unlock] icon
:TEMPerature	
:PROTection	
[:HIGH]	
[:LEVel] {<temperature>[, <sensor>]}	Sets the OTP value
:CLEar[, {<sensor>}]	Clears the latched protection status of the over-temperature protection (OTP)
:DELay	Sets time-out period
[:TIME] {<delay>[, <sensor>]}	Sets the OTP programming delay
:STATe {<bool>[, <sensor>]}	Enables/disables OTP on the selected temperature sensor
:TRIPped? [<sensor>]	Returns status of OTP activation
:TIME {<hh>,<mm>,<ss>}	Sets the time of the system clock
:VERSion?	Returns the SCPI version number

TRIGger

[:SEQuence]	
[:IMMediate]	
:DELay {<delay>}	Sets the time delay between the detection of a trigger event and the start of any corresponding trigger action
:SLOPe {polarity}	Sets the polarity of the PIN<n> (external) trigger signal
:SOURce {<source>}	Sets the trigger source

