OPERATOR MANUAL FOR
FLX-HV Series High Voltage
POWER SUPPLY
Document: 83551001 Rev B

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1. Introduction

1.1. General

The FLX-HV series are Flexible and Versatile High Voltage Programmable AC to DC Power Supplies that offer performance and versatility combined with feature rich multi-function local controls, standard USB/LAN interfaces, and class leading wide range 110/230VAC input voltage with Active PFC.

Available Output voltages are 3kV, 10kV, 30kV, and 50kV at power levels of 200Watts, 500Watts, and 1,000Watts. Wide range single-phase 110/230VAC Input (100-254VAC, 47-63Hz) with Active PFC (PF>0.95) is standard for all models. The FLX-HV supply features standard integrated USB and LAN digital interfaces.

All models are CE Marked in accordance with the Low Voltage and EMC Directives, and are RoHS compliant and offer a three (3) year Warranty.

1.2. Scope

After reading this operating manual the user should be familiar with the following:

♦ Operating principles
♦ Safety regulations
♦ Initial operation, transport and storage
♦ Detailed operation
♦ Maintenance
♦ Removal from service and disposal.

In addition, the user will learn about some potential hazards from using the power supply and on how to use and operate the unit in a safe manner. The warning notices contained in this user manual are valid for the complete operating range of the power supply.

CAUTION
Inadequate information may cause damage to property! ♦ Obtain details regarding current national standards and requirements. ♦ Add relevant complementary information, e.g. on work safety or environmental protection to your manual. ♦ Without this information you should not operate the power supply and signifies incorrect use of the device.

1.3. Target Group

This operating manual is written for qualified electricians or personnel with a suitable technical background who are aware of potential electrical hazards and capable of minimizing risks for themselves and other users.

Only the target group is authorized to operate and handle the power supply.

1.4. Signs and Symbols

1.4.1. General

Actions   Actions are always presented as in the following manner:

If an action is required, please proceed as follows:

    1.   Step 1.

    2.   Step 2.

    3.   Step 3.

    4.   Step 4.

    ✓   The action is completed.

Lists   ♦ Primary level list items

    -    Secondary level list items

1.4.2. Danger Classes

> ⚠ **HAZARD**
>
> **Identifies a hazardous situation which may potentially be fatal or cause severe injuries.**
> ♦ Hazard prevention measures can be found here.

> ⚠ **WARNING**
>
> **Identifies a hazardous situation which may potentially be fatal or cause severe injuries.**
> ♦ Hazard prevention measures can be found here.

> ⚠ **ATTENTION**
>
> **Identifies a possibly hazardous situation which could lead to minor or moderate injuries.**
> ♦ Hazard prevention measures can be found here.

> **CAUTION**
>
> **Identifies a situation which could lead to material damage.**
> ♦ Hazard prevention measures can be found here.

> **NOTE**
>
> Find useful suggestions and directions for correct use of the FLX-HV power supply here.

1.4.3. Warning Symbols

	General warning / standard symbol
	Electric Shock
	Danger of crushing / hand injuries
	Combustible substances / Flammable Material

Table 1. Warning Symbols

1.4.4. Mandatory Signs

	Standard symbol / Mandatory Action Label
	Disconnect mains plug

	Earth before use
	Disconnect for maintenance and repair work

1.5. Serial Number Label

The serial number label is located on the rear of the power supply. Figure 1 shows an example serial number label:

Type: FLX50P20 ——————————— 1
P/N: 00551018 ——————————— 2
Output: 50kV   20mA ——————— 3
Input: 1/N/PE AC 47-63Hz 110-230V —— 4
SN: 4415 21619-01-01 ——————— 5
⊟   E1, E2 2 x 12,5T (5 x 20mm) ——— 6
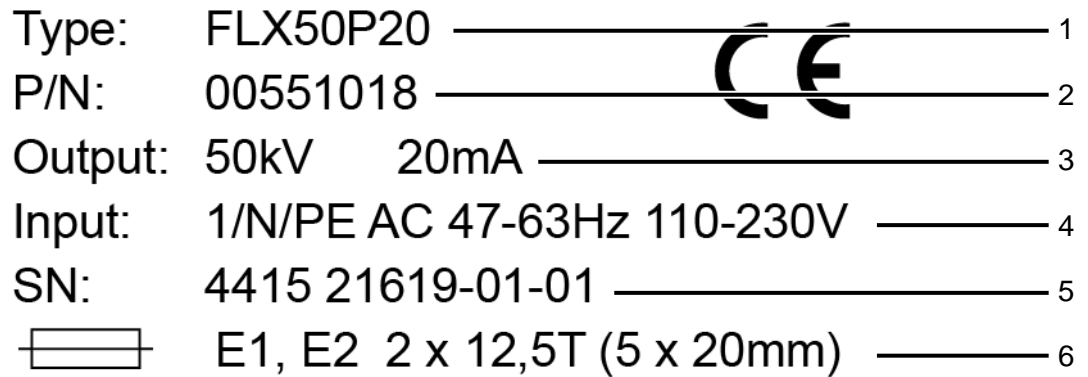
Figure 1. Example Serial Number Label

A brief explanation of the serial labels is shown Table 2 below.

1	Model Number
2	Part Number
3	Output Voltage/Current Rating
4	AC Input Rating
5	Manufacture date (e.g. 4415 = week 44 2015) and Serial number (e.g. 21619-01-01)
6	Fuse type

Table 2. Serial Label Description.

> **NOTE**
>
> Refer to the exact model <u>and</u> serial number if you have a specific question, want to order spare parts, have warranty requests, or want to reorder an identical model.

1.6. Contact Information

TDK-Lambda Americas Inc, Programmable and High Voltage

405 Essex Road, Neptune, NJ 07753 USA

Phone:+1-732-795-4149
Fax: +1-732-922-1441
Email: sales@us.tdk-lambda.com
Web: https://www.us.lambda.tdk.com/

1.7. User Manual Storage

- ♦ This manual is part of the power supply and should be kept in the immediate vicinity of the power supply in a place which is always accessible for users.

- ♦ Before commencing any work, users must have read and understood this operating manual.

- ♦ For safe operation of the unit, all specified safety notes and instructions must be observed.

- ♦ Keep this manual for future reference and pass on this operation manual, e.g. if you sell the power supply.

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2. FLX-HV Series Specification

2.1. Technical Specifications

Average Output Power	200, 500, 1000 Watts
Output Voltage Range (kV)	3, 10, 30, 50kV, variable from 0.1 to 100% of rated voltage
Output Current Range (mA)	4, 7, 10, 17, 20, 33, 50, 100, 333mA, variable from 0.1 to 100% of rated current
AC Input	Wide range 110-230VAC (100-253VAC) Single phase, 47-63Hz
AC Input Connector	IEC60320 C20 receptacle, mating cable included
Power Factor	> 0.95 at full load and nominal AC line
Efficiency	85 - 90% at full load
Safety	CE marked, EN61010-1 compliant
EMC	EN61000-6-2 (Immunity) and EN61000-6-3 (Emission)
Output Control	Continuous adjustment from 0 to rated voltage/current by front panel mounted encoders with Coarse and Fine adjustment settings
Response Time	< 500ms for 10-90 or 90-10% of rated output voltage, at rated load For load changes from 10-100% or 100-10% < 2% deviation, to 1% < 5ms
Polarity	Specify Positive (P), or Negative (N) when ordering, Grounded return
Set Point Resolution	±0.1% of rated
Line Regulation (current & voltage)	±0.01% for ±10% AC line voltage variation
Load Regulation (current & voltage)	±0.1% no load to full load
Voltage Ripple	0.1% peak to peak
Stability	±0.1% over 8hours under constant conditions after 30minute warm up
Temperature Coefficient	±0.1% per °C
Ambient Temperature	0 to +40°C operating, 0 to +60°C storage
Humidity	0-80% at 0-31°C, linearly decreasing to 50% at 40°C
Cooling	Forced air cooling with variable speed fan
Altitude	Operating: 6,500ft (2,000m)
HV Output Connection	Mating HV connector and 9ft cable supplied
HV Insulating Medium	Outputs ≤ 10kV - air insulated, ≥ 30kV - solid dielectric silicone encapsulation
Front Panel	Voltage and Current encoders, Power switch, HV ON/OFF switch. Multi function display shows actual outputs, set points, set/display IP address, unit status, MAC address, baud rate
LAN Interface (standard)	Full duplex with 5 simultaneous connections possible via Ethernet, IP address, subnet mask, configurable via front panel display, transfer speed of 10/100Mbit/s. TCP/IPv4 protocol
USB Interface (standard)	Virtual COM port on PC side, 115kBaud
Mechanical	2U (3.5") rackmount package x 17.9" deep x 17.5" wide
Weight	10kV models - 22lbs / 30-50kV models - 37lbs
Protection	Open/short circuits, Arcs, Overtemp, Flashover
Warranty	3 years
All specifications subject to change without notice	

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2.2. Arc Detection (flashover counter)

When operating above 20% of rated output voltage, if more than three load arcs are detected in a period of 5 seconds, the FLX-HV output will shut-down for a short duration (approximately 5 seconds). The power supply will automatically restart and attempt to reach the programmed voltage/current setpoints, however if load arcs continue the shut-down sequence will repeat.

Arc events (an arc event is defined as multiple arcs in a short duration that cause the unit to shut down for approx. 5 seconds) are captured by the FLX-HV supply and cause the arc counter to increase. If an arc has been detected, the display shows 'ARC' instead of 'V-Set' and 'C-Set' for 10 seconds. The arc event counter can be read and reset via the remote interface, see Section 9 Command Set.

2.3. Temperature Monitoring and Fan Control

The internal power circuit temperatures are continuously monitored and in the event of an over temperature condition the unit will shut down. Over temperature conditions and faults are shown in the display and captured in the error memory with a time stamp.

Device status and corresponding errors can be read via the remote interface.

The temperature sensors also control the cooling fan speed to minimize the FLX-HV power supply noise and power consumption.

2.4. Operational Timer

The operational timer provides the time system for the FLX-HV power supply. One of the display submenus shows the operating time counter in hours and seconds, see Section 6.8 Operating Time Screen.

Error memory entries are stored along with a time stamp of the operational timer in hours and seconds.

The error rating for the Operational Timer oscillator is show below:

- ♦ +/-20 ppm tolerance
- ♦ +/-30 ppm stability (-40°C ... +85°C)

2.5. Binary Communication

A binary communication protocol can be used for fast command and data transfer.

All current data such as actual output values and device status can be transferred with one string. Setpoints and the control commands can be transferred with one string.

> **NOTE**
>
> Binary data packages should be transferred with checksum verification.
>
> See Section 9 Command Set to learn more about commands, command parameters and interfaces.

2.6. Data streaming

The >AUT1 (binary) and >AUT2 (ASCII) commands can be used to configure automatic outputs. They can be set from 1 ms to > 100,000 ms. The data is provided with a time stamp

indicating the operating time. See Section 9 Command Set to learn more about commands, command parameters and interfaces.

2.7. Rack Installation

The FLX-HV supply includes rack adapters for the front panel. The rack adapters are not installed when the unit is shipped. A Torx T10 driver is required to mount the rack adapters to the unit. Note that the rack adapters are not intended to support the weight of the unit.

Remove the four feet, and the unit can be mounted on rack angles or a shelf. Contact the factory for details of mounting rack slides to the unit.

2.8. What's in the Box

♦ FLX-HV series power supply
♦ AC power cable (8ft)
♦ Mating HV connector with 9ft cable
♦ Rack adapter brackets and installation screws (Torx T10 head)

2.9. FLX-HV Power Supply Models

Model	Power (Watts)	Voltage (kV)	Current (mA)	Ripple (Vp-p)	Max Stored Energy (J)
FLX3P333	1000	3	333	3	1.1
FLX10P20	200	10	20	10	1.1
FLX10P50	500	10	50	10	1.7
FLX10P100	1000	10	100	10	3.1
FLX30P7	200	30	7	30	2.4
FLX30P17	500	30	17	30	2.4
FLX30P33	1000	30	33	30	3.5
FLX50P4	200	50	4	50	3.5
FLX50P10	500	50	10	50	3.4
FLX50P20	1000	50	20	50	4.9
Positive models shown. N replaces P in the model number for negative polarity (e.g. FLX10N20).					

Table 3. FLX-HV Output Parameters

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3. Safety

3.1. Safety Instructions

The FLX-HV power supply provides potentially **<u>dangerous high voltages!</u>** Make sure that no personnel or equipment is in a hazardous situation because of the high voltage before initial operation!

> ⚠ **CAUTION**
>
> ⚠ **High voltage connectors can only hold off their rated voltage/dielectric strength when mated.**

> **ⓘ NOTE**
>
> **Before initial operation.**
>
> Please read the complete operating manual carefully! Observe all warnings and instructions contained in this manual. Non-compliance with this operating manual violates safety regulations for the operation of this unit. TDK-Lambda is not liable for any consequences resulting from non-observance of safety instructions.

3.1.1. AC Input Voltage

Make sure that the AC input voltage and frequency shown on the serial number label match the local AC power.

3.1.2. Grounding

The FLX-HV power supply is equipped with protective grounding (protection class I). To prevent electric shock hazards, the power supply has to be connected using the AC line cord supplied. In addition, the ground stud on the rear panel should be used to connect the unit to a solid central grounding point.

3.1.3. Operating Environment

The FLX-HV power supply should be operated in a clean and dry environment. Make sure that no foreign objects or fluids enter the chassis through the ventilation openings. Owing to the risk of sparks, the power supply should not be operated close to any flammable gases or vapors.

3.1.4. Cooling

In order to guarantee adequate cooling, the ambient temperature must not exceed 40°C. Dissipated heat from the unit is removed by forced ventilation. Do not expose the power supply to direct sunlight. Allow 4" front and rear ventilation.

3.1.5. Opening the unit

There are no user serviceable parts inside, do not open this unit. The FLX-HV power supply has large internal filter capacitors which discharge slowly. Use extreme care if opening the unit to ensure that capacitors are discharged and any hazard is eliminated.

3.2. Operating the Power Supply

3.2.1. Intended Use

The FLX-HV power supply is only intended to be used in dry, indoor environments.

The power supply is intended to be used in accordance with the technical specifications indicated on the serial number label.

3.2.2. Incorrect Use

The FLX-HV power supply is not intended to be used in series or parallel with other units or models.

3.3. General Safety Instructions

3.3.1. FLX-HV Power Supply Symbols

The following warning labels are fixed to the power supply:

Figure 2. Dangerous high voltage warning label

Figure 3. Connect without voltage warning

The Connect without voltage warning indicates that the high voltage cable or connection should not be made or broken when voltage is present.

3.3.2. Protection and Warning Installations

The FLX-HV Power Supply provides the following protection and warnings:

♦ AC input fuses
♦ LED indicator for active output (HV OUTPUT ON)
♦ Warning messages on the display

3.4. Operator Duties

The FLX-HV power supply is intended for industrial and commercial use. The operator has to observe all statutory rules and policies concerning industrial safety.

The operator must adhere to the safety instructions contained in this manual. In addition, all local safety regulations, accident prevention and environmental protections should be observed.

3.5. Personnel Duties

Staff members are only allowed to work with the FLX-HV power supply if they have read and understood this operating manual.

3.6. Mechanical Hazards

> **⚠ WARNING**
>
> **Limb injuries may be caused by the power supply falling from a transportation or lifting device.**
> ♦ Always use the handles attached to the unit when transporting the power supply.
> ♦ Take note of the power supply weight and maximum dimensions.

3.7. Electrical Hazards

> **⚠ HAZARD**
>
> **Improper grounding may cause electric shocks.**
> ♦ Connect the power supply with the 3-pin power cord with protective earth connector that is supplied with the unit.
> ♦ The ground stud on the rear panel should be used to connect the unit to a solid central grounding point.
> ♦ When the AC power is turned off, it is possible that residual output voltage may be present but it is not indicated on the display.

> **⚠ WARNING**
>
> **Improper handling of the power supply may cause electric shock.**
> ♦ Disconnect the power supply from AC power and all external high voltage connections before opening.
> ♦ Wait at least 1 minute before opening the power supply.
> ♦ Only use a dry, clean cloth for cleaning.
> ♦ Clean all air inlet and exit vents.
> ♦ Never remove or handle the high voltage cable when the unit is operating or connected to AC power.
> ♦ Ensure the high voltage cable is clean and undamaged before installing in the unit.

> **⚠ WARNING**
>
> **Severe or fatal injuries may occur owing to electric shock.**
> ♦ Only replace the original fuses using components with an identical or equivalent rating.
> ♦ NEVER replace the AC power cord with an inappropriate part. Only use spare parts that comply with TDK-Lambda specifications.

> **⚠ WARNING**
>
> **Severe or fatal injuries may occur owing to electric shock.**
> ♦ Only operate the power supply if you belong to the target group, see Section 1.3 Target Group.
> ♦ Disconnect from AC power and all external high voltage connections before opening.
> ♦ Wait at least 1 minute before opening the power supply.
> ♦ Disconnect from AC power before working on the power supply.
> ♦ Verify safe isolation of the unit from AC power, ground the power supply and provide a safeguard to prevent unintentional reconnection of AC power. Cover or separate adjacent parts and components which have applied voltage.
> ♦ Only use insulated tools.
> ♦ Immediately switch off the unit if irregularities occur in the AC power supply.
> ♦ Never remove or handle the high voltage cable when the unit is operating or connected to AC power.
> ♦ Ensure the high voltage cable is clean and undamaged before installing in the unit.

3.8. Hazards due to spark formation

> **⚠ HAZARD**
>
> **Risk of fire due to sparks in the presence of flammable gases and vapors.**
> ♦ DO NOT operate the power supply near flammable gases and vapors

3.9. General Warnings

<table>
<tr><td colspan="2">⚠️ **HAZARD**</td></tr>
<tr>
<td>⚠️</td>
<td>

Severe injuries may occur if safety installations are bypassed.
- Install all safety-relevant components, e.g. external fuses.
- Check the function of safety-relevant components and replace them if necessary.
- The FLX-HV power supply's protection mechanisms only work when the unit is used as intended.

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</table>

<table>
<tr><td>**CAUTION**</td></tr>
<tr>
<td>

Overheating of the power supply may occur.
- Only operate the power supply in a horizontal position.
- Ensure cooing air inlet and outlet are not obstructed.
- Remove all objects that may obstruct air inlets or outlets.
- Make sure that sufficient air ventilation is given if operated in a rack – 4" front / back.

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</table>

<table>
<tr><td>**CAUTION**</td></tr>
<tr>
<td>

Material damage to the power supply may occur owing to improper handling.
- Only use the power supply in the intended way, see Section 3.2.1 Intended Use.
- Please note that the HV output cable extends beyond the outline of the unit when installed.
- Ensure the HV cable is not damaged (e.g. due to excessive bending).

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4. Mechanical Layout

4.1. FLX-HV Power Supply Front Panel Layout

The front panel layout is shown in Figure 4 below.
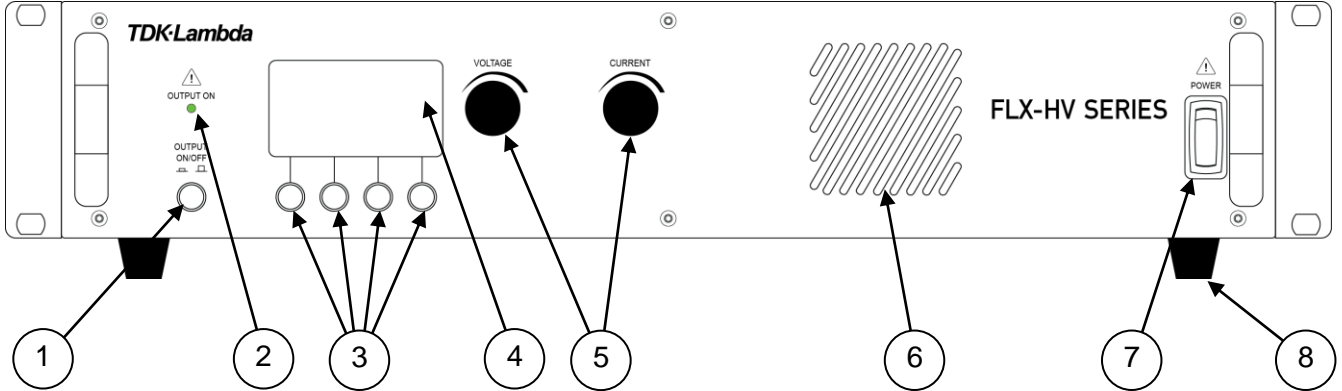
Figure 4. FLX-HV Front Panel Features

REF	DESCRIPTION	NOTE	SECTION
1	HV ON/OFF Button	Turns HV output ON/OFF (does not disconnect the HV output, or AC Input).	4.1.1
2	HV ON LED	Illuminates when HV output is turned ON.	4.1.2
3	Softkeys	Power supply control function push buttons.	4.1.3
4	Display	Voltage/Current and multi-function/status display.	4.1.4
5	Output Voltage/current controls	Encoders for output voltage and current control.	4.1.5
6	Cooling Vent	Cooling air inlet vent.	4.1.6
7	Power switch	Turns on/off Main AC power to unit.	4.1.7
8	Feet	Feet for use with table top operation, can be removed.	4.1.8

Table 4. FLX-HV Front Panel Features

The function of the front panel controls is outlined in Table 4 above with details in 4.1.1 through 4.1.8.

4.1.1. HV OUTPUT ON/OFF Push Button

Push button switch to turn ON and OFF the high voltage output. When the HV output is turned ON, the switch will turn HV OFF with the display in any screen as long as the unit is in LOCAL mode.

The HV ON/OFF push button has no function when the unit is operating in REMOTE mode.

> **NOTE**
>
> With the HV output turned OFF, it can only be turned ON when the multi-function display is in the Home screen and the unit is in LOCAL mode (see Section 6.3).

The user can turn HV ON using the OUTPUT switch only if the following conditions are met:

♦ Power switch POWER is ON and the power indicator light is illuminated.
♦ The power supply is operating in LOCAL mode.
♦ Multi-function Display shows HOME screen.
♦ There are no active errors.
♦ OUTPUT switch is set to ON.

4.1.2. HV ON LED

Green LED that illuminates when the HV output circuits are enabled and the unit is generating high voltage.

♦ The OUTPUT ON LED indicates the unit's output is enabled.

The green indicator LED is active in both LOCAL and REMOTE mode.

4.1.3. Softkeys

The front panel softkeys are push buttons that have multiple functions depending on the display mode and status of the power supply (context sensitive). The softkey functions are;

♦ Shown in the display above each softkey.
♦ Can change according to the display mode.
♦ All softkeys do not function in all displays.

See Section 6 Multi-Function Display for details.

4.1.4. Display

LCD display showing the high voltage setpoints and actual output parameters along with multiple other product status messages depending on the display screen. See Section 6 Multi-Function Display for details.

4.1.5. Output Voltage/current controls

High resolution encoders for output voltage and current control. Encoders can be switched between coarse and fine mode (see Section 6.3) and also set other functions such as IP address. Full details in section 6.

The controls are used to:

♦ Set the output levels in the main display.
♦ Change select settings in some of the menus.

The voltage/current encoders also control the following functions:

♦ In the main screen you can increase the resolution of the current and voltage controls with the FINE softkey.
♦ In the main screen you can prevent accidental adjustment of the output setpoints via the current/voltage controls using the LOCK softkey.

The user can adjust the output current/voltage fine and coarse step settings via interface configuration commands, see Section 9 Command Set.

4.1.6. Cooling Vent

Cooling air inlet vent. Allow minimum of 4" clearance in front of the opening to allow sufficient cooling air to enter the unit.

4.1.7. Power switch

Turns ON/OFF Main AC power to unit. When power is ON the switch is illuminated.

4.1.8. Feet

Feet for use with table top operation, can be removed if the unit is mounted in a rack on support brackets or a shelf.

4.2. FLX-HV Power Supply Rear View
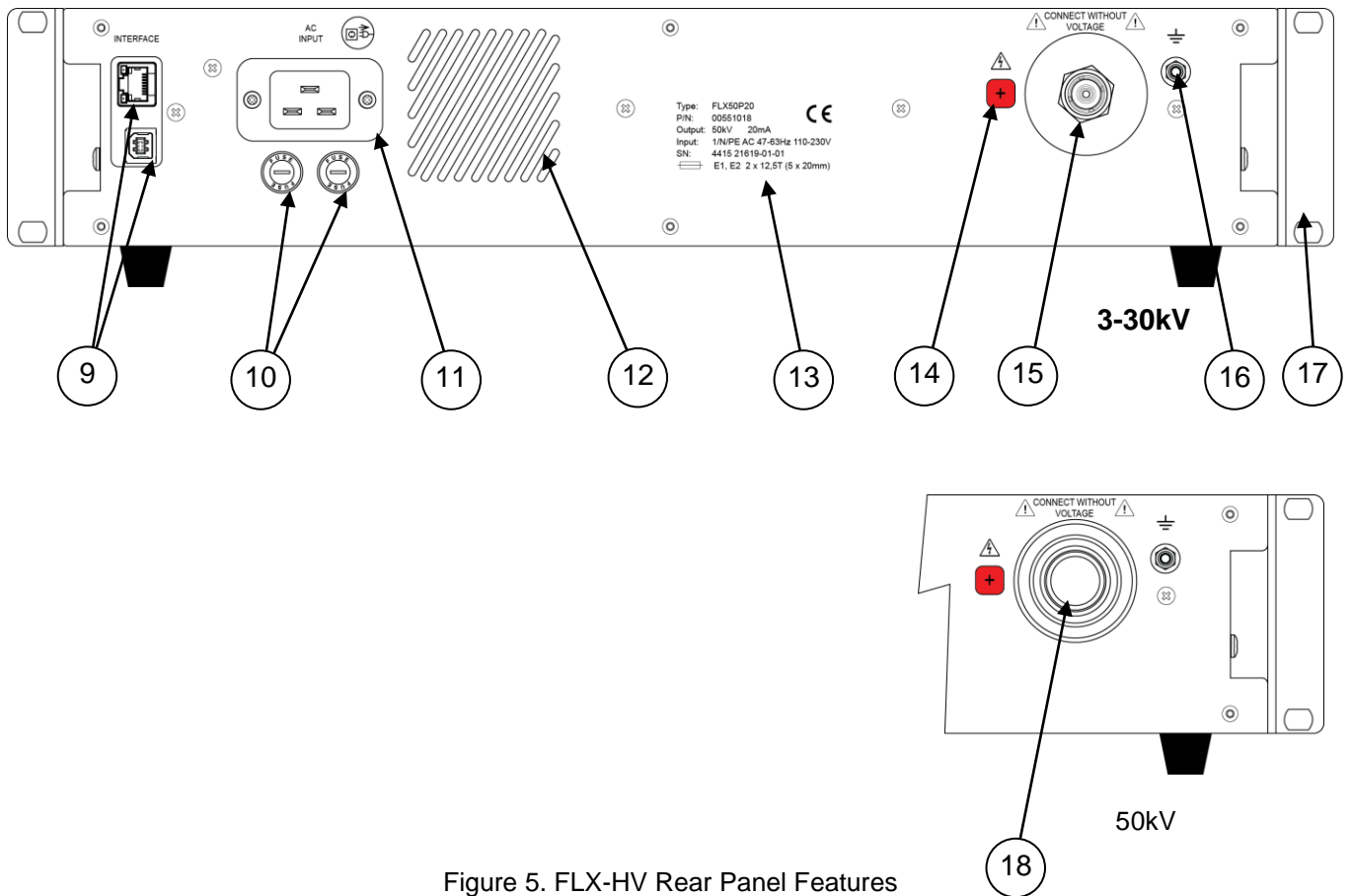
Figure 5. FLX-HV Rear Panel Features

REF	DESCRIPTION	NOTE	SECTION
9	Interfaces	LAN RJ45 and USB Type B remote interface connectors	4.2.1
10	Fuses	AC line fuses, E1, E2 HBC 12.5T (5 x 20mm)	4.2.2
11	AC Input	IEC 320 type 19 AC input socket	4.2.3
12	Cooling Vent	Cooling air exit vent	4.2.4
13	Serial Label	Unit serial number and model label	4.2.5
14	Polarity	Output polarity indicator	4.2.6
15	HV Connector	Output connector for 10 and 30kV models	4.2.7
16	Ground Stud	M4 Ground Stud	4.2.8
17	Rack adapter	Removable front panel rack adapter bracket (not intended for mechanical support)	4.2.9
18	HV Connector	Output connector for 50kV models	4.2.10

Table 5. Rear Panel Feature Outline

4.2.1. Interfaces

LAN RJ45 and USB Type B interface connectors for remote control operation. LAN connector includes LEDs that indicates the presence of data on the interface bus.

4.2.2. Fuses

Internal AC line protection fuses, E1, E2. Fuse type is HBC 12.5T 5x20mm.

4.2.3. AC Input

AC input connector, IEC 320 type 19 socket. An 8ft long power cable is supplied with the unit. Cable features a NEMA 5-15P plug on one end and IEC 320 type 20 plug on the other end.

4.2.4. Cooling Vent

Cooling air exit vent. Allow minimum of 4" clearance behind the opening to allow sufficient cooling air to exit the unit.

4.2.5. Serial Label

Unit serial number and model label, shows the FLX part (model) number, the TDK-Lambda part number (format is 00551XXX), Output rating in kV and mA, AC input rating, Manufacture date (first 4 letters of serial number), Serial number, and the AC line fuse rating.

4.2.6. Polarity

High voltage Output polarity indicator, a RED symbol with a "+" sign means that the HV output is positive with respect to ground. A BLUE symbol with a "-" sign means that the HV output is negative with respect to ground.

4.2.7. HV Connector

High voltage output connector for 3, 10 and 30kV models. Connector is GES HB41, mating connector is GES HS40.

4.2.8. Ground Stud

M4 Ground Stud should be used to securely connect FLX-HV supply to load, max torque 10in.lbs.

4.2.9. Rack adapter

Front panel rack adapter bracket. Bracket mounts to chassis with provided Torx T10 head M4 screws, max torque 11in.lbs.

4.2.10. HV Connector

High voltage output connector for 50kV models. Connector is GES GB150, mating connector is GES KS150. Models rated at 50kV are supplied with a connector cover that should be removed before attempting to connect the cable supplied with the unit. When the unit is not in use and a cable not connected, the cover should be secured in place.

Before installing the cable the user should ensure it is clean and undamaged.

ATTENTION

Damage may occur to the FLX-HV power supply owing to improper handling.
- Please note that when the HV cable is installed it extends beyond the rear panel of the unit.
- Tight bending of the HV cable could result in damage. Typical minimum bend radius should be 4 x the cable diameter.

4.3. Transport and Storage

⚠ HAZARD

Limb injuries may be caused by the power supply falling from a transportation or lifting device.
- Always use the handles attached to the unit when transporting the power supply.
- Be aware of the weight and maximum dimensions of the power supply.

Transport Use the front panel handles when transporting the unit. Ensure that the weight is evenly distributed on all handles during transport.

> **NOTE**
>
> Only transport the power supply when switched off and disconnected.

Storage   Observe the ambient temperature and humidity conditions, see Section 2.1 Technical Specifications. Store the power supply in its original packaging.

5. Installation

> **NOTE**
>
> The operator is responsible for the safety of the system into which FLX-HV power supply is integrated.

5.1. Preparation

Follow the steps below to prepare the power supply for initial operation:

1. Ensure that the specified ambient conditions are met, see Section 2.1 Technical Specifications.

2. Verify the AC input voltage and frequency indicated on the serial label corresponds with available AC power.

3. Only operate the power supply in a clean and dry environment. The FLX-HV power supply is designed for contamination degree 1 (ordinary, non-conductive contamination).

4. Make sure that no objects or fluids enter the FLX-HV chassis through the ventilation openings.

> **⚠ HAZARD**
>
> **Sparks may occur owing to flammable gases or vapors.**
> ♦ Do NOT operate the power supply close to any flammable gases or vapors.

5. If the power supply is operated in a rack, the user must ensure that sufficient cooling air ventilation is provided (front / rear 4").

✓ The power supply is now ready for initial operation.

5.2. Grounding

The FLX-HV power supply features protective grounding (protection class I).
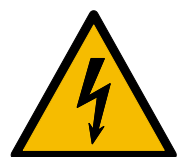
> **⚠ HAZARD**
>
> **Improper grounding may cause electric shocks.**
> ♦ Connect AC power with a 3-pin power cord with protective earth connector that is supplied with the unit.
> ♦ Connect the ground stud on the rear panel to a solid central grounding point.

✓   The power supply is now grounded.

5.3.   Setup and Connections

NOTE
ⓘ   Only position the power supply in a location that gives access to the power switch and any external circuit breakers at all times.

CAUTION
Overheating of the power supply may occur. ♦ Only place the power supply in a horizontal position. ♦ Make sure air inlet and outlets are not obstructed. ♦ Remove all objects that may block air inlets or outlets. ♦ Make sure that sufficient air ventilation is given (front rear ventilation of 4").

Proceed as follows to set up and connect the power supply:

1.   Place the power supply in a horizontal position.

2.   Install the power supply appropriately. If operating in an equipment rack, the unit should have the feet removed and be supported by a shelf or brackets. Contact the factory for appropriate rack slide mounting details.

⚠ WARNING
Incorrect accessories may cause electric shocks. ♦ Only use the supplied AC power cord.

3.   Connect the supplied AC power cord to the FLX-HV power supply.

4.   Ground the power supply using the rear panel ground stud.

> **NOTE**
>
> If you plan to use external circuit-breakers as additional protection, TDK-Lambda suggests using components with a 'C' or 'K' characteristic and a rating of 16A. Ensure the power supply is in a location that gives access to the power switch and circuit breakers at all times.

5.   Use external fuses with a rating greater than those in the unit (e.g. 16A). The internal fuse rating is shown on the serial label.

6.   Connect a load using the HV output cable supplied with the unit.
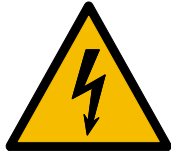
> **WARNING**
>
> **Improper grounding may cause electric shocks.**
> ♦ Ensure the output current cannot flow back through the AC power earth.
> ♦ Connect the HV output cable shield to ground.
> ♦ Use the supplied HV cable/connector or an approved equivalent part from TDK-Lambda.

7.   Connect the current return to the shield of the HV cable. Alternatively: Connect the current return to the ground stud using a separate cable.

> **WARNING**
>
> **Improper grounding may cause electric shocks.**
> ♦ Ensure the output current cannot flow back through the AC power earth.
> ♦ Connect the HV output cable shield to ground.
> ♦ Use the supplied HV cable/connector or an approved equivalent part from TDK-Lambda.

8.   Connect the supplied AC power cord to the AC line.

✓   The power supply is now set up and connected.

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6. Multi-Function Display

6.1. Save Settings in the Display

The following settings are saved and they load the next time the power supply is turned on or before it is turned off:

- ◆ LOCAL / REMOTE operation.
- ◆ Setpoints for current and voltage in LOCAL mode.
- ◆ NORMAL / FINE settings for the output voltage/current encoders.
- ◆ LOCK mode for the encoders for setpoint settings. Lock prevents accidental adjustment of output current / voltage.

6.2. Multi-Function Display Menus

The Multi-function display menus and the navigation sequence is shown in Figure 6 below.

Home → Status Monitor 1
↓
Status Monitor 2
↓
Status Monitor 3
↓
Operating Time
↓
Ethernet Settings
↓
Device Info 1
↓
Device Info 2
↓
Device Info 3
↓
Device Info 4
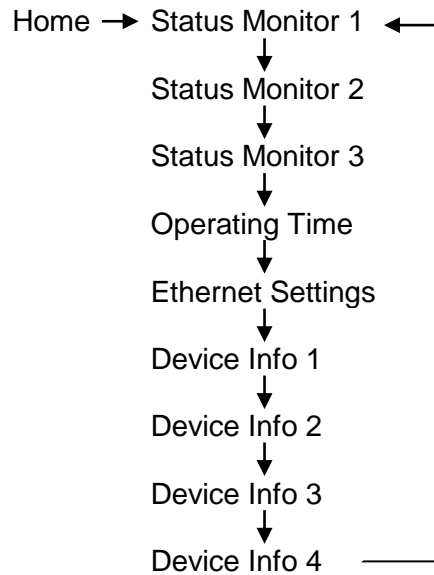
Figure 6. Display Menu Screen Sequence

6.3. Home Display Screen in LOCAL Mode

An example of the Home screen in LOCAL mode is shown in Figure 7 below.
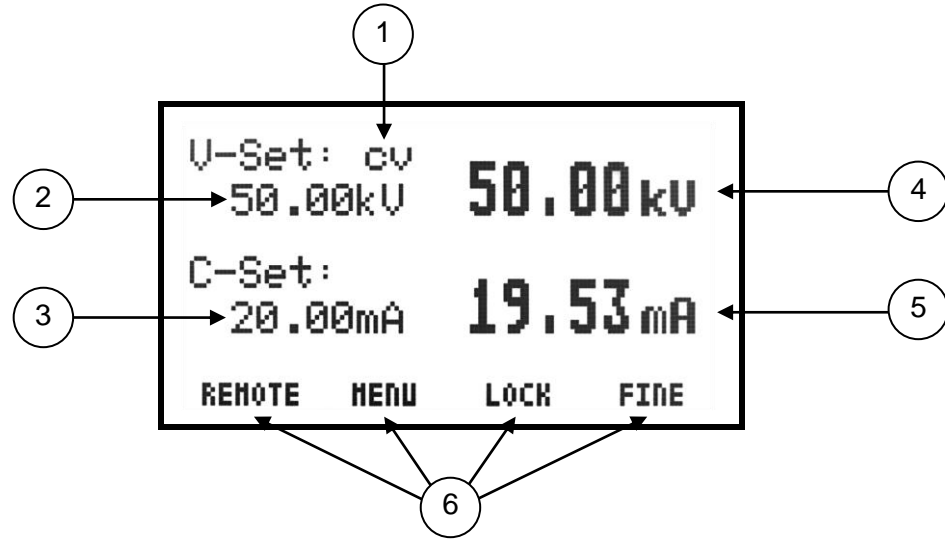
Figure 7. Multi-Function Display Home Screen in LOCAL mode

The function/meaning of the display indications are outlined in Table 6.

1	cv next to V-Set: unit in constant voltage mode cc next to C-Set: unit in constant current mode
2	Output voltage setpoint (below V-Set)
3	Output current setpoint (below C-set)
4	Actual output voltage
5	Actual output current
6	Softkey function(s) - see below
	1 – REMOTE – Switch to REMOTE mode
	2 – MENU – Go to next MENU
	3 – LOCK – Lock/Unlock output voltage/current controls
	4 – FINE – Standard/Fine output control setting
VOLTAGE control – sets the output voltage	
CURRENT control – sets the output current	

Table 6. Home Screen Display Function and Indications

6.4. Home Display Screen in REMOTE Mode

An example of the Home screen in REMOTE mode is shown in Figure 8 below.
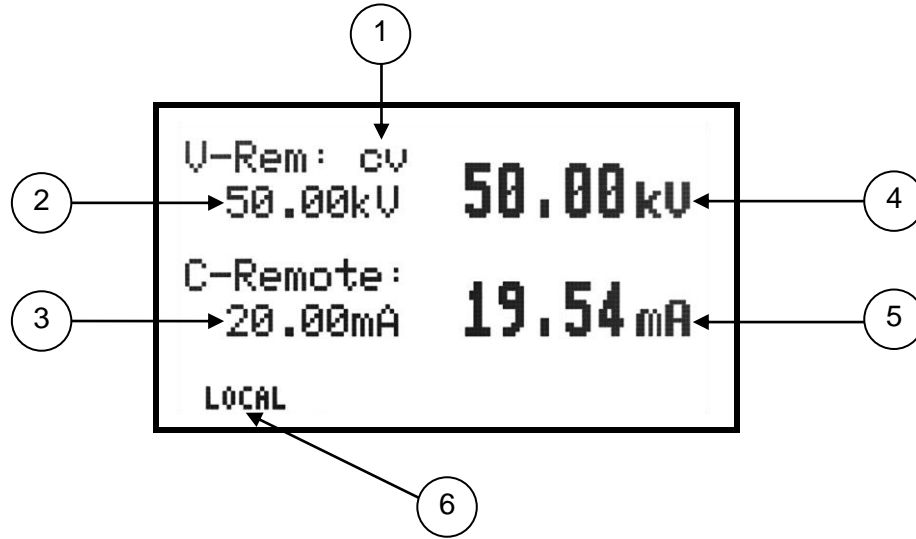
Figure 8. Multi-Function Display Home Screen in REMOTE Mode

In the Main screen in REMOTE mode, the softkeys and voltage/current controls have the following functions:

1	cv next to V-Rem: unit in constant voltage mode cc next to C-Rem: unit in constant current mode	
2	Output voltage setpoint (below V-Rem)	
3	Output current setpoint (below C-Rem)	
4	Actual output voltage	
5	Actual output current	
6	Shows softkey function(s)	
	1 – LOCAL – Switch to LOCAL mode	
	2 through 4 have no function	
VOLTAGE control – no function		
CURRENT control – no function		

Table 7. REMOTE mode control functions and indications

6.5. Status Monitor 1 Screen (LOCAL Mode)

An example of the Status Monitor 1 screen is shown in Figure 9 below.
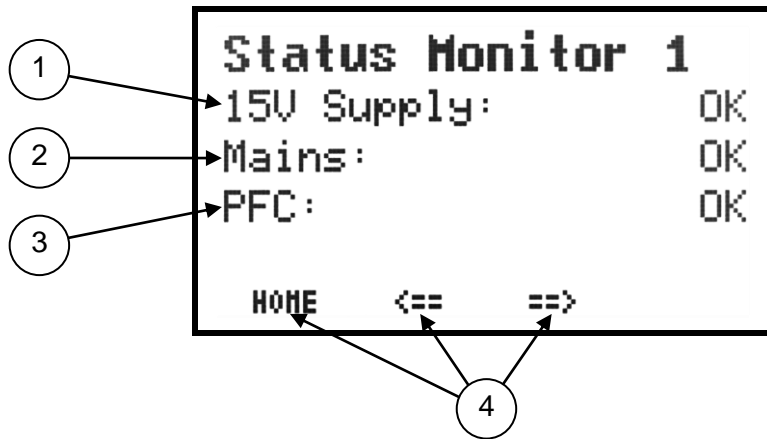
Figure 9. Multi-Function Display Status Monitor 1 Screen.

In Status Monitor 1 screen the softkeys and voltage/current controls have the following functions:

1	15V Bias Supply status – OK/ERROR
2	AC Power Status – OK/ERROR
3	PFC Status – OK/ERROR
4	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see Section 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (HOME)
	3 - NEXT – Go to the next screen in the menus (STATUS MONITOR 2)
VOLTAGE control – no function	
CURRENT control – no function	

Table 8. Status Monitor 1 screen softkey control functions and indications

6.6. Status Monitor 2 Screen (LOCAL Mode)

The Status Monitor 2 screen shows the power supply internal temperatures. The following messages are displayed (see Figure 10 below):
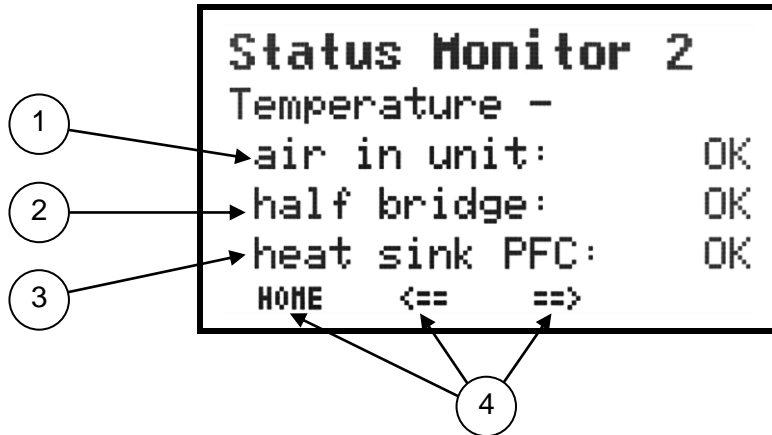
Figure 10. Multi-Function Display Status Monitor 2 Screen.

In Status Monitor 2 screen the softkeys and voltage/current controls have the following functions:

1	Cooling Air temperature in unit – OK/ERROR
2	PWM Half bridge temperature – OK/ERROR
3	PFC Heat Sink Temperature – OK/ERROR
4	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see Section 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (STATUS MONITOR 1)
	3 - NEXT – Go to the next screen in the menus (STATUS MONITOR 3)
VOLTAGE control – no function	
CURRENT control – no function	

Table 9. Status Monitor 2 screen softkey control functions and indications

6.7. Status Monitor 3 Screen (LOCAL Mode)

The Status Monitor 3 screen shows the power supply bias supply, output, and Inverter status. An example of the Status Monitor 3 screen is shown below (see Figure 11 below).
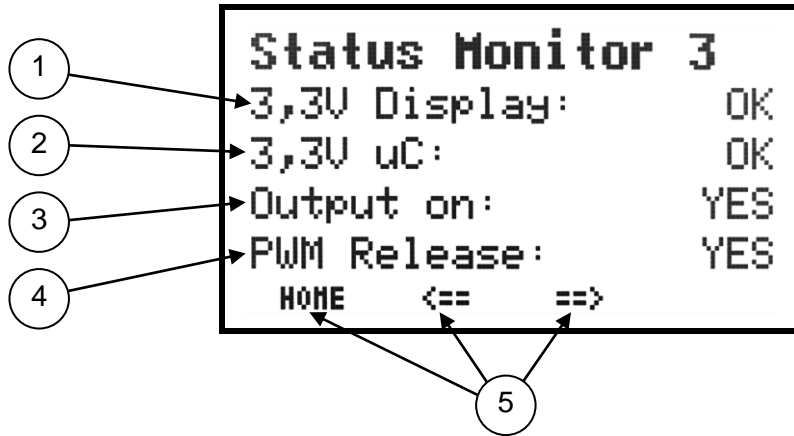
Figure 11. Multi-Function Display Status Monitor 3 Screen.

In Status Monitor 3 screen the softkeys and voltage/current controls have the following functions:

1	3.3V Display Bias Supply – OK/ERROR
2	3.3V Microcontroller Bias Supply – OK/ERROR
3	HV Output ON – YES/NO
4	PWM Release – YES/NO (Inverter running)
5	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see Section 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (STATUS MONITOR 2)
	3 - NEXT – Go to the next screen in the menus (Operating Time Screen)
VOLTAGE control – no function	
CURRENT control – no function	

Table 10. Status Monitor 3 screen softkey control functions and indications

6.8. Operating Time Screen

The Operating Time screen shows the elapsed operating hours timer in hours and seconds. See Figure 12 for an example:
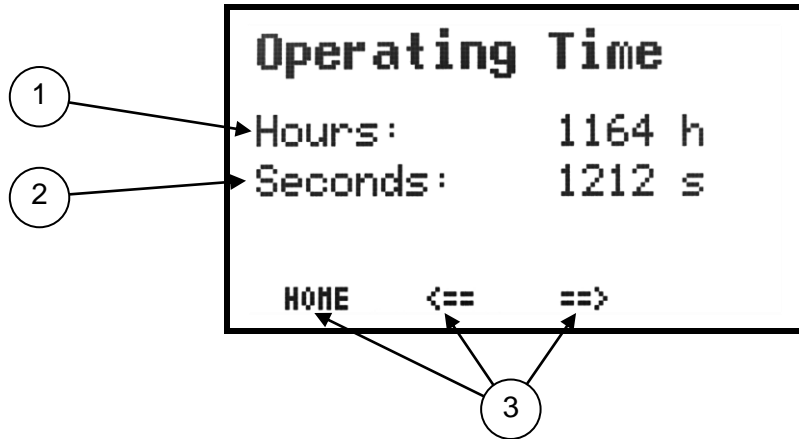
Figure 12. Example of the Operating Hours Screen.

1	Operating Hours – time in hours
2	Operating seconds – time in seconds
3	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (STATUS MONITOR 3)
	3 - NEXT – Go to the next screen in the menus (Ethernet Settings Screen)
VOLTAGE control – no function	
CURRENT control – no function	

Table 11. Operating Time screen softkey control functions and indications

6.9. Ethernet Settings Screen

The Ethernet Settings screen shows the current IP address and the network mask and enables the user to change the settings, see Figure 13 below.
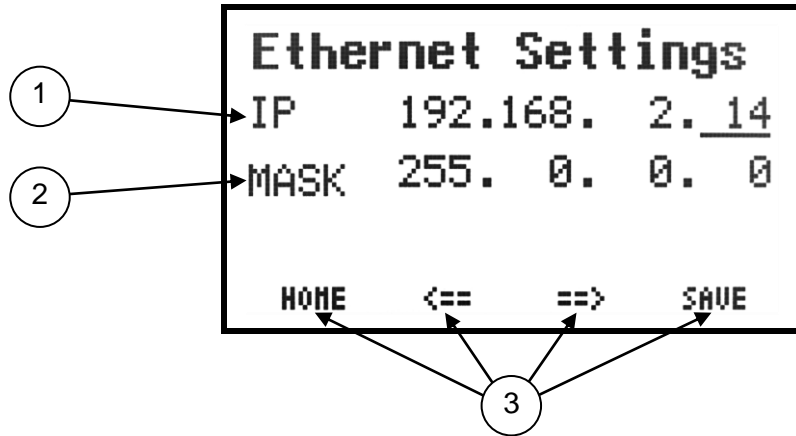
Figure 13. Example of the Ethernet Settings Display

1	IP Address
2	Mask
3	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (OPERATING TIME)
	3 - NEXT – Go to the next screen in the menus (Device Info 1)
	4 – SAVE – Saves the selected settings (must be pushed to save any changes)
VOLTAGE control – allows the user to select the various IP/MASK address values. The selected value has an underscore (shown under 14 in the image above)	
CURRENT control – increase/decrease the selected IP or Mask address value	

Table 12. Ethernet Settings screen softkey control functions and indications

6.10. Device Info 1 Screen

The device info 1 screen shows the current port and MAC address of the Ethernet interface, see Figure 14 below.
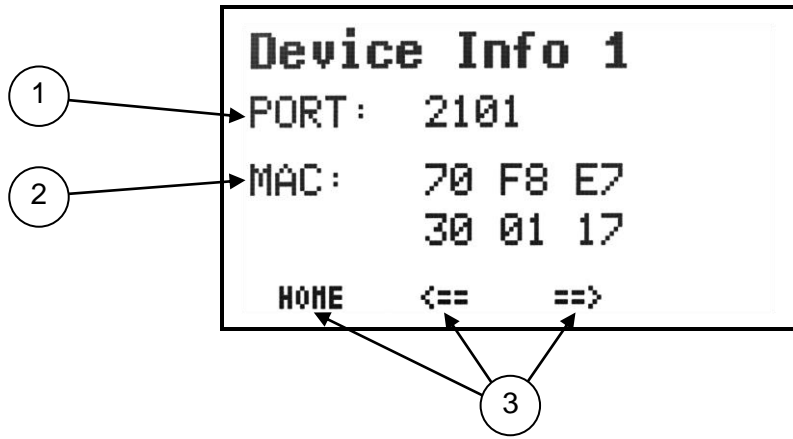
Figure 14. Device Info 1 Screen

1	Ethernet Port Address
2	MAC address
3	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (ETHERNET SETTINGS)
	3 - NEXT – Go to the next screen in the menus (Device Info 2)
VOLTAGE control – no function	
CURRENT control – no function	

Table 13. Status Device Info screen softkey control functions and indications

6.11. Device Info 2 Screen

The device info 2 screen shows the Unit Serial Number, Date of Manufacture, and Firmware Revision, see Figure 15 below.
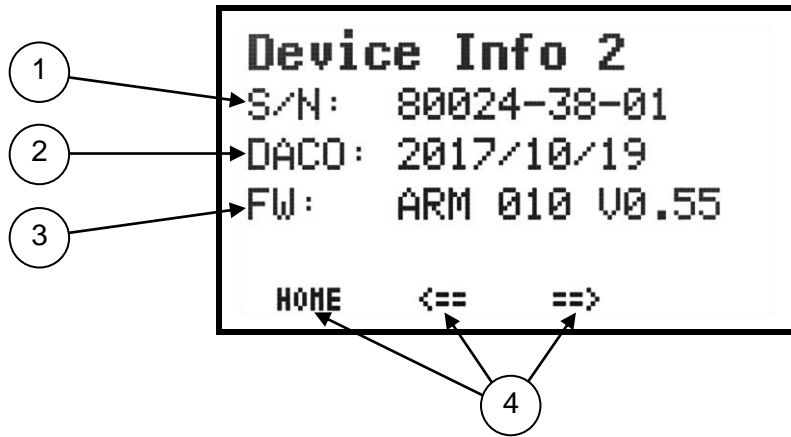
Figure 15. Device Info 2 Screen

1	Unit Serial Number
2	Date of Manufacturing (Year/Month/Day)
3	Firmware Revision
4	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (Device Info 1)
	3 - NEXT – Go to the next screen in the menus (Device Info 3)
VOLTAGE control – no function	
CURRENT control – no function	

Table 14. Device Info 2 screen softkey control functions and indications

6.12. Device Info 3 Screen

The device info 3 screen shows the current port and MAC address of the Ethernet interface, see Figure 16 below.
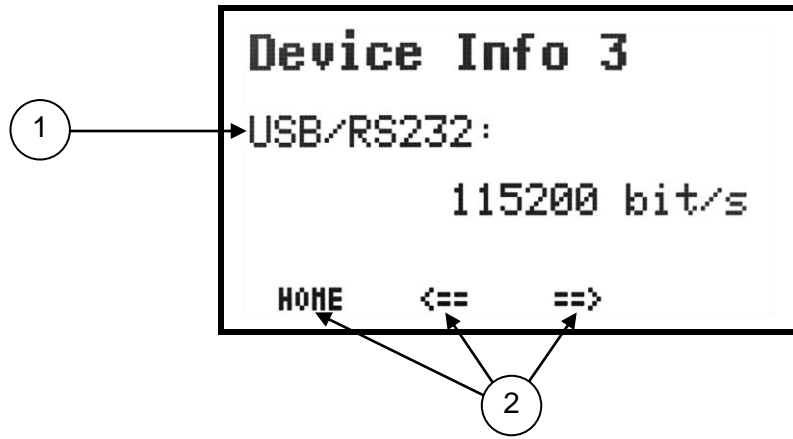
Figure 16. Device Info 3 Screen

1	USB/RS232 Baud Rate
2	Shows softkey function(s)
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (Device Info 3)
	3 - NEXT – Go to the next screen in the menus (Status Monitor 1)
VOLTAGE control – no function	
CURRENT control – no function	

Table 15. Device Info 3 screen softkey control functions and indications

6.13. Device Info 4 Screen

The device info 4 screen shows the Unit Voltage and Current Rating, see Figure 17 below.
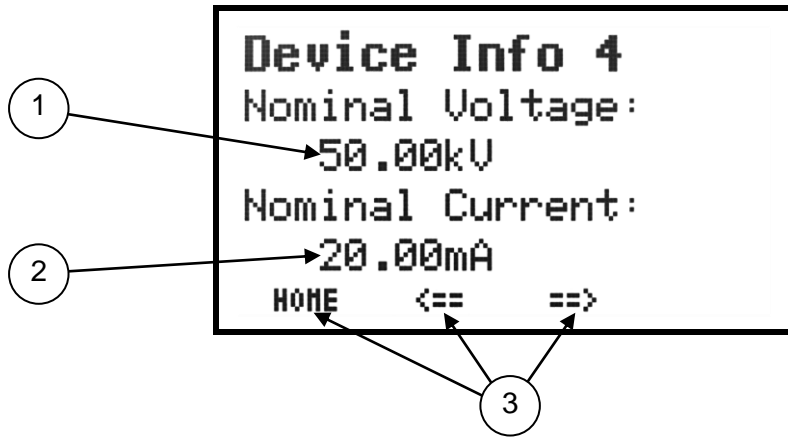
Figure 17. Device Info 4 Screen

1	Rated voltage of the unit (if the polarity is negative, a '-' symbol is also shown)
2	Rated current of the unit
3	Firmware Revision
	1 – HOME – Switch to Main Display Screen (see 6.3)
	2 - PREVIOUS – Go to the previous screen in the menus (Device Info 1)
	3 - NEXT – Go to the next screen in the menus (Device Info 3)
VOLTAGE control – no function	
CURRENT control – no function	

Table 16. Device Info 4 screen softkey control functions and indications

7. Normal Operation

7.1.   LOCAL Mode

In LOCAL mode, the FLX-HV power supply is controlled from the front panel. Setting the outputs and turning the HV output ON/OFF is only possible using the front panel encoders and the HV ON/OFF push button. Data and settings can still be read via the USB/LAN interfaces.

> ⚠️ **WARNING**
>
> Improper handling of the FLX-HV power supply may cause electrical accidents.

The FLX-HV front panel is shown in Figure 18 below.
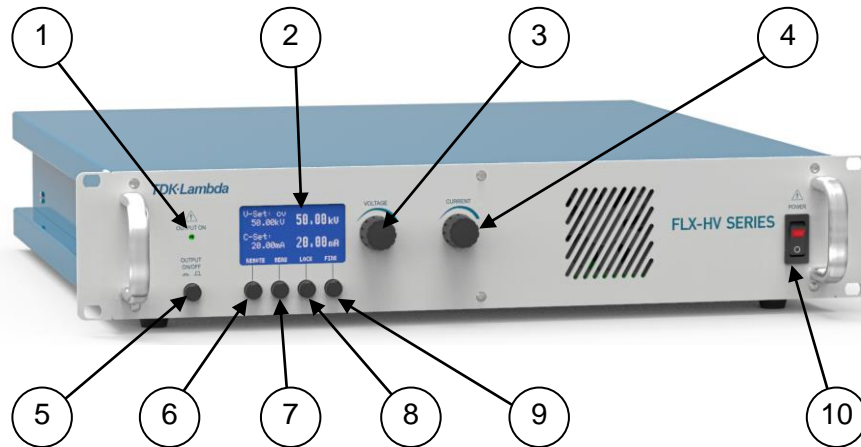
Figure 18. FLX-HV Front Panel

1	HV ON LED (Illuminates when HV output is ON in LOCAL or remote mode)
2	Multi Function Display (see section 6)
3	Output Voltage Encoder
4	Output Current Encoder
5	HV ON/OFF Push Button
6	Softkey 1
7	Softkey 2
8	Softkey 3

9	Softkey 4
10	AC Power Switch

Follow these steps to operate the FLX-HX power supply in LOCAL mode.

1. Follow all steps in Section 5, and then and Turn on the AC power switch (item 10).

♦ The power supply is now connected to AC power and turns ON.

2. Ensure the unit is in LOCAL mode (see Section 6.3)

3. Set the desired output Voltage and Current with the Encoders (items 3/4).

4. Push the HV ON/OFF button (item 5)

♦ HV ON LED Illuminates

✓ The FLX-HV power supply is now ready for operation.

7.2. Powering UP the FLX-HV Supply

> **NOTE**
>
> The operating mode (i.e. LOCAL or REMOTE) is retained from the last time the unit was powered down.

FLX-HV power supply was in LOCAL mode before last power down:

♦ After switching the AC power ON, the HV output is not turned ON even if the HV OUTPUT push-button is in the ON position. The display shows a prompt to turn the OUTPUT switch OFF (see Figure 19).

```
OUTPUT ON/OFF
HV Output is disabled
but OUTPUT switch is
ON. Please turn off
the OUTPUT switch.
```
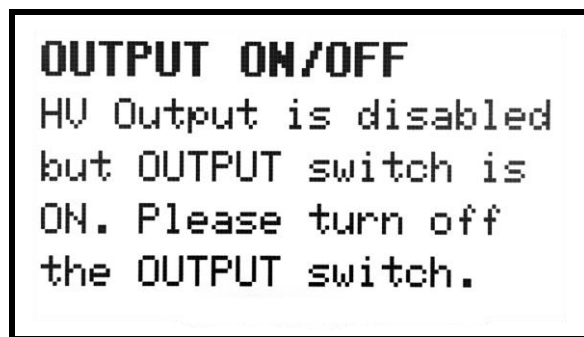
Figure 19. Display prompting user to turn HV Output OFF

♦ The last defined voltage and current setpoints are retained.

FLX-HV power supply was in REMOTE mode before last power down:

♦ After switching the AC power ON, the HV output is not turned ON, even if the HV OUTPUT push-button is in the ON position.
♦ Only a remote interface command can turn on the output.
♦ The last defined voltage and current setpoints are NOT retained, and the outputs are set to ZERO.

7.3. Change Operating Modes between LOCAL / REMOTE

The user can only select the operating mode using the "LOCAL / REMOTE" softkey on the front panel.

7.4. Switching from LOCAL to REMOTE with HV ON

With the unit in LOCAL mode, output current and voltages set, and HV output is ON. When the User pushes the REMOTE softkey, the unit switches to REMOTE mode, the voltage and current setpoints are transferred from the LOCAL settings, and the HV output remains ON.

7.5. Switching from LOCAL to REMOTE with HV OFF

With the unit in LOCAL mode, output current and voltages set, and HV output is OFF. When the User pushes the REMOTE softkey, the unit switches to REMOTE mode, the voltage and current setpoints are transferred from the LOCAL settings, and the HV output remains OFF.

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8. Operation via Digital Interface (REMOTE)

The FLX-HV power supply family features standard USB and LAN interfaces for REMOTE control operation. The interface connectors are located on the rear panel of the unit, see Figure 5.

8.1. USB REMOTE Control Interface Connection

The USB connector on the rear panel of the FLX-HV power supply is a USB type B socket.

The USB connection is electrically isolated. Power for the USB receiver is provided by the USB transmitter or control PC. The maximum potential difference between the power supply and receiver is limited to 60V.

When the user connects the FLX-HV supply to a control computer, the USB drivers should be automatically installed. USB drivers can be manually installed/downloaded at the following location:

http://www.ftdichip.com/Drivers/D2XX.htm

8.1.1. USB port connection

The following data is required in order to establish a connection to the FLX-HV supply via the USB interface:

♦ USB port name (Default FT232R USB UART)

8.1.2. Virtual COM port connection

The following data is required to establish a connection to the laboratory power supply via virtual COM-Port:

♦ COM-Port number (e.g. COM4)
♦ Baud rate: 115200 Baud (cannot be modified)
♦ Data bits: 8
♦ No parity
♦ Stop bits: 1
♦ No flow control

8.2. Ethernet, LAN, TCP/IP connection

No additional drivers are required to establish a connection to the power supply via Ethernet.

♦ A patch cable or crossover cable can be used, the interface supports Auto-MDIX.
♦ Interface supports TCP/IP v4.
♦ Transmission rate 10/100 Mb/s, full duplex.
♦ Ethernet settings can be changed using the multi-function display or the interfaces. Changing Ethernet settings via Ethernet aborts the connection which, after having received the new command, will re-establish with new settings, see Section 6.9 Ethernet Settings.
♦ Simultaneous communication with 5 sockets is possible via Ethernet. All sockets are equal.
♦ The Ethernet interface is electrically isolated.
♦ The interface only supports static IP, DHCP is not supported.

The following data is required to establish a connection to the FLX-HV power supply via the Ethernet interface:

♦ Current IP address of the power supply. Note that the IP address of the power supply is shown in the multi-function display, see Section 6.9 Ethernet Settings. The first two bytes of the unit's IP address must match the first two bytes of the control PC's IP address.
♦ Port number: 2101
♦ Subnet mask

8.2.1. RJ 45 Connector LEDs

Status indicator LEDs are incorporated in the RJ45 socket:

♦ The green LED shows the link status. When the LED is illuminated, the connection is 'OK'.
♦ A flashing yellow LED indicates data traffic.

In REMOTE mode the FLX-HV power supply can be controlled via its REMOTE interfaces. All interfaces or Ethernet sockets, have the same communication priority.

The user can access the power supply via every connected interface simultaneously. Using the LAN interface the user can access the power supply over 5 sockets, even from different PCs.

The display still shows the current unit data. 'Interface' allows you to read out the operating mode, but does not allow the mode to be changed for safety reasons.

8.3. Switching from REMOTE mode to LOCAL mode:

8.3.1. Switching from REMOTE to LOCAL with HV Push Button ON

FLX-HV supply is in REMOTE mode with HV Output ON. User switches to LOCAL mode with HV Output push button in the ON position. The HV Output remains ON with the voltage and current setpoints passed from the REMOTE mode operating condition.

FLX-HV supply is in REMOTE mode with HV Output OFF. User switches to LOCAL mode with HV Output push button in the ON position. The HV Output remains OFF with the voltage and current setpoints passed from the REMOTE mode operating condition, and the Multi-function display shows a message indicating the HV Output button is in the ON position and should be turned OFF.

8.3.2. Switching from REMOTE to LOCAL with HV Push Button OFF

FLX-HV supply is in REMOTE mode with HV Output ON. User switches to LOCAL mode with HV Output push button in the OFF position. The HV Output turns OFF with the voltage and current setpoints passed from the REMOTE mode operating condition.

FLX-HV supply is in REMOTE mode with HV Output OFF. User switches to LOCAL mode with HV Output push button in the OFF position. The HV Output remains OFF with the voltage and current setpoints passed from the REMOTE mode operating condition.

If the user turns the HV Output switch OFF when the unit is in REMOTE mode the output will not be deactivated. In REMOTE mode the FLX-HV power supply HV Output can only be controlled via the REMOTE interface.

9. Command Set

LOCAL/REMOTE mode can only be changed with the 'LOCAL/REMOTE' softkey on the display in the Home screen (see Section 6.3).

The user can access all commands shown in Section 9.1 Command Overview and Permissions when the unit is in REMOTE.

Binary codes can be transmitted together with ASCII codes.

Start flag, command name, and, if required, checksums and end flag are ASCII characters. Parsing the individual commands works like using ASCII commands.

- ♦ All commands and queries must be terminated with <CR><LF>.
- ♦ The supply responds to every command and query.
- ♦ 'Empty' command strings, i.e. strings that only consist of terminator characters, are rejected and result in no response.
- ♦ All data and 'handshake strings' read back from the power supply end with the <CR><LF> terminator.
- ♦ There are no receive timeouts.
- ♦ String length: individual strings can contain a maximum of 70 characters.
- ♦ Receive buffer: the interface features a receive buffer of 500 bytes.
- ♦ Checksum: critical applications can be verified by checksum, see Section 9.4 Checksum-secured Data Transmission and the description of the >CCS registers in Section 9.3.1 Configuration Values.
- ♦ Block queries: Several commands can be sent as a data package. The data package cannot be exceed the receive buffer size. The power supply processes 1 data package command per millisecond.
- ♦ Programming commands for voltage/current must not include polarity
- ♦ Voltage/current readback commands (M0,M1) do include polarity indication if the unit polarity is negative
- ♦ Write only (WR) commands are only valid in REMOTE mode.

NOTE

The programming commands are not case sensitive.

The command string prefix (>) and terminators are omitted in the following descriptions for clarity.

9.1. Command Overview and Permissions

The following permissions apply to the programming command set:

- ♦ RW - read & write
- ♦ WR - write only
- ♦ RD - read only
- ♦ NO - no access
- ♦ RWK - read & write in calibration mode

Note zero's in commands/queries are represented by 0, the letter O by 0.

A full list of commands and read/write permissions are shown in Table 17 through Table 19.

Command	Description	Permission
HIN0	Hex input data package	WR
HOUT1	Hex output data package	RD
STAT	Status bit query	RD
BON	Turn power supply HV Output ON/OFF	RW
S0	Program output voltage	RW
S1	Program output current	RW
M0	Monitor output voltage	RD
M1	Monitor output current	RD
M0R	Monitor output voltage, uncalibrated raw value	RD
M1R	Monitor output current, uncalibrated raw value	RD
DVR	CV, power supply is in constant voltage mode	RD
DIR	CC, power supply is in constant current mode	RD
DMAINS	AC input voltage error: input voltage is not within a specific voltage range	RD
DNOT1	Excessive internal power supply temperature	RD
DNOT2	Excessive inverter heat sink temperature	RD
DNOT3	Excessive PFC heatsink temperature	RD
DPFC	PFC output voltage is out of the normal range	RD
DS15	+/-15V bias supply voltages are out of normal range	RD
DHWR	HV output status ('1' = OUTPUT ON)	RD
DSD3	3.3V display bias supply status	RD

Table 17. List of Programming Commands and Query's

Command	Description	Permission
ARC	Arc counter / flashover counter (resettable)	RW
ARCALL	Non resettable Arc counter / flashover counter	R
TIME	Operational time counter	RD
HIS	View device history	RD
MAC	View MAC address	RD
IP	View / set IP address	RW
MASK	View / set IP mask	RW
ERCO	Confirm error	WR
CHAN	View communication channel number	RD
CALI	Activate configuration mode	RW
AUT1	Turn automated input 1 on / off	RW
AUT2	Turn automated input 2 on / off	RW
RESF	Reset to factory presets	WR
RES	Reset, restart power supply	WR
CLIST	View all configuration settings	RW
CFV	View firmware version	RD
CFN	Serial number string	RD
CFNNUM	Numerical serial number	RD
CCS	Checksum activation	RWK
CIP	IP address	RWK
CMASK	IP mask	RWK
CDFIN	Set encoders to fine mode	RWK
CDLOC	LOCAL / REMOTE mode setting	RWK
CILOCK	Lock output voltage/current encoders	RWK
CIVS	Encoder voltage step size	RWK
CIVSF	Encoder voltage step size - fine	RWK
CICS	Encoder current step size	RWK
CICSF	Encoder current step size - fine	RWK
CDSV	Set voltage after power up	RWK
CDSC	Set current after power up	RWK

Table 18. List of Programming Commands and Query's

Command	Description	Permission
CDIM	Display brightness adjustment	RWK
CS0T	Vprogram rated value	RWK
CS0GP	Vprogram gain positive	RWK
CS0GN	Vprogram gain negative	RWK
CS0OP	Vprogram offset positive	RWK
CS0ON	Vprogram offset negative	RWK
CS1T	Iprogram rated value	RWK
CS1GP	Iprogram gain positive	RWK
CS1GN	Iprogram gain negative	RWK
CS1OP	Iprogram offset positive	RWK
CS1ON	Iprogram offset negative	RWK
CM0T	Monitor voltage rated value	RWK
CM0GP	Monitor voltage gain positive	RWK
CM0GN	Monitor voltage gain negative	RWK
CM0O	Monitor voltage Offset	RWK
CM1T	Monitor current rated value	RWK
CM1GP	Monitor current gain positive	RWK
CM1GN	Monitor current gain negative	RWK
CM1O	Monitor current offset	RWK

Table 19. List of Programming Commands and Query's

NOTE

Default configuration and calibration data can be viewed and loaded only, but they cannot be modified.

All custom settings are lost if the unit is reset to factory defaults.

Read and save the power supply using the ">CLIST" query before resetting the unit.

The user can reset configuration and calibration data to factory presets using the ">RESF SETTOFACTORYDEFAULT" command when the FLX-HV is in REMOTE mode. Note that this command argument must be in uppercase.

9.2. Command Format

FLX-HV series power supplies use the following REMOTE programming command format:

"*>name x*"

Where: *name* is the Name of the command, e.g. "s0" for program voltage setpoint.
Note: The commands are not case sensitive

     x   is the Argument, usually a number, that is written to the register.

For a query, *x* can be replaced with a *?* e.g. *>s0 ?*

NOTE

There has to be at least one blank space between the command and argument.

Example: Program the output current.

- ">S1 13.5e-3" programs the output current to 13.5mA.
- The FLX-HV power supply's response is: ">S1:1.350000E-2"
- If there is an error, the power supply's response is: ">S1:E5 [OUT OF RANGE]"
- Refer to the error codes in Section 9.5 Checking received data for errors for further details.

Query commands

FLX-HV series power supplies use the following REMOTE programming query format:

">name ?"

The power supply's response is:

">name: x"

Where: *name* is the Name of the query, e.g. 'S0' for program voltage setpoint.

     x is the query data, e.g. integer or floating number or ASCII string.

Example 1: Query the output voltage setpoint

- ">S0 ?" query the output voltage setpoint.
- FLX-HV power supply responds with: ">S0:2.334000e+03" (for example)

Example 2:

- ">M0 ?" query the actual output voltage.
- FLX-HV power supply responds with: ">M0:2.334000E+03"

Example 3:

- ">RES ?" Resets FLX-HV power supply.
- FLX-HV power supply responds with: ">RES:E14 [WRITE ONLY]"

Please refer to the error codes in Section 9.5 Checking received data for errors for further details.

9.2.1. Output Voltage Control

The programmed output voltage must not be higher than the rated voltage which is stored in CS0T. Program voltages are always sent without the polarity sign.

Command/ Query	Read/ Write	Function	Valid Argument (x)	Value after RESET
>S0	RW	Program or query the output voltage setpoint	Floating number	0
			?	

Example: Program the output voltage to 27,334 volts.

- ♦ ">S0 27.334e3" programs output voltage to 27334.
- ♦ FLX-HV power supply responds with: ">S0:2.733400E+4"

9.2.2. Output Current Control

The programmed output current must not be higher than the rated current which is stored in CS1T. Program voltages are always sent without the polarity sign.

Command/ Query	Read/ Write	Function	Valid Argument (x)	Value after RESET
>S1	RW	Program or query the output current setpoint	Floating number	0
			?	

Example: Query the output current programmed value

- ♦ ">S1 ?" Query's output current setpoint.
- ♦ FLX-HV power supply responds with: ">S1:2.733400E-2"

9.2.3. HV ON/OFF

Turns HV output ON and OFF via the remote interface.

Command/ Query	Read/ Write	Function	Valid Argument (x)	Value after RESET
>BON	RW	Turns ON or OFF the high voltage	0 (HV OFF)	0
			1 (HV ON)	
			?	

Example 1: Turn the HV output ON

- ♦ ">BON 1" turns ON the HV output.
- ♦ FLX-HV power supply responds with: ">BON:1"

Example 2: Turn the HV output OFF

- ♦ ">BON 0" turns OFF the HV output.
- ♦ FLX-HV power supply responds with: ">BON:0"

Example 3: Query the HV output status

♦ ">B0N ?" queries the HV output status.
♦ FLX-HV power supply responds with: ">BON:1 or >BON:0"

9.2.4. Measure Output Voltage

The output voltage and current are continually monitored in the background.

Command/ Query	Read/ Write	Function	Valid Argument (x)
>M0	RD	Read the actual output voltage	?
>M0R	RD	Read the raw (uncalibrated) output voltage	?
>M1	RD	Read the actual output current	?
>M1R	RD	Read the raw (uncalibrated) output current	?

Example: Query the actual HV output voltage

♦ ">M0 ?" queries the actual measured output voltage.
♦ FLX-HV power supply responds with: ">M0:5.001188E+04"

Example: Query the actual HV output current

♦ ">M1 ?" queries the actual measured output current.
♦ FLX-HV power supply responds with: ">M1:5.001188E-04"

9.2.5. Status Registers

These Registers are read only, and provide operating status of the FLX power supply.

Name	Read / Write	Function	Valid Argument (x)
>DVR	RD	Query CV mode status ('1' in CV mode)	?
>DIR	RD	Query CV mode status ('1' in CC mode)	?
>DMAINS	RD	AC input voltage status ('1' = OK, in range)	?
>DFAN	RD	Cooling Fan status ('1' = OK)	?
>DNOT1	RD	Internal temperature status ('1'=OK)	?
>DNOT2	RD	Inverter heatsink temperature status ('1' = OK)	?
>DNOT3	RD	PFC heatsink temperature status ('1' = OK)	?
>DPFC	RD	PFC output voltage status ('1' = OK)	?
>DS15	RD	+/-15 V supply voltages status ('1' = OK)	?

>DHWR	RD	HV Output Status ('1' = OUTPUT ON)	?
>DSD3	RD	3.3 V display PS Status ('1' = OK)	?
>DLOC	RD	REMOTE/LOCAL Status ('1' = LOCAL)	?

Example: Query the actual CV status

- ">DVR ?" queries the CV mode status.
- FLX-HV power supply responds with: ">DVR:1", indicating the unit is operating in constant voltage mode

9.2.6. Ethernet Interface Commands

The settings are taken over immediately after having been received and saved. If the commands were sent via Ethernet interface the connection is aborted. You can access laboratory power supply instantly with the new parameters.

Name	Read / Write	Function	Valid Argument (x)
>MAC	RD	Read the power supply's MAC address	?
>IP	RW	Read / set IP address. Setting is effective immediately and the connection is aborted (if FLX supply is connected)	? 0..255 0..255 0..255 0..255
>MASK	RW	Read / set IP mask. Setting is effective immediately and the connection is aborted (if FLX supply is connected)	? 0..255 0..255 0..255 0..255

Example 1: Read the MAC address

- ">MAC ?" Read MAC address.
- FLX-HV power supply responds with: ">MAC:AA BB CC DD FF 01"

Example 2: Program/set the IP address

- ">IP 192 168 0 200" programs IP address.
- FLX-HV power supply responds with: ">IP:192 168 0 200"

9.2.7. Reset Commands

> **NOTE**
>
> All custom settings are lost if the user resets the FLX-HV supply to factory presets (factory default).
>
> Read and save the FLX-HV power supply settings with ">CLIST ?" before resetting the unit.

Name	Read / Write	Function	Valid Argument (x)
>RESF	WR	Reset all configuration data to factory presets. Restart the FLX-HV power supply.	SETTOFACTORYDEFAULT (uppercase only)
>RES	WR	Restart microcontroller	No argument required. FLX response: RESET UNIT

Example 1: Reset the FLX HV microcontroller (unit must be in REMOTE mode)

♦ ">RES" Restarts microcontroller.
♦ FLX-HV power supply responds with: ">RES: RESET UNIT"

9.2.8. History Commands

Name	Read / Write	Function	Valid Argument (x)
>HIS	RD	Read history memory	?

Example 1: Read the FLX-HV history

♦ ">HIS ?" Reads the history memory.
♦ FLX-HV power supply example responses:

">HIS: 15h 2194003ms IP ADDRESS RESET TO DEFAULT"

">HIS: 15h 2194003ms HOST NAME RESET TO DEFAULT"

">HIS: 129h 2899410ms TCP ERROR 4"

♦ Details regarding reported error codes can be found in Section 9.5 Checking received data for errors for further details, and Section 10 Error Messages and Warning Signals.

9.2.9. Other Commands

Name	Read / Write	Function	Valid Argument (x)
>TIME	RD	Read operating hours counter in hours and seconds.	?

>STAT	WR	Read FLX-HV status bits Description starting with left bit: 1 – supply in CV mode 2 – supply in CC mode 3 – Inverter (PWM) active '1' 4 – 15V bias supply OK '1' 5 – PFC circuit OK '1' 6 – AC input OK '1' 7 – Internal temperature OK '1' 8 – Inverter heatsink temperature OK '1' 9 – PFC heatsink temperature OK '1' 10 – Reserved (default is '1')	? Example response: 1 0 0 0 0 0 0 0 0 0 (1 2 3 4 5 6 7 8 9 10)
>ERC0	WR	Command to confirm errors. All errors must be confirmed. After any error the output can only be activated when all errors are removed.	None
>CHAN	RD	View current communication channel, e.g. COM number of microcontroller	?
>CALI	RW	Activate calibration mode	0
			1
			?
>ARC	RW	Resettable Arc Counter, 0 resets count, ? reads count	0
			?
>ARCALL	R	Non-resettable Arc Counter	?

Example 1: Read the FLX-HV operating hours counter

♦ ">TIME ?" Reads operating hours counter.
♦ FLX-HV power supply example response: ">TIME: 22 h / 2456 sec"

Example 2: Read the FLX-HV resettable ARC count

♦ ">ARC ?" Reads ARC counter.
♦ FLX-HV power supply responds: ">ARC:4"

The ARC counter can be reset to 0 using the command ">ARC 0".

9.2.10. Automated output commands

Name	Read / Write	Function	Valid Argument (x)
>AUT1	RW	Automated output 1 (BINARY): Turn on / off measurement data output to analysis software.	1…4,200,000 ms till next data output 0 STOP ? single query
>AUT2	RW	Automated output 2 (ASCII): Turn on / off measurement data output to analysis software.	1…4,200,000 ms till next data output 0 STOP ? single query

Example 1: Set the binary output every 100ms

- ♦ ">AUT1 100" Starts binary data output in 100 ms intervals.
- ♦ FLX-HV power supply response: ">AUT1 ………"

The data format is shown in the following:
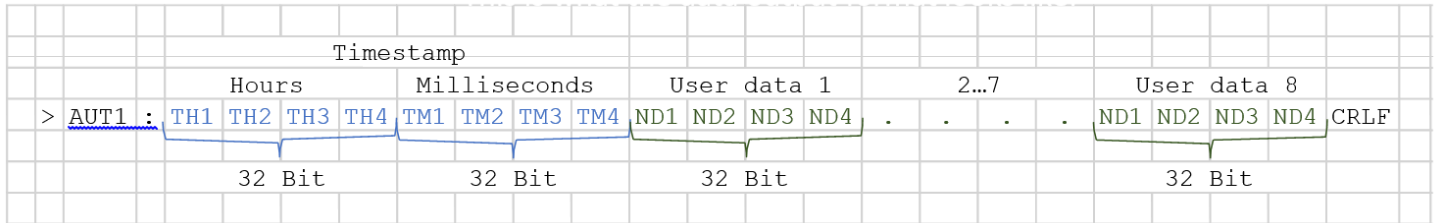
Data output is in binary format. Time stamp is based on the operating hours counter so that events occurring in the FLX-HV power supply can be linked to the 'operating hours'.

Two 32bit fields are provided for the time stamp: hours and milliseconds.

It is possible to retrieve up to 8 measured values with each device response. To do so, 8 user data fields of 32 bits are available.

For the FLX-HV series:

- ♦ User data 1 – output voltage
- ♦ User data 2 - output current
- ♦ remaining user data are 0
- ♦ Hours and milliseconds format is 'unsigned integer'.
- ♦ User data format is 'floating'.

Example 2: Set the ACII output every 100ms

- ♦ ">AUT2 100" Starts ASCII data output in 100 ms intervals.
- ♦ FLX-HV power supply response: ">AUT2 ………"

The data format is shown below:

	Hours				Milliseconds							Monitor0			Monitor1			Status bits			
> AUT2 :	TH1	TH2	TH3 ;	TM1	TM2	TM3	TM4	TM5	TM6	TM7 ;	M1	M2…M10	M11 ;	M1	M2…M10	M11 ;	STB1 ;	…	STB11 ;	CRLF
	3 digits minimum					7 digits							12 digits			12 digits					

Data output is in ASCII format. Time stamp is based on the operating hours counter so that events occurring in the FLX-HV power supply can be linked to the 'operating hours'.

Two fields are provided for the time stamp: hours and milliseconds. The hours require 3 digits and the milliseconds 7 digits.

Output voltage and current format is exponential (12 digits, e.g. `3.500001E-02`).

Status bits either are '0' or '1' (one character!), the sequence is as follows:

`DVR; DIR; DMAINS; DNOT1; DNOT2; DNOT3; DPFC; DS15; DHWR; DSD3;`

> **NOTE**
>
> The ASCII format output data can be used for data analysis in EXCEL. The data fields are separated with a semicolon which allows the data to be saved in a *.csv file for easy import into EXCEL.

9.2.11. Device Setting Query

The following commands can be used to retrieve the device data for the C-commands.

Name	Read / Write	Function	Valid Argument (x)
>CLIST	WR	Reset C-command output query and output of column headlines	no argument
	RD	As the CLIST command is repeatedly sent, the supply responds with the content of the next register. (can be saved in file to document and copy configuration constants)	?

Example 1: Reading configuration data contents (C-commands):

♦ ">CLIST" Sets the list indicator to the first CLIST item (firmware revision).
♦ FLX-HV power supply responds with: "Name: Content". Then all registers can be read in sequence by repeatedly sending the ">CLIST ?" query.
♦ The first response is ">CFV:ARM 010 V0.55"

The CLIST query can be repeatedly sent until the FLX-HV responds with: ">CLIST: END LIST>*". All configuration registers have then been read.

9.2.12. Binary Commands

H-commands (`HIN0` and `HOUT1`) are specifically designed to offer a swift, cyclical device communication.

Both voltage/current setpoints as well as unit status can be read simultaneously with one command string. The FLX-HV power supply responds with an output string in which both monitor values as well as all digital conditions are combined.

The command set offers binary command or user data, respectively. Only the command identifier is transmitted as ASCII code. There is no need for sender or receiver to convert data to ASCII or vice versa.

> **NOTE**
>
> (!) Binary data packages should be sent with checksum verification.

The `HIN0` command can be used to send data to the FLX-HV power supply. Command format is shown in the following table.

Byte	Position	Description
0	LSB	Voltage programming, floating number, Sets >S0
1	MSB	
2	LSB	
3	MSB	
4	LSB	Current programming, floating number, Sets >S1
5	MSB	
6	LSB	
7	MSB	
8	Bit 0	FLX-HV output ON, Sets >BON
	Bit 1	
	Bit 2	
	Bit 3	
	Bit 4	
	Bit 5	
	Bit 6	
	Bit 7	
9	Bit 0	
	Bit 1	
	Bit 2	
	Bit 3	

	Bit 4	
	Bit 5	
	Bit 6	
	Bit 7	
10	Bit 0	
	Bit 1	
	Bit 2	
	Bit 3	
	Bit 4	
	Bit 5	
	Bit 6	
	Bit 7	
11	Bit 0	
	Bit 1	
	Bit 2	
	Bit 3	
	Bit 4	
	Bit 5	
	Bit 6	
	Bit 7	
12	LSB	
13	MSB	
14	LSB	
15	MSB	

The `HOUT1` command can be used to read data from the FLX-HV power supply. Command format is shown in the following table.

Byte	Position	Description
0	LSB	Reads Output Voltage, floating number, `>M0`
1	MSB	
2	LSB	
3	MSB	
4	LSB	Reads Output Current, floating number, `>M1`
5	MSB	
6	LSB	
7	MSB	
8	Bit 0	Status: AC input out of range
	Bit 1	Status: Internal over temperature
	Bit 2	Status: Inverter heatsink over temperature
	Bit 3	Status: PFC heatsink over temperature

		Bit 4	Status: PFC output voltage out of range
		Bit 5	Status: +/-15V bias supply out of range
		Bit 6	Status: Unit in CC mode
		Bit 7	Status: Unit in CV mode
9		Bit 0	Status: HV output
		Bit 1	Status: 3.3V display power
		Bit 2	
		Bit 3	
		Bit 4	
		Bit 5	
		Bit 6	
		Bit 7	
10			
11			
12			
13			
14			
15			Indicates Error has occurred

NOTE

Points for binary data.
The Command string and checksum are transmitted in ASCII
format.

Example 1: (set binary values)

♦ ">HIN0 ...."

Example 2: (set binary values with checksum):

♦ ">HIN0 .... 043C"

Example 3: (read binary data):

♦ ">HOUT1 ?"
♦ FLX-HV power supply responds: ">HOUT1: ...."

Example 4: (read binary data, with checksum):

♦ ">HOUT1 ? 01FD"
♦ FLX-HV power supply responds: ">HOUT1: .... 5FD6"

9.3. Configuration Mode

> **NOTE**
>
> The contents of the configuration register can only be changed in configuration mode.
>
> Configuration data is write-protected in order to prevent any accidental modification.

Configuration data contains the calibration data for actual output and setpoints, the basic unit settings, encoder step size, ADC-DAC gain and offset etc.

All configuration commands start with letter 'C'.

It is possible for the user to change configuration data/settings, but changes should only be made after careful consideration.

> **NOTE**
>
> Before making and configuration changes, make a copy of the data to be changed into a text file as a precaution so that no settings are lost.

The user can read all C-commands sequentially by sending the ">CLIST ?" command repeatedly.

The unit can be reset to factory default settings using the ">RESF" command.

Sending the CALI command enables or disables configuration mode which then allows data to be changed.

The FLX-HV power supply must be restarted to set the following data:

- Ethernet settings: CIP and CMASK,
- Checksum-secured transmission settings: CCS.
- Enter ">CALI 1" command to enable configuration mode.
- Enter ">CALI 0" in order to disable configuration mode. Alternatively: Turn off the FLX-HV power supply.

9.3.1. Configuration Values

All configuration values are stored in a non-volatile memory. The user has read or write access to configuration values. If the user attempts to write into a configuration register when the configuration mode is not activated, the old value remains unaffected and an error message is returned.

The user can read all C-commands sequentially by sending the ">CLIST ?" command repeatedly.

The unit can be reset to factory default settings using the ">RESF SETTOFACTORYDEFAULT" command.

> **NOTE**
>
> Note that in configuration mode NO checksum is being used.
>
> To prevent accidental modification of the data, configuration values can only be changed in configuration mode.

9.3.2. Analog setpoints

The following table shows the possible configuration settings for analog programming.

Name	Read / Write	Function		Valid Argument (x)
>CS0T	RW	Vprogram	Rated value	Floating number
				?
>CS0GP	RW		Positive gain	Floating number
				?
>CS0GN	RW		Negative gain	Floating number
				?
>CS0OP	RW		Positive offset (in bits)	Integer
				?
>CS0ON	RW		Negative offset (in bits)	Integer
				?
>CS1T	RW	Iprogram	Rated value	Floating number
				?
>CS1GP	RW		Positive gain	Floating number
				?
>CS1GN	RW		Negative gain	Floating number
				?
>CS1OP	RW		Positive offset (in bits)	Integer
				?
>CS1ON	RW		Negative offset (in bits)	Integer
				?

9.3.3. Analog readbacks

The following table shows the possible configuration settings for analog readbacks.

Name	Read / Write	Function			Valid Argument (x)
>CM0T	RW	Vmonitor		Rated value	Floating number
					?
>CM0GP	RW			Positive gain	Floating number
					?
>CM0GN	RW			Negative gain	Floating number
					?
>CM0O	RW			Offset (in bits)	Integer
					?
>CM1T	RW	Imonitor		Rated value	Floating number
					?
>CM1GP	RW			Positive gain	Floating number
					?
>CM1GN	RW			Negative gain	Floating number
					?
>CM1O	RW			Offset (in bits)	Integer
					?

9.3.4. General configuration values

The following table shows the possible general configuration settings.

Name	Read / Write	Function	Valid Argument (x)
>CFN	RW	Serial number	String with max. 50 characters
			?
>CFNNUM	RW	Numerical factory number	0...2147483647
>CFV	RD	Firmware revision	?
>CCS	RW	Type of checksum for command and response strings	0: no checksum
			1: 2 Byte Hex checksum

>CDIM	RW	Read/program the display for maximum and minimum brightness (LOCAL).	
		Arg 1: max. Brightness in %	`0..100`
		Arg 2: min. Brightness in %	`0..100`
		Arg 3: Waiting time in s until display dims.	`0..65535`
		Settings are active only after a reset or restart	

Example 1: Configure display dimming functions

♦ "`>CDIM 100 50 1800`" sets the maximum brightness to 100%, the minimum brightness to 50% and the waiting time to 1800s.

9.3.5. Ethernet interface Configuration Settings

Name	Read / Write	Function	Valid Argument (x)
>CIP	RW	Read / set IP address after delivery	?
		Settings are activated following reset or restart	`0..255`
			`0..255`
			`0..255`
			`0..255`
>CMASK	RW	Read / set IP mask	?
		Settings are activated following reset or restart	`0..255`
			`0..255`
			`0..255`
			`0..255`

Modified Ethernet settings are activated following a power supply restart!

9.3.6. Voltage/current setpoint configuration values and encoders

Name	Read / Write	Function	Valid Argument (x)
>CDSV	RW	Display voltage setpoint after power up	Floating number, ?
>CDSC	RW	Display current setpoint after power up	Floating number, ?

>CIVS	RW	Voltage encoder step size in coarse mode	Floating number, ?
>CIVSF	RW	Voltage encoder step size in fine mode	Floating number, ?
>CICS	RW	Current encoder step size in coarse mode	Floating number, ?
>CICSF	RW	Current encoder step size in fine mode	Floating number, ?

Example 1: Set rated voltage

♦ ">CS0T 10000" Set rated voltage to 10,000 V.
♦ If the FLX-HV power supply is in configuration mode the content of the CS0T register is written, and after several milliseconds the unit responds with: ">CS0T: 10000"
♦ If the unit is not in configuration mode, write protection is activated and the value is rejected and resulting in an "E8" response: ">CS0T: E8 [FRAM WRITE PROTECTED]"

Example 2: Read the rated voltage

♦ ">CS0T ?" Query the rated voltage.
♦ FLX-HV power supply responds with: ">CS0T: +1.00000e+04".

9.4. Checksum-secured Data Transmission

Critical applications can be verified by a checksum in the data transmission.

> **NOTE**
>
> Please note that in configuration mode NO checksum is being used.

9.4.1. Checksum

Set the >CCS register to "1" to activate checksum-secured data transmission.

The user can either secure ASCII or binary commands with the help of checksums. The checksum is attached to the transferred data as a 4-digit hexadecimal number.

NOTE

Corrupted data packages are rejected, and an error message is returned to sender.

Checksum calculation:

First, a blank space is attached to the command string without terminator in order to separate the checksum that follows.

All ASCII codes of the characters of the basic command string, including the blank space, are summed. The calculation is a 16 bit unsigned addition.

The checksum is then attached to the command string as a 4-digit hexadecimal number.

Then command string is completed with one or more terminator signs (<CR>, <LF>).

All response strings are complimented with a checksum in the same manner.

Example 1: Set the output voltage to 15.3 V:

♦ The original command string: ">S0 15.3" plus attached space: ">S0 15.3 "
♦ Addition of ASCII codes (Hex form):
♦ 3E+53+30+20+31+35+2E+33+20 = 01C8.
♦ The hexadecimal number is attached to the string:
♦ Command string with checksum: ">S0 15.3 01C8"
♦ The following terminator sign is not part of the checksum.
♦ The FLX-HV power supply responds with: ">S0: 15.3 01C8"

Example 2:

♦ The checksum is activated (>CCS register shows '1') and the user wants to deactivate it. To do so, the >CCS register has to be set to ,1' while the configuration mode is unlocked:
♦ Original command string: ">CCS 0" plus attached space: ">CCS 0 "
♦ Addition of ASCII codes (Hex form): 3E+43+43+53+20+30+20 = 0187
♦ Now, the hexadecimal number is attached to the string:
♦ Command string with checksum: ">CCS 0 0187"

The following terminator sign is not part of the checksum.

9.4.2. Reset Checksum Settings

NOTE

Once the FLX-HV power supply is configured for 'checksum' data transmission, only a checksum-secured data transmission can restore the unit to non-checksum data transmission.

Example:

♦ Set configuration mode: ">CALI 1 01C8"
♦ Deactivate checksum: ">CCS 0 0187"

9.5. Checking received data for errors

Data sent to the FLX-HV supply is verified with respect to thresholds and reasonable data content, with any detected errors being reported to the user.

All ASCII commands produce a response with the data interpreted by FLX-HV power supply. Data is converted to ASCII and returned as a response. This gives the user the opportunity to verify the data interpreted by the power supply.

Errors are shown in the following table.

Code	Text	Description	Probable cause
E0	NO ERROR	no error	
E2	UNKNOWN COMMAND	unknown command	Command is unknown (possibly a typing error).
E4	INVALID ARG	invalid argument	The command argument is not valid.
E5	OUT OF RANGE	Range exceeded	e.g. defined setpoint higher than the units rated voltage
E6	READ ONLY	Read-only register	Certain registers can only be read, writing is not possible, e.g. the voltage or current monitor
E7	RECEIVE OVERFLOW	Receive Overflow	Command string is longer than 50 characters.
E8	FRAM WRITE PROTECTED	Configuration value write-protected	User tried to write data into a configuration register, but the configuration mode is not activated.
E14	WRITE ONLY	Write-only register	Certain registers are write-only, and cannot be read.
E15	STRING TOO LONG	Argument of a command is too long	e.g. factory number string is too long
E16	CHECKSUM ERROR	Checksum is wrong	Faulty checksum received, see Section 9.4 Checksum
E17	ACCESS DENIED	No access	The access to the related command has been denied, insufficient user authorization.
E18	LOCAL MODE ERROR	No write-access via interface in LOCAL mode operation permissible	If the FLX-HV power supply is operating in LOCAL mode: there is no write-access allowed in LOCAL mode.

10. Error Messages and Warning Signals

The HV ON LED (Figure 4, item 2) indicates the status of the output of the Unit. The voltage and current setpoints are present at the HV output, if the LED is illuminated.

If an error occurs a message is displayed in LOCAL mode, then the user has to confirm with the appropriate softkey. The image below shows an example of an error confirmation display:

```
Error
Power Factor
Correction defect

Confirm Error ...
                          CONF
```
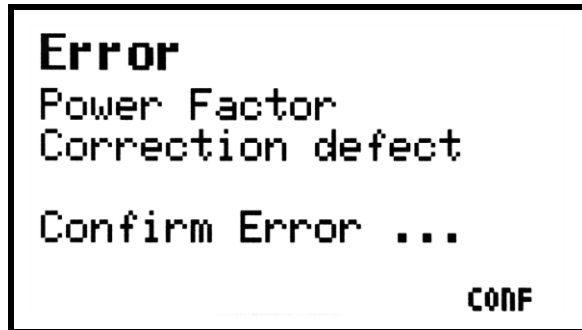
10.1. Failure

If the power supply detects a failure the following processes run automatically:

1. HV Output is turned OFF, and the PWM release signal is deactivated.

2. Output Setpoints are set to 'ZERO'.

3. The error is recorded in the error memory together with operating hours timestamp.

4. The Error message is shown on the display.

5. Error confirmation is required before any operations can proceed.

> **NOTE**
>
> ❗ All errors will be detected and reported.
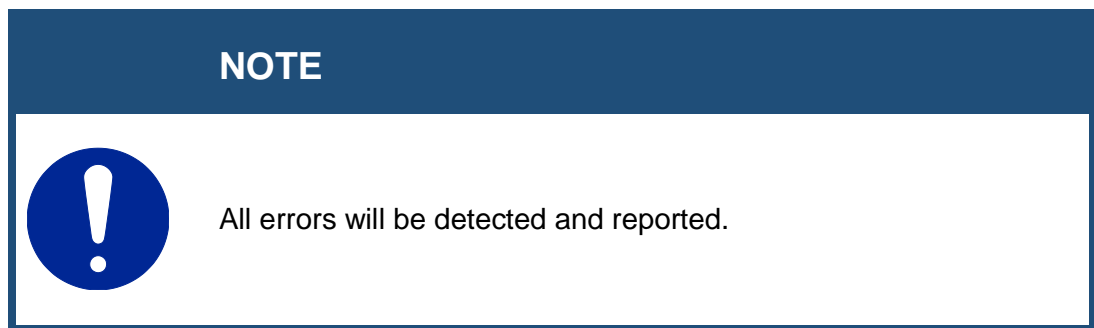
10.2. Error Shut-Down of the FLX-HV Supply

The FLX-HV power supply seizes various errors that force the unit to shut down. These errors are detected by internal sensing circuits. The error signals are recorded in hardware memory (error memory) until the user resets the hardware. If the error condition is continuous the hardware prevents any further restart of the power supply.

The internal microcontroller can only reset the hardware error memory, but it cannot bypass the error. This guarantees the safety of the unit even if the microcontroller module is defective.

10.3. Error Memory

Errors are recorded together with operating hours timestamp and stored in the error memory. After a maximum of 99 entries the oldest entry will be overwritten by the most recent.

♦ Error memory example format showing typical event when AC power is removed:

♦ `">HIS:  95h 3451194ms POWER FACTOR CORRECTION ERROR BY MAINS"`

In the event of a continuing error, it is only recorded once in the error memory.

The following errors may be recorded in the error memory:

Error memory entry	Description
`15V SUPPLY ERROR`	Internal +/-15V bias supply voltages are out of range
`POWER FACTOR CORRECTION ERROR`	PFC output voltage is not within a defined voltage range
`POWER FACTOR CORRECTION ERROR BY MAINS`	PFC error caused by AC line failure or removal
`OVERTEMPERATURE 1`	Excess internal temperature
`OVERTEMPERATURE 2`	Excess inverter heatsink temperature
`OVERTEMPERATURE 3`	Excess PFC heat sink temperature
`RTOS MUTEX ERROR`	Operating system error, Mutex error occurred
`TCP ERROR`	TCP error, e.g. receive / send buffer overrun, other TCP errors, etc.
`EXCEPTION_xxxxxxxxx`	Operating system error
`CONFIG DATA RESET TO DEFAULT`	Configuration data was reset to factory presets
`USER DATA RESET TO DEFAULT`	User data was reset to factory presets
`IP ADDRESS RESET TO DEFAULT`	IP address was reset to factory presets
`HOST NAME RESET TO DEFAULT`	Host name was reset to factory presets
`FRAM ERROR`	Data storage in FRAM failed
`ACTUAL DATA NV-MEM RESET`	Reset of operating data, e.g. flashover counter
`RINGBUF TRANSMIT OVERRUN`	Overrun of the send buffer of the respective communication channel

10.4. LOCAL Mode Errors

Follow these steps in the event of an error in LOCAL mode:

1. Confirm the error with the 'CONF' softkey.

♦ The display shows the prompt to turn the HV OUTPUT switch OFF.

2. Switch the HV OUTPUT OFF.

✓ If the error signal is no longer displayed, the FLX-HV supply returns to normal operation.

♦ If the error signal is still displayed, the HV output cannot be turned ON.

3. Observe the error signal status in the 'Status Monitor' menu.

> **NOTE**
>
> When the HV OUTPUT switch is OFF and the error signal is still present, the confirm error message is not shown.

♦ V-Set and C-Set will be replaced with 'Error' in the home screen.

4. Switch the HV OUTPUT ON.

♦ The error screen appears.

5. Confirm the single errors.

✓ If the error signal is no longer displayed, the FLX-HV supply returns to normal operation.

10.5. LOCAL Mode Error Messages

The following error messages may be displayed in LOCAL mode if an error occurs:

10.5.1. +/-15V Supply Error

Internal +/-15V bias supply voltages are out of range or defective.

10.5.2. Power Factor Correction Error

PFC output voltage is not within a defined voltage range.

10.5.3. Overtemperature air inside unit

Excess unit internal temperature.

10.5.4. Overtemperature half bridge

Excess inverter heat sink temperature.

10.5.5. Overtemperature heat sink PFC

Excess PFC heat sink temperature.

10.6. REMOTE mode Errors

It is suggested that the unit status is read at regular intervals.

Before the FLX-HV power supply output can be turned on again with a command, any device error has to be confirmed with an ERC0 command, see Section 9 Command Set.

> **NOTE**
>
> If the user does not actively monitor the device status, the REMOTE control unit does not receive errors information via the interface.

V-Set and C-Set will be replaced by 'Error' in the home screen.

10.7. REMOTE Mode Error Messages

The following error messages may appear on the display in REMOTE mode:

"Waiting for confirm via interface" – see the example screen below.

```
Remote Error
Waiting for confirm
via interface ..
Or change into
LOCAL mode  ..
 LOCAL
```

These errors have to be confirmed with an ERC0 command via the REMOTE interface, see Section 9 Command Set.

It is also possible to switch the operating mode to LOCAL, then the error messages are displayed as described in LOCAL mode, see Section 10.4.

10.8. Error diagnosis and Troubleshooting

Follow these steps in case of an error:

1. Identify the cause of the error by reading the error message on the display (Figure 4, item 4).

2. Disconnect power supply from the AC line, see Section 12.2 Power Down.

3. Remove the cause of the error, see fault table, see Section 9.5 Checking Received Data for Errors

> **NOTE**
>
> If the user has any doubt or concern about errors, please contact the factory – see section 1.6.

10.9. Exceptional Situations / Emergency Situations

1. Turn off the FLX-HV power supply, see Section 12.2 Power Down.

2. If necessary, administer first aid.

3. Inform your company's safety officer to make sure any necessary steps are taken.

4. Identify the cause of the accident.

5. Remove the cause of the accident.

6. Confirm that the function of the laboratory power supply is restored and it returns to safe operation.

NOTE
Inform TDK-Lambda about the incident and any consequences

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11. Maintenance

11.1. General

The FLX-HV power supply is maintenance free. Clean the power supply periodically depending on operating hours or level of contamination.

> ⚠️ **WARNING**
>
> **Improper handling of laboratory power supply may cause electrical accidents.**
> ♦ Only use a dry, lint-free cloth for cleaning.
> ♦ Clean all air inlet and outlet slots (Figure 4, item 6).

11.2. Planned Maintenance

Check the FLX-HV power supply for contamination on a daily basis using visual inspection.

If necessary, clean the power supply with a lint-free cloth, paying particular attention to the air inlet and outlet vents.

11.3. Maintenance

> **NOTE**
>
> The FLX-HV power supply is maintenance free.
>
> Please contact the factory for maintenance and service – see Section 1.6.

11.4. Repair and Replacement Parts

> **NOTE**
>
> Only skilled TDK-Lambda skilled service personnel are authorized to conduct repairs and service on the FL-HV power supply.
>
> Please contact the factory for maintenance and service – see Section 1.6.

> ⚠️ **WARNING**
>
> ⚡ **Severe or fatal injuries may occur owing to electric shock.**
> - Replace the original fuses with parts that have an identical current and voltage rating.
> - NEVER replace removable power cords with power cords that are too short. Only use spare parts that comply with TDK-Lambda specifications.

12. *Removal from Service*

12.1. General

If the FLX-HV power supply is not used for a long period of time, the user should check the functionality every 2 years.

12.2. Power Down

Proceed as follows to power down the FLX-HV power supply:

1. Push the HV Output ON/OFF switch to turn HV OFF.

   ♦ HV ON LED is no longer illuminated.

2. Turn off the AC power switch.

   ♦ Display backlight remains illuminated for about 10 s.

√ The FLX-HV power supply is now turned off.

12.3. Disassembly

Proceed as follows in order to disassemble the FLX-HV power supply:

1. Disconnect laboratory power supply from any energy supply (e.g. mains socket).
2. Disconnect the load from the HV socket.
3. Disconnect the HV cable from the power supply.
4. Disconnect the supplied power cord from the power supply.
5. If necessary, remove the earth wire connection to the ground stud / PE.

√ The FLX-HV power supply is now disassembled.

For transport and storage please refer to Section 4.3 Transport and Storage.

12.4. Recycling

Please contact the local authorities for further information about recycling ewaste.

12.5. Disposal

The disposal of the FLX-HV power supply, including all operating material, is subject to local environmental protection and waste disposal regulations.

If the power supply has reached the end of its service life the unit should be disposed of in a professional and sustainable manner, especially with regard to environmentally hazardous components and substances.

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13.   Accessories, Spare Parts and Consumables

13.1.   Accessories

> **CAUTION**
>
> **Incorrect accessories/spare parts may cause material damage.**
>
> ♦ Only use accessories that comply with the specifications set by TDK-Lambda.
> ♦ Noncompliant material invalidates any claim with regard to warranty.

13.2.   Rack Adapter

Mounting height: 2U (3.5" or 89 mm)

> **NOTE**
>
> If replacement rack adapters are required, be sure to specify the height is 2U.
>
> Contact TDK-Lambda, see Section 1.6 Contact Information.

13.3.   High Voltage Output Cable

Replacement cables are available from TDK-Lambda. The standard cable length is 9ft, but other lengths are available if required.

For models rated at 10kV and 30kV, the replacement cable part is 15551109.

For models rated at 50kV, the replacement cable part is 15551509.

> **NOTE**
>
> If replacement cables, double terminated cables, or spare bulkheads are required contact TDK-Lambda, see Section 1.6 Contact Information.

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Abbreviations

Abbreviation	Description
°C	Degrees Celsius
A	Unit ampere for current
A/D	Analog / Digital
ADC	Analog / Digital Converter
bit/s	Unit for data transmission in bits per second
C-Set	Current setpoint
DACO	Date Code, date of manufacture
FP	Front panel
FRAM	Ferroelectric Random Access Memory
FW	Firmware, device software
h	Unit hour for time
HW	Hardware
HAL	Hardware Abstraction Layer
I	Current
ID	Identification number
IP	IP address, computer network address
kV	Unit kilovolt for voltage
LED	Light Emitting Diode
MAC	MAC address, explicit hardware address of network interface
MMI	Man Machine Interface (user interface)
mA	Unit milliampere current
ms	Unit millisecond for time
NV	non volatile memory
PCB	Printed Circuit Board
PFM	Pulse Frequency Modulator
R	Resistance
RP	Rear panel
RS232	Serial interface for data transmission

Abbreviation	Description
RTOS	Realtime Operating System
s	Unit second for time
SW	Software
t	Time
TCP/IP	Transmission Control Protocol/Internet Protocol
TELNET	Telecommunication Network, widespread internet protocol
USB	Universal Serial Bus, e.g. interfaces
PC	Personal Computer
V	Unit volt for voltage
VAC	Volts (alternating current)
VDC	Volts (direct current)
V-Set	Voltage setpoint
Vpp	Volts peak-to-peak
W	Unit watt for power
µC	Microcontroller
.txt	Text file extension, contains ASCII characters only