BK PRECISION ®

Instruction Manual

Model 9120, 9121, 9122 & 9123
SINGLE OUTPUT PROGRAMMABLE DC POWER SUPPLY

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General Information

Single output programmable DC power supplies.

Output voltage is: 0 to 30.0 V for Model 9120

                                           0 to 20.0 V for Model 9121

                                           0 to 60.0 V for Model 9122

                                           0 to 30.0 V for Model 9123

Output current is: 0 to 3.00 A for Model 9120

                                           0 to 5.00 A for Model 9121

                                           0 to 2.50 A for Model 9122

                                           0 to 5.00 A for Model 9123

The power supply can be locally or remote controlled.

Available interfaces for 912x power supply models:

	9120	9121	9122	9123
RS-232	Standard	Standard	Standard	Standard
GPIB / 488	Optional	Optional	Optional	Standard

The commands available in remote interface mode are

- SCPI (*Standard Commands for Programmable Instruments*) commands (1999 SCPI standard)
- IEEE 488.2 commands
- IEEE 488 bus commands (only for GPIB / 488 interface)

Features

- **Constant Voltage / Constant Current modes of operation**

This power supply can operate in either constant voltage or constant current modes. The passing from one mode of operation to another is automatic.

The active mode of operation is indicated using two indicators:

CV – constant voltage mo de of operation
CC – constant current mode of operation

- **Overvoltage protection**

Overvoltage protection circuit can be locally or remote activated.

When it is active, **ovp** indicator is displayed.

- **Output on / off**

When output off, output voltage is 0 V.

This permits a zero output voltage without switching off the power supply.

- **100 operating states storage**

States are identified by location number and name.

Stored parameters are: voltage limit, voltage step, overvoltage protection level, state of overvoltage protection circuit, current limit, current step, voltage trigger value, current trigger value, trigger delay value, trigger source, stored state name, state of display, output state.

After power on, state 0, named *power_up* will become the current operating state.

- **error messages**

Errors are stored in a 20 locations FIFO (first in first out) queue.

They can be read in local mode (error number returned) or in remote operation mode (error number and definition returned).

Every error is announced by a beep and the **err** indicator.

Local mode operation

Front Panel Description
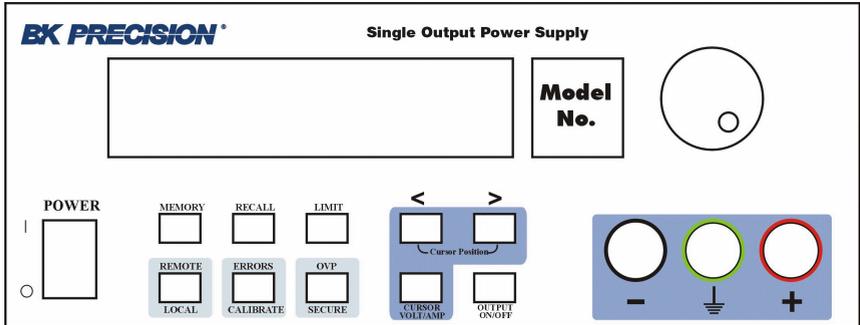
Memory Key

Note: Memory location 00 is the *power_up* state. When the unit is powered up, the power supply will set itself to the settings stored in location 00.

Note: If you press the Recall button while turning the power on, the power supply will power up using memory location 01 parameters.

This button is used to store power supply's current operating state in non-volatile memory. Using this function all operating parameters are saved so they can be recalled. You can store 100 different operating states (numbered from 0 to 99) in the non-volatile memory.

Stored parameters are: voltage limit, voltage step, overvoltage protection level, state of overvoltage protection circuit, current limit, current step, voltage trigger value, current trigger value, trigger delay value, trigger source, stored state name, state of display, output state.

By pressing **Memory** key, you enter in Memory menu.
By turning the knob following options will be displayed:

Store State

Name State

Exit

Options are selected by pressing **Memory** key when the desired option is displayed.

Memory Menu Overview

```
Store State
```

Store State option will store the current operating state without setting a name for this state.
By pressing **Memory** key, state number and state name (if you set one) are displayed in ascending order by turning the knob.

In this menu, **Exit** option is available, too. In this case, you leave the store operation mode, without changing anything. **No Change** message will be displayed and the power supply returns to the previous state (the state before entering **Memory** menu).

The states are scrolled using the knob.
A location is selected by pressing **Memory** key. If the location you choose is already written, it is overwritten (without any warning) with the current state parameters, but the name (the set one or the default one remains unchanged). **Done** message will be displayed.

```
Name State
```

Name State option allows you to set a name for selected state (you can also change a name set before).
The state name can have up to 10 charatcters. The default name is 10 blank characters.

By pressing **Memory** key, state number of non-volatile memory locations is displayed in ascending order by turning the knob.

By pressing **Memory** key again, state name can be set.

When setting the name, selected digit has the cursor underneath it. Characters of the name are selected by rotating the knob. When desired ASCII character is displayed, you can pass to another digit selection using > < cursor position keys. When the desired name is set, you press **Memory** again and the state name is stored in the selected location of the non-volatile memory. **Done** message will be displayed.

In this menu **Exit** option is available, too. In this case, you leave the store operation mode, without changing the name for any state. **No Change** message will be displayed and the power supply returns to the previous state (the state before entering **Memory** menu).

Important note!
Store State option will store the parameters of current operation state in the selected location and will not set a name for the stored state.
NameState option will set a name for the selected state.

```
Exit
```

Exit option allows you to leave the store operation mode, without changing anything. **No Change** message will be displayed and the power supply returns to the previous state (the state before entering **Memory** menu).

Important note!
If you enter in the **Memory** menu and no action takes place for approx. 20 seconds, the power supply leaves the **Memory** menu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering **Memory** menu).

Storing States in Front Panel Mode

To store an operating state in front panel mode you must follow the steps described bellow:

1.   Set the power supply in the desired operating state
Stored parameters are: voltage limit, voltage step, overvoltage protection level, state of overvoltage protection circuit, current limit, current step, voltage trigger value, current trigger value, trigger delay value, trigger source, stored state name, state of display, output state.

Voltage step, current step, voltage trigger value, current trigger value, trigger delay value, trigger source and state of display parameters can be set only over the remote interface, using SCPI commands (for more information, please refer to *SCPI Commands* section).
The rest of the parameters can be set either from the front panel, or over the remote interface.

2.   Enter the Memory menu
By pressing **Memory** key, you enter **Memory** menu.
By turning the knob, following options are displayed:

| Store State |
| Name State |
| Exit |

Options are selected by pressing **Memory** key when desired option is displayed.

3.   Select *StoreState* option
When **Store State** or **Name State** options are selected, state number and state name (if available) of non-volatile memory locations are displayed in ascending order, by turning the knob.

If **Store State** option is selected, the stored operating state has the default name, if none set before.

Store State option will store the parameters of current operation state and will not set a name (or will not change it, if the name was set before) for the stored state.

The saving action is realized by pressing **Memory** key. After that, **Done** message will be displayed and the power supply returns to normal mode.

4. Select *Name State* option
In order to select this option , **Memory** key must be pressed again.
NameState option allows you to set a name for the selected state.

The saving action is realized by pressing **Memory** key. After that, **Done** message will be displayed.

```
 Done
```

 Important note!
The power supply allows 100 states to be stored. When shipped, the power supply has *power_up* state stored and all the other locations are empty.

The stored states are kept in a non-volatile memory, so they won't be lost when the power supply is turned off.

A state location can be overwritten (both name and parameters) without any notification from the power supply.

Recall Key

This key is used to recall an operating state from the storage locations in non-volatile memory. You can recall any operating state from 100 different operating states stored in the non-volatile memory. The recalled state becomes the current operating state.

By pressing **Recall** key, you enter in Recall menu.
By turning the knob, following options will be displayed:

00: power_up

01:

02: Test_mode

etc. (all 100 operating states are displayed)

Exit

Reset

Options are selected by pressing **Recall** key when the desired option is displayed.
Recalling action is terminated by pressing **Recall** key. After that, **Done** message will be displayed.

Recall Menu Overview

01: State 1

When a state option is selected, the stored state recalled becomes the current operating state of the power supply.

Recalled parameters are: voltage limit, voltage step, overvoltage protection level, state of overvoltage protection circuit, current limit, current step, voltage trigger value, current trigger value, trigger delay value, trigger source, stored state name, state of display, output state.

Exit

Exit option allows you to leave the **Recall** menu, without changing anything. **No Change** message will be displayed and the power supply returns to the previous state (the state before entering **Recall** menu).

Reset

Reset option allows you to reset the power supply without switching off (for more information, please refer to *Reset Values* section).

00: power_up

After power up, the power supply recalls state 0.

When delivered, *power_up* state has the following parameters:

$U_{lim} = 1$ V
I_{lim} = maximum available current value (see *Programing ranges* table, in the *Techincal Specifications* section)
OVP trip level = maximum programmable value (see *Programing ranges* table, in the *Techincal Specifications* section)
Output state on

The rest of the parameters have the default value after reset. (please refer to *Reset values* table, in the *Techincal Specifications* section)

For this operating state, *Name State* option is not available (so the state name cannot be changed), but *Store State* option is available (so the user can save the desired state for power up).

Important note!
If you enter **Recall** menu and no action takes place for approx. 20 seconds, the power supply leaves the **Recall** menu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering **Recall** menu).

Recalling States in Front Panel Mode

To recall an operating state in front panel mode, you must follow the steps described bellow:

1.   Enter the Recall menu
By pressing **Recall** key, you enter the **Recall** menu.
By turning the knob, following options are displayed:

01: State 1

02: Test_mode

etc. (all 100 operating states are displayed)

Exit

Reset

2. Select the operating state
By using < > keys (to select the digit you modify by turning the knob) and turning the knob all operating states stored in non-volatile memory are displayed. An operating state is recalled by pressing **Recall** key when desired state is displayed.

3.   Recall the operating state
When **Recall** key is pressed, the selected operating state becomes the current operating state of the power supply, after **Done** message is displayed.

Limit Key

The power supply works in 2 modes:
➢ *Limit* mode
➢ *Normal* mode

In *limit* mode limit values of voltage and current are displayed. These are the programmed values (from the front panel or over the remote interface).

Limit key is used to get the power supply to *limit* mode. In this mode, **lmt** indicator and limit values for voltage and current will be displayed.

In *limit* mode, limit values can be adjusted by turning the knob. To adjust values in *limit* mode, > < keys must be used to select the digit you want to adjust. The selected digit has the cursor underneath it. To increase / decrease value of digit, knob must be turned.

After setting the limit values, by pressing **Limit** key, the power supply returns to *normal* mode. It also returns to *normal* mode after several seconds (display time-out) with no action.

In *normal* mode, voltage and current values measured at the output terminals of the power supply are displayed.

When you turn on the power supply, the cursor is placed underneath the voltage value (units digit). To pass from voltage value to current value **Volt/Amp** key must be used. This key toggles between voltage value and current value.

Modes of Operation

Depending on the application, the power supply can be used as a constant current source or as a constant voltage source.

In order to understand constant current and constant voltage operation, a numeric example will be used.
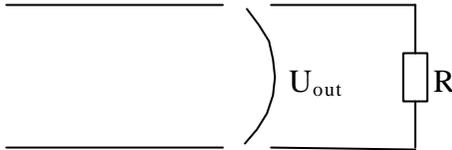
Let's consider a resistor connected to the output terminals of the power supply (R resistor).
Limit (programmed) values are:

$$U_{lim}=5V$$
$$I_{lim} =2A$$

U_{out} and I_{out} are the voltage and current values measured at the output terminals of the power supply.

Depending on the resistor value, the power supply will pass from one mode of operation to another

R ($\tilde{U}$)	U_{out} (V)	I_{out} (A)	Mode of operation
10	5	0.5	CV
5	5	1	CV
1	2	2	CC

In constant voltage mode, programmed voltage value is equal with the voltage value measured at the output terminals of the power supply. ($U_{out} = U_{lim}$).
Using Ohm's law, depending on the resistor's value, output current value can be calculated and it is smaller than current limit value (see first and second rows of the table).

The power supply will remain in CV operation as long as the limit current value is greater than output current value.

When the resistor's value decreases so the output current value becomes equal to the current limit value, power supply will go to constant current operation (see third row of the table).

If the resistor value is $R = 1 \, \Omega$, for $U_{out} = 5V$, using Ohm's law the output current is 5A. But this value is greater than current limit value, so the power supply limits the output current to the limit programmed value. That is why in the third row of the table $I_{out} = 2$ A. In this case, U_{out} is changed, too. Using Ohm's law again, the output voltage is calculated using output current value and the resistor value, so it is 2 V.

So the power supply will go to constant current operation when the output current value becomes equal or greater than the limit value.

When the output current value becomes smaller than the limit value (by changing resistor's value), the power supply will go back to constant voltage operation.

In conclusion:

CV: $\mathbf{U_{out} = U_{lim}}$ **and** $\mathbf{I_{out} < I_{lim}}$

CC: $\mathbf{U_{out} < U_{lim}}$ **and** $\mathbf{I_{out} = I_{lim}}$

The following section will explain how to get the power supply in constant current operation mode and in constant voltage operation mode.

Constant Current Operation

In constant current operation, current values in *limit* mode and *normal* mode are the same, but voltage values are not.

To set the power supply in constant current operation, you must follow the steps described bellow:

1. **Select the limit values for voltage and current parameters (U_{lim} and I_{lim}), depending on the application**

2. **Calculate resistor's value R_{load}.**
    Using Ohm's law, calculate the resistor's value that allows the power supply to go in constant current mode of operation.

3. **Turn on the power supply and set *limit* mode operation**
    Press **Limit** key to set *limit* mode.
    Now the power supply displays limit values for voltage and current. **lmt** indicator is displayed, too. (it will be displayed until you go to *normal* mode).

4. **Set voltage and current limit values**
    Limit values must be chosen so the following conditions are respected:

$$U_{lim} > I_{lim} \cdot R_{load} \quad ,so \qquad U_{lim} < U_{out}$$

$$I_{lim} < I_{out}$$

Voltage and current limit values are set using:
   Volt / Amp key to select current value,
   $><$ keys to select the digit to adjust (selected digit has cursor underneath it)
   knob to set the digit to desired value

5. **Set *normal* mode operation**
    You can set *normal* mode operation by pressing **Limit** key or let the display time-out (after several seconds with no action, power supply returns to *normal* mode operation).

6. **Disable the output of the power supply**
    By pressing **On / Off** key, the output of the power supply can be disabled.

7. **Connect R_{load} resistor to the output terminals**
    R_{load} resistor is connected between (-) and (+) terminals of the power supply.

8. Enable the output of the power supply

By pressing **On / Off** key, you enable the output.

Power supply goes to *normal* mode operation and **CC** indicator will be displayed. In this case constant current operation is active.

If **CV** indicator will be displayed, you must set a higher value for voltage limit.

Important note!

By turning the knob, voltage and current limit values can be adjusted.

The adjustion of the voltage limit value can be seen only in *limit* mode.

The adjustion of the current limit value can be seen in both *limit* mode and *normal* mode.

Important note!

Constant current operation can be used depending on the application.

It is very useful to protect the circuitry connected to the power supply from accidently increases of current value.

Constant Voltage Operation

In constant voltage operation, voltage values in *limit* mode and *normal* mode are the same, but current values are not

To set the power supply in constant voltage operation, you must follow the steps described bellow:

1. **Select the limit values for voltage and current parameters (U_{lim} and I_{lim}), depending on the application**

2. **Calculate resistor's value R_{load}.**
Using Ohm's law, calculate the resistor's value that allows the power supply to go in constant current mode of operation.

3. **Turn on the power supply and set *limit* mode operation**
Press **Limit** key to set *limit* mode.
Now the power supply displays limit values for voltage and current. **lmt** indicator is displayed, too. (it will be displayed until you go to *normal* mode).

4. **Set voltage and current limit values**
Limit values must be chosen so the following conditions are respected:

$$U_{lim} < I_{lim} \cdot R_{load} \quad \text{,so} \qquad U_{lim} < U_{out}$$
$$I_{lim} < I_{out}$$

Voltage and current limit values are set using:
    Volt / Amp key to select current value,
    $>\,<$ keys to select the digit to adjust (selected digit has cursor underneath it)
    knob to set the digit to desired value

5. **Set *normal* mode operation**
You can set *normal* mode operation by pressing **Limit** key or let the display time-out (after several seconds with no action, power supply returns to *normal* mode operation).

6. **Disable the output of the power supply**
By pressing **On / Off** key, the output of the power supply can be disabled.

7. **Connect R_{load} resistor to the output terminals**
R_{load} resistor is connected between (-) and (+) terminals of the power supply.

8. Enable the output of the power supply

By pressing **On / Off** key, you enable the output.

Power supply goes to *normal* mode operation and **CV** indicator will be displayed. In this case constant voltage operation is active.

If **CC** indicator will be displayed, you must set a higher value for current limit.

Important note!

By turning the knob, voltage and current limit values can be adjusted.

The adjustion of the current limit value can be seen only in *limit* mode.

The adjustion of the voltage limit value can be seen in both *limit* mode and *normal* mode.

On / Off Key

On / Off key is used to enable / disable the output of the power supply from the front panel. By pressing **On / Off** key, you alternate these two states: output on / output off.

When the output is off, power supply displays:

Output off

The indicators according to power supply's state will also be displayed (e.g.: ovp, err indicators).

When output off, output voltage is 0 V. So this command permits a zero output voltage without switching off the power supply.

When output off, knob is disabled, to prevent the unwanted changes in voltage and current values. The keys from the front panel are not disabled. You can also go to *limit* mode and set limit values for voltage and current. In this case both **lmt** and **off** indicators will be displayed.

When output off, by pressing **On / Off** key, the output is enabled. The power supply will go to *normal* mode of operation (voltage and current measured values are displayed) or to *limit* mode of operation (voltage and current limit values are displayed), depending on the state the power supply was before disabling the output.

The output state of the power supply is one of the parameters stored in non-volatile memory for each state .

Remote / Local Key

This key has a double function, depending on the state of the power supply (*remote* mode or *local* mode).

Local Mode Function

While in *local* mode of operation, **Remote / Local** key has a double function, depending on the state of the power supply.

If the power supply is in *calibrating* mode, **Remote / Local** key is used to leave the *calibrating* mode and return to normal mode of operation (for more information, please refer to **Calibration Overview** section)

If the power supply is in *limit* mode or *normal* mode of operation, by pressing **Remote / Local** key, available interfaces are displayed.

Remote Interface Configuration

Available interfaces for 912x power-supply models:

	9120	9121	9122	9123
RS-232	Standard	Standard	Standard	Standard
GPIB / 488	Optional	Optional	Optional	Standard

If a power supply has both interfaces implemented, only one interface can be enabled at a time.

Interface selection (and coresponding parameters) is kept in a non-volatile memory, so when powered on, the last selected interface is active.

For a power supply that has both interfaces implemented, when delivered GPIB / 488 interface is selected.

The remote interface can be selected by using front panel or by using a command sent over the interface. Here is described remote interface selection using front panel keys.

If the power supply is in local mode of operation, by pressing **Remote / Local** key, selected interface is displayed (RS-232 or GPIB / 488).

By turning the knob, following options will be displayed:

```
RS - 232
```

```
GPIB / 488
```

By pressing **Remote / Local** key once again, the displayed interface is selected and the specific parameters can be set (for RS – 232 interface, baud rate and parity will be set, for GPIB interface GPIB address of the power supply will be set).

The parameter values can be changed by turning the knob. When desired value for the parameter is displayed, **Remote / Local** key must be pressed.

Important note!
If you enter **Remote / Local** submenu and no action takes place for approx. 20 seconds, the power supply will leave this submenu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering this submenu).

Important note!
If you enter **Remote / Local** submenu and no action takes place for approx. 20 seconds, the power supply will leave this submenu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering this submenu).

Important note!
While in *local* mode, if by pressing **Remote / Local** key

```
I / O Error
```

message will be displayed, it means that the remote interface parameters cannot be read from the non-volatile memory. The power supply must be turned off and then turned on.
If this message is displayed again after pressing **Remote / Local** key in *local* mode, the power supply must be delivered to **B&K Precision** for service.

RS-232 Configuration

Available settings for RS-232 interface:

♦ Baud rate: 1200, 2400, 4800, 9600 (**factory setting: 9600**)
♦ Parity and data bits: None – 8 data bits **(factory setting)**
                                      Odd – 7 data bits
                                      Even – 7 data bits
♦ Number of start bits: 1 bit (cannot be changed)
♦ Number of stop bits: 1 bit (cannot be changed)

Set RS – 232 remote interface parameters

1. Select RS – 232 interface
Press **Remote / Local** key. If "GPIB / 488" is displayed, turn the knob until
"RS-232" will be displayed.

```
RS - 232
```
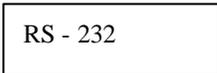
Press **Remote / Local** key again. Baud rate settings will be displayed.

2. Select baud rate
By turning the knob, you will view available baud rates: 1200, 2400, 4800,
9600 bits per second.
When desired baud rate is displayed, press **Remote / Local** key. Parity settings
will be displayed.

3. Select parity
By turning the knob, available parities will be displayed:. Even, odd or no
parity. Select the desired parity.

By pressing **Remote / Local** key, the settings will be saved in the non-volatile
memory and **Saved** message will be displayed.

If you didn't change any of the previous set parameters, the power supply will
display **No Change** message.
If you did change a single parameter from the previous set parameters, **Saved**
message will be displayed.
After one of these messages is displayed for several seconds, the power supply
returns to the previous state.

GPIB / 488 Configuration

Available setting for GPIB / 488 interface is address of the power supply.

An IEEE 488 address can take values from 0 to 30.

GPIB address is kept in a non-volatile memory, so when powered on, the last selected address is active.
When supplied from the factory, power supply's GPIB address is 5.

Set GPIB remote interface parameters

1. Select GPIB / 488 interface
Press **Remote / Local** key. If "RS-232" is displayed, turn the knob until "GPIB / 488" will be displayed.

> GPIB / 488

Press **Remote / Local** key again. GPIB address will be displayed.

2. Select GPIB address
By turning the knob, GPIB address can be selected.

> ADDR 05

When desired GPIB address is displayed, press **Remote / Local** key. By pressing **Remote / Local** key, the settings will be saved in the non-volatile memory and **Saved** message will be displayed.

If you didn't change any of the previous set parameters, the power supply will display **No Change** message.
If you did change a single parameter from the previous set parameters, **Saved** message will be displayed.
After one of these messages is displayed for several seconds, the power supply returns to the previous state.

Remote Mode and Indicators

When RS-232 interface is selected, *SYSTem:REMote* command must be the first sent command. Otherwise, if another command is sent first, **Power supply in local mode** message will be sent to PC.

While in *remote interface* mode of operation (after sending *SYSTem:REMote* command), **rmt** indicator will be displayed. In this case, all front panel keys are disabled, except **Remote / Local** key, which is active. This key allows you to put the power supply in *local* mode of operation, so all front panel keys become active.

In order to control the power supply using remote commands again, *SYSTem:REMote* command must be sent again, before any other commmand.

When GPIB interface is selected, **adr** indicator is displayed when the power supply is addressed (either as a Listener or as a Talker) or when a GPIB command is sent over the interface.

When *SYSTem:REMote* command is sent over the GPIB interface, an error will be generated: **Err 501, Command allowed only in RS-232**.

Errors / Calibrate Key

This key has a double function: errors related in *normal* mode (see this section) and calibration related in *calibration* mode (see calibration section).

There are 2 types of errors: user defined errors and errors defined by SCPI 1999 standard.

Every time an error is generated, a beep will be generated by the power supply and **err** indicator will be displayed.

Generated errors are saved in an error queue, in FIFO (first in – first out) order. If more than 20 errors are generated, the last error is overwritten with *–350* error (queue overflow error) and no more errors are saved.

While in *remote* mode (**rmt** indicator is displayed), errors are erased from the queue as you read them.

By pressing **Errors / Calibrate** key, you enter **Errors / Calibrate** menu. By turning the knob, following options are displayed:

Errors

Cal String

Exit

Options are selected by pressing **Errors / Calibrate** key when the desired option is displayed.

Errors

Errors option allows you to view the generated errors.
If you press **Errors / Calibrate** key again, by turning the knob you can see all generated errors. Error's code will be displayed. When all errors were viewed, if continue to turn the knob, they will be displayed again.

After you viewed all errors, you press **Errors / Calibrate** key again. The power supply will erase all the errors from the error queue and **Errors Erased** message will be displayed.

30

After several seconds the power supply will go back to *normal* mode. The **err** indicator will not be displayed anymore.

If there are no errors in the queue and you select **Errors** option in order to view the errors, the power supply will display:

> No Errors

And then it will return to *normal* mode.

There are 3 ways of erasing the error queue:
- ♦ By turning off and then turning on the power supply
- ♦ By pressing **Errors / Calibrate** key after errors are displayed, in *local* mode
- ♦ By reading errors, in *remote* operation.

Important note!
If you let the display time out while viewing errors locally, the power supply will go back to *normal* mode, without erasing the error queue.

> Cal String

The power supply allows you to store a calibration message. It may contain last calibration date, the date when the next calibration must be done or the name and the phone number of the person to contact for a new calibration.

This message can have up to 40 characters. It can be set only remote interface and it is saved in non-volatile memory.

When delivered, the power supply has the following calibration string set: "CALIBRATION DATE: MMM/DD/YYYY" (for example: CALIBRATION DATE: Feb/11/2005)

Cal String option allows you to view the calibration string.

If you press **Errors / Calibrate** key when **Cal String** option is displayed, the calibration message will be displayed. To increase the scrolling speed, you must press > key. To decrease scrolling speed, you must press < key.

After the first scrolling of the calibration message, < or > keys must be pressed in order to scroll the message again.

Exit

Exit option allows you to leave this menu, without changing anything. **Exiting** message will be displayed and the power supply returns to the previous state (the state before entering this menu).

Important note!
If you enter in the **Errors / Calibrate** menu and no action takes place for approx. 20 seconds, the power supply leaves this menu. **Exiting** message is displayed and the power supply returns to the previous state (the state before entering **Errors / Calibrate** menu).

Calibration Overview

Calibration is a procedure that ensures that the power supply will work properly, with parameters specified within *Technical Specification* section.

Before initiating the calibration procedure, the following conditions must be assured:
- disconnect any loads connected to the power supply and turn it on
- let the power supply turned on for 1 hour, with no loads connected before you start the calibration procedure
- calibration ambient temperature must be 25 ^{0}C
- ambient relative humidity must be less then 80%.

Recommended calibration interval is 1 year.

Important note!
In order to perform the calibration procedure, a digital multimeter is needed. It must have the following characteristics:

> Voltage resolution: 0.1 mV
> Current resolution: 0.01 mA
> Acurracy: 0.01 %

Calibration Security Code

To prevent accidental or unauthorized calibration procedures, the power supply has a calibration security code. This security code is optional, so you may have it or not. The power supply will work properly in both cases.

Security code may contain numbers (0..9), small letters (a..z) and spaces (" "). Any of these characters may be used as the first character in security code.
Security code may contain up to 11 characters. But it is not necessary for you to use all 11 characters for the security code.
The security code is saved in non-volatile memory and it doesn't change when you turn on or turn off the power supply.

When delivered, power supply has the following security code**: 0000**

In order to initiate the calibration procedure, first you must unsecure the power supply (if a security code is set).

Unsecure Procedure for Calibration

To unsecure the power supply, the next steps bust be followed:

1. Turn on the power supply in *calibrating* mode
To enter *calibrating* mode, you must turn on the power supply while pressing
Errors / Calibrate key. You release the key after the long beep. After that, the
power supply will display:

```
Calibrating Mode
Secured
```

if the power supply is secured (if the power supply has a security code set). If
this message is displayed, go to step 2.

or :

```
Calibrating Mode
Unsecured
```

if the power supply is not secured (if the power supply has been turned off after
the unsecure procedure).
If the power supply is already unsecured, you can proceed with calibration (see
Calibration procedure section)

2. Enter security code
Press **OVP / Secure** key. The power supply will display:

```
Security code:
_ _ _ _ _ _ _ _ _ _
```

Here you must enter the security code, using > < keys and knob. The selected
digit has the cursor underneath it. If you set the digit to the desired value, you
must press > key and go to the next digit, if you want.

After you entered the security code, press **OVP / Secure** key and if the security
code is correct, the power supply will display:

```
Calibrating Mode
Unsecured
```

From this moment you can proceed with calibration (see **Calibration procedure** section) or you can go back to *normal* mode operation.

From now on, the power supply remains unsecured until you set a new secure code.

If the security code you entered is not correct, power supply will display:

```
Security code:
invalid
```

for 1 second. 703 error (*Invalid secure code*) and a short beep will be generated. You can see the error in *normal* mode operation (by pressing **Local** key).

After that power supply will display again:

```
Security code:
_ _ _ _ _ _ _ _ _ _
```

and you must enter security code again, using < > keys and knob. If you don't remember the correct security code, you may follow the hardware unsecure procedure (see **Hardware unsecure procedure**).

Important Note!

While in c*alibrating* mode, before you unsecure the power supply, only **Local, < >** and **Secure** keys are active (all the rest are locked). The knob is also active. **Local** key can be used at any moment of unsecure procedure to leave *calibrating* mode and go back to *normal* mode operation. **Secure** key is used in unsecure procedure of the power supply (allows you to enter and validate the secure code).

While in c*alibrating* mode, after you unsecure the power supply, only **Local**, **Secure, < >** and **Calibrate** keys are active. The knob is also active.

Local key is used to leave *calibrating* mode and go back to *normal* mode operation.

Secure key is used to set a new security code (you may introduce a new security code and secure again the power supply).

Calibrate key is used to proceed with calibration.

Attention!

Local key is active all the time while in *calibrating* mode and by pressing it the power supply returns to *normal* mode. Leaving the unsecure procedure (before

it is finished) does not change anything concerning the secure state of the power supply (secured or unsecured).

After you changed the security code or unsecured the power supply, you can go back to *normal* mode by pressing **Local** key. (You can come back to *calibrating* mode only by turning off the power supply and starting it in *calibrating* mode).

But once you started the calibration procedure, it is recommended to finish it and to go back to *normal* mode by turning off and on the power supply.

Hardware Unsecure Procedure for Calibration

This procedure may be used to unsecure the power supply if you forgot the security code.

To unsecure the power supply without using the security code, follow the next steps:

1. Turn off the power supply. Disconnect the power cord and all loads connected to the power supply.
2. Remove power supply's cover. Set **J6** jumper for hardware unsecuring mode.

Normal unsecuring   Hardware unsecuring
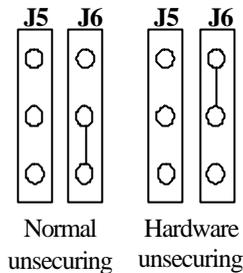
3. Connect the power cord to the power supply. Turn on the power supply in *calibrating* mode.
4. Unsecure the power supply.

To unsecure the power supply you must press **Secure** key. Power supply will display:

Calibrating Mode
Secured

Press again **Secure** key the power supply will display:

Security code:
_ _ _ _ _ _ _ _ _

Here any security code may be introduced, since it is not verified by the power supply.
Press again **Secure** key and you will unsecure the power supply. It will display:

Calibrating Mode
Unsecured

The power supply remains unsecured until you enter a new security code.

Important note!
Even if you are in *calibrating* mode, you cannot set a security code as long as the **J6** jumper is in hardware unsecuring position.

5.   Set **J6** jumper for normal unsecuring mode.

Important note!
If you turn on the power supply in either *normal* mode or *calibrating* mode and **J6** jumper is in hardware unsecuring position, error 701 (*Calibration security disabled by jumper*) will be generated.

6.   Turn off the power supply and reassemble it.

Calibration Procedure

Before initiating the calibration procedure, the following conditions must be assured:

- disconnect any loads connected to the power supply and turn it on
- let the power supply turned on for 1 hour, with no loads connected before you start the calibration procedure
- calibration ambient temperature must be 25 ^{0}C
- ambient relative humidity must be less then 80%.

On calibration procedure there are three parameters that must be calibrated: voltage, OVP and current.

You can leave the calibration procedure at any time by turning off the power supply or by pressing **Local** key.

But once you started the calibration procedure, it is recommended to finish it and to go back to *normal* mode by turning off and then turning on the power supply.

In order to be sure that the power supply will work properly in *normal* mode after you leave the calibration procedure, you must turn off the power supply.

Recommended calibration interval is 1 year.

Before calibrating the power supply you must unsecure it, if secured (see **Calibration Overview**section).

After you unsecured the power supply and you pressed **Calibrate** key, you go to **Calibrate** menu. By turning the knob next options are available:

1. Volt Zero Scale
2. Volt Full Gain
3. OVP
4. Curr Zero Scale
5. Curr Full Gain

Options are selected by pressing **Calibrate** key.

Important note!
In order to perform a correct calibration, the calibration procedures from the **Calibrate** menu must be followed in the order they are displayed by the power supply.

Voltage Calibration Procedure

After you unsecured the power supply and you pressed **Calibrate** key, you entered *calibrate* mode.

Volt Zero Scale Calibration

1. Select V*olt Zero Scale* calibration procedure
In order to start voltage calibration procedure, you must select **Volt Zero Scale** option.
The power supply will display:

```
Calibrating Mode
Volt Zero Scale
```

You select this option by pressing **Calibrate** key.
The power supply will display:
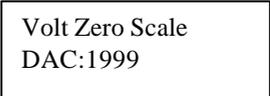
```
Volt Zero Scale
DAC:1999
```

2. Initiate DAC calibration procedure
Connect a digital voltmeter to the output terminals of the power supply. After that, you must adjust DAC value displayed by the power supply until the voltmeter indicates the closest possible to 0.000 V value.
For this, you use > < keys and the knob.

It is not necessary to disconnect the digital voltmeter, since you will need it later on calibration procedure!

3. Initiate ADC calibration procedure
Press **Calibrate** key. This will initiate ADC calibration procedure. The power supply will display:
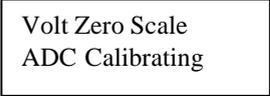
```
Volt Zero Scale
ADC Calibrating
```

After ADC calibration, power supply will return to **Calibrate** menu **Volt Full Gain** calibration procedure.

Volt Full Gain Calibration

1. Select V*olt Full Gain* calibration procedure
In order to finish voltage calibration procedure, you must select **Volt Full Gain**
option.
The power supply will display:

```
Calibrating Mode
Volt Full Gain
```

You select this option by pressing **Calibrate** key.
The power supply will display:

```
Volt Full Gain
DAC:31470
```


2. Initiate DAC calibration procedure
Connect a digital voltmeter to the output terminals of the power supply. After
that, you must adjust DAC value displayed by the power supply until the
voltmeter indicates the correct voltage value, depending on the model of the
power supply (see the table bellow).

Power supply model	Voltage value for Volt Full Gain calibration
9120	16.3840 V
9121	16.3840 V
9122	32.7700 V
9123	16.3840 V

 For this, you use > < keys and the knob

3. Initiate ADC calibration procedure
Press **Calibrate** key. This will initiate ADC calibration procedure. The power
supply will display:

```
Volt Full Gain
ADC Calibrating
```

After ADC calibration, power supply will return to **Calibrate** menu, **OVP**
calibration procedure.

OVP Calibration

While performing this calibration procedure, the power supply must have no loads connected to the output terminals.

1. Select *OVP* calibration procedure
In order to initiate OVP calibration procedure, you must select **OVP** option.
The power supply will display:

> Calibrating Mode
> OVP

You select this option by pressing **Calibrate** key.
The power supply will display:
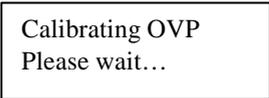
> Calibrating OVP
> Please wait…

Important note!
This calibration procedure will take several minutes.

After OVP calibration, power supply will return to **Calibrate** menu, **Current** calibration procedure.

Current Calibration Procedure

Current calibration procedure must be permormed after **Voltage** calibration procedure.

Current Zero Scale Calibration

While performing this calibration procedure, the power supply must have no loads connected to the output terminals.

1. Select *Curr Zero Scale* calibration procedure
In order to start current calibration procedure, you must select **Curr Zero Scale** option.
The power supply will display:
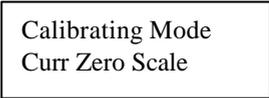
```
Calibrating Mode
Curr Zero Scale
```

2. Initiate DAC calibration procedure
You select this option by pressing **Calibrate** key. So **Current Zero Scale** calibration procedure will be initiated.

The power supply will display:
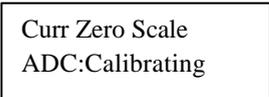
```
Curr Zero Scale
ADC:Calibrating
```

After a while, the power supply will display:
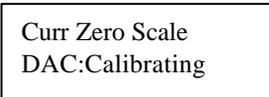
```
Curr Zero Scale
DAC:Calibrating
```

Important note!
This calibration procedure will take several minutes.

After **Current Zero Scale** calibration procedure, power supply will return to **Calibrate** menu, **Curr Full Gain** calibration procedure.

Current Full Gain Calibration

1. Select *Curr Full Gain* calibration procedure
In order to finish current calibration procedure, you must select **Curr Full Gain** option.
The power supply will display:

```
Calibrating Mode
Curr Full Gain
```

You select this option by pressing **Calibrate** key.
The power supply will display:

```
Curr  Full Gain
Connect Ammeter
```

2. Initiate DAC calibration procedure
In order to initiate Curr Full Gain calibration procedure, you must connect a digital ammeter to the output terminals of the power supply.
If don't connect a digital ammeter within 30 seconds, the power supply will display:

```
Calibrating Mode
CC Not Set
```

and it will return to Calibrate menu.

After you connected the digital ammeter, you must adjust DAC value displayed by the power supply until the ammeter indicates indicates the correct current value, depending on the model of the power supply (see the table bellow).

Power supply model	Current value for Curr Full Gain calibration
9120	2.62144 A
9121	2.62144 A
9122	1.31072 A
9123	2.62144 A

For this, you use > < keys and the knob

3. Initiate ADC calibration procedure

Press **Calibrate** key. This will initiate ADC calibration procedure. The power supply will display:

```
Curr Full Gain
ADC Calibrating
```

After ADC calibration, power supply will return to **Calibrate** menu.

In this moment, the calibration procedure is finished. By presing **Local** key, the power supply will return to *local* mode.

Important note!

In order to be sure that the power supply will work properly in *normal* mode after you leave the calibration procedure, you must turn off the power supply.

OVP / Secure Key

This key has a double function: OVP settings in *normal* mode operation and secure key in *calibration* mode operation (for the latter see **Calibration** section).

In this section OVP functions will be described.

OVP circuit prevents the output voltage from rising above a programmed voltage value. So the load connected to the output terminals is protected of overvoltage situations.

Overvoltage protection circuit is activated when output voltage value becomes equal or greater than the programmed trip level for overvoltage protection circuit.

OVP Menu Overview

By pressing **OVP / Secure** key, you enter OVP menu.
Here, programmed OVP trip level will be displayed.

When you turn on the power supply, OVP trip level is OVP trip level value saved at *power_up* state (state 0). This value can be changed by the user (and saved in *power_up* state if wanted).

Here you can set desired OVP trip level, by using > < keys to select the digit you want to adjust (selected digit has the cursor underneath) and knob to set the digit to desired value.

The programming range for OVP trip level depends on the model of the power supply (see the table bellow):

Power supply model	OVP min value	OVP max value
9120	1 V	33 V
9121	1 V	22 V
9122	1 V	63 V
9123	1 V	33 V

The OVP trip level you set is saved by pressing **OVP / Secure** key.

After that, you enter the OVP menu.

By turning the knob, following options are displayed:

OVP On

OVP Clear

OVP Off

Options are selected by pressing **OVP / Secure** key when the desired option is displayed.

OVP On

OVP On option enables overvoltage protection circuit. OVP trip level is the level value you programmed on **Level** option (after you first pressed **OVP / Secure** key).

If you want to keep the previously programmed trip level, you simply press **OVP / Secure** key, without changing anything.

If you enable the overvoltage protection circuit, when you return to *normal* mode, **ovp** indicator will be displayed.

OVP Off

OVP Off option makes OVP trip level equal to maximum availabale OVP value, no matter what what value is set in OVP menu (but the value from OVP menu does not change).
For maximum available OVP value, see the table above.

If you select **OVP Off** option, when you return to *normal* mode, **ovp** indicator will not be displayed anymore.

Important note!
When **OVP On** option is selected, OVP trip level is equal to the programmed level, shown in OVP menu.
When **OVP Off** option is selected, OVP trip level is equal to the maximum available value for this parameter, depending on the model of the power

supply (see the table above). In this case, the programmed OVP trip level, shown in OVP menu does not change!

> OVP Clear

OVP Clear option is used to clear to OVP condition (for more information about how you get back to *normal* mode after OVP level was tripped, please refer to the next section).

After you select the desired option, a message will be displayed.
If you didn't change anything of the previous set parameters, the power supply will display **No Change** message.
If you did change a single parameter from the previous set parameters **Done** message will be displayed.
After one of these messages is displayed for several seconds, power supply returns to *normal* mode.

Important note!
If you enter in the **OVP** menu and no action takes place for approx. 20 seconds, the power supply will leave the **OVP** menu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering **OVP** menu).

If the output voltage value becomes equal or greater than OVP programmed level and the overvoltage protection circuit is enabled, the power supply will display:

> Over Voltage
> Output Off

And the output voltage value will be 0 V (output is disabled).

There are three ways of clearing the OVP condition:
➢ By increasing OVP trip level and clearing the OVP condition
➢ By decreasing the output voltage and clearing the OVP condition
➢ By disabling OVP circuit and clearing the OVP condition

Important note!
When you turn on the power supply, the overvoltage protection circuit is enabled and the OVP trip level is equal to the one saved in *power_up* state (factory setting: maximum available value).

Programming OVP Circuit in Front Panel Mode

If you want to program an OVP trip level and to enable the overvoltage protection circuit using front panel keys, follow the next steps:

1. Turn on the power supply

When you turn on the power supply, the overvoltage protection circuit is enabled and OVP trip level is set to maximum available value for OVP parameter, depending on the model of the power supply (see table in the prevous section).

2. Enter the OVP menu and set OVP trip level

By pressing **OVP / Secure** key, you enter the OVP menu. The power supply will display the programmed OVP trip level.

For changing this value, you can use > < to select the digit you want to adjust (selected digit has the cursor underneath) and then turn the knob to set the desired value.

After you set the desired value for OVP trip level, you press **OVP / Secure** key.

Important note!

You cannot set an OVP trip level lower than 1 Volt.
The maximum OVP trip level value depends on the model of the power supply (see table in the previous section)

3. Enable the OVP circuit

After you set the desired OVP trip level and you pressed **OVP / Secure** key, **OVP On, OVP Off and OVP Clear** options are available.
To enable the OVP circuit, you select **OVP On** option by turning the knob
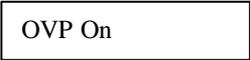
```
OVP On
```

4. Exit the OVP submenu

To exit the OVP submenu and to validate all the settings you have done, then you press **OVP / Secure** key.

After that, **Changed** message will be displayed and the power supply return to previous state (the state before you entered the OVP submenu), in *normal* mode operation.

ovp indicator will be displayed. If you didn't change anything, the power supply will display **No Change** message.

Clearing Overvoltage Condition

There are three ways of clearing the OVP condition:
➢ By increasing OVP trip level and clearing the OVP condition
➢ By decreasing the output voltage and clearing the OVP condition
➢ By disabling OVP circuit and clearing the OVP condition

Attention!
The latter solution disables the OVP circuit, but the first and the second don't!

In this section we will describe the steps you must follow to clear the OVP condition in all three cases.

If the output voltage value becomes equal or greater than OVP programmed level and the overvoltage protection circuit is enabled, the power supply will display:

> Over Voltage
> Output Off

And the output voltage value will be 0 V (output is disabled).

Clear OVP Condition by Increasing OVP Trip Level

1. Enter the OVP menu
By pressing **OVP / Secure** key, you enter the OVP menu.

2. Adjust OVP trip level
When you enter OVP menu, OVP trip level is displayed.
Here, you set OVP trip level to a level higher than the programmed voltage value (U_{lim}).

3. Clear OVP condition
After you set the OVP trip level, you press **OVP / Secure** key.
Here, **OVP On**, **OVP Off**, **OVP Clear** options are available. Select **OVP Clear** option by turning the knob.

> OVP Clear

After that, press **OVP / Secure** key. The power supply will display:

> Clear OVP:Done

and after several seconds it will return to *normal* mode. **ovp** indicator will be displayed (the OVP circuit is still enabled).

Important note!
If you enter the **OVP** menu and no action takes place for approx. 20 seconds, the power supply will leave the **OVP** menu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering **OVP** menu).

Clear OVP Condition by Decreasing the Output Voltage

1. Decrease the output voltage level bellow OVP trip level
Press **Limit** key and enter *limit* mode. Limit values of voltage and current will
be displayed. **ovp** and **lmt** indicators will also be displayed.

Adjust for output voltage limit to a lower value than the OVP trip level.

Press **Limit** key to exit *limit* mode.

2. Enter OVP menu and clear OVP condition
Here you check that the OVP trip level is greater than the output voltage limit
you set. If it isn't, go to step 1.
Don't adjust OVP trip level!

Clear OVP condition by turning the knob and selecting **OVP Clear** option:

OVP Clear

After that, press **OVP / Secure** key. The power supply will display:

Clear OVP:Done

and after several seconds it will return to *normal* mode. **ovp** indicator will be
displayed (the OVP circuit is still enabled).

Important note!
If you enter **OVP** menu and no action takes place for approx. 20 seconds, the
power supply will leave the **OVP** menu. **No Change** message is displayed and
the power supply returns to the previous state (the state before entering **OVP**
menu).

Clear OVP Condition by Disabling OVP Circuit

1. Disable OVP circuit

By pressing **OVP / Secure** key, you enter OVP menu.
Here you disable OVP circuit by turning the knob and selecting **OVP Off** option.

```
OVP Off
```

It doesn't matter if you change or not OVP trip level as long as you disable the OVP circuit. But you must be careful to set it to the right value before you enable OVP circuit next time.

After you selected **OVP Off** option and you pressed **OVP / Secure** key, the power supply will display

```
Over Voltage
Output Off
```

because you didn't clear the OVP condition yet

2. Enter OVP menu and clear OVP condition

You enter OVP menu again by pressing **OVP / Secure** key. Now you clear OVP condition by turning the knob and selecting **OVP Clear** option:

```
OVP Clear
```

After that, press **OVP / Secure** key. The power supply will display:

```
 Clear OVP:Done
```

and after several seconds it will return to *normal* mode. **ovp** indicator will be displayed (the OVP circuit is still enabled).

Important note!

If you enter in the **OVP** menu and no action takes place for approx. 23 seconds, the power supply will leave the **OVP** menu. **No Change** message is displayed and the power supply returns to the previous state (the state before entering **OVP** menu).

Rear Panel Description

On the rear panel of the power supply there are:
- RS-232 interface connector
- AC inlet
- Power-line fuse-holder assembly
- Rear output terminals.
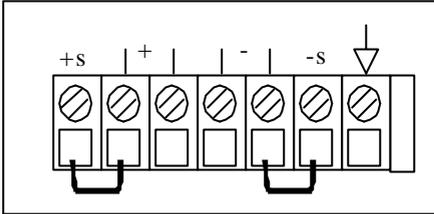
The sensing terminals (+s and -s) are connected to the output terminals of the power supply by jumpers.
For the power supply to work properly, the jumpers must be kept in that position.

Remote Interface

For remote communication, there are two available interfaces: GPIB / 488 interface and RS-232 interface. The selected interface and the coresponding settings are saved in a non-volatile memory and does not change after the power supply is turned off or after a *RST command.

Only one interface can be active at a time.
When the power supply is delivered, GPIB / 488 interface is selected.

RS-232 Interface

In order to connect the power supply to the RS-232 interface, the male DB-9 connector from the rear panel must be used. For all communication sessions over RS-232 interface, the power supply usses two handshake lines: DTR (Data Terminal Ready, pin 4) and DSR (Data Set Ready, pin 6).

For more information about the DB-9 connectorand about the connection to a computer terminal, please refer to *Interface Cable* section.

A character frame transmitted over RS-232 interface consists of one start bit, seven data bits and a parity bit / eight data bits and no parity and a stop bit.

Here is the frame format used by the power supply:

Parity even/odd:

Start bit	7 Data bits	Parity bit	Stop bit

No parity:

Start bit	8 Data bits	Stop bit

After start bit, least significant bit is sent first.

GPIB / 488 Interface

GPIB / 488 interface availability for different models:

	9120	9121	9122	9123
RS-232	Standard	Standard	Standard	Standard
GPIB / 488	Optional	Optional	Optional	Standard

GPIB (General Purpose Interface Bus) interface is also known as IEEE 488.

The original 488.1 specification defines the mechanical and electrical characteristics of the interface and its fundamental protocols.

The 488.2 specification defines a minimum configuration, and adds specifications for a basic set of instrument commands and common data formats.

In order to communicate with the power supply over GPIB interface, a GPIB interface card must be placed in the computer.

A GPIB system allows interconnection of instruments and other devices to a controlling computer.

Here are some specifications of IEEE 488.1:
- Up to 15 devices may be interconnected in a GPIB network
- Configuration of the bus network may be linear or bus
- 24 bus lines: 8 data lines, 8 control and management lines, 8 GND lines
- Data transfer mode: 8-bit parallel
- Handshake: '3 wire handshake'; reception of each data byte is acknowledged.
- total transmission path length: 20m, or $L < 2N$
  L – total transmission path length
  N – number of devices
- Maximum transmission rate: 1 megabyte per second. The actual data rate is determined by the slowest device.
- Each device connected to the interface must have a unique address between 0 to 30 (decimal value).

Functional Description of GPIB Interface

Devices from the interface are classified into 3 types:

Listener: a device capable of receiving data over the interface when addressed to listen by the Active Controller.
There can be up to 14 Listeners on the bus at one time.
Usually the Active Controller will be the Talker, while a single device is the Listener.
But it is also possible that multiple Listeners will be assigned. In this case, all of them will execute the received commands.

A device becomes a Listener when it is addressed to listen (when it receives its Listen address).
 It stops being a Listener only when:
- UNL command is received
- Interface Clear (IFC) command is sent over the interface.

Talker: a device capable of transmitting data over the interface when addressed to talk by the Active Controller.
There can be only one Talker on the bus at one time.
Usually, when a device is addressed to talk, it becomes the Talker over the interface and Active Controller becomes a Listener.

A device becomes a Talker when it is addressed to talk (when it receives its Talk address).
 It stops being a Talker only when:
- UNT command is received
- A new Talker is assigned (since there can be only one addressed Talker on the bus at one time)
- Interface Clear (IFC) command is sent over the interface

Controller: a device capable of specifying the Talker and the Listeners for a data or command transfer.
In multiple controller systems, active control may be passed between controllers. There can be only one addressed Controller on the bus at one time.
The Controller function is usually handled by a computer.

The power supply can only be a Listener or a Talker (when addressed to talk).

IEEE 488 Addressing

An IEEE 488 address can take values from 0 to 30.

When supplied from the factory, power supply's GPIB address is 5.

An IEEE 488 device has a Listen address and a Talk address. Listen address and Talk address bytes are different.

Listen address is defined by adding decimal value of 32 to the address.
Talk address is defined by adding decimal value of 64 to the address.

Decimal value of 31 is a special address value. Listen address byte has the value of 63 decimal (31 + 32 = 63 decimal). This is a special address byte, called Unlisten (UNL). This address byte is sent by the Controller before assigning new Listeners. It tells to the currently assigned Listeners to stop listening.

For decimal value of 31, Talker address byte has the value of 95 (31 + 64 = 95). This is a special address byte, called Untalk (UNT). This address byte is sent by the Controller and it tells to the currently addressed Talker to stop being a Talker, because a new Talker will be assingned.

This power supply has no secondary address implemented.

Bus Description

The interface signal lines are organized into three functional groups:
- Data lines (8 lines)
- Handshake lines (3 lines)
- General bus management lines (5 lines)

The bus signal lines use low true logic protocol.

Data lines:
- allow transfer of one byte at a time.
- Bytes are transferred over the interface in a byte-serial, bit-parallel manner.
- DIO1 represents least significant bit of the byte, while DIO8 represent most significant bit of the byte transffered over the interface.

Handshake lines:
- control byte transfer between devices, using 3-wire handshaking.
- the speed of the data transfer is given by the slowest listener, so every listener can read bytes transferred over the interface correctly.
- reception of each data byte is acknowledged.

DAV (Data Valid)
- this line is controlled by the Talker
- the talker sets DAV line true (active low) when all devices from bus release NRFD line (NRFD line high).
- DAV line true means that data byte is stable on the bus (so it can be read by the listeners).

NRFD (Not Ready For Data)
- this line is controlled by the Listeners to indicate to the Talker if they are ready to receive new data.
- NRFD line will not go high until all Listeners release the line.

NDAC (Not Data Accepted)
- this line is controlled by the Listeners to indicate to the Talker if data was read from the bus
- when NDAC line false (high), addressed Listeners indicate that they read the data from the bus
- NDAC line will not go high until all Listeners release the line.

General bus management lines:

- ATN, IFC, REN, SRQ, EOI and they are used by the Active Controller or System Controller to manage GPIB interface

SRQ (Service Request):
- This line is used by any device from the bus.
- when is set true (low), the device notifies the Controller that it needs servicing a request.
- Controller will perform a Serial Poll or a Parallel Poll in order to determine which device requested a service and why.

IFC (Interface Clear):
- This line is used only by the Controller.
- When IFC line is true (low) all devices from the bus reset the GPIB interface (Talker and Listeners are unaddressed, service request idle and Serial Poll disabled).

REN (Remote Enable):
- This line is used only by the Controller.
- When REN line is set true (low), the bus is in remote mode, so devices can be addressed to listen or to talk.
- A device will go into remote mode only when addressed to listen. While in remote mode, the device ignores its local front panel controls (only *Remote / Local* key is active) and it receives instructions over GPIB interface.
- when REN line is set false (high), the bus and all devices go to local mode.

EOI (End or Identify):
- this line is used by the active Talker
- when EOI line is true (low), the active Talker indicates that the last byte of a data stream is sent over the interface.
- multiple termination schemes are available, depending on the GPIB interface card you use.

ATN (Attention):
- this line is used only by the Controller
- when ATN line is true (low), the bus is in command mode. Address and GPIB command bytes are transferred over the interface. These bytes are used to assign Listeners and Talker, to obtain device status etc. All devices from the bus must acknowledge them.

- when ATN line is false (high), the bus is in data mode and data bytes are transferred over the interface. These bytes may be SCPI commands sent by the addressed Talker to the addressed Listeners.
  or a response sent by a previously interrogated Listener (eg: response to an interogative command). The interrogated device must be addressed as a Talker in order to be able to transmit the response.
  Only addressed Listener (s) will acknowledge them.

Sending Ccommands over GPIB Remote Interface

GPIB byte commands are sent together with address bytes while ATN line is low.

SCPI commands are sent after address bytes are sent. The power supply must be addressed as Listener. While sending address bytes, ATN line is low. While sending SCPI commands, ATN line is high.

If the SCPI command is interrogative, after sending the command, the Active Controller must address the power supply as a Talker. Then ATN line goes high and the power supply can send the answer to the Active Controller.

Command terminators
When GPIB interface is selected, a command string sent to the power supply may terminate in different ways, depending on the GPIB interface card.
- Line feed character (0a h) combined with EOI line low
- Line feed character (0a h) and carriage return character (0d h) combined with EOI line low
- EOI line low
- For multiple commands sent in a single message, command separator is semicolon character (03b h).
  When multiple commands are sent in the same message, EOI line goes low while the last character of the message is sent (it may be line feed character, carriage return character or the last character of the last command).

When addressed as a Talker, the power supply use the following termination scheme: line feed character combined with EOI line low.

When Status Byte is transmitted by the power supply (part of Serial Poll Procedure), EOI line does not go low.

Serial Poll Procedure

When serial poll procedure is initiated, a device is addressed to talk and Active Controller sends Serial Poll Enable command (ATN line is low, because addresses and GPIB command bytes are transferred over the interface).

The addressed device sends back to Active Controller a Status Byte (ATN line is high, because data bytes are transferred over the interface).

Then, the Active Controller sends Serial Poll Disable command (ATN line is low, because address and command bytes are transferred over the interface) to end the serial poll sequence.

In order to obtain Status Byte from each device from bus, Active Controller addresses the devices one by one.

Status Byte of each device must be analyzed. This makes serial poll procedure to be relatively slow for large systems.

Interrogative Commands Over GPIB Interface

After receiving an interrogative command, when the response is ready to be read, Message Available Bit (bit 4 of Status Byte Register) is set. Serial Poll Enable command can be sent to read Status Byte.
Any other ommand (except Serial Poll) clears the output buffer and the response to the previous interrogative command is lost. In this case an error is generated by the power supply (**Err -410, Query interrupted**) and MAV bit is cleared.

In order to read the response to the previous interrogative command, the power supply must be addressed as a Talker.
After the response is sent MAV bit is cleared.

MAV bit is also set when the power supply receives a command and it is not able to execute it. **Err -365, Timeout error** message will be available in the output buffer of the power supply.

When MAV bit is set, the power supply has a message to transmit to the Active Controller. The power supply has to be addressed as a Talker in order to be able to transmit the message.

Commands Sent Over Remote Interface

There are several types of commands that can be sent over the remote interface, in order to control the power supply:

- **SCPI (*Standard Commands for Programmable Instruments)* commands**
    - these commands are defined in the Power Supply Instrument Classes of the 1999 SCPI standard.
    - a complete description of synthax and functionality is contained in the 1999 SCPI standard.
    - these commands can be sent over RS-232 interface and GPIB / 488 interface.

- **Non-SCPI commands**
    - these commands are power supply specific.
    - these commands can be sent over RS-232 interface and GPIB / 488 interface.

- **IEEE 488.2 commands**
    - The 488.2 specification defines a minimum configuration, and adds specifications for a basic set of instrument commands.
    - these commands can be sent over RS-232 interface and GPIB / 488 interface.

- **IEEE 488 bus commands**
    - in command mode, the power supply can receive talk and listen addresses, universal commands and addressed commands (for more information, please refer to *IEEE 488 bus commands* section).
    - These commands can be sent over GPIB interface

Introduction to SCPI Language

Here are some conventions used in SCPI standard:

- A command consists of a command keyword (command name) and a parameter (it may be optional or not)
- Lower case and upper case letters are considered equivalent
- Letter case is used to differentiate between the accepted short form (the uppercase characters) and the long form (the whole keyword)

- Square brackets ([ ]) are used to enclose:
    - a keyword that is optional when programming the command
    - one or more parameters that are optional when controlling the instruments.

  If no parameter is specified, default parameter is considered.

  The braces are not sent with the command string.

- Braces or curly brackets ({}) are used to enclose one or more parameters that may be included zero or more times.

  The braces are not sent with the command string.

- The angle brackets (<>) are used to enclose the type name.

  A value of the specified type must be added to the command.

  The angle brackets are not sent with the command string.

- The vertical bar (|) can be read as "or" and it is used to separate alternative parameter options.

  Only one parameter can be sent with the command.

- The query form of a command is generated by appending a question mark to the last keyword. Not all commands have a query form and some commands exist only in query form.

SCPI Command Terminators

A command string sent to the power supply must terminate with a *new line* character (ASCII decimal code of 10) or a a *carriage return* character (ASCII decimal code of 13).

For multiple commands sent in a single message, command separator is semicolon character (03b h).

 Important note!
The power supply will go to remote mode of operation (it can accept commands over RS-232 interface) if *SYSTem:REMote* command is sent.

If other remote interface commands are sent before sending *SYSTem:REMote* command, the power supply will respond with **Power supply in local mode** message.

SCPI Commands

DISPLAY Subsystem
:DISPlay
 [:WINDow][:STATe] {OFF|ON}
 [:WINDow][:STATe]?
 [:WINDow]:TEXT[:DATA] *<quoted string>*
 [:WINDow]:TEXT[:DATA]?
 [:WINDow]:TEXT:CLEar

MEASure Subsystem
:MEASure
 :CURRent[:DC]?
 [:VOLTage][:DC]?

MEMory Subsystem
MEMory:STATe
 :NAME *<numeric value>,<quoted string>*
 :NAME? *<numeric value>*

OUTPut Subsystem
:OUTPut
 [:STATe] {OFF|ON}
 [:STATe]?

SOURce Subsystem
[:SOURce]
:CURRent[:LEVel][:IMMediate][:AMPLitude] {*<current>*|MIN|MAX|UP|DOWN}
:CURRent[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]
:CURRent[:LEVel][:IMMediate]:STEP[:INCrement] {*<numeric value>*|DEFault}
:CURRent[:LEVel][:IMMediate]:STEP[:INCrement]? [DEFault]
:CURRent[:LEVel]:TRIGgered[:AMPLitude] {*<current>*|MIN|MAX}
:CURRent[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX]

:VOLTage[:LEVel][:IMMediate][:AMPLitude] {*<voltage>*|MIN|MAX|UP|DOWN}
:VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]
:VOLTage[:LEVel][:IMMediate]:STEP[:INCrement] {*<numeric value>*|DEFault}
:VOLTage[:LEVel][:IMMediate]:STEP[:INCrement]? [DEFault]
:VOLTage[:LEVel]:TRIGgered[:AMPLitude] {*<voltage>*|MIN|MAX}
:VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX]

:VOLTage:PROTection[:LEVel] {*<voltage>*|MIN|MAX}
:VOLTage:PROTection[:LEVel]? [MIN|MAX]
:VOLTage:PROTection:STATe {0|1|OFF|ON}
:VOLTage:PROTection:STATe?
:VOLTage:PROTection:TRIPped?
:VOLTage:PROTection:CLEar

STATus Subsystem

STATus:QUEStionable
 [:EVENt]?
  :ENABle *<enable value>*
  :ENABle?

SYSTem Subsystem

:SYSTem
 :BEEPer[:IMMediate]
 :COMMunicate:GPIB:RDEVice:ADDRess *<numeric value>*
 :COMMunicate:GPIB:RDEVice:ADDRess?
 :ERRor?
 :INTerface GPIB|RS232
 :VERSion?

TRIGger Subsystem

INITiate[:IMMediate]
TRIGger[:SEQuence]:DELay *{<seconds>*/MIN|MAX}
TRIGger[:SEQuence]:DELay? [MIN|MAX]
TRIGger[:SEQuence]:SOURce {BUS|IMM}
TRIGger[:SEQuence]:SOURce?
*TRG

Non-SCPI commands

SET {*<voltage>*|DEF|MIN|MAX}[,*<current>*|DEF|MIN|MAX]
SET?

CALibration:MESSAGE *<quoted string>*
CALibration:MESSAGE?

SYSTem:REMote

IEEE 488.2 commands

*CLS
*ESE *<enable value>*
*ESE?
*ESR?
*IDN?
*OPC
*OPC?
*PSC {0|1}
*PSC?
*RCL {0 | 1 | 2 | … | 99}
*RST
*SAV {0 | 1 | 2 | … | 99}
*SRE *<enable value>*
*SRE?
*STB?
*TRG

IEEE 488 bus commands

DCL
LLO
SPE
SPD
GET
SDC
GTL

SCPI commands overview

DISPlay Subsystem

This subsystem controls the presentation of textual information and measurement data.

:DISPlay[:WINDow][:STATe] {0|1|OFF|ON}
This command turns power supply's display off and on.
When the display is off, only indicators are displayed.
When the display is on, power supply is in *nomal* mode (measured or programmed values of voltage and current are displayed.).
You can replace **off|on** parameters with **0|1** numeric values.

:DISPlay[:WINDow][:STATe]?
This command queries front panel display status. It returns only numeric values: **0 (off)** or **1 (on).**

:DISPlay[:WINDow]:TEXT[:Data] *<quoted string>*
This command displays a message on the front panel. The power supply will display up to 16 characters and all the rest will be truncated. The string can be sent between simple or double quotes.

:DISPlay[:WINDow]:TEXT[:DATA]?
This command queries the displayed message. It returns a quoted string of maximum 16 characters.

:DISPlay[:WINDow]:TEXT:CLEar
This command clears the message displayed on the front pannel. Only indicators will be displayed

MEASure Subsystem

This subsystem contains commands that allow you to measure the current and voltage to the output terminals of the power supply.

:MEASure:CURRent[:DC]?
This command queris the current measured to the output terminals of the power supply.

:MEASure[:VOLTage][:DC]?
This command queries the voltage measured to the output terminals of the power supply.

Important note!
VOLT? Command returns previously programmed voltage level.
MEAS[:VOLT][:DC]? Command returns voltage measured to the output terminals of the power supply.

CURR? Command returns previously programmed current value.
MEAS:CURR[:DC]? Command returns the measured current to the output terminals of the power supply.

MEMory Subsystem

This subsystem contains commands that manage power supply's memory locations.

MEMory:STATe:NAME *\<numeric value\>,\<quoted string\>*
This command allows you to name a memory location.
The numeric value parameter gives the number of the memory location that will be named. It can be between 0 and 99.
The quoted string contains the name of the location. The name can be sent between simple or double quotes and it can have up to 10 characters.
When delivered, the power supply has 99 locations free and one location ocupied (*power_up* state is saved in location 0). Free locations have no name when the power supply is delivered (the name is 10 space characters). The state name is saved in the non-volatile memory.
Location 0 (*power_up* state) cannot be renamed. The rest of the locations can all be renamed, without notice.

MEMory:STATe:NAME? *\<numeric value\>*
This command queries the nameof the specified location.

OUTPut Subsystem

This subsystem controls the output of the power supply.

:OUTPut[:STATe] {0|1|OFF|ON}
This command enables and disables the output of the power supply. You can replace **off | on** parameters with **0 | 1** numeric values.
When output is enabled, the power supply will display voltage and current value measured on the output terminals of the power supply.
When output is disabled, the power supply will display **Output Off** message and the indicators according to power supply's state.
When output is disabled, output voltage is 0 V and the current is 0.002 A.
When delivered, after power on reset, output will be disabled (it depends on the parameters saved in *power_up* location).

OUTPut[:STATe]?
This command queries the output state of the power supply. It returns only numeric values: **0** (for **off** state) or **1** (for **on** state)

SOURce Subsystem

According to SCPI standard, **SOURce** node is optional, so the devices which are primarily sources accept shorter commands.

This subsystem contains commands that program power supply parameters or commands that query programmed power supply parameters (for example: programmed values for current and voltage, programmed values for step current and step voltage, lowest or highest value possible to program for current and voltage etc.)

:CURRent[:LEVel][:IMMediate][:AMPLitude] {*<current>*|MIN|MAX|UP|DOWN}
This command allows you to set the current value to the output of the power supply.

Instead of a numeric value, you can use MIN or MAX, UP or DOWN parameters.

MIN allows you to set the lowest current value, which is 0 A.

MAX allows you to set the highest possible current value for mo del you have.

With UP or DOWN parameters, this command allows you to increase / decrease the output value of the current with a preset value (the step you set with **:CURRent:STEP {*<numeric value>*|DEFault}** command, or the default step of the power supply).

The power supply does not allow you to increase over the maximum allowed value for this parameter or to decrease above the minimum allowed value of this parameter (when the minimum/maximum value is reached, the power supply does not decrease/increase that value anymore).

:CURRent[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]
This command queries the programmed current level.

MIN and MAX parameters are optional. When using MIN or MAX parameters, the power supply returns the lowest or the highest value that are possible to program for current, depending on the parameter.

:CURRent[:LEVel][:IMMediate]:STEP[:INCrement] {*<numeric value>*|DEFault}
This command allows you to set the current step for CURR UP or CURR DOWN command. The default value for current step is 1 mA.

:CURRent[:LEVel][:IMMediate]:STEP[:INCrement]? [DEFault]
This command queries the programmed current step value (if no parameter specified), or the default current step value (if DEFault parameter is specified within the command). The returned value is specified in Amps.

> ***Example***: Here is an example of how you program current step value and how you increase / decrease current output value using step.

```
CURR:STEP 0.2          ;program current step value
CURR UP                ;increase output current

CURR:STEP 0.5          ;program current step value
CURR DOWN              ;decrease output current
```

Note: If no step value was programmed before CURR UP or CURR DOWN commands, default step value (0.001 A) will be used.

CURRent[:LEVel][:IMMediate]:TRIGgered[:AMPLitude] {*<current>*|MIN|MAX}
This command allows you to program the current trigger value, which is transfered to the output terminals when a trigger signal occurs.
By programming this value, you don't change the current programmed value.
Instead of a numeric value, you can use MIN or MAX parameters.
MIN allows you to set the lowest current value, which is 0 V.
MAX allows you to set the highest possible current value for model you have.

:CURRent[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]? [MIN|MAX]
This command queries the programmed current trigger level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value allowed for current trigger parameter.

:VOLTage[:LEVel][:IMMediate][:AMPLitude] {<voltage>|MIN|MAX|UP|DOWN}
This command allows you to set the voltage value to the output of the power supply.
Instead of a numeric value, you can use MIN or MAX, UP or DOWN parameters.
MIN allows you to set the lowest voltage value, which is 0 V.
MAX allows you to set the highest possible voltage value for model you have.
With UP or DOWN parameters, this command allows you to increase / decrease the output value of the voltage with a preset value (the step you set with **:VOLTage:STEP {*<numeric value>*|DEFault}** command, or the default step of the power supply).
The power supply does not allow you to increase over the maximum allowed value for this parameter or to decrease above the minimum allowed value of this parameter (when the minimum/maximum value is reached, the power supply does not decrease/increase that value anymore).

:VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]
This command queries the programmed voltage level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value that is possible to program for voltage, depending on the parameter.

:VOLTage[:LEVel][:IMMediate]:STEP[:INCrement] {<*numeric value*>|DEFault}
This command allows you to set the voltage step for VOLT UP or VOLT DOWN command. The default value for voltage step is 10 mV.

:VOLTage[:LEVel][:IMMediate]:STEP[:INCrement]? [DEFault]
This command queries the programmed voltage step value (if no parameter specified), or the default voltage step value (if DEFault parameter is specified within the command) for voltage. The returned value is specified in Volt.

> ***Example*:** Here is an example of how you program voltage step value and how you increase / decrease voltage output value using step.

> | VOLT:STEP 0.2 | *;program voltage step value* |
> |---|---|
> | VOLT UP | *;increase output voltage* |
> | | |
> | VOLT:STEP 0.5 | *;program voltage step value* |
> | VOLT DOWN | *;decrease output voltage* |

> *Note: If no step value was programmed before VOLT UP or VOLT DOWN commands, default step value (0.010 V) will be used.*

:VOLTage[:LEVel][:IMMediate]:TRIGgered[:AMPLitude] <*current*>|MIN|MAX}
This command allows you to program the voltage trigger value, which is transfered to the output terminals when a trigger signal occurs.
By programming this value, you don't change the voltage programmed value.
Instead of a numeric value, you can use MIN or MAX parameters.
MIN allows you to set the lowest voltage value, which is 0 V.
MAX allows you to set the highest possible voltage value for model you have.

:VOLTage[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]? [MIN|MAX]
This command queries the programmed voltage trigger level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value allowed for voltage trigger value, depending on the parameter.

:VOLTage:PROTection[:LEVel] {<*voltage*>|MIN|MAX}
This command allows you to set the voltage level at which the overvoltage protection circuit will be activated. If the output voltage will get equal or greater than the programmed OVP level, then the power supply will have output voltage value 0 V (output is disabled).

:VOLTage:PROTection[:LEVel]? [MIN|MAX]

This command queries the programmed voltage protection level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value that is possible to program for voltage protection level, depending on the parameter.

:VOLTage:PROTection:S TATe {0|1|OFF|ON}

This command allows you to disable / enable the overvoltage protection circuit. After power on reset, the overvoltage protection circuit is enabled and the programmed OVP value depends on the model you have.

:VOLTage:PROTection:STATe?

This command queries the overvoltage protection circuit state. The returned parameter is always a numeric parameter: **0** (for **OFF** state) or **1** (for **ON** state)**.**

:VOLTage:PROTection:TRIPped?

This command queries if the protection circuit is tripped or not. The returned parameter is always a numeric parameter:. **0** for OVP circuit not tripped or **1** for OVP circuit tripped**.**

:VOLTage:PROTection:CLEar

This command allows you to clear the overvoltage protection circuit and it does not affect the programmed voltage trip level.

After this command the power supply returns to the previous state (output voltage will have the same value as before OVP was enabled). In this case, before you clear the protection circuit, you must lower the output voltage below OVP trip level or increase the OVP trip level above the output voltage value.

Here are some examples of how you work with overvoltage protection circuit using remote interface commands:

> *Example 1*: **Here is an example of how you program the overvoltage protection circuit using remote interface commands:**

> VOLT:PROT 5   ;*set OVP trip level at 5V*
> VOLT:PROT?   ;*responds with programmed OVP trip level (5V)*
>
> VOLT:PROT:STAT ON   ;*enable OVP circuit*
> VOLT:PROT:STAT?   ;*responds with OVP circuit state (1)*
>
> VOLT:PROT:TRIP?   ;*responds if OVP circuit is tripped*
>   ;*(0 if output voltage lower than OVP trip*
>   ;*level and 1 otherwise)*

OVP circuit is enabled. If output voltage becomes equal or greater than OVP programmed trip level, OVP circuit trips and **Over Voltage** and **Output Off** messages will be displayed. Output voltage will become 0 V.

It is not necessary to check every setting with the interogative command! This is an example of how you use this commands.

Example 2: Here is an example of how you clear the overvoltage condition by increasing OVP trip level, using remote interface commands:

Let's say that the output voltage is lower than 5V. No load connected.

VOLT:PROT 5   ;program OVP trip level
VOLT:PROT:STAT ON   ;enable OVP circuit

If OVP circuit is already enabled, you don't have to enable it again!

VOLT 6   ;OVP circuit tripped

When output voltage becomes equal or greater than OVP trip level (here is 5V), OVP circuit trips. Output is disabled and **Over Voltage** and **Output Off** messages will be displayed. Output voltage becomes 0 V.

VOLT:PROT 6.5   ;increase OVP trip level

Still output is disabled and **Over Voltage** message is displayed (because you didn't clear OVP condition yet)

VOLT:PROT:CLEAR   ;clear OVP condition

Power supply returns to previous state before enabling OVP circuit. It will display 6V and 0A. Since you didn't disable OVP circuit, **ovp** indicator will be displayed.

Example 3: Here is an example of how you clear the overvoltage condition by decreasing output voltage level, using remote interface commands:

Let's say that the output voltage is lower than 10V. No load connected.

VOLT:PROT 10   *;program OVP trip level*
VOLT:PROT:STAT ON   *;enable OVP circuit*

If OVP circuit is already enabled, you don't have to enable it again!

VOLT 10   *;OVP circuit tripped*

*When output voltage becomes equal or greater than OVP trip level (here is 10V), OVP circuit trips. Output is disabled and **Over Voltage** message will be displayed.*

VOLT 5.5   *;decrease output voltage level*
VOLT?   *;returns programmed output voltage (5.5V)*

*Still output is disabled and **Over Voltage** message is displayed (because you didn't clear OVP condition yet)*

VOLT:PROT:CLEAR   *;clear OVP condition*

*Power supply returns to previous state before enabling OVP circuit. It will display 5.5V and 0A. Since you didn't disable OVP circuit, **ovp** indicator will be displayed.*

Example 4: **Here is an example of how you clear the overvoltage condition by disabling OVP circuit, using remote interface commands:**

Let's say that the output voltage is lower than 7V. No load connected.

VOLT:PROT 8   *;program OVP trip level*
VOLT:PROT:STAT ON   *;enable OVP circuit*

If OVP circuit is already enabled, you don't have to enable it again!

VOLT 15   *;OVP circuit tripped*

*When output voltage becomes equal or greater than OVP trip level (here is 8V), OVP circuit trips. Output is disabled and **Over Voltage** message will be displayed.*

VOLT:PROT:STAT OFF   ;*Disable OVP circuit*

Attention: *if you have anything connected to the output terminals of the power supply, it it strongly recommended that you disconnect it before disabling OVP circuit (because you don't change output level and this it may harm your connected circuitry)*

VOLT:PROT:STAT?   ;*returns OVP circuit state (0 – off state)*

*Still output is disabled and **Over Voltage** message is displayed (because you didn't clear OVP condition yet)*

VOLT:PROT:CLEAR   ;*clear OVP condition*

*Power supply returns to previous state before enabling OVP circuit. It will display 15V and 0A. Since you disabled OVP circuit, **ovp** indicator will not be displayed anymore, until you enable OVP circuit again.*

STATus Subsystem

This subsystem controls SCPI defined status reporting structures.

STATus:QUEStionable:EVENt?
This command queries Status Questionable Even Register. The power supply returns a decimal value which is the binary weighted sum of all bits of the register. Reading Status Questionable Event Register does not clear it.

STATus:QUEStionable:ENABle *<enable value>*
This command sets Status Questionable Enable Register. This is a mask register.
If a bit of this register is set, the coresponding bit of Standard Event Register is reported to Status Byte Register.

STATus:QUEStionable:ENABle?
This command queries Status Questionable Enable Register. The power supply returns a decimal value which is the binary weighted sum of all bits of the register.

SYSTem Subsystem

This subsystem contains functions that are not directly related to power supply performance.

:SYSTem:BEEPer[:IMMediate]
This command determines the power supply to generate a beeper right after she received this command.

SYSTem:COMMunicate:GPIB:RDEVice:ADDRess <numeric value>
This command will change the power supply's GPIB address.

SYSTem:COMMunicate:GPIB:RDEVice:ADDRess?
This command queries the power supply's GPIB address.

:SYSTem:ERRor?
This command queries the power supply's error queue. Errors are retrieved in a first-in-first-out order, so the first generated error is the first read error.
The error queue can store up to 20 errors. If more errors will be generated, the last error is overwritten and on the last position will be written – *350* error (queue overflow). No more errors will be stored until the queue is cleared (but they are generated).
The power supply will return error number followed by error definition.
When all the errors were read, **err** indicator will not be displayed anymore and error queue is empty. Sending this command now, determines the power supply to respond with **No errors** message.

SYSTem:INTERFACE GPIB|RS232
This command will select an interface, which becomes the active interface. The next command must be sent over the new active interface.

:SYSTem :VERSion?
This command queries the SCPI version number for which the instrument complies. The response is a string in the form *YYYY.V*, where *YYYY* represents the year version and *V* represents the approved revision number for that year (for example, 1990.0).

TRIGger Subsystem

The power supply has a trigger subsystem, so voltage and current values can be changed when receiving a trigger signal.
Depending on the trigger source selected, this change takes place immediately (when receiving the trigger signal), or after a time period equal with the delay you set (a time period from the moment the power supply receives the trigger signal)

 To activate the trigger subsystem you must follow the steps described bellow:

1. **Specify the source of the trigger signal. The power supply accepts a bus trigger or an immediate trigger coming from the remote interface.**

Bus trigger source
TRG command is considered the trigger signal.
The current and voltage trigger values become the output programmed values after a time period (from the moment the power supply received the trigger signal), called trigger delay.
The trigger subsystem must be initiated before sending the trigger signal (for initiation you mus use the *INITIATE* command). Otherwise, -211 error is generated (trigger ignored error).

Immediate trigger source
INITIATE[:IMMEDIATE] command is considered the trigger signal.
The current and voltage trigger values become the output programmed values immediately after receiving *INITIATE* command.
In this situation, *TRG* command is ignored (the power supply doesn't do anything and it doesn't generate any errors).

After an interface reset or after power on reset, bus trigger source is selected.

2. **Program the *volt:trig* and *curr:trig* values.**

When receiving the trigger signal, the power supply transfers these values to *volt* and *current* programmed values immediatly (if *imm* trigger source is selected) or after a period of time equal to the trigger delay programmed value (if *bus* trigger source is selected).

At power on reset or *RST* command, voltage and current trigger values are the programmed values (values displayed in *limit* mode) until you explicitly program them with the desired values.

So before programming voltage and current values,
:VOLTage[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]?and
:CURRent[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]?
commands return the programmed values for voltage and current.

Trigger programmed values are available until a new programming command for a certain parameter, no matter how many times you use the trigger subsystem.

If voltage and current trigger values are programmed, they do not change when you change the output voltage and current values.

3. Program the trigger delay value.

Set the time delay between the trigger signal recognition and the changes the power supply must execute according to the settings of the trigger subsystem.

This value is not considered if *IMMEDIATE* trigger source is selected.

The programmed value is available until a new programming command for delay parameter, no matter how many times you use the trigger subsystem.

At power on reset or *RST* command the trigger delay value is 0.

Important note!
These steps may be executed in any order you want, but before initiating the trigger subsystem.

4. Initiate the trigger subsytem.

Trigger subsystem is initiated using *INITiate[:IMMediate]* command.
If *IMM* trigger source is selected, voltage and current trigger values become the output values immediately.
If *BUS* trigger source is selected, voltage and trigger values become the output values after a delay period from the moment the power supply received the triger signal (*TRG* command). It is important to initiate the trigger subsystem before sending the trigger signal. Otherwise, *Trigger ignored* error (err -211) is generated.

Here are described the commands used to set trigger subsystem's parameters:

:CURRent[:LEVel][:IMMediate]:TRIGgered[:AMPLitude] <*current*>|MIN|MAX}
This command allows you to program the current trigger value, which is transfered to the output terminals when a trigger signal occurs.
By programming this value, you don't change the current programmed value.
Instead of a numeric value, you can use MIN or MAX parameters.
MIN allows you to set the lowest current value, which is 0 V.
MAX allows you to set the highest possible current value for model you have.

:CURRent[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]? [MIN|MAX]
This command queries the programmed current trigger level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value allowed for current trigger parameter.

:VOLTage[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]{<*current*>|MIN|MAX}
This command allows you to program the voltage trigger value, which is transfered to the output terminals when a trigger signal occurs.
By programming this value, you don't change the voltage programmed value.
Instead of a numeric value, you can use MIN or MAX parameters.
MIN allows you to set the lowest voltage value, which is 0 V.
MAX allows you to set the highest possible voltage value for model you have.

:VOLTage[:LEVel][:IMMediate]:TRIGgered[:AMPLitude]? [MIN|MAX]
This command queries the programmed voltage trigger level. When using MIN or MAX parameters, the power supply returns the lowest or the highest value allowed for voltage trigger parameter.

:INITiate[:IMMediate]
This command initiates the trigger subsystem.
If immediate trigger source is selected, trigger programmed values become the output values immediately.
If bus trigger source is selected, trigger programmed values become the output values after the trigger delay period from the moment the power supply received the trigger signal

:TRIGger:DELay {<seconds> | MIN | MAX}
This command allows you to set the trigger delay value in seconds.
This is the time delay between the receive of the trigger signal and the corresponding action (trigger values become the output values).
Instead of a numeric value, you can use MIN or MAX parameters.
MIN parameter allows you to set the trigger delay to 0 seconds.

MAX parameter allows you to set the trigger delay to 36,000 seconds (equivalent to 10 hours).

At power on reset or after *RST* command this value is set to 0 seconds.

:TRIGger:DELay? [MIN | MAX]

This command queries the trigger delay programmed value. When using MIN or MAX parameters, the power supply returns the lowest and the highest value that are possible to program for trigger delay.

:TRIGger:SOURce {BUS | IMMediate}

This command allows you to select the trigger source from which the power supply accepts the trigger signal.

The power supply accepts an immediate trigger or a bus trigger.

After power on reset or *RST* command bus trigger source is selected.

;TRIGger:SOURce?

This command queries the seleted trigger source. Power supply returns BUS or IMM message, depending on the selected trigger source.

*TRG

This command generates the trigger signal for the trigger subsystem, if BUS trigger source is selected.

Important note!

If bus trigger source is selected and trigger delay parameter value is greater than zero, the power supply will not accept other interface command until delay value is passed and trigger values become the output programmed values.

While in remote mode, the only active key is **Remote/Local** key. If pressing this key while delay trigger is passing, the power supply will transfer trigger values to the output programmed values immediately, no matter what trigger delay value is programmed. The power supply will go to local mode.

Trigger subsystem parameters (voltage trigger value, current trigger value, trigger delay value, trigger source) are saved, too, when saving the current state.

Non-SCPI Commands

SET {<voltage>|DEF|MIN|MAX}[,<current>|DEF|MIN|MAX]
This is a non-SCPI command.
This command allows you to program output voltage and current values in the same time, using one command only.
Using this command, you can program output voltage or output voltage and current values. So if you specify one parameter only, it is considered as voltage programming value.
Instead of using numeric parameters for current and voltage values, you can use DEFault, MIN or MAX parameters. For more information about these parameters, please refer to **Technical Specifications** section, programming ranges tables.

SET?
This command queries voltage and current programmed values. The power supply returns both values in a single string (voltage value first):
$$+1.000000E+01,+5.000000E+00$$

CALibration:MESSAGE *<quoted string>*
This command allows you to store some informations about the power supply (e.g.: power supply's serial number, last calibration date, service information etc)
Calibration message may contain up to 40 characters and it is stored in a non-volatile memory.

CALibration:MESSAGE?
This command queries calibration message.
You can write this message only over the remote interface, but you can view it using **Errors / Calibrate** key when in *local* mode. For more informations you can refer to ***Local Mode Operation, Errors / Calibrate key*** section.

SYSTem:REMote
This command is used to place the power supply in remote mode (the power supply receives commands over RS-232 interface).
If commands are sent over the RS-232 interface without placing the power supply in remote mode, **Power supply in local mode** message is sent to PC.
If the command is sent over GPIB interface, **Err 510, Command allowed only in RS232** is generated.

IEEE 488.2 Commands

The 488.2 specifications include some instrument commands and a status information scheme.
For more information about SCPI Status Registers, see **Status Reporting Overview** section.

*CLS (Clear Status)
This command clears Status Byte Register and all the Event Registers summarized in Status Byte, such as Questionable Status Event Register and Standard Event Register.

*ESE *<enable value>* **(Standard Event Status Enable)**
This command allows you to set Standard Event Enable Register with a decimal value between 0 and 255.
If a bit of this register is set, the coresponding bit of Standard Event Register is reported to Status Byte Register.

*ESE?
This command queries the Standard Event Enable Register value.
The power supply returns a decimal value between 0 and 255, which is the binary weighted sum of all bits of the register.

*ESR? (Event Status Register)
This command queries the Standard Event Register value.
The power supply returns a decimal value between 0 and 255, which is the binary weighted sum of all bits of the register.
After sending this value, Standard Event Register is cleared.

*IDN? (Identification)
This command queries the identification string of the power supply.
The identification string has four fields: the first field is manufacturer's name, the second field is model number (depending on the model number of the power supply), the third field is serial number (always 0), the fourth field is firmware revision level (first number indicates firmware revision number for main processor and the second number indicates firmware revision number for communication processor).
For 9121 model, the power supply returns a string with the following format:
      S.C. CODEC S.R.L. ROMANIA, 9121 , 0, 1.0_1.0

*OPC (Operation Complete)
This command sets bit 0 (Operation Complete bit) from the Standard Event Register when the power supply completes all operations, including *OPC command.

*OPC?

The power supply returns an ASCII "1" after all operations, including this command are executed.

*RST

This command allows you to reset the power supply.

The power supply reset can be achieved by sending this command or by selecting **RESET** option from the **Recall** menu (**Recall** key).

The power supply reset values for different parameters are listed in **Technical Specifications** section.

*SAV {0 | 1 | 2 | … | 99}

This command saves the current state of the power supply in the specified location.

Stored parameters are: voltage limit, step voltage, overvoltage protection level, current limit, step current, voltage trigger value, current trigger value, trigger delay value, trigger source, stored state name, state of overvoltage protection circuit, state of display, output state.

The saved states are kept in a non-volatile memory, so they won't be lost when turning off the power supply.

A state location can be overwritten without any notification from the power supply.

*RCL {0 | 1 | 2 | … | 99}

This command recalls the specified state so this state becomes the current operating state.

When delivered from the fcatory, the memory locations are empty.

*SRE <enable value> (Service Request Enable)

This command allows you to set Status Byte Enable Register with a decimal value between 0 and 255.

*SRE?

This command queries the Status Byte Enable Register. The power supply returns a decimal value, which is the binary weighted sum of all bits of the register.

*STB?   (Status Byte)

This command queries Status Byte register. The power supply returns a decimal value between 0 and 255.

*TRG

This command is the trigger signal when bus trigger source is selected.

IEEE 488 Bus Commands

These comands are GPIB / 488 interface specific commands.
In command mode (ATN line low), the power supply can receive three classes of commands:

Talk and Listen addresses: They define which device from GPIB interface will be the active Talker and which devices will be the active Listeners. When ATN line is true, all devices must wait for the commands: listeners an talker will be assigned.

Universal commands: they are commands sent by the Controller to all devices from GPIB interface. The universal commands consist of:

- commands sent using general bus management lines. They are called uniline commands. For more information, please refer to **General bus management lines** section.

- commands encoded as bytes. They are sent over DIO lines, so they are called multiline commands.

  DCL (Device Clear)
  Resets the power supply to its default state. This command is equivalent to the *RST command, so the power supply will go to reset state.

  LLO (Local Lockout)
  Disables front panel keys, including *Remote/Local* key (which allows you to put the power supply in local mode). The power supply settings can no longer be changed from the front panel.

  SPE (Serial Poll Enable)
  Tells the addressed Talker to send a status byte. This byte gives informations about the device to the Controller.
   For more information about Status Byte, please refer to **SCPI Status Registers** section.
   For more information about Serial Poll, please refer to **Serial Poll Procedure** section.

  SPD (Serial Poll Disable)
  Disables Serial Poll procedure. For more information about Serial Poll, please refer to **Serial Poll Procedure** section.

Addressed commands: they are byte commands sent by the Controller only to the addressed Listeners. So these commands are sent with address bytes.

GET (Groupe Execute Trigger)

This command is equivalent to the *TRG command. For more information about trigger subsystem of the power supply, please refer to **Trigger Subsystem** section.

SDC (Selected Device Clear)

Resets the power supply to its default state. This command is equivalent to the *RST command, so the power supply will go to reset state.

GTL (Go To Local)

The power supply will go to local mode. It will receive commands only from front panel.

ASCII Table For GPIB

Ch	Ctrl	Cmd	Dec	Hex		Ch	Cmd	Dec	Hex
NUL	^ @		0	0		Sp	L0	32	20
SOH	^ A	GTL	1	1		!	L1	33	21
STX	^ B		2	2		"	L2	34	22
ETX	^ C		3	3		#	L3	35	23
EOT	^ D	SDC	4	4		$	L4	36	24
ENQ	^ E	PPC	5	5		%	L5	37	25
ACK	^ F		6	6		&	L6	38	26
BEL	^ G		7	7		'	L7	39	27
BS	^ H	GET	8	8		(	L8	40	28
HT	^ I	TCT	9	9		)	L9	41	29
LF	^ J		10	a		*	L10	42	2a
VT	^ K		11	b		+	L11	43	2b
FF	^ L		12	c		,	L12	44	2c
CR	^ M		13	d		--	L13	45	2d
SO	^ N		14	e		.	L14	46	2e
SI	^ O		15	f		/	L15	47	2f
DLE	^ P		16	10		0	L16	48	30
DC1	^ Q	LLO	17	11		1	L17	49	31
DC2	^ R		18	12		2	L18	50	32
DC3	^ S		19	13		3	L19	51	33
DC4	^ T	DCL	20	14		4	L20	52	34
NAK	^ U	PPU	21	15		5	L21	53	35
SYN	^ V		22	16		6	L22	54	36
ETB	^ W		23	17		7	L23	55	37
BS	^ H	SPE	24	18		8	L24	56	38
HT	^ I	SPD	25	19		9	L25	57	39
LF	^ J		26	1a		:	L26	58	3a
VT	^ K		27	1b		;	L27	59	3b
FF	^ L		28	1c		<	L28	60	3c
CR	^ M		29	1d		=	L29	61	3d
SO	^ N		30	1e		>	L30	62	3e
SI	^ O		31	1f		?	UNL	63	3f

Ch	Cmd	Dec	Hex		Ch	Cmd	Dec	Hex
@	T0	64	40		'	SC0	96	60
A	T1	65	41		a	SC1	97	61
B	T2	66	42		b	SC2	98	62
C	T3	67	43		c	SC3	99	63
D	T4	68	44		d	SC4	100	64
E	T5	69	45		e	SC5	101	65
F	T6	70	46		f	SC6	102	66
G	T7	71	47		g	SC7	103	67
H	T8	72	48		h	SC8	104	68
I	T9	73	49		i	SC9	105	69
J	T10	74	4a		j	SC10	106	6a
K	T11	75	4b		k	SC11	107	6b
L	T12	76	4c		l	SC12	108	6c
M	T13	77	4d		m	SC13	109	6d
N	T14	78	4e		n	SC14	110	6e
O	T15	79	4f		o	SC15	111	6f
P	T16	80	50		p	SC16	112	70
Q	T17	81	51		q	SC17	113	71
R	T18	82	52		r	SC18	114	72
S	T19	83	53		s	SC19	115	73
T	T20	84	54		t	SC20	116	74
U	T21	85	55		u	SC21	117	75
V	T22	86	56		v	SC22	118	76
W	T23	87	57		w	SC23	119	77
X	T24	88	58		x	SC24	120	78
Y	T25	89	59		y	SC25	121	79
Z	T26	90	5a		z	SC26	122	7a
[	T27	91	5b		{	SC27	123	7b
\	T28	92	5c				SC28	124	7c
]	T29	93	5d		}	SC29	125	7d
^	T30	94	5e		~	SC30	126	7e
_	UNT	95	5f		DEL	SC31	127	7f

The SCPI Status Registers

Status reporting scheme is described in this section.

Questionable Status

Event Register Enable Register

Voltage
Current
Not Used
Not Used
Not Used
Not Used
Not Used
Not Used
Not Used
Overvolt
Not Used
Not Used
Not Used
Not Used
Not Used
Not Used

OR
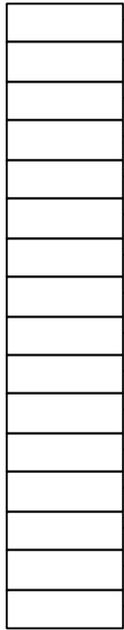
Output Buffer
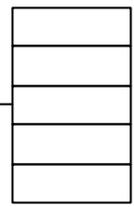
Status Byte

Summary Reg Enable Reg

Not Used
Not Used
Not Used
QUES
MAV
ESB
RQS
Not Used

OR
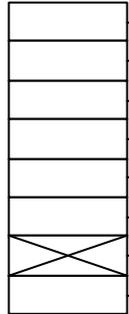
Standard Event

Event Register Enable Register

OPC
Not Used
QYE
DDE
EXE
CME
Not Used
PON

OR
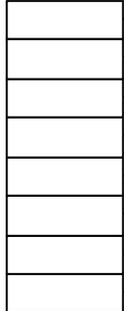
Event Register is a read only register. Bits in an event register are set depending on the state of the power supply.

An event register is cleared after its value was queried or by sending *CLS command.

A *RST command does not clear event registers.

When an event register is queried, the power supply returns a decimal value, which is the binary – weighted sum of all bits of the register.

An *Enable Register* defines which bits from the corresponding event register are logically Ored to form the coresponding bit in the Status Byte.

An enable register is readable and writable.

An enable register is not cleared after quering it, or by *CLS command.

Questionable Status Register

The Questionable Status Register contains bits which give an indication of the quality of different parameters. A set bit indicates that the associated parameter is of questionable quality.

Bit 0   -Voltage
  - is set when the voltage becomes unregulated.
  - indicates that the power supply is / was in constant current mode

Bit 1   -Current
  - is set when the current becomes unregulated.
  - indicates that the power supply is / was in constant voltage mode

Bits 2..8 -Not used
  - always set to 0

Bit 9   -Overvoltage
  - is set when over voltage protection circuit has tripped

Bits 10..15 -Not used
    - always set to 0

Questionable Status Event Register is cleared by:

− *CLS command

− quering event register, using *STATus:QUEStionable?* Command

Questionable Status Enable Register is cleared by:

− *STATus:QUEStionable:ENABle 0 command*

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Standard Event Register

Standard Event Register reports different instrument events, such as: query errors, device dependent error, execution errors, command errors, power on event. A set bit indicates that an event of the specified type occurred.

Bit 0 - **OPC (Operation Complete)**
   - indicates that all previous commands have been executed and the device is ready to accpet new commands
   - this bit is set only after an *OPC* command

Bit 1 - **Not used**
   - always set to 0

Bit 2 - **QYE (Query Error)**

Bit 3 - **DDE (Device Dependent Error)**
   - indicates that a device dependent (user defined) error has occurred, such as self test errors, or calibration errors

Bit 4 - **EXE (Execution Error)**
   - indicates that an execution error occured

Bit 5 - **CME (Command Error)**
   - indicates that a command error occured

Bit 6 - **Not used**
   - always set to 0

Bit 7 - **PON (Power On)**
− indicates that the power supply was turned off and on since the last time Standard Event Register was cleared or read.

Standard Event Register is cleared by:

− *CLS command

− quering event register, using *ESR?* Command

Standard Event Enable Register is cleared by:

− *ESE 0 c*ommand

Status Byte Register

Status Byte Register reports conditions from the defined status registers, depending on the bits from the enable registers. So clearing an event register will clear the coresponding bits from the Status Byte Register.

Bits 0..2 - Not used
- always set to 0

Bit 3   - QUES
- indicates that one or more bits are set in questionable status register (and the corresponding bits in the enable register are set, too)

Bit 4   - MAV (message available)
- indicates that there is data in the output buffer

Bit 5   - ESB
- indicates that one or more bits sre set in standard event register (and the corresponding bits in the enable register are set, too)

Bit 6   - RQS
- all the bits from the Status Byte register which have the corresponding bit from the Status Byte Enable Register set, are logically Ored. The result is kept in RQS bit.

Bit 7   - Not used
- always set to 0.

Status Byte Register is cleared by:

− *CLS command

− quering Standard Event Register, using *ESR?* Command will clear bit 5 in Status Byte Register

Status Byte Enable Register is cleared by:

− *SRE 0 c*ommand

Error Messages

There are 2 kinds of errors that will be generated by the power supply:
- ♦ **standard errors** (errors defined by SCPI standard, in [-299,-100] interval)
- ♦ **device specific errors** (user defined errors, in [-399,-300] or [1,32767] interval)

Following types of errors may occur:
- ♦ Command errors (defined by SCPI standard)
- ♦ Execution errors (defined by SCPI standard)
- ♦ Device-specific errors (defined by SCPI standard)
- ♦ Self test errors (device specific errors, user defined)
- ♦ Calibration errors (device specific errors, user defined)

Command Errors

Error - 101: Invalid character
An invalid character was received in the command string, within the parameter

Error - 102: Syntax error
The command string is not in syntactically correct (*, : in the wrong place)

Error - 103: Invalid separator
Wrong separator between commands in the same command string.

Error - 108: Parameter not allowed
More parameters than expected were received for the header

Error - 109: Missing parameter
Fewer parameters than required were received for the header

Error - 113: Undefined header
The received header was not defined for this device

Error - 114: Header suffix out of range
The value for the numeric suffix attached to the program mnemonic is not correct. The device recognizes only the default header suffix (which is 1).

Error - 121: Invalid character in number
An invalid character was received within the numeric parameter (or within the suffix).

Error -123: Exponent too large
The numeric parameter received has an exponent larger than 32,000.

Error -124: Too many digits
The decimal numeric parameter has a mantissa which contains more than 255 digits, excluding leading zeros

Error - 128: Numeric data not allowed
A legal numeric data element was received, but is not the right data element for the header

Error -131: Invalid suffix
The received suffix for the numeric parameter is not specified for this device.

Error - 138: Suffix not allowed
This numeric parameter does not accept a suffix.

Error - 141: Invalid character data
The character data element contains an invalid character.

Error - 148: Character data not allowed
A descrete parameter was received but a character string or a numeric parameter was expected.

Error - 151: Invalid string data
A string data element was expected, but it was invalid for some reason (it didn't start/stop with simple/double quotes).

Error - 158: String data not allowed
A legal string data element was received, but it is not the right data element for the header.

Execution Errors

Error – 211: Trigger ignored
*TRG command was received, but it was ingnored because trigger subsystem was not initiated (using *INITiate* command).

Error - 222: Data out of range
The numeric parameter value is out of range.

Error - 223: Too much data
A legal string program data element contains more data than the device could handle due to memory or due to device specific requirements.

Error - 224: Illegal parameter data value
A legal type of parameter was received, but it is not the expected parameter for the header.

Device Specific Errors

Error - 350: Queue overflow
Queue error is full, more than 20 errors occurred. No more errors will be saved until error queue will be erased.

Error - 361: Parity error in program message
Parity bit not correct when data received over the RS-232 interface

Error – 362: Framing error in program message
Stop bit not detected when data received over the RS-232 interface (stop bit detected as clear)

Error – 363: Input buffer overrun
Hardware input buffer of the serial port overflows with data because of the improper reading of the buffer.

Error – 365: Time -out error

The communication session was interrupted before it was finished (no terminator was sent).

Err -410: Query interrupted
A command was received before the response to the previous interrogative command was sent.

Err -420: Query unterminated
The power supply was addressed to talk (to send data over the interface), but it didn't previously receive a command which sends data to the output buffer (an interrogative command).

Err 510: Command allowed only in RS232
system:remote command was sent, when GPIB interface selected.

Self Test Errors

Self test errors are user defined. They are generated after power up.
Here are self test errors generated by the power supply:

Error 601: Front panel does not respond

Error 602: CV not high

Error 603: CV not low

Error 604: CC not high

Error 605: CC not low

Error 606: OVP not high

Error 607: OVP not low

Error 608: Fan test failed

Error 609: Unable to sense line frequency

If one of the errors above is generated, the power supply must be turned off and then turned on. If one of these errors is generated again, the power supply must be delivered to **B&K Precision** for service.

Error 611: EEPROM absent

Error 612: ADC offset register V checksum failed

Error 613: ADC offset register I checksum failed

Error 614: DAC offset register V checksum failed

Error 615: DAC offset register I checksum failed

Error 616: ADC full gain register V checksum failed

Error 617: ADC full gain register I checksum failed

Error 618: DAC offset register OVP checksum failed

Error 619: DAC V step register checksum failed

Error 620: DAC I step register checksum failed

Error 621: DAC OVP step register checksum failed

If one of the errors above is generated, the calibration procedure must be done. If one of these errors is generated again, the power supply must be delivered to **B&K Precision** for service

.
Error 630: Data in location 1 checksum failed

If this error is generated, a new saving for the *power_up* state must be done. If the error persists, the power supply must be delivered to **B&K Precision** for service.

Error 641: Filter register error

Error 642: ADC not locked

Error 643: ADC not ready

Error 644: ADC out of range

Error 651: DAC out of range

Error 661: I/O processor does not respond

Error 662: I/O processor failed self test

Error 663: I/O processor communication error

If one of the errors above is generated, the power supply must be turned off and then turned on. If one of these errors is generated again, the power supply must be delivered to **B&K Precision** for service.

Calibration Errors

Here are calibration error messages generated by the power supply:

Error 637: Secure code checksum failed
If this error is generated, the power supply must be unsecured using hardware unsecure procedure. After that, the power supply must be secured. For more information, see **Calibration Overview**section.
If the error persists, the power supply mu st be delivered to **B&K Precision** for service.

Error 701: Calibration security disabled by jumper
The power supply was turned on and J6 jumper is set for *calibrating* mode operation**.**

Error 703: Invalid secure code
The introduced secure code is not correct. (it does not match with the code introduced when the power supply was secured)

Error 706: Secure code memory bad
If this error is generated, the power supply must be turned off and then turned on. If the error persists, the power supply must be delivered to **B&K Precision** for service.

Error 711: DAC offset register V start value out of range

Error 712: DAC offset register V out of range

Error 713: DAC V calibration failed

Error 714: DAC offset register V memory bad

Error 715: ADC offset register V out of range

Error 716: ADC offset register V memory bad

Error 721: DAC V step register start value out of range

Error 722: DAC V step register out of range

Error 723: DAC V step calibration failed

Error 724: DAC V step register memory bad

Error 725: ADC full gain register V out of range

Error 726: ADC full gain register V memory bad

Error 731: DAC offset register OVP start value out of range

Error 732: DAC offset register OVP out of range

Error 733: DAC offset register OVP memory bad

Error 734: DAC OVP step register start value out of range

Error 735: DAC OVP step register out of range

Error 736: DAC OVP step register memory bad

Error 741: I_{mon} register out of range

Error 742: ADC offset register I out of range

Error 743: ADC offset register I memory bad

Error 744: DAC offset register I start value out of range

Error 745: DAC offset register I out of range

Error 746: DAC offset register I memory bad

Error 751: DAC I step register start value out of range

Error 752: DAC I step register out of range

Error 753: DAC I step calibration failed

Error 754: DAC I step register memory bad

Error 755: ADC full gain register I out of range

Error 756: ADC full gain register I memory bad

If one of the errors above is generated, the calibration procedure must be done. If one of these errors is generated again, the power supply must be delivered to **B&K Precision** for service.

Important note!
Following messages may be displayed:
> **OVP fault**

CC fault
CV fault

In this case, the power supply must be turned off and then turned on. If the messages persist, the power supply must be delivered to **B&K Precision** for service.

Technical specifications

Table 1: Technical Specifications for 9120 Model

Parameter		9120
Output Ratings (at 0° - 40° C)		0 to + 30 V / 0 to 3 A
Programming Accuracy [1]	Voltage	< 0.05%+10 mV
12 months (at 25° C±5° C) ± (% of output + offset)	Current	< 0.2%+10 mA
Readback/Meter Accuracy[1]	Voltage	< 0.05%+5 mV
12 months(over RS 232 or front panel with respect to actual output at 25° C ± 5° C) ± (%of output + offset)	Current	< 0.15%+5 mA
Ripple and Noise (with output leads shielded, or with either output terminal grounded, 20Hz to 20MHz)	*Normal* mode voltage	< 0.5 mV$_{rms}$ and 5 mV$_{p-p}$
	Normal mode current	< 4 mA$_{rms}$
	Common mode current	< 1.5 µA$_{rms}$
Load Regulation(utilizing **Remote Senseing**), ± (% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 µA
Line Regulation, ±(% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 µA
Programming Resolution	Voltage	< 1 mV
	Current	< 0.1 mA
Readback Resolution	Voltage	0.25 mV
	Current	0.04 mA
Front Panel Resolution	Voltage	10 mV
	Current	1 mA

Table 2: Technical Specifications for 9121 Model

Parameter		9121
Output Ratings (at 0° - 40° C)		0 to + 20 V / 0 to 5 A
Programming Accuracy [1] 12 months (at 25° C$\pm 5^{\circ}$ C) $\pm$ (% of output + offset)	Voltage	< 0.05%+10 mV
	Current	< 0.2%+10 mA
Readback/Meter Accuracy[1] 12 months(over RS 232 or front panel with respect to actual output at 25° C $\pm 5^{\circ}$ C) $\pm$ (% of output + offset)	Voltage	< 0.05%+ 5mV
	Current	< 0.15%+5 mA
Ripple and Noise (with output leads shielded, or with either output terminal grounded, 20Hz to 20MHz)	*Normal* mode voltage	< 0.5 mV$_{rms}$ and 5 mV$_{p-p}$
	Normal mode current	< 4 mA$_{rms}$
	Common mode current	< 1.5 μA$_{rms}$
Load Regulation(utilizing **Remote Sensing**), $\pm$ (% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 μA
Line Regulation, $\pm$(% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 μA
Programming Resolution	Voltage	< 1 mV
	Current	< 0.1 mA
Readback Resolution	Voltage	0.25 mV
	Current	0.04 mA
Front Panel Resolution	Voltage	10 mV
	Current	1 mA

Table 3: Technical Specifications for 9122 Model

Parameter		9122
Output Ratings (at 0° - 40° C)		0 to + 60 V / 0 to 2.5 A
Programming Accuracy [1] 12 months (at 25° C$\pm5^\circ$ C) $\pm$ (% of output + offset)	Voltage	< 0.05%+10 mV
	Current	< 0.2%+10 mA
Readback/Meter Accuracy[1] 12 months(over RS 232 or front panel with respect to actual output at 25° C $\pm 5^\circ$ C) $\pm$ (% of output + offset)	Voltage	< 0.05%+5 mV
	Current	< 0.15%+5 mA
Ripple and Noise (with output leads shielded, or with either output terminal grounded, 20Hz to 20MHz)	*Normal* mode voltage	< 1 mV$_{rms}$ and 8 mV$_{p-p}$
	Normal mode current	< 4 mA$_{rms}$
	Common mode current	< 1.5 µA$_{rms}$
Load Regulation(utilizing **Remote Sensing**), $\pm$ (% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 µA
Line Regulation, $\pm$(% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 µA
Programming Resolution	Voltage	< 2 mV
	Current	< 0.05 mA
Readback Resolution	Voltage	< 0.5 mV
	Current	< 0.02 mA
Front Panel Resolution	Voltage	10 mV
	Current	1 mA

Table 4: Technical Specifications for 9123 Model

Parameter		9123
Output Ratings (at 0° - 40° C)		0 to + 30 V / 0 to 5 A
Programming Accuracy [1] 12 months (at 25° C$\pm5^{\circ}$ C) $\pm$ (% of output + offset)	Voltage	< 0.05%+10 mV
	Current	< 0.2%+10 mA
Readback/Meter Accuracy[1] 12 months(over RS 232 or front panel with respect to actual output at 25° C $\pm 5^{\circ}$ C) $\pm$ (%of output + offset)	Voltage	< 0.05%+5 mV
	Current	< 0.15%+5 mA
Ripple and Noise (with output leads shielded, or with either output terminal grounded, 20Hz to 20MHz)	*Normal* mode voltage	< 0.5 mV_{rms} and 5 mV_{p-p}
	Normal mode current	< 4 mA_{rms}
	Common mode current	< 1.5 μA_{rms}
Load Regulation(utilizing **Remote Senseing**), $\pm$ (% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 μA
Line Regulation, $\pm$(% of output + offset)	Voltage	< 0.01 % + 3 mV
	Current	< 0.01 % + 250 μA
Programming Resolution	Voltage	< 1 mV
	Current	< 0.1 mA
Readback Resolution	Voltage	0.25 mV
	Current	0.04 mA
Front Panel Resolution	Voltage	10 mV
	Current	1 mA

[1]Accuracy specifications are after an 1-hour warm-up with no load and calibration at 25°C

Transient Response Time

Less than 50µsec for output to recover to within 15mV following a change in output from full load to half load or vice versa.

Settling time

Less than 90msec for the output voltage to change from 1% to 99% or vice versa following the receipt of VOLTAGE or SET command via RS-232 or GPIB / 488 interface

OVP Accuracy, $\pm$ (% of output + offset)

$<$ 50mV

Activation time: Average time for output to start to drop after OVP condition occurs.

$\leq$ 1.2 msec

Supplemental Characteristics

Remote sensing capability

Voltage drop   Up to 1V per each lead

Load regulation   Add 5mV to spec for each 1-volt change in the + outputs
lead due to load current change.

Load voltage   Substract voltage drop in load leads from specified output
voltage rating.

Temperature coefficient, ±(% of output+offset)

Maximum change in output/readback per $^\circ$C after a 30-minute warm-up:
Voltage $\leq 0.02\%+2mV$

Current $\leq 0.1\%+1mA$

Output voltage overshoot

During turn-on or turn-off of AC power, output plus overshoot will not exceed
1V if the output control is set to less than 1V. If the output control is set to 1V
higher, there is no overshoot.

Programming language
SCPI (Standard Commands for Programmable Instruments)

State storage memory:
100 user configurable states

Recommended calibration interval:
1 year

Output terminal isolation (maximum, from chassis ground):
±60 Vdc when connecting shorting conductors without insulation between the
(+) output and the (+) sense terminals and between the (-) output and the (-)
sense terminals.
±240 Vdc when connecting insulated shorting conductors between the(+)
output and the (+) sense terminals and between the (-) output and the (-) sense
terminals.

AC Input Ratings (selectable via the line voltage receptacle switch):

115 Vac ± 10 % for 47 to 63 Hz
230 Vac ± 10 % for 47 to 63 Hz

Line voltage selection:
The line fuse is located in the space just below the input receptacle. To change line voltage values first remove fuse holder and then remove tan colored fuse bracket. The line voltage value is determined by value shown through the window of the fuse holder. Please ensure correct insertion and fuse rating.

Fuse ratings:
Model 9120: 3.15A/250V for 115Vac, 2A / 250V for 230V
Model 9121: 3.15A/250V for 115Vac, 2A /250V for 230V
Model 9122: 5A/250V for 115Vac, 3.15A / 250V for 230V
Model 9123: 5A/250V for 115Vac, 3.15A / 250V for 230V
All fuses are type T (temporized) for high power up currents.

Cooling:
Fan cooled

Operating temperature:
32° to $+104^{\circ}$ F (0° to 40° C), $\leq$75% R.H. for full rated output.

Storage temperature:
-4° to $+158^{\circ}$ F (-20° to $+70^{\circ}$ C), $\leq$85%R.H. for storage environment.

Environmental conditions:
Designed for indoor use.

Net weight:
12.5 (5.6 kg)

Dimensions (H x W x D):
3.15 x 8.27 x 15" (8 x 21 x 38 cm)

Important note!

The technical specification are warranted for 32° to 104°F (0° to 40°C) with a resistive load. Supplemental characteristics are not warranted. They are determined either by testing or design.

Programming Ranges

The power supply parameters are programmed using command of SOURce subsystem. Here are programming ranges, programming values for MINimum, MAXimum, DEFault parameters and reset state:

Table 5: Programming ranges for voltage parameter

Voltage parameters	Model 9120	Model 9121	Model 9122	Model 9123
Programming range	0 to 30.5V	0 to 20.5V	0 to 30.5V	0 to 30.5V
MINimum	0 V	0 V	0 V	0 V
MAXimum	30.5 V	20.5 V	60.5 V	30.5 V
DEFault	0 V	0 V	0 V	0 V
Reset	0 V	0 V	0 V	0 V

Table 6: Programming ranges for current parameter

Current parameters	Model 9120	Model 9121	Model 9122	Model 9123
Programming range	0 to 3.05 A	0 to 5.05 A	0 to 2.55 A	0 to 5.05 A
MINimum	0 A	0 A	0 A	0 A
MAXimum	3.05 A	5.05 A	2.55 A	5.05 A
DEFault	0 A	0 A	0 A	0 A
Reset	3.00 A	5.00 V	2.5 V	5.0 A

Table 7: Programming ranges for OVP parameter

OVP parameter	Model 9120	Model 9121	Model 9122	Model 9123
Programming range	1 to 33 V	1 to 22 V	1 to 63 V	1 to 33 V
MINimum	1V	1V	1V	1 V
MAXimum	33 V	22 V	63 V	33 V
Reset	33 V	22 V	63 V	33 V

Important note!
Reset value for a parameter is the value after a *RST command or after recalling *Reset* state.

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Reset Values

Here are the power supply parameter values after a *RST command or after recalling *Reset* state.

Table 8: Reset values for power supply parameters

Power supply parameters	Model 9120	Model 9121	Model 9122	Model 9123
Voltage	0 V	0V	0V	0 V
Voltage step	0.01 V	0.01 V	0.01 V	0.01 V
Voltage trigger	0 V	0 V	0 V	0 V
OVP circuit state	ON	ON	ON	ON
OVP trip level	33 V	22 V	63 V	33 V
Current	3.00 A	5.00 A	2.50 A	5.00 A
Current step	0.001 A	0.001 A	0.001 A	0.001 A
Current trigger	3.00 A	5.00 A	2.50 A	5.00 A
Display state	ON	ON	ON	ON
Output state	OFF	OFF	OFF	OFF
Trigger delay	0 s	0 s	0 s	0 s
Trigger source	BUS	BUS	BUS	BUS

Interface Cable

In order to command the power supply over the remote interface, you must connect it to a computer terminal.

Usually, the computer terminals are DTE (Data Terminal Equipment). The power supply is also DTE, so you need a DTE to DTE interface cable. These cables are called null-modem or crossover cables.

There are 2 types of serial connectors: DB-9 and DB-25. The power supply has a male DB-9 connector.

Here is cable pin diagram for DB-9 connector:

```
Instrument                              PC

RX    2  _____      _____  2    RX
TX    3  _____  \  /  _____  3    TX
                        \/
DTR   4  _____   /\   _____  4    DTR
GND   5  _____  /  \  _____  5    GND
                      /    \
DSR   6  _____/      _____  6    DSR


     DB-9                              DB-9
   connector                        connector
```

The rest of the pins are not connected.

If the serial port from your PC has a DB-25 connector, you must use a DB-25 to DB-9 adapter.

B&K PRECISION ®

Limited One-Year Warranty

B&K Precision Corp. warrants to the original purchaser that its product and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the data of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its' option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing and mailing the enclosed warranty card to B&K Precision Corp., 22820 Savi Ranch Parkway, Yorba Linda, CA 92887 within fifteen (15) days from proof of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alternations or repairs. It is void if the serial number is alternated, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

Model Number: _____   **Date Purchased: _____**

22820 Savi Ranch Parkway
Yorba Linda, CA 92887
714.921.9095
714.921.6422 Facsimile

Service Information

Warranty Service: Please return the product in the original packaging with proof of purchase to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device.

Non-Warranty Service: Return the product in the original packaging to the below address. Clearly state in writing the performance problem and return any leads, connectors and accessories that you are using with the device. Customers not on open account must include payment in the form of a money order or credit card. For the most current repair charges contact the factory before shipping the product.

Return all merchandise to B&K Precision Corp. with pre-paid shipping. The flat-rate repair charge includes return shipping to locations in North America. For overnight shipments and non-North America shipping fees contact B&K Precision Corp..

B&K Precision Corp.
22820 Savi Ranch Parkway
Yorba Linda, CA 92887
Phone: 714- 921-9095
Facsimile: 714-921-6422
Email: service@bkprecision.com

Include with the instrument your complete return shipping address, contact name, phone number and description of problem.

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