Programming Manual

HPS Series
High Power Programmable DC Power Supplies

BK PRECISION

Contents

About this Manual

This manual describes how to use the Commands for Programming Instruments to communicate with the HPS Series.

1.1 Intended Audience

This document is designed for instrument programmers tasked with creating proprietary-based programs for the HPS Series.

1.2 Related Documents

Refer to the following documents for more information:

- HPS Series User's Manual. This manual describes the operation of the HPS Series.
- IEEE Std 488.2-1992, The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017-2394, USA (ISBN 1-55937-238-9)

Syntax Convention

2.1 Introduction

The HPS Series uses a proprietary command set.

The commands can be issued over VISA or socket using TCP port 5025.

2.1.1 Types of Messages

In order to program an HPS instrument, it is necessary to create a program message. This message comprises one or more appropriately formatted proprietary commands transmitted from the controller to the HPS instrument. The program message, which can be sent at any time, requests the instrument to execute a specific action or provide data or status information. These requests are also referred to as queries.

Upon receiving a query, the HPS instrument responds by sending a response message back to the controller. This response message contains data formatted in a specific proprietary format.

2.2 Types of Proprietary Commands

Two types of proprietary commands are available: common commands, described below, and device-specific subsystem commands, described in **section 2.2.2**.

2.2.1 Common Commands

Common proprietary commands, as defined by IEEE 488.2, are responsible for controlling and managing generic system functions like reset, self-test, configuration storage, and device identification. Typically, common commands start with an asterisk (*), have a length of four to five characters, and may involve one or more parameters. The command keyword is separated from the initial parameter by a space. Multiple commands can be separated using a semicolon (;), as demonstrated below:

*RST; *CLS

Refer to **Table 2.1** for a summary of these common SCPI commands applicable to programming the HPS series. For a detailed description of these commands, consult Chapter ??.

Command	Description
CLS	Clears all Event Registers summarized in the status byte. All Queues, except the Output Queue, that are summarized in the status byte are emptied
*ESR	Returns an NR1, which is the value of the Standard Event Status Register.
*RST	Sets the device to teh default defined state.
*STB	Returns the current binary value of the Status Byte Register.

Table 2.1 Common SCPI Commands

2.2.2 Proprietary Subsystem Commands

Proprietary subsystem commands are either measurements-related or other device specific commands for programming the HPS instrument.

The follwoing subsystems are available on the HPS instruments:

- **Source** : Commands within the source subsystem pertain to controls that directly influence device-specific settings associated with the output's characteristics, excluding current characteristics.
- **Current** : Commands within the current subsystem pertain to controls that directly influence current characteristics.
- **Limit** : The Limits subsystem queries the predefined limit values.
- **List** : The list subsystem manages the automated sequencing of specified output values within associated lists.
- **Script** : The script subsystem provides the adminstrativee features needed to program the instruments internal script, which controls one or more user-programmed tasks resident in an instrument.

2.3 Syntax of Program Messages

A program message consist of one or more properly formatted SCPI commands, a parameter (if necessary, and a terminator sent from the controller to the HPS instrument to request some action or to query the instrument for a response.

Figure 2.3 shows the syntax of a program message:

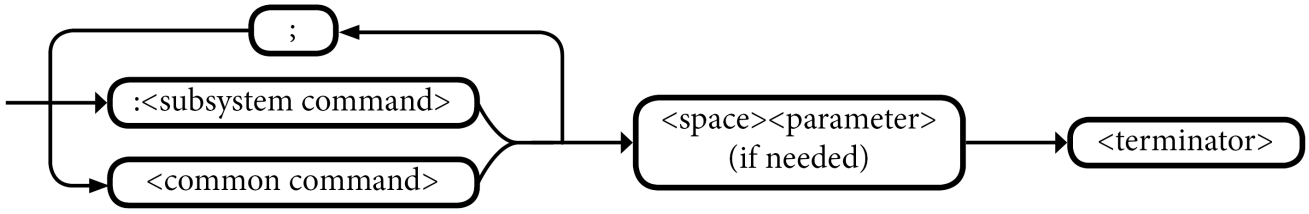

Figure 2.1 Syntax of Program Messages

Data Types

The HPS series uses the following subset of data types:

- Character
- <NR1>
- <NR2>
- <NRf>
- <Boolean>

3.1 Character Data Types

If a command paramter takes data type, a specific number of settings are allowed for the parameter.

Example In the command MODE the user can specify one of the follwoing character data types:

{ UI | UIP | UIR | PVSIM | USER | SKRIPT }

Character data types have the following characteristics:

- Can be expressed in either the short or long form, while response messages return them exclusively in the short form.
- Are case insensitive in program messages but in response messages are standardized to uppercase.
- Must have a specific length.

3.2 <NR1> Value Data Type

The data type <NR1> is utilized to indicate zero, positive, and negative integer values, including optional signs.

The following values are examples of the <NR1> data types:

0 100 -10

3.3 <NR2> Value Data Type

The data type <NR2> is utilized to indicate zero, positive, and positive and negative decimal values, including optional signs and decimal points.

The difference between <NR1> and <NR2> is the explicit decimal point.

The following values are examples of the <NR1> data types:

200.50 100.0 0.0

NOTICE 0 is a special case and redundant deciaml points are ignored.

3.4 <NRf> Value Data Type

The <NRf> data type is employed to define floating-point values. These values encompass digits with an implied decimal point, an explicit decimal point, or an explicit decimal point along with an exponent.

The following values are examples of the <NRf> data types:

200 15.000e-3 0.015

3.5 Boolean Data Type

A Boolean data type for a paramter and response represents a single binary condition that is either True or False. Boolena values are defined as follows:

- **0 or OFF** : Indicates that the condition is False.
- **1 or ON** : Indicates that the codition is True.

NOTICE The charaters OFF and ON are not case sensitive.

About Commands & Queries

This section lists and describes the remote control commands and queries recognized by the instrument. All commands and queries can be executed in either local or remote state.

The description, command syntax, query syntax, example and respond can be found in a section. The commands are given in both long and short form. All examples are shown in short form. Queries perform actions such as obtaining information, and are recognized by the question mark (?) following the header.

4.1 How They are Listed

The commands are listed by subsystem and alphabetical order according to their short form.

4.2 How They are Described

In the descriptions themselves, a brief explanation of the function performed is given. This is followed by a presentation of the formal syntax, with the header given in Upper-and-Lower-Case characters and the short form derived from it in ALL UPPER-CASE characters. Where applicable, the syntax of the query is given with the format of its response.

4.3 When can they be used?

The commands and queries listed here can be used for the HPS seires.

4.4 Command Notation

The following notation is used in the commands:

< > Angular brackets enclose words that are used as placeholders, of which there are two types: the header path and the data parameter of a command.

:= A colon followed by an equals sign separates a placeholder from the description of the type and range of values that may be used in a command instead of the placeholder.

{ } Braces enclose a list of choices, one of which one must be made.

[ ] Square brackets enclose optional items.

… An ellipsis indicates that the items both to its left and right may be repeated a number of times.

Source Subsystem

The source subsystem commands deal with controls that directly affect device-specific settings of the device and not those related to the signal-oriented characteristics.

5.1 OVP (Over Voltage Protection)

Description This command asjust the over voltage protection. Entering the command without parameters returns the preset set point.

Parameters <over voltage protection>

Response <over voltage protection>

Data Format <NR2>

Example > OVP,500

<200.00 V

The respond indicates the over voltage protection is set for 500 V.

NOTICE If the set point exceeds 1.2 times the unit's voltage maximum, the range error bit in the ESR register of the interface is activated, while the current set point remains unaltered.

5.1.1 OVP Example

For the following example lets assume the model being used is a HPS20K800.

- **GTR**: Places the instrument in remote operation mode.
- **OVP,500**: Configures the over voltage protection to 500 V.
- **UA,10**: Configures the output voltage to 10 V.
- **IA,5**: Confiugre the output current to 5 A.
- **SB,R**: Enabled the output.
- **OVP**: Query of the adjusted OVP.
- **OVP,500.0V**: Query response, the unit answers: OVP = 500 V.

5.2 RA (Internal Resistance)

Description This command adjusts the internal resistance for UIR mode. Entering the command without parameters displays the present set point.

Parameters RA,<R_i>

Response RA,<R_i>

Data Format <NR2>

<R_i> := { Configurable range }

NOTICE

The configurable range can be requested with the commands **LIMRMAX** and **LIMRMIN**. If the set point is out of adjustment range the range error bit of the interface is set in the ESR register. The present set point remains unchanged.

Example

▷ **RA**

Query the output's internal resistance.

✓ **RA,0.1**

The intrument responds 100 mΩ.

▷ **RA,0.2**

Sets the output's internal resistance to 200 mΩ.

5.3 REGLER (Controller Parameters)

Description This command adjusts the controller parameters in UIP, UIR and PVsim mode. Entering the command without parameters displays the present settings as a table.

Parameters REGLER,<Nr>,<K_p>,<K_i>,<K_d>

Response Type P I D

P <K_p>,<K_i>,<K_d>

Ri <K_p>,<K_i>,<K_d>

Pv <K_p>,<K_i>,<K_d>

Data Format

Parameter	Format	Function
<Nr>	<NR1>	Selects controller being configured. 0 = Controller for UIP 1 = Controller for UIR 2 = Controller for PV_{sim}
<K_p>	<NR1>	Proportional coefficient $\times 10$
<K_i>	<NR1>	Integral replaced by a summation.
<K_d>	<NR1>	Differential replaced by a difference.

Table 5.1 Controller Parameters

The common differntial equation of a PID controller is as follows:

$$y = k_p \times (e + \frac{1}{T_n}\int e(t)dt + T_v\frac{de}{dt})$$

E Controller deviation

K_p Proportional coefficient

T_n Reset time

T_v Derivative time

Since the digital controller is a discrete-time system, the integral is replaced by a summation and the differential by a difference:

$$y = k_p \times (e_i + \frac{T_s}{T_n}\sum_{m=-\infty}^{m=1} e_m + \frac{T_v}{T_s}(e_i - e_{i-1}))$$

T_s Sampling Time

The following equationputs the controller into practice within the instrument:

$$y = 0.1 \times P \times e_i + 0.001 \times I \times \sum_{m=-\infty}^{m=1} e_m + 0.1 \times D \times (e_i - e_{i-1})$$

The parameters P, I, and D are calculated as follows:

$$P = 10 \times K_p \qquad I = \frac{1000 \times K_p \times T_s}{T_n} \qquad D = \frac{10 \times K_p \times T_v}{T_n}$$

Example

▷ **REGLER**

Query the set controller values.

✓ **P 10 20 5**
Ri 20 20 2
Pv 10 5 5

The intrument responds:
UIP Mode Kp = 20 Ki = 10 Kd = 5
UIR Mode Kp = 20 Ki = 20 Kd = 5
PV Mode Kp = 10 Ki = 5 Kd = 5.

▷ **REGLER,0,10,10,5**

Sets the new values for the UIP controller.

▷ **REGLER,1,22,18,5**

Sets the new values for the UIR controller.

▷ **SS**

Save the new values.

5.4 SB (Standby)

Description The standby command enables/disables the output. Entering the command without parameters displays the present standby status.

Parameters SB,<state>

Response SB,<state>

Data Format <Character | Boolean>

<state> := { S | R | 1 | 0}

NOTICE The parameters S and 1 enable standby mode, the output is disabled. The paramettetrsR and SB,0 disable the standby mode, the output is enabled.

Example

▷ **SB,R**

Enable output.

▷ **SB**

Query the output state.

✓ **SB,R**

The intrument responds the output is enabled.

Current Subsystem

This subsystem controls the signal amplitude characteristics of the source.

6.1 IA (I Set)

Description This command adjusts the set current. Entering the command without parameters displays the set value.

Parameters <I_{set}>

Response <I_{set}>

Data Format <NR2>

<I_{set}> := { min current - max current }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 6.1 Output Rating

Example > IA,10

< 10.00 A

The response indicates that the current output is set to 10 A.

CAUTION

If the set value is higher than the maximum current of the unit, the range-error-bit within the ESR register of the interface is set, and the present set value remains unchanged. If the set value is higher than the I_{limit} value, which was adjusted by the user's settings, but lower than the maximum current of the unit, the current is limited to the I_{limit} value. No error message.

NOTICE

In master/slave mode, the programmed device's current is adjusted. When connected in parallel, the maximum current is adjusted to $n \times IA$.

6.1.1 IA Example

For the following example lets assume the model being used is a HPS20K800 and the current limit was adjusted to 10 A via the configuration menu.

- **GTR**: Places the instrument in remote operation mode.
- **OVP,200**: Configures the over voltage protection to 200 V.
- **UA,10**: Configures the output voltage to 10 V.
- **IA,5**: Confiugre the output current to 5 A.
- **SB,R**: Enabled the output.
- **IA,33**: Configures the output current to 33A. This command is ignored because the current is higher than the maximum current of the device. 'Rangeerror' is set within the status byte.
- **IA,15**: Configure the output current to 15A, since the output current was limited to 10 A via the configuration menu, current limiting is set to 10 A. The error bit is not set.
- **IA**: Query of the adjusted current.
- **IA,200.0A**: Query response, the unit answers: Ilimit = 200 A.

6.2 IMPP

Description This command adjusts the MPP current for PV_{sim} mode. Entering the command without parameters displays the set value.

Parameters <I_{MPP}>

Response <I_{MPP}>

Data Format <NR2>

<I_{MPP}> := { min current - max current }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 6.2 Output Rating

Example $>$ IA,10

$<$ 10.00 A

The response indicates that the I_{MPP} current is set to 10 A.

CAUTION

If the set value is higher than the maximum current of the unit, the range-error-bit within the ESR register of the interface is set, and the present set value remains unchanged. If the set value is higher than the I_{limit} value, which was adjusted by the user's settings, but lower than the maximum current of the unit, the current is limited to the I_{limit} value. No error message.

NOTICE

In master/slave mode, the programmed device's current is adjusted. When connected in parallel, the maximum current is adjusted to $n \times IA$.

6.2.1 IMPP Example

For the following example lets assume the model being used is a HPS20K800 and the current limit was adjusted to 10 A via the configuration menu.

- **GTR**: Places the instrument in remote operation mode.
- **OVP,200**: Configures the over voltage protection to 200 V.
- **UA,10**: Configures the output voltage to 10 V.
- **IA,5**: Confiugre the output current to 5 A.
- **UMPP,40.4**: Configures the MPP voltage of a simulated 40.4 V PV generator.
- **IMPP,8.2**: Configure the MPP current of a simulated 8.2 A PV generator.
- **MODE,PVSIM**: Activates PV simulation mode.
- **SB,R**: Enables the output.

Limit Subsystem

The Limits subsystem queries the predefined limit values.

7.1 LIMI (Current Limit)

Description This command queries the predefined maximum current limit.

Parameters none

Response <max current limit>

Data Format <NR2>

<max current limit> := { min current - max current }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 7.1 Output Rating

Example > LIMI

< 20.00 A

The response indicates that the maximum current limit was predefined to 20 A.

7.2 LIMP (Maximum Power)

Description This command queries the predefined maximum power limit.

Parameters none

Response <max power limit>

Data Format <NR2>

<max power limit> := { min power - max power }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 7.2 Output Rating

Example > LIMP

< 20.00 kW

The response indicates that the maximum power limit was predefined to 20 kW.

7.3 LIMR (Resistance Range)

Description This command queries the adjustable resistance range within UIR mode.

Parameters none

Response <resistance range>

Data Format <NR2>

<resistance range> := { min resistance - max resistance }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 7.3 Output Rating

Example > LIMR

< 1 Ω

The response indicates that the adjustable predefined resistance range is 1 Ω.

7.4 LIMRMAX (Maximum Resistance)

Description This command queries the predefined maximum resistance limit within UIR mode.

Parameters none

Response <maximum resistance limit>

Data Format <NR2>

<maximum resistance limit> := { min resistance - max resistance }

Example > LIMRMAX

< 1 Ω

The response indicates that the maximum resistance is 1 Ω.

7.5 LIMRMIN (Minimum Resistance)

Description This command queries the predefined minimum resistance limit within UIR mode.

Parameters none

Response <minimum resistance limit>

Data Format <NR2>

<minimum resistance limit> := { min resistance - max resistance }

Example > LIMRMIN

< 20 mΩ

The response indicates that the minimum resistance is 20 mΩ.

7.6 LIMU (Voltage Limit)

Description This command queries the predefined maximum voltage limit.

Parameters none

Response <max voltage limit>

Data Format <NR2>

<max voltage limit> := { min voltage - max voltage }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 7.4 Output Rating

Example > LIMU

< 500.00 V

The response indicates that the maximum voltage limit was predefined to 500 V.

7.7 PA(Set Powe Limit)

Description This command adjusts the power limitation for UIP mode. Entering the command without parameter displays the present set point.

Parameters <P_{LIMIT}>

Response <P_{LIMIT}>

Data Format <NR2>

<P_{LIMIT}> := { min power rating - max power rating }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 7.5 Output Rating

Example > PA,1800

< 1800.00 W

The response indicates that the maximum pwoer limit was predefined to 1800 W.

NOTICE f the set point is higher than the maximum power of the unit, the range error bit within the ESR register of the interface is set. The present set point remains unchanged.

NOTICE In master/slave mode the power of a programmed device is adjusted. Total output is n x PA.

7.7.1 PA Example

- **GTR**: Places the instrument in remote operation mode.
- **MODE,UIP**: Enables UIP mode.
- **OVP,200**: Configures the over voltage protection to 200 V.

- **UA,10**: Configures the output voltage to 10 V.
- **IA,5**: Confiugre the output current to 5 A.
- **PA,1800**: Confiugre the power limit to 1800 W.
- **SB,R**: Enabled the output.

Commands

8.1 CLS (Clear Status)

Description Clears all event registers summarized in the Status Byte (STB) register, described on table ??.

Parameters None

Response None

Data Format None

Example > CLS

The response indicates that 3 acquisition boars are installed on the instrument.

NOTICE

All queues that are summarized in the Sdtatus Bute (STB) register,except the output queue, are emptied. The device is forced into the operation complete idle state and the operation complete query is set to idle state.

8.2 DCL (Device Clear)

Description Resets the initialization data.

Parameters None

Response None

Data Format None

Example > DCL

CAUTION

All initialization data will be reset, including interface parameters.

8.3 GTL (Go to Local)

Description This command activates front panel operation. If the 'Local Lockout' (LLO) was previously activated, it will be reset.

Parameters None

Response None

Data Format None

Example > GTL

8.4 GTR (Go to Remote)

Description This command activates digital interface operation. The optional parameter affects the future behavior of the unit at power on. The setting is saved permanently.

Parameters <behavior>

Response None

Data Format <NR1>

<behavior> := { 0 | 1 | 2 }

- **0** := The command GTR must be entered to activate the unit's remote operation mode. This mode is useful if the unit shall be operated manually and at the same time, measurement values shall be read out via the digital interface.
- **1** := The unit automatically switches to remote operation when receiving a command via digital interface. The only exception is the GTL command, which switches the unit to local mode.
- **2** := At power on, remote mode is immediately activated, and front panel operation is deactivated.

Example > GTR,1

8.5 *IDN?

Description The identification query returns the unique identification of device over the system interface.

Syntax *IDN?

Parameters None

Response <manufacturer>,<model>,<serial number>, <software version>

Data Format <ARBITRARY ASCII RESPONSE DATA>

<manufacturer>:= Defines the manufacturer of the instrument.

<model>:= A model identifier less than 14 characters will contain the model number.

<serial number>:= Number that uniquley identifies the instrument.

<firmware version>:= Firmware revision number.

NOTICE

Thre data format of the response is <ARBITRARY ASCII RESPONSE DATA>, the ***IDN?** query shoud be the last <QUERY MESSAGE UNIT> in a <TERMINATED PROGRAM MESSAGE>.

Refer to $IEEE488.2 - 1992$, sections 6.5.75, 8.7.11 and 10.14, for more information.

Example > *IDN?

< Sefram, DAS1800, (667G23005), 1.0.2.0

The response indicates that Sefram is the manufacturer of the device, DAS1800 is the model of the isntrument, 667G23005 is the serial number of the instrument , and 1.0.2.0 is the version of the firmware.

8.6 LLO (Local Lockout)

Description Deactivates the local button, preventing the instrument from reverting to local mode using the front panel.

Parameters None

Response None

Data Format None

Example > LLO

8.7 MODE

Description This command configures the operational mode. Executing the command without a parameter returns the currently chosen operational mode. Inputting the command with a parameter sets the specified operational mode. Alternatively, the operational mode can be specified by a numerical value.

Parameters <operation mode>

Response <operation mode>

Data Format <string>/<NR1>

<operation mode>:= { UI/0 | UIP/1 | UIR/2 | PVSIM/3 | USER/4 | SKRIPT/5 }

Example

Command	Function
MODE,UI MODE,0	Sets the opeartional mode to UI.
MODE,UIP MODE,1	Sets the opeartional mode to UIP.
MODE,UIR MODE,2	Sets the opeartional mode to UIR.
MODE,PVSIM MODE,3	Sets the opeartional mode to PVsim.
MODE,USER MODE,4	Sets the opeartional mode to User-defined UI. Refer to **List Commands** for more details.
MODE,SKRIPT MODE,5	Sets the opeartional mode to Script. The script is read from the memory card or loaded after the command SCR has been entered.

Table 8.1 Opeartional Modes

8.8 *OPT?

Description This command performs an optional identification query. The query returns the firmware version installed.

Parameters None

Response <firmware version>

Data Format <string>

Example > *OPT?

< 08.06.2023 V1

8.9 PC1

Description This command adjusts the RS232 interface paramters. Entering the command without parameter displays present interface parameters.

Parameters PC1,<baud>,<parity>,<data bits>,<stop bits>,<handshake>,<echo>

Response PC1,RS232,<baud>,<parity>,<data bits>,<stop bits>,<handshake>,<echo>

Data Format

Parameter	Format	Function
<baud>	<NR1>	Baud rate in bps
<parity>	<character>	O = Odd = Uneven parity
		E = Even = Even parity
		N = None = No parity bit
<data bits>	<NR1>	Number of data bits
<stop bits>	<NR1>	Number of stop bits
<handshake>	<character>	H = Hardware
		S = Software
		N = None (no handshake)
<echo>	<character>	E = Echo = echo on
		N = None = echo off

Table 8.2 RS232 Parameters

Example

▷ **PC1**
Query the RS232 interface parameters

✓ **PC1,RS232,9600,N,8,2,N,E**
The intrument responds PC1 is a RS232 interface, 9600 bauds, 8 data bits, 2 stop bits, no handshake, no parity, echo on.

▷ **PC1,115200,N,8,2,N,E**
Configures the baud rate to 115200 baud.

NOTICE The new baud rate is immediately configured after sending the command. To permanently change parameters use the **SS** command after the PC1 command.

8.10 *RST

Description The reset command performs a device reset.

Parameters None

Response None

Data Format None

Example > *RST
The instrument will return to a known state (factory-supplied) that is independent of the past-use history of the device.

NOTICE

All queues that are summarized in the Sdtatus Bute (STB) register,except the output queue, are emptied. The device is forced into the operation complete idle state and the operation complete query is set to idle state.

8.11 SS (Save Setup)

Description The save setup command saves the instrument's present parameters. These parameters include all interace and controller parameters.

Parameters None

Response None

Data Format None

Example > SS

8.12 STATUS

Description Query the instrument's devive status. The status is returned in binary.

Parameters None

Response <FN1>

Data Format

Bit	Function
D15	Number of units in M/S mode. If no other device is connected, 1 is displayed, if two devices are connected to the bus, 2 is displayed etc. If M/S mode was disabled via configuration menu, 0 is displayed.
D14	
D13	
D12	
D11	- reserved -
D10	- reserved -
D9	- reserved -
D8	Limit mode, unit in power limitation mode
D7	Limit mode, unit in current limitation mode
D6	Local lockout (1 = LLO active, 0 = LLO not active)
D5	Local (1 = front panel operation)
D4	Remote (1 = digital interface operation)
D3	- reserved -
D2	- reserved -
D1	Standby (1 = unit in standby mode)
D0	OVP (1 = shut down by over voltage protection)

Table 8.3 Device Status

Example

▷ **STATUS**
Query the the instrument's status.

✓ **STATUS,0000000100010000**
The intrument responds that remote operation mode and power limitation are enabled.

8.13 *STB

Description Query the instrument's interface status. The status is returned in binary.

Parameters None

Response <FN1>

Data Format

Bit	Function
D15	Parity error
D14	Over run error
D13	Framing error
D12	Timeout error
D11	Echo on
D10	used internally, can be 1 or 0
D9	Hardware handshake (RTS/CTS)
D8	Software handshake (XON/XOFF)
D7	Parity enable
D6	Parity mode (1 = odd, 0 = even)
D5	Stop bit (1 = 2 stop bits; 0 = 1 stop bit)
D4	Data format (1 = 8 bit; 0 = 7 bit)
D3	used internally, can be 1 or 0
D2	→ **Table 8.5**
D1	→ **Table 8.5**
D0	→ **Table 8.5**

Table 8.4 Interface Status

D2	D1	D0	Error
0	0	1	Syntax
0	1	0	Command
0	1	1	Range
1	0	0	Unit
1	0	1	Hardware
1	1	0	Read

Table 8.5 Interface Errors

Example

▷ ***STB**
Query the the instrument's interface status.

✓ ***STB,0010000000000000**
The intrument responds that a syntax error has occured.

List Commands

The list subsystem controls automatic sequencing through associated lists of specified signal values.

9.1 DAT

Description Defines the voltage and current for individual step in a list.

Parameters <V>,<I>

Response None

Data Format <NRf>

<V> := { min voltage - max voltage }

<I> := { min current - max current }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 9.1 Output Rating

Example > DAT,90,1

The comand specifies a step with a 90 V and 1 A outpu.

NOTICE

All queues that are summarized in the Sdtatus Bute (STB) register,except the output queue, are emptied. The device is forced into the operation complete idle state and the operation complete query is set to idle state.

9.2 WAVE (End Userwave Data)

Description This instruction concludes the transmission of a user-defined output characteristic. The execution of the command will result in layer interpolation for values between the fulcrums.

Parameters None

Response None

Data Format None

Example > WAVEL

9.3 WAVELIN (End Userwave Data Linear)

Description This instruction concludes the transmission of a user-defined output characteristic. The execution of the command will result in linear interpolation of values between the fulcrums.

Parameters None

Response None

Data Format None

Example > WAVELIN

9.4 WAVERESET (Start User Wave Data)

Description This instruction starts the transfer of a user defined output characteristic.

Parameters <V_{max}>,<I_{max}>

Response None

Data Format <NRf>

<V_{max}> := { min voltage - max voltage }

<I_{max}> := { min current - max current }

Model	HPS20K800	HPS20K1500
Output Rating		
Output Voltage	0 to 800 V	0 to 1500 V
Output Current	0 to 25 A	0 to 13.4 A
Output Power	20 kW	

Table 9.2 Output Rating

Example > WAVELIN

9.5 List Example

- **GTR**: Places the instrument in remote operation mode.
- **OVP,200**: Configures the over voltage protection to 200 V.
- **WAVERESET,100,10**: Configures the maximum output limits of the list to 100 V and 10 A.
- **DAT,95,1**: Configures the output characteristic of the step to a 95 V and 1 A.
- **DAT,60,5**: Configures the output characteristic of the step to a 60 V and 5 A.
- **DAT,20,6**: Configures the output characteristic of the step to a 20 V and 6 A.
- **DAT,10,9**: Configures the output characteristic of the step to a 10 V and 9 A.
- **WAVELIN**: Specifies the end characteristic as linear interpolation.
- **MODE,USER**: Activates the created UI characteristic.
- **SB,R**: Enables the output state.

The example above results in the output shown in **figure 9.1**.

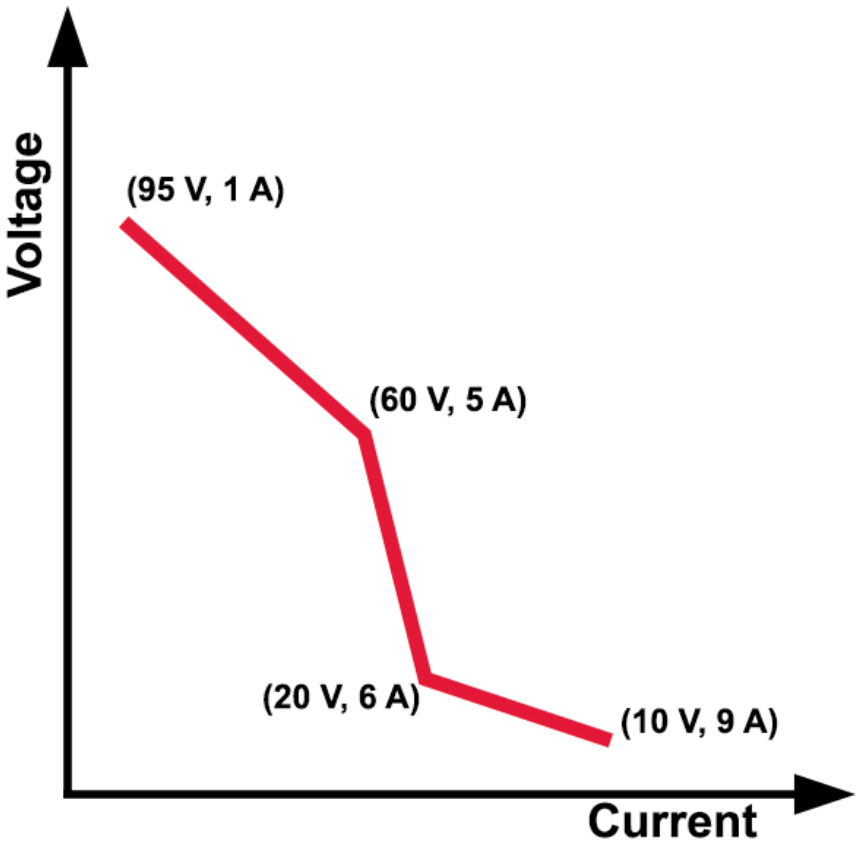

Figure 9.1 List Example

Script Subsystem

The script subsystem provides the adminstrativee features needed to program the instruments internal script, which controls one or more user-programmed tasks resident in an instrument.

10.1 SCR (Load Script)

Description The load script command allows users to program the script in the instument internal memory. The command SCR without parameters initializes the programming procedure. The command SCR with parameters writes the commands into the script memory. The order of the commands corresponds to the order of commands of the script. Script commands and their parameters are described in chapter **Script Subsystem**.

Parameters SCR,<Character>

Response None

Data Format <Character>

Character	Description
; or #	Entering commented text.
DELAY<t>, DELAYS<t>	Delays execution of the script for duration of time t.
I<I in ampère>	Set point output current.
IMPP<I in ampère>	MPP current in ampère for PV simulation.
LOOP, LOOPCNT	Define return address.
PMAX	Maximum output for UIP mode.
PV	Activate PVsim mode.
RI	Set point internal resistance in ohm for UIR mode.
RUN	Enable output.
STANDBY	Disable output.
U	Set point output voltage in V.
UI	Activate UI mode.
UIP	Activate UIP mode.
UIR	Activate UIR mode.
UMPP	Set point MPP voltage (for PV simulation)
USER	Generates set points for current and voltage using the internal table.
WAIT	Waits for user action.
WAVE, WAVELIN	Characteristic programming.

Table 10.1 Controller Parameters

NOTICE

The parameters S and 1 enable standby mode, the output is disabled. The parametteтrsR and SB,0 disable the standby mode, the output is enabled.

Example

▷ **SB,R**

Enable output.

▷ **SB**

Query the output state.

✓ **SB,R**

The intrument responds the output is enabled.