**Operation Manual**

DDP Series – Rev 1.5 P/N 160933-10

# DDP Series
# Programmable DC Power Supply


ADAPTIVE POWER SYSTEMS™

**ADAPTIVE** Power Systems

Worldwide Supplier of Power Equipment

PAGE LEFT INTENTIONALLY LEFT BLANK FOR HARDCOPY VERSIONS OF THIS DOCUMENT

# Table of Contents

# Table of Tables

# Table of Figures

# 1 Contact Information

## AMERICA / CANADA

Adaptive Power Systems
Irvine, USA
Phone: +1(949) 752-8400
Fax: +1 (949) 756-0838
Email: support@adaptivepower.com

## EUROPE

Caltest Instruments Ltd.
Guildford, United Kingdom
Phone: +44(0)1483 302 700
Fax: +44(0)1483 300 562
Email: support@adaptivepower.com

## CHINA

PPST Shanghai Co. Ltd.
Shanghai, China
Phone: +86-21-6763-9223
Fax: +86-21-5763-8240
Email: support@adaptivepower.com

Web: http://www.adaptivepower.com

# 2 Front Matter

## 2.1 Limited Warranty

Adaptive Power Systems, Inc. (APS) warrants each unit to be free from defects in material and workmanship. For the period of two (2) years from the date of shipment to the purchaser, APS will either repair or replace, at its sole discretion, any unit returned to the APS factory in Irvine, California or one of its designated service facilities. It does not cover damage arising from misuse of the unit or attempted field modifications or repairs. This warranty specifically excludes damage to other equipment connected to this unit.

Upon notice from the purchaser within (30) days of shipment of units found to be defective in material or workmanship, APS will pay all shipping charges for the repair or replacement. If notice is received more than thirty (30) days from shipment, all shipping charges shall be paid by the purchaser. Units returned on debit memos will not be accepted and will be returned without repair.

**This warranty is exclusive of all other warranties, expressed or implied.**

## 2.2 Service and Spare Parts Limited Warranty

APS warrants repair work to be free from defects in material and workmanship for the period of ninety (90) days from the invoice date. This Service and Spare Parts Limited Warranty applies to replacement parts or to subassemblies only. All shipping and packaging charges are the sole responsibility of the buyer. APS will not accept debit memos for returned power sources or for subassemblies. Debit memos will cause return of power sources or assemblies without repair.

**This warranty is exclusive of all other warranties, expressed or implied.**

## 2.3 Safety Information

This chapter contains important information you should read BEFORE attempting to install and power-up APS Equipment. The information in this chapter is provided for use by experienced operators. Experienced operators understand the necessity of becoming familiar with, and then observing, life-critical safety and installation issues. Topics in this chapter include:

- Safety Notices
- Warnings
- Cautions
- Preparation for Installation
- Installation Instructions

Make sure to familiarize yourself with the **SAFETY SYMBOLS** shown on the next page. These symbols are used throughout this manual and relate to important safety information and issues affecting the end user or operator.

## SAFETY SYMBOLS

**Direct current (DC)**

**Alternating current (AC)**

**Both direct and alternating current**

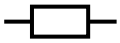

**Three-phase alternating current**

**Protective Earth (ground) terminal**



**On (Supply)**

**Off (Supply)**



**Fuse**

**Caution: Refer to this manual before this Product.**

**Caution, risk of electric shock**

## 2.4 Safety Notices

**SAFETY SUMMARY**

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Adaptive Power Systems assumes no liability for the customer's failure to comply with these requirements.

**GENERAL**

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

**ENVIRONMENTAL CONDITIONS**

This instrument is intended for indoor use in an installation category I, pollution degree 2 environments. It is designed to operate at a maximum relative humidity of 80% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

**BEFORE APPLYING POWER**

Verify that the product is set to match the available line voltage and the correct fuse is installed.

**GROUND THE INSTRUMENT**

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the AC power supply mains through a properly rated three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

**FUSES**

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired Fuses or short circuit the fuse holder. To do so could cause a shock or fire hazard.

**DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.**

Do not operate the instrument in the presence of flammable gases or fumes.

**KEEP AWAY FROM LIVE CIRCUITS.**

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages

may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

**DO NOT SERVICE OR ADJUST ALONE.**

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

**DO NOT EXCEED INPUT RATINGS.**

This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

**DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.**

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Adaptive Power Systems Sales and Service Office for service and repair to ensure that safety features are maintained.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

# 3 Product Overview

This chapter provides an overview of the APS DDP Series programmable DC power supplies. It introduces the reader to general operating characteristics of these power supplies.

## 3.1 General Description

The APS DDP Series DC power supply is designed to provide accurate, stable and clean DC power to a unit under test. The APS DDP Series power supply can be operated from the front panel (manual mode) or using RS232, RS485, USB, LAN (Ethernet) or GPIB remote control.

The performance of the DDP Series DC power supply models are detailed in section 4, "Technical Specifications". Maximum voltage, current and power capability depends on the specific model. This manual covers standard DDP Series models. If your unit has a custom voltage and current range, most of the information in this manual still applies.

## 3.2 Product Features

The following key characteristics apply to all DDP Series models;

- Fully programmable electronic DC power supply with advanced controller function.
- Fully remote control of all settings and metering read back.
- High accuracy and high-resolution voltage, current and power meters.
- Over voltage, current and over power protection.
- High resolution, large, full graphics LCD display.
- External voltage sense.
- Analog I/O.
- Remote Interlock.
- PV Simulation mode.
- Master/Slave mode for increased flexibility.

## 3.3 Operating Modes

The block diagram of the fully digital power supply controller is shown in Figure 3-1 below. It shows the key functional blocks of the various control loops present in the power supply and illustrates the various adjustment options that are available to the user.

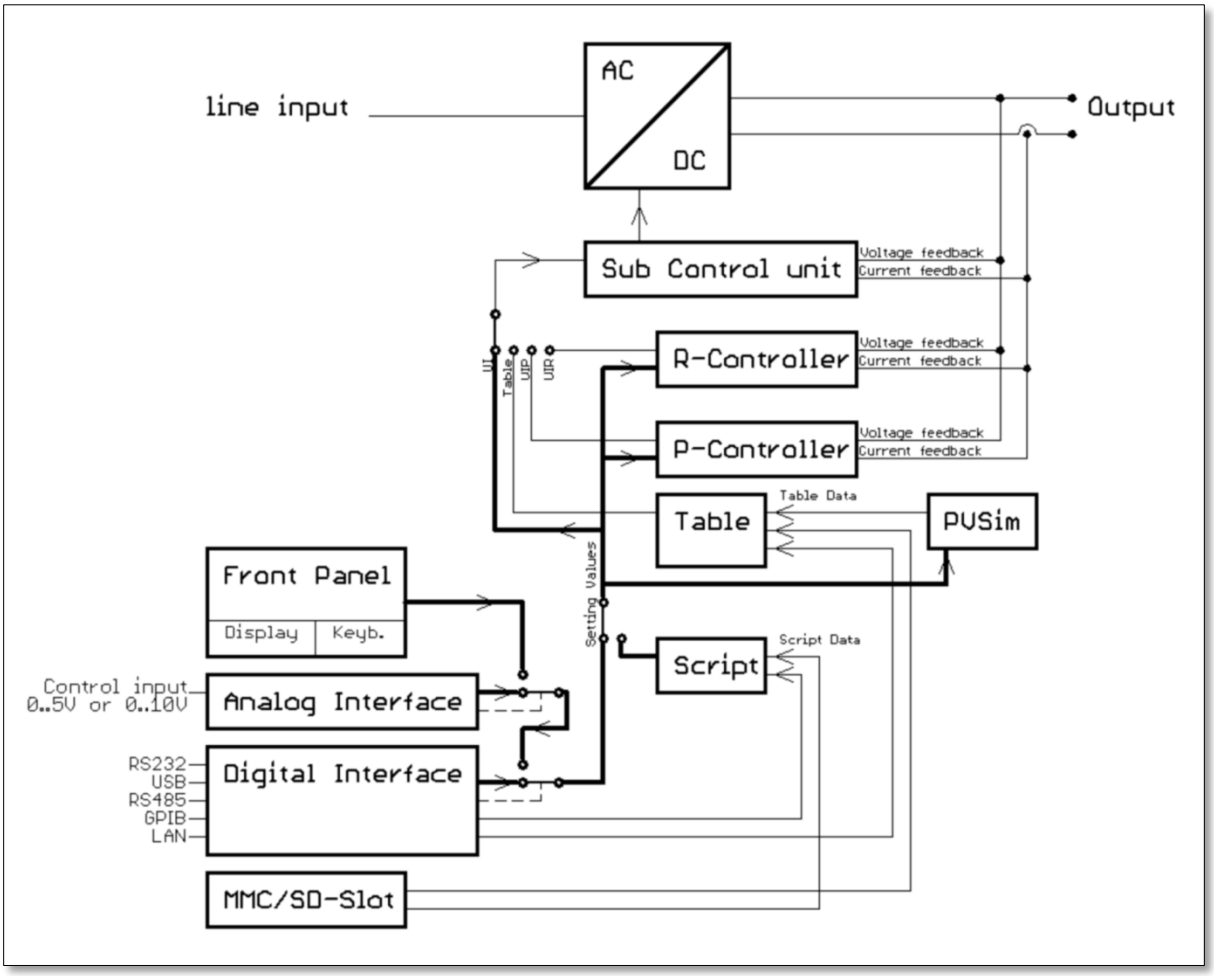



*Figure 3-1: DDP Series Controller Block Diagram*

Available operating modes for all models are:

- Constant Voltage (UI) mode
- Constant Power (UIP) mode
- Internal Resistance (UIR) mode
- Table Mode (Table) mode
- Photo-voltaic Simulation (PVsim) mode

A more detailed explanation of each mode and under what condition each mode is most appropriate to use follows.

### 3.3.1 Constant Voltage (UI) Mode

In Constant Voltage mode, the DC supply will attempt to maintain precise voltage regulation regardless of the amount of current demanded by the load. Thus, the power supply operates as a voltage source. Once the current demanded by the load reaches the current limit ($I_{max}$) setting value, the power supply will cross over to operate in constant current mode. At this point, the voltage will be reduced as needed from the voltage set point to maintain the $I_{max}$ current level. Once the load impedance increases again, the supply will revert back to constant voltage mode at the set voltage.

**Note:** When connecting the DC power supply to an active load such as a battery, make sure to use reverse current blocking diode to prevent current from flowing into the DC supply output. This could happen if the battery voltage exceeds the DC supply's output voltage.

### 3.3.2 Constant Power (UIP) Mode

This mode is an extension of the UI mode. In this mode, the DC supply regulates its output voltage at the voltage set point as long as the power dissipated by the load does not exceed the power level set point. Once the power demanded by the load reaches the power set point, the current will be regulated as needed to maintain the set power level as long as the maximum current limit ($I_{max}$) is not exceeded. This mode is appropriate for battery charging applications or situations where the voltage is allowed to vary but the power has to remain constant.

### 3.3.3 Internal Resistance (UIR) Mode

In Internal Resistance mode, the DC supply will not zero load regulate but rather operate the set voltage point minus a voltage drop determined by the load current and the programmed internal resistance setting. Thus, the DC supply will simulate having an internal impedance that causes the output voltage to drop as the load current increases.

$$Vout = Vset - (Iout * Ri)$$

UIR mode is useful for simulating the effects of battery discharge over time by adjusting the value of Ri as a function of time.

### 3.3.4 Lookup Table (Table) Mode

Table mode allows a series of voltage and current set points to be stored in memory and sequenced to change the DC supply output as a function of time. Table data can be loading using one of three methods:

1. PVsim Mode: Data is generated based on specifications of the solar panel to be simulation. See next paragraph
2. SC-Card: If this option is present, table data can be programmed using a script from an SD memory card. Scripts are simple text files than can be created using any text editor. Refer to section 11, "SD-Card Option Script Mode" starting on page 99 for more information.

3. Digital Interface: Table data can be loaded by sending the relevant WAVE and DAT commands. Refer to section 8.6.1, “Setting Commands” starting on page 66 for more information.

### 3.3.5 Photo-voltaic Simulation (PVsim) Mode

In photo-voltaic simulation mode (PVsim), the I-V curve of a solar panel is simulated. This feature is implemented using the table mode. Available parameter values are:

- Uo Open-circuit voltage.
- Ik Short-circuit current.
- Ummp Voltage at which the solar panel delivers the maximum power (Umpp and Impp), also referred to as the maximum power point (MPP). Allowable setting range for Umpp depends on the power supply model used and is from 0.6 to 0.95 * Full scale voltage.
- Immp Current at which the solar panel delivers the maximum power (Umpp and Impp), also referred to as the maximum power point (MPP). Allowable setting range for Impp depends on the power supply model used and is from 0.6 to 0.95 * full scale current.

These values can generally be found in the specification sheets of the simulated solar panel(s).

## 3.4 Controller Description

The DDP Series power supplies use an advanced all digital controller with multiple high speed feedback loops.

The software contains three separate digital proportional-integral-derivative (PID) controllers. One PID controller each is assigned to the UIR, UIP and PVsim mode. When required, the controller PID coefficients can be changed using one of the digital remote control interfaces.

**CAUTION**

**IMPROPER ADJUSTMENT OF THE CONTROLLER CAN LEAD TO CONTROLLER OSCILLATIONS WHICH MAY DAMAGE CONNECTED LOADS!**

### 3.4.1 Controller Configuration for PVSim and User Modes

The current set point is calculated from the output voltage and a table. This set point stands for the input signal of the PID controller after it was subtracted from the actual value. The PID controller releases the current set point for the power supply. The current set point is limited to the short circuit current, as a maximum. The voltage set point of the power supply is permanently set to the open circuit voltage of the table. In PVsim mode the current is regulated while the voltage is fixed.

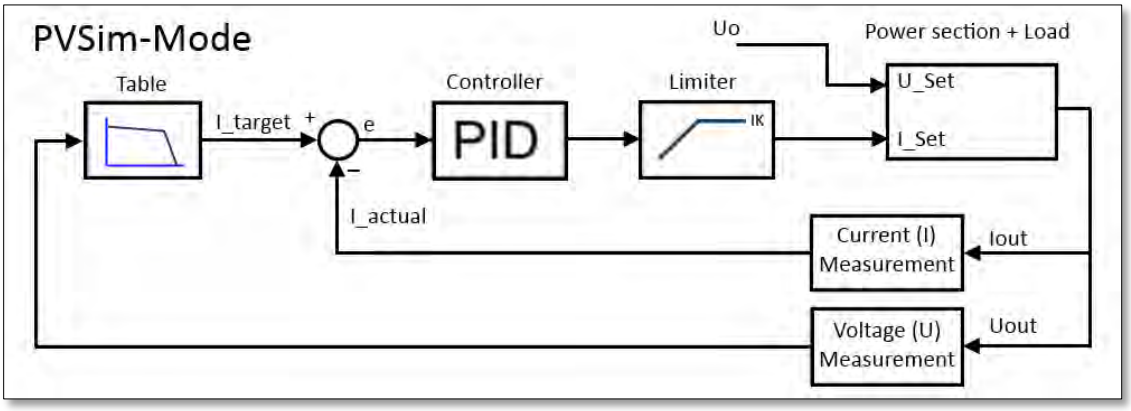



*Figure 3-2: Block Diagram – PVSim Mode PID Controller*

### 3.4.2 Controller Configuration for UIP Mode

The output voltage is multiplied with the output current. The result is subtracted from the power set point. This signal is the input signal of the PID controller, which releases the current set point for the power supply. The current set point is limited to the current set point, as a maximum. The voltage setting of the power supply is permanently set to the voltage set point. In UIP mode the current is regulated, while the voltage is fixed.

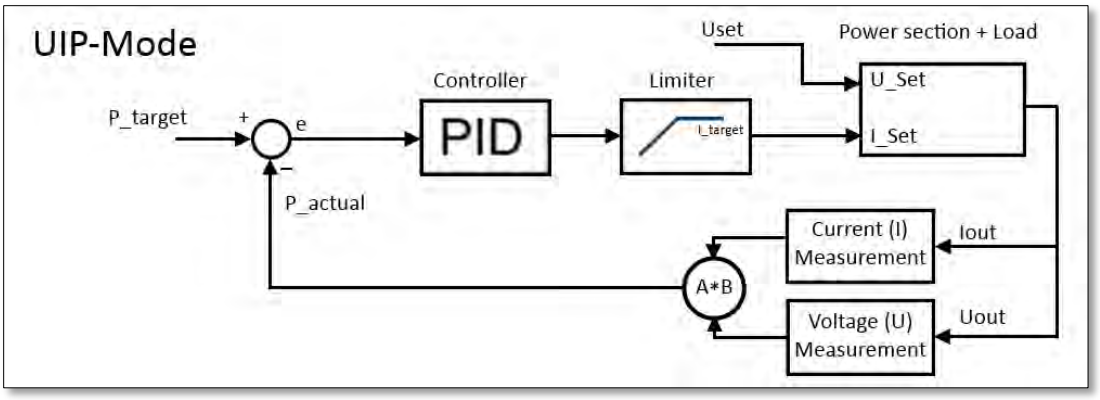



*Figure 3-3: Block Diagram - UIP Mode PID Controller*

### 3.4.3 Controller Configuration for UIR Mode

The measured output current is multiplied with the adjusted internal resistance. The result is subtracted from the adjusted set point and is then the set point for the voltage controller:

U_target = U_set - Iout * Ri

The output signal is limited to the voltage set point. The current setting of the power supply is permanently set to I_set. In UIR mode the voltage is regulated while the current is fixed.

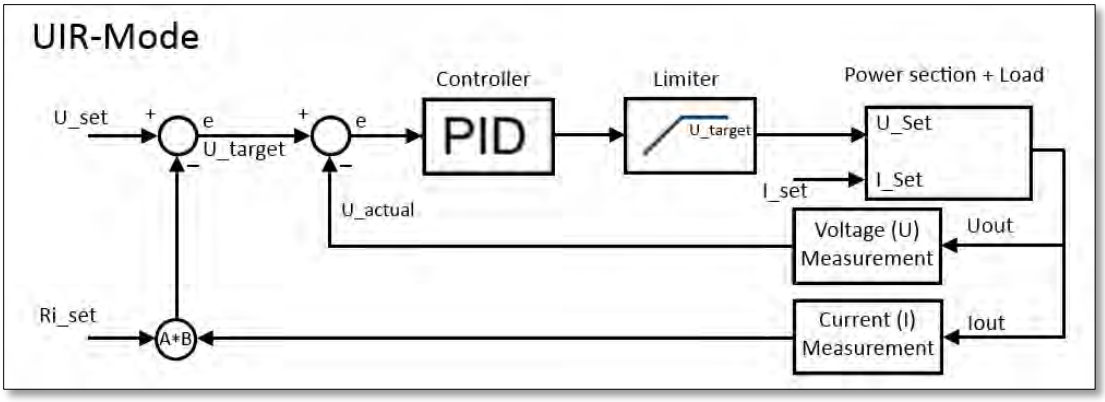



*Figure 3-4: Block Diagram - UIR Mode PID Controller*

## 3.5 PID Controller Coefficients

The function for a PID controller can be expressed as follows:

$$y = Kp \cdot \left( e + \frac{1}{Tn} \int e(t)dt + Tv \frac{de}{dt} \right)$$

Following symbols are used in this equation:

| Symbol | Description |
|---|---|
| **E** | Controller deviation |
| **Kp** | Proportional coefficient |
| **Tn** | Reset time |
| **Tv** | Derivative time |

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

$$y = Kp\left( e_i + \frac{Ts}{Tn} \sum_{m=-\infty}^{m=i} e_m + \frac{Tv}{Ts}\left(e_i - e_{i-1}\right) \right)$$

Where Ts is the sampling interval in seconds.

The following equation shows the actual controller in firmware:

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

Parameters values for P, I and D may be calculated as follows:

$$P = 10 \cdot Kp \quad I = \frac{1000 \cdot Kp \cdot Ts}{Tn} \quad D = \frac{10 \cdot Kp \cdot Tv}{Ts}$$

**Note:** The sampling interval used by the is Ts = 300 usec.

For special applications where custom control loops are desired, these controller parameters can be re-programmed via the digital remote control interface using the "**REGLER**" command. For more details, refer to section 8.6.1, "Setting Commands" on page 66.

## 3.6 Slew Rates

Slew rate is defined as the change in current or voltage over time. The rate of change of voltage and or current at the output of the DC supply is determined largely by the load. Under no load condition, slewing the voltage down from one level to a lower level may take considerable time as there is no way for the stored energy in the DC supply's output capacitors to bleed off. Under full load however, this energy will be absorbed by the load much more quickly.

The transition time is defined as the time required for the output to change from 10% to 90% or from 90% to 10% of the programmed setting. In cases where the transition from one setting to another is small, the bandwidth of the supply limits the transition time. The definition of slew rate is shown in Figure 3-5.

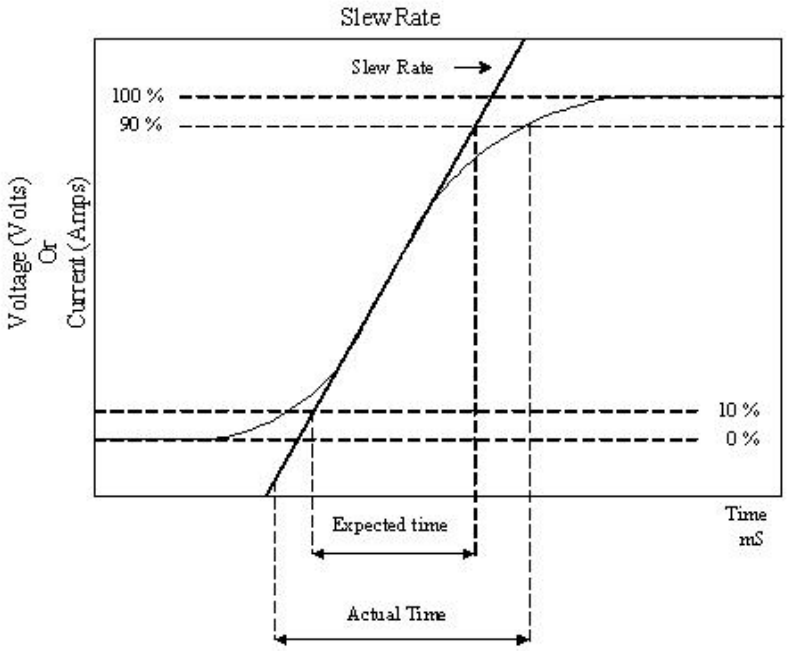



*Figure 3-5: Rise Time Performance Limits*

## 3.7 Measurement Read-back

The voltage setting and current levels of the power supply can be set from the front panel or over the remote control interface. During testing, power supply output voltage and current can be read back.

## 3.8 Accessories Included

The following accessories are included with each DDP Series DC power supply. If one or more of these is missing upon incoming inspection of the product, please contact Adaptive Power Systems customer service.

| Item | Quantity |
|---|---|
| Operation Manual in PDF Format | 1 |
| AC Line Cord (230Vac Single Phase input models only) | 1 |
| Certificate of Conformance | 1 |

*Table 3-1: Included Accessories*

## 3.9 Remote Control Interfaces

Following options can be ordered at time of original purchase. It is possible to have up to three different remote control interfaces per unit. Note that RS232 is standard so two more additional interfaces may be ordered.

| Option | | Model No. |
|---|---|---|
| RS-232 Interface | Standard | -RS232 |
| RS-485 Interface | Option -485 | -RS485 |
| GPIB Interface | Option –GPIB | -GPIB |
| USB Interface | Option -USB | -USB |
| LAN Interface | Option -LAN | -LAN |

*Table 3-2: Available Remote Control Interface Options*

# 4 Technical Specifications

Technical specifications shown here apply at an ambient temperature of 25° C ± 5°.

## 4.1 Output Ranges

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP15-200 | 3000 | 0-15 | 0-200 |
| DDP35-90 | 3000 | 0-35 | 0-90 |
| DDP60-50 | 3000 | 0-60 | 0-50 |
| DDP80-38 | 3000 | 0-80 | 0-38 |
| DDP100-30 | 3000 | 0-100 | 0-30 |
| DDP150-20 | 3000 | 0-150 | 0-20 |
| DDP300-10 | 3000 | 0-300 | 0-10 |
| DDP600-5 | 3000 | 0-600 | 0-5 |
| DDP1000-3 | 3000 | 0-1000 | 0-3 |
| DDP1200-2.6 | 3000 | 0-1200 | 0-2.6 |

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP20-200 | 4000 | 0-20 | 0-200 |
| DDP35-115 | 4000 | 0-35 | 0-115 |
| DDP60-67 | 4000 | 0-60 | 0-67 |
| DDP80-50 | 4000 | 0-80 | 0-50 |
| DDP100-40 | 4000 | 0-100 | 0-40 |
| DDP150-30 | 4000 | 0-150 | 0-30 |
| DDP300-15 | 4000 | 0-300 | 0-15 |
| DDP600-7 | 4000 | 0-600 | 0-7 |
| DDP1000-4 | 4000 | 0-1000 | 0-4 |
| DDP1200-3.4 | 4000 | 0-1200 | 0-3.4 |

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP25-200 | 5000 | 0-25 | 0-200 |
| DDP35-150 | 5000 | 0-35 | 0-150 |
| DDP60-83 | 5000 | 0-60 | 0-83 |
| DDP80-63 | 5000 | 0-80 | 0-63 |
| DDP100-50 | 5000 | 0-100 | 0-50 |
| DDP150-35 | 5000 | 0-150 | 0-35 |
| DDP300-17 | 5000 | 0-300 | 0-17 |
| DDP600-8.5 | 5000 | 0-600 | 0-8.5 |
| DDP1000-5 | 5000 | 0-1000 | 0-5 |
| DDP1200-4.2 | 5000 | 0-1200 | 0-4.2 |

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP15-400 | 6000 | 0-15 | 0-400 |
| DDP20-300 | 6000 | 0-20 | 0-300 |
| DDP35-175 | 6000 | 0-35 | 0-175 |
| DDP60-100 | 6000 | 0-60 | 0-100 |
| DDP80-75 | 6000 | 0-80 | 0-75 |
| DDP100-60 | 6000 | 0-100 | 0-60 |
| DDP150-40 | 6000 | 0-150 | 0-40 |
| DDP300-20 | 6000 | 0-300 | 0-20 |
| DDP600-10 | 6000 | 0-600 | 0-10 |
| DDP1000-6 | 6000 | 0-1000 | 0-6 |
| DDP1200-5 | 6000 | 0-1200 | 0-5 |

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP20-440 | 8000 | 0-20 | 0-440 |
| DDP35-230 | 8000 | 0-35 | 0-230 |
| DDP60-133 | 8000 | 0-60 | 0-133 |
| DDP80-100 | 8000 | 0-80 | 0-100 |
| DDP100-80 | 8000 | 0-100 | 0-80 |
| DDP150-55 | 8000 | 0-150 | 0-55 |
| DDP300-30 | 8000 | 0-300 | 0-30 |
| DDP600-15 | 8000 | 0-600 | 0-15 |
| DDP1000-8 | 8000 | 0-1000 | 0-8 |
| DDP1200-6.7 | 8000 | 0-1200 | 0-6.7 |

| MODEL | Rated Power | Voltage Range | Current Range |
|---|---|---|---|
| DDP20-500 | 10000 | 0-20 | 0-500 |
| DDP35-300 | 10000 | 0-35 | 0-300 |
| DDP60-167 | 10000 | 0-60 | 0-167 |
| DDP80-125 | 10000 | 0-80 | 0-125 |
| DDP100-100 | 10000 | 0-100 | 0-100 |
| DDP150-70 | 10000 | 0-150 | 0-70 |
| DDP300-33 | 10000 | 0-300 | 0-33 |
| DDP600-17 | 10000 | 0-600 | 0-17 |
| DDP1000-10 | 10000 | 0-1000 | 0-10 |
| DDP1200-8.4 | 10000 | 0-1200 | 0-8.4 |

## 4.2 DC Output

| DC OUTPUT | |
|---|---|
| Operation Modes | Constant Voltage (UI), Constant Current (UI), Constant Power (UIP), Internal Resistance (UIR), Table, PVsim |
| Voltage | |
| Accuracy | ± 0.25 % of F.S. |
| Static Regulation | ± 0.05 % of F.S. |
| Dynamic Response | < 2 ms (typ.) |
| Ripple RMS | < 0.2 % (typ.) |
| Stability | ± 0.05% |
| Line Regulation | < ± 0.1 % of F.S. |
| Load Regulation | < ± 0.1 % of F.S. |
| Current Limit | |
| Accuracy | ± 0.4 % of F.S. |
| Static Regulation | ± 0.1 % of F.S. |
| Isolation | 3000V |

## 4.3 Protection Modes

| PROTECTION MODES | |
|---|---|
| Protection Modes | Over Current |
| | Over Voltage |
| | Over Power |
| | Over Temperature |
| OVP Range | 0 - 120% Vmax |

## 4.4 Metering

| MEASUREMENTS | |
|---|---|
| Voltage Range | See Model Tables |
| Accuracy | ± 0.25 % of F.S. +1 digit |
| Current Range | See Model Tables |
| Accuracy | ± 0.5 % of F.S. + 1 digit |
| Power Range | See Model Tables |
| Accuracy | ± 1.0 % of F.S. + 1 digit |

## 4.5 Analog and Digital I/O

| ANALOG & DIGITAL I/O | |
|---|---|
| Analog Inputs | Set V, I, OVP / 0-5 V or 0-10 V for Full-scale / Isolated<br>Input Impedance = 1 MΩ<br>Maximum Input Voltage = 25 V |
| Analog Outputs | Monitor Vset, Vmeas, Iset, Imeas / 0-5 V or 0-10 V for Full-scale / Isolated<br>Output Impedance =100 Ω<br>Minimum allowable load resistance = 2 k Ω<br>Minimum allowable load resistance for 0.1% accuracy = 100 k Ω |
| Digital Inputs | Analog I/O Enable / Output Disable (+5V to +10V)<br>Input Impedance = 47 kΩ<br>Maximum input voltage = 50 V<br>High level > 2 V, Low level < 0.8V |
| Digital Outputs | CV mode / Output Enabled Status / Error Out<br>Open collector output with internal 10 KΩ pull-up to +5V<br>Imax sink = 50 mA |
| Voltage Reference Output | Uref = 10 V ± 10 mV<br>Output Impedance < 10 Ω<br>Max. output current = 10 mA (not short circuit protected) |
| 5V DC Supply Output | Output Voltage = 5 V ± 300 mV<br>Max. output current = 50 mA (not short circuit protected) |

## 4.6 AC Input

| Version | 3 kW | 4 kW | 5 kW | 6 kW | 8 kW | 10 kW |
|---|---|---|---|---|---|---|
| Connection | 3 wire (1P+N+E) or 5 wire (3P+N+E) | | | | | |
| Input -230 | 1 x 230 $V_{ac}$ (207-253 $V_{ac}$ 47-63 Hz) | | | | | |
| Input -3P208 | 3 x 208 $V_{ac}$ (187-229 $V_{ac}$ 47-63 Hz) | | | | | |
| Input -3P400 | 3 x 400 $V_{ac}$ (360-440 $V_{ac}$ 47-63 Hz) | | | | | |
| Input -3P440 | 3 x 440 $V_{ac}$ (396-484 $V_{ac}$ 47-63 Hz) | | | | | |
| Input -3P480 | 3 x 480 $V_{ac}$ (432-528 $V_{ac}$ 47-63 Hz) | | | | | |
| Max. allowed V unbalance | < 3 % (3 Phase AC input only) | | | | | |
| **-230 Input Option** | | | | | | |
| Input Voltage | 1 x 230 $V_{ac}$ (207-253 $V_{ac}$ 47-63 Hz) | | | | | |
| Nominal RMS Phase Current[1,2] | 23 A | 31 A | 37 A | N/A | | |
| Inrush Transient Peak Current[2] | 48 A | 48 A | 146 A | | | |
| Internal Fuse Rating[3] | 32 A | 40 A | 50 A | | | |
| Recommended Supply Breaker (value and curve) | 32A Type D/K | 64A Type D/K | 64A Type D/K | | | |
| **-3P208 Input Option** | | | | | | |
| Input Voltage | 3 x 208 $V_{ac}$ (187-229 $V_{ac}$ 47-63 Hz) | | | | | |
| Nominal RMS Phase Current[1,2] | 15 A | 20 A | 24 A | 30 A | 40 A | 50 A |

[1] for nominal current and nominal voltage
[2] for nominal input voltage
[3] internal main fuse

| Version | 3 kW | 4 kW | 5 kW | 6 kW | 8 kW | 10 kW |
|---|---|---|---|---|---|---|
| Inrush Transient Peak Current[2] | 48 A | 48 A | 146 A | 98 A | 98 A | 98 A |
| Internal FuseRating[3] | 20 A | 25 A | 32 A | 40 A | 50 A | 60 A |
| Recommended Supply Breaker (value and curve) | 16 A Type D/K | 16 A Type D/K | 16 A Type D/K | 16/32 A Type D/K | < 32 A Type D/K | < 32 A Type D/K |
| **-3P400 Input Option** | | | | | | |
| Input Voltage | 3 x 400 $V_{ac}$ (360-440 $V_{ac}$ 47-63 Hz) | | | | | |
| Nominal RMS Phase Current[1,2] | 7.5 A | 10 A | 12 A | 15 A | 20 A | 25 A |
| Inrush Transient Peak Current[2] | < 25 A | < 25 A | < 76 A | < 51 A | < 51 A | < 51 A |
| Internal FuseRating[3] | 15 A | 15 A | 15 A | 20 A | 25 A | 32 A |
| Recommended Supply Breaker (value and curve) | 16 A Type D/K | 16 A Type D/K | 16 A Type D/K | 16/32 A Type D/K | < 32 A Type D/K | < 32 A Type D/K |
| **-3P440 Input Option** | | | | | | |
| Input Voltage | 3 x 440 $V_{ac}$ (396-484 $V_{ac}$ 47-63 Hz) | | | | | |
| Nominal RMS Phase Current[1,2] | 7 A | 10 A | 11 A | 14 A | 19 A | 23 A |
| Inrush Transient Peak Current[2] | 25 A | 25 A | 76 A | 51 A | 51 A | 51 A |
| Internal FuseRating[3] | 15 A | 15 A | 15 A | 20 A | 25 A | 32 A |
| Recommended Supply Breaker (value and curve) | 16A Type D/K | 16A Type D/K | 16A Type D/K | 16A / 32A Type D/K | 32A Type D/K | 32A Type D/K |
| **-3P480 Input Option** | | | | | | |
| Input Voltage | 3 x 480 $V_{ac}$ (432-528 $V_{ac}$ 47-63 Hz) | | | | | |
| Nominal RMS Phase Current[1,2] | 7 A | 9 A | 10 A | 13 A | 17 A | 21 A |
| Inrush Transient Peak Current[2] | 25 A | 25 A | 76 A | 51 A | 51 A | 51 A |
| Internal FuseRating[3] | 15 A | 15 A | 15 A | 20 A | 25 A | 25 A |
| Recommended Supply Breaker (value and curve) | 16A Type D/K | 16A Type D/K | 16A Type D/K | 16A / 32A Type D/K | 32A Type D/K | 32A Type D/K |
| **Common Input Specifications** | | | | | | |
| Leakage Current | < 35 mA | < 35 mA | < 35 mA | < 35 mA | < 35 mA | < 35 mA |
| Cos phi | > 0.7 | > 0.7 | > 0.7 | > 0.7 | > 0.7 | > 0.7 |
| Harmonic Content[4] | 50 Hz = 72 % | | | | | |
| | 100 Hz = 2 % | | | | | |
| | 150 Hz = 0.9 % | | | | | |
| | 200 Hz = 0.1 % | | | | | |
| | 250 Hz = 11 % | | | | | |
| | 350 Hz = 0.6 % | | | | | |
| Efficiency Type[Error! Bookmark not defined.] | 94 % | 94 % | 94 % | 94 % | 94 % | 94 % |
| Dissipated Power | 200 W | 260 W | 320 W | 390 W | 520 W | 640 W |

[4] total harmonic distortion input current ([%]/I1

## 4.7 Dimensions & Weight

| DIMENSIONS & WEIGHT | | |
|---|---|---|
| Models | 3kW, 4kW, 5kW | 6kW, 8kW, 10kW |
| Dimensions (H x W x D) | 89 x 483 x 432mm<br>3.5” x 19” x 17.3” | 89 x 483 x 600mm<br>3.5” x 19” x 23.6” |
| Weight (net) | 19 kg / 42 lbs. | 26 kg / 57.3 lbs. |
| shipping | 26 kg / 57.3 lbs. | 33 kg / 72.8 lbs. |

*See dimension drawings on next page.*

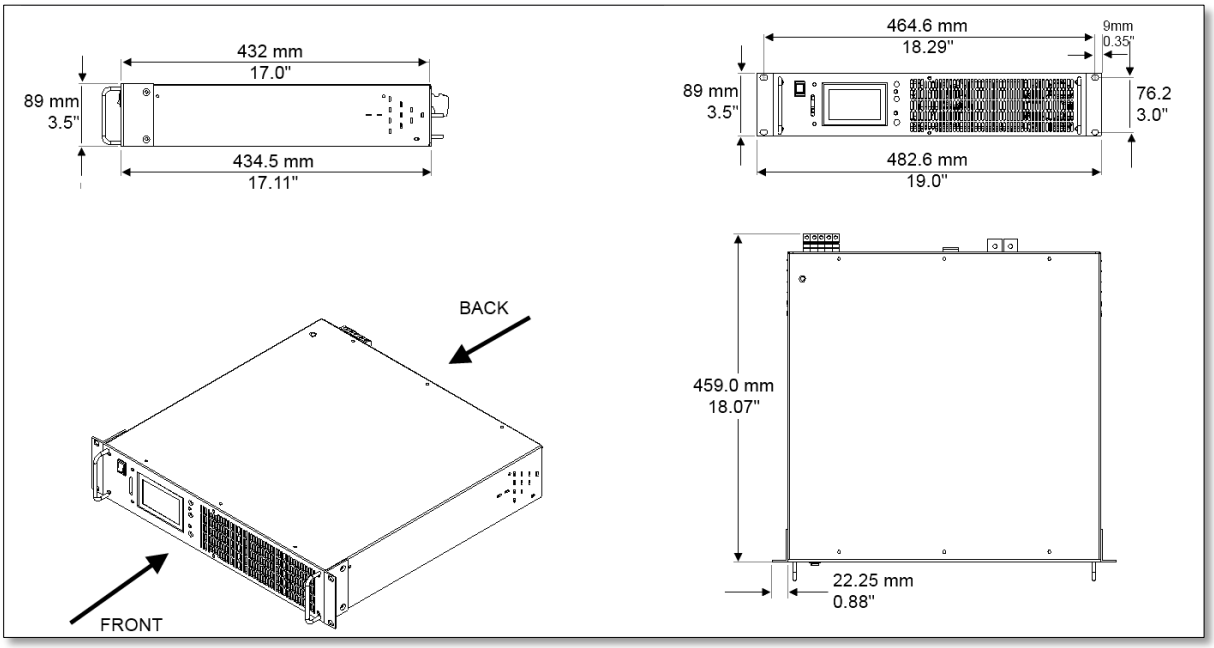



*Figure 4-1: Dimension Drawing DDP 3KW - 5KW Models*

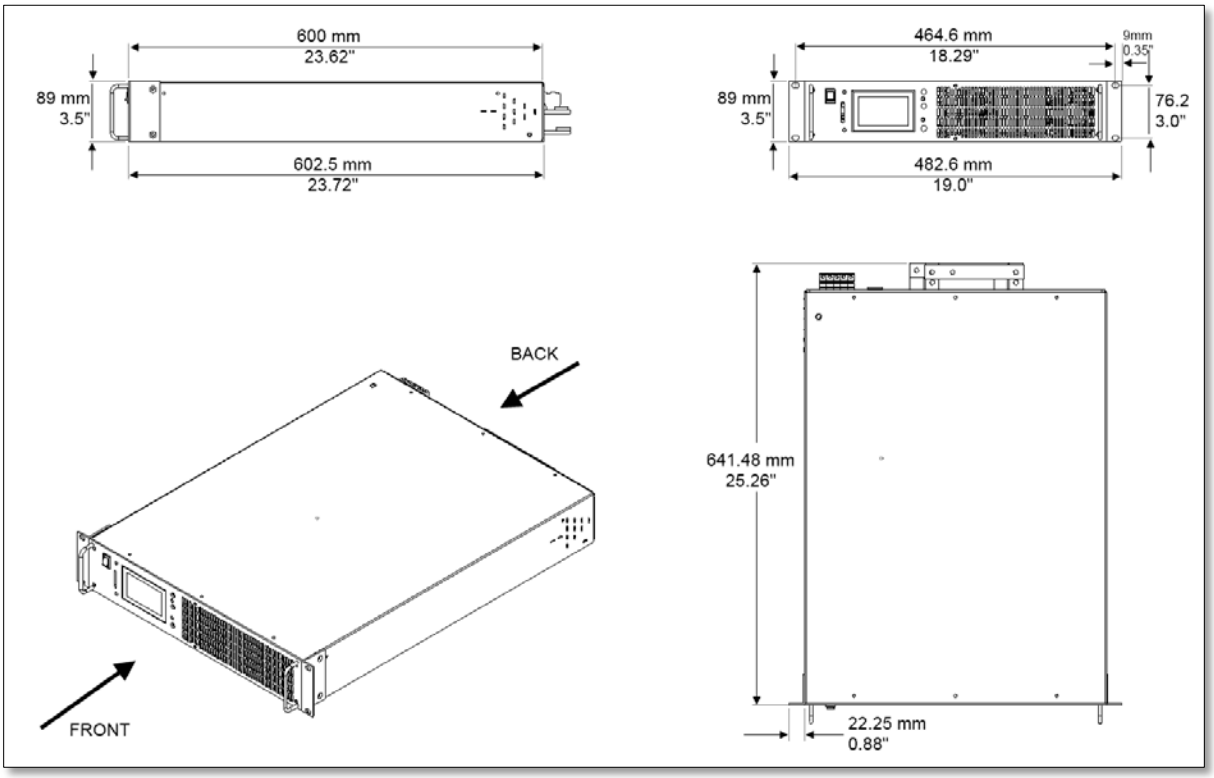



*Figure 4-2: Dimension Drawing DDP 6KW - 10KW Models*

## 4.8 Environmental

| ENVIRONMENTAL | |
|---|---|
| Cooling | Fan Cooled |
| Operating Temperature | 0 to 50 °C / 32 to122 °F |
| Storage Temperature | -20 to 70 °C / -4 to 158 °F |
| Humidity | < 80%, non-condensing |
| Altitude (max.) | 2000 m / 6500 feet |
| Vibration Resistance | 10 - 55 Hz, 1 minute, 2 G XYZ |
| Shock | < 20 G |

## 4.9 Safety & Regulatory

| SAFETY & REGULATORY | |
|---|---|
| Safety Standard | EN 60950 |
| EMC Emissions | EN61000-6-4:2007 |
| EMC Immunity | EN61000-6-2:2005 |
| Product Category | EN61010-1:2006 (Measurement, Laboratory and Control Equipment) |
| Approvals | CE Mark |

## 4.10 Digital Interfaces

| **RS232** | |
|---|---|
| Baud rate: | 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 62500, 115200 |
| Parity: | O = Odd = uneven parity<br>E = Even = even parity<br>N = None = no parity bit |
| Number of data bits: | 7 or 8 |
| Number of stop bits: | 1 or 2 |
| Handshake: | H = Hardware, S = Software, N = None (no handshake)<br>The defined character for XON is 0 x 11 and for XOFF it is 0 x 13. |
| Signal Levels: | |
| Inputs (RxD, CTS) | Maximum input voltage: ± 25 V<br>Input Impedance: 5 kΩ (Type)<br>Switching thresholds: $V_H$ < - 3 V, $V_L$ > + 3 V |
| Outputs (TxD, RTS) | Output voltage (at $R_{LOAD}$ > 3 kΩ): min ± 5 V, Type ± 9 V, max ± 10 V<br>Output Impedance: < 300 Ω<br>Short circuit current: Typ. ± 10 mA |

| **RS485** | |
|---|---|
| Baud rate: | 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 62500, 115200 |
| Parity: | O = Odd = uneven parity<br>E = Even = even parity<br>N = None = no parity bit |
| Number of data bits: | 7 or 8 |
| Number of stop bits: | 1 or 2 |
| Timeout: | 0-100 msecs |
| Signal Levels: | |
| Maximum input voltage | ± 5 V |
| Input resistance | > 12 kΩ |
| Output current | ± 60 mA Max |
| High level | $U_d$ > 0.2 V |
| Low level | $U_d$ < - 0.2 V |

| **GPIB** | |
|---|---|
| Supported Functions | |
| SH1 | Source Handshake function available |
| AH1 | Acceptor Handshake function available |
| T6 | Talker, Serial Poll, end addressing by MLA |
| L4 | Listener function, end addressing by MTA |
| SR1 | Service request available |
| RL1 | Remote/Local function available |
| PP0 | No parallel poll function |
| DC1 | Device clear function available |
| DT0 | No trigger function |
| C0 | no controller function |
| E1 | Open-collector driver |

# 5 Unpacking and Installation

## 5.1 Inspection

The DDP Series of DC power supplies are carefully inspected before shipment. If instrument damage has occurred during transport, please inform Adaptive Power Systems' nearest sales and service office or representative.

DDP models configured for single phase AC input operation are shipped with a power cord for the type of outlet used at your location. If the appropriated cord was not included, please contact your nearest sales office to obtain the correct cord.

DDP models that require three phase AC input are furnished with a compression terminal block for AC input. A suitable line cord and power disconnect is required (but not included) to connect these DDP power supplies to the mains.

Refer to "check line voltage" to check the line voltage selection and fuse type.

## 5.2 Check Line Voltage

The DDP Series power supply can be ordered with a range of AC input voltage configurations. Prior to connecting the DC power supply to the local mains, it is important to check the type label on the unit to verify that its AC input configuration matches the local utility power.

Do not connect the power supply to the mains if the AC input voltage, phasing and frequency does not match.

**CAUTION**

**The unit may only be operated when connected directly to the mains. To avoid damage, do not connect the unit to isolating transformers, auto-transformers, magnetic current limiters or similar devices.**

## 5.3 AC Input Connections

The AC input connections must be made at the rear panel AC terminal block. This input block has a removable safety cover that must be installed when the instruments is used on a bench or otherwise accessible at the rear. If mounted in a cabinet with a locked door or screen, the AC input safety cover may be omitted if needed.

The AC input terminal phasing is marked on the rear panel and shown in the illustration below. A five wire mains connection is required. (L1, L2, L3, Neutral and Earth Ground). For lower power models equipped with the 230Vac single phase AC input option, a three terminal connector is used. (L, N, PE).

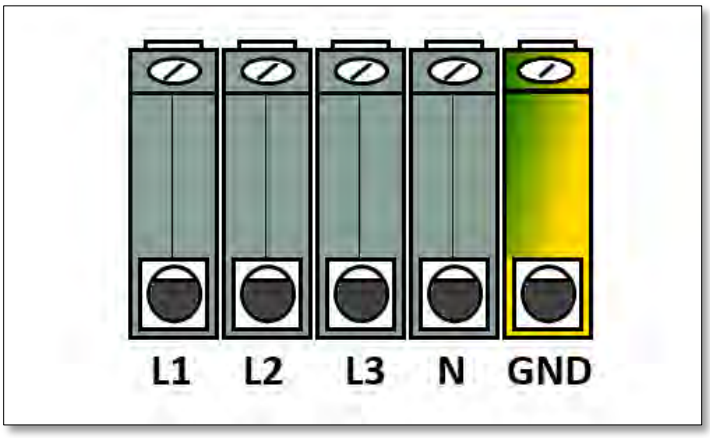



*Figure 5-2: AC Input Terminal Block - Rear Panel*

## 5.4 Grounding Requirements

**WARNING**

**SHOCK HAZARD**

**EQUIPMENT MUST BE GROUNDED**

The unit is grounded via the AC Input. A line cord with proper Earth Ground must be used at all times. Correct grounding of your electrical system infrastructure according to applicable national standards must also be observed.

## 5.5 AC Input Fuses

This product is fitted with internal mains input fuses. If any of these need to be replaced, please contact customer service.

## 5.6 Bench Use

The DDP Series chassis is not equipped with surface protection feet as it is intended primarily for 19" rack mount use. For use on the bench, use protective sheet to prevent damage to table top surfaces.

## 5.7 Rack Mounting

The DDP Series chassis is designed to be rack mounted in a standard 19 inch rack for system applications. Zero stacking with other DDP unit or test equipment is possible.

## 5.8 Cleaning

To clean this product uses a soft or slightly damp cloth.

**CAUTION**

**BEFORE you clean the unit, switch the mains power off and disconnect the input line cord.**
**・Please do NOT use any organic solvent capable of changing the nature of the plastic such as benzene or acetone.**
**・Please ensure that no liquid is allowed to penetrate this product.**

## 5.9 Powering Up

The following procedure should be followed before applying mains power:

1. Check that the POWER switch is in the OFF (O) position.
2. Verify that the model nameplate AC input specification match the local utility power.
3. Make sure that nothing is connected to any of the DC OUTPUT terminals on the rear panel.
4. Verify the AC Line input specifications on the power supply match the local utility mains.
5. Connect the correct AC mains line cord to the DDP Series AC input terminal.

6. Plug the line cord plug into a suitable AC outlet socket.
7. Turn on (I) the POWER switch.
8. If the instrument does not turn on for some reason, turn OFF the POWER switch and verify the presence of the correct AC line input voltage using appropriate safety measures.

## 5.10 In Case of Malfunction

In the unlikely event of an instrument malfunction or if the instrument does not turn on despite the presence of the correct AC line voltage, please attach a warning tag to the instrument to identify the owner and indicate that service or repair is required. Contact Adaptive Power Systems or its authorized representative to arrange for service.

## 5.11 Interface Options

The DDP Series supports one of five different remote control interface options. The RS232 interface is standard. Other interfaces specified at the time of order are installed at the factory prior to shipment. It is not possible to retrofit interface options in the field.

### 5.11.1 RS232 Serial Interface

Figure 5-3 shows the RS232 connector (Male) on the rear panel. This connects the power supply to an RS232 port of a computer.

Signal Pin Assignments:


*Figure 5-3: RS232 Connector*

| PIN | Abbreviation | Description |
|---|---|---|
| **Pin1** | N.C. | Not connected |
| **Pin2** | TXD | Transmit Data |
| **Pin3** | RXD | Receive Data |
| **Pin4** | N.C. | Not connected |
| **Pin5** | GND | Ground |
| **Pin6** | N.C. | Not connected |
| **Pin7** | CTS | Clear To Send. From PC to unit. Only required for hardware handshake. |
| **Pin8** | RTS | Request To Send. From unit to PC. Only required for hardware handshake. |
| **Pin9** | RI | Not connected |

*Table 5-1: RS232 DB9 Pin Assignments*

**NOTE:** To connect to a standard PC or Laptop RS232 DB9 connector, a **NULL-MODEM** 9 pin Female to 9 pin Female cable is required.

Factory set RS232 settings are:

9600 baud, no parity, 8 data bits, 1 stop bit, echo on

If echo is on, the interface confirms each incoming character by sending the same character back to the sender. The interface parameters can be adjusted via software and the command “PCx” command (refer to section 8.6.4, “System Commands”). These settings can be saved in non-volatile memory with the “SS” command.

Interface Reconfiguration

In for any reason the user has forgotten the interface configuration setup, there are two ways to reconfigure the interface:

1. By sending a new configuration using the “PCx” command from one of the other available remote control interfaces.
2. By using the “DISPLAY” to configure the Interface Parameters from the front panel.

### 5.11.2 RS485 Interface (Option)

The RS485 interface uses the same type DB9 connector and pin out as the RS232 interface but supports multi-drop capabilities.

The timeout parameter defines the time between receipt and sending of a message. The connected device is selected by entering the command and prefixing the "#" character followed by the number of the device. When using the word "ALL" instead of a number, the command that follows will be executed by all connected devices.

**Examples:**

#1,ID
#22,GTR
#ALL,GTL

### 5.11.3 GPIB Interface (Option)

GPIB connection is via a 24pin IEEE-488 Centronics connector on the rear panel of the unit. The device address is adjusted with the DIP switches S1-S5 located near the IEEE-488 connector. S1 is the least significant bit (lsb) and S5 is the most significant bit (msb).

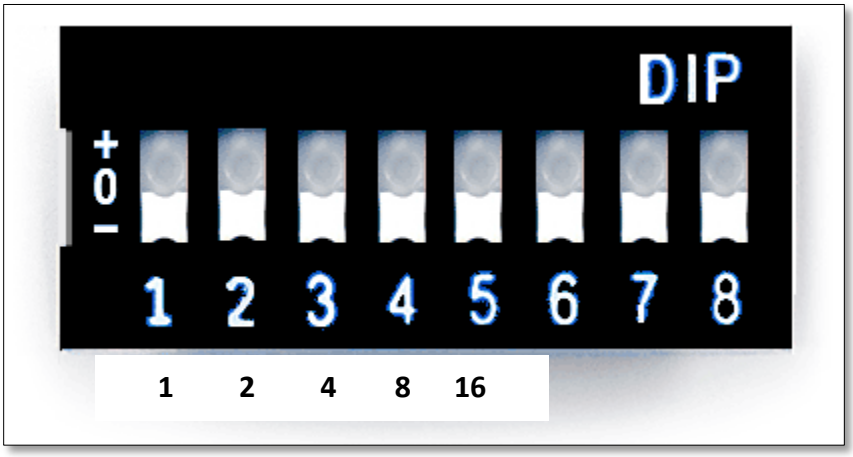



*Figure 5-4: GPIB Address Setting*

**NOTE:** The GPIB device address is read from the DIP switch **only** when the unit is switched on. Changing the DIP switches while the unit is power on will **not** change the device address!. Cycle power to activate the new GPIB address setting.

The GPIB connector is located on the rear panel. This socket allows the unit to be connected to a GPIB controller and other GPIB devices. A GPIB system can be connected in any configuration (star, linear, or both) as long as the following conditions are met:

- The maximum number of devices including the controller is equal or less than 15.
- The maximum length of the GPIB cable is no more than 2 meters.
- The total lead length of all devices connected together totals less than 20 meters.
- Please make sure the lock screws are firmly hand-tightened, use a screwdriver only for the removal of screws.

The GPIB connector pin-out is defined by the IEEE-488 standard and shown for reference only in Table 5-2 below.

| No | Name | Function |
|---|---|---|
| **1** | DIO1 | Data line 1 |
| **2** | DIO2 | Data line 2 |
| **3** | DIO3 | Data line 3 |
| **4** | DIO4 | Data line 4 |
| **5** | EOI | End or Identify |
| **6** | DAV | Data Valid |
| **7** | NRFD | Not Ready For Data |
| **8** | NDAC | No Data Accepted |
| **9** | IFC | Interface Clear |
| **10** | SRQ | Service Request |
| **11** | ATN | Attention |
| **12** | SHIELD | Shield |
| **13** | DIO5 | Data line 5 |
| **14** | DIO6 | Data line 6 |
| **15** | DIO7 | Data line 7 |
| **16** | REN | Remote Enable |
| **18 - 23** | GND | Ground |
| **24** | SGND | Signal Ground |

*Table 5-2: IEEE-488 Connector Pin Assignments*

### 5.11.4 USB Interface

The USB interface provides a virtual COM port for the PC. Via this port, the unit can be controlled as a normal RS232 interface, e. g. with a terminal program or user application program. Corresponding virtual com drivers (VCP drivers) for all current operating systems are available for download at the following URL:

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

Refer to the section 9, “USB Driver Installation” for further setup and configuration information.

### 5.11.5 LAN Interface

The DC power supply can be ordered with a LAN (Ethernet) interface. The LAN interface connector is installed on the rear panel. The MAC address of the unit can be found near the LAN connector.

No special device drivers are required to use the LAN interface as it uses TCP/IP protocol but the IP address needs to be configured to operate on the user's local area network or private network.

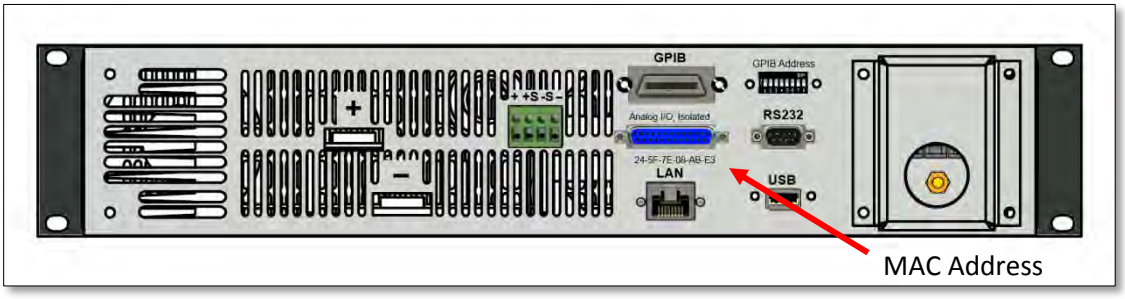



*Figure 5-5: DDP Rear Panel Layout*

Refer to section 10, "LAN Interface Configuration" for configuration details.

# 6 Front Panel Operation

This Chapter provides an overview of front panel operation for the DDP Series DC power supplies. For remote control operation, refer to Section 8 “Remote Control Programming” of this manual for an overview of available programming commands.

## 6.1 Front Panel Layout

The front panel layout is shown in Figure 6-1 below. The number of buttons is kept to a minimum to ensure simple front panel operation for casual and experienced users alike. The shuttle knob is used to slew parameter values and move through menus to make selections.

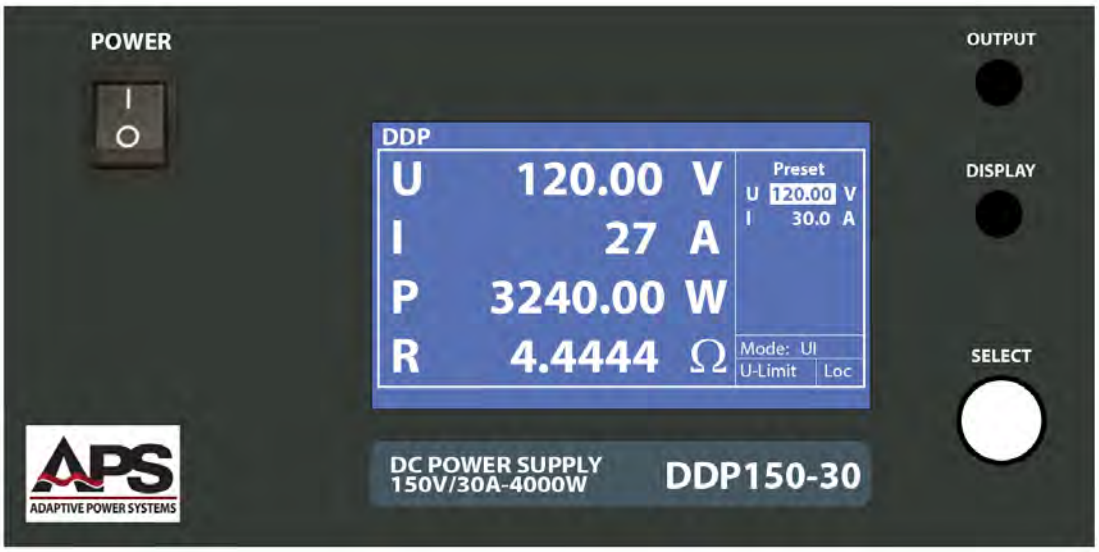



*Figure 6-1: DDP Series Front Panel View*

A large back-lit LCD display is located on the right hand side. User controls are located directly to the right of the displays. The power ON/OFF switch is found in the upper left corner of the front panel.

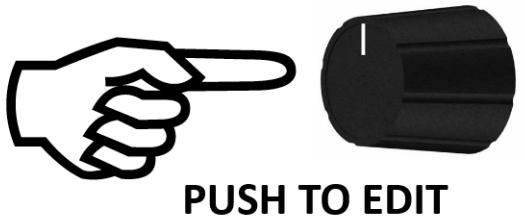
### 6.1.1 Buttons

There are only two buttons on the front panel.

| Button | Function |
|---|---|
| **OUTPUT** | Enables or disables power output from the DC power supply. When the output is OFF, the LCD display will show Standby indicating the unit is programmed and ready to provide power but the output is disabled. |
| **DISPLAY** | This button changes the displayed screen (display mode). It also enables entry into the menu system. Pressing and holding the DISPLAY button for one second brings up the CONFIGURATION menu. |

### 6.1.2 Shuttle Knob

The shuttle knob or rotary digital encoder is used to navigate (scroll) through menus and select fields to modify settings. The shuttle knob also includes a SELECT push button function. Turning the shuttle in either direction will cause the selected field to change. Once on a field, pushing the shuttle inward will invoke the Edit mode for the selected field. Once in EDIT mode, a parameter value can be changed by turning the shuttle left (decrease) or right (increase). Once the desired value or setting is obtained, press on the shuttle knob again to confirm and exit the EDIT mode.




The various menus and settings available to the user from the front panel are detailed in subsequent paragraphs.

## 6.2 Front Panel Control Priority

The adjustment of operating set points and the selection of an operation mode can be accomplished via the front panel controls (Front Panel Operation), one of the digital interfaces (Remote Control) or the analog/digital IO (AI Ext. Control).

In order of priority, commands which have been sent by remote control interface take precedence, followed by analog/digital-IO and lastly, by keyboard. For example, if the remote control interface specifies a set point, the corresponding values will be set, irrespective of analog inputs or front panel settings.

Another easy way to automate operations is offered by script control (Script Control). A list of commands is saved to the script memory and enables the user to change the sequence of certain settings. The script memory can be programmed via memory card or one of the digital interfaces.

Measurement values of the latest output data are permanently available at all interfaces. Therefore, the present output voltage can be read from the display or via digital interface, even if control of the unit is carried out via analog/digital IO.

## 6.3 General Settings

General settings are those other than operating mode and voltage and current set points. They include:

- Configuration
- LCD Contrast

### 6.3.1 Configuration Menu

The configuration menu can be accessed by holding the "DISPLAY" button (lower button) for at least 1 second. This opens the CONFIGURATION menu where general settings of the unit can be changed.

These settings are $U_{limit}$, $I_{limit}$, OVP and Remember last setting. Provided the unit is equipped with these options, AI Type and Master/Slave mode can also be selected in the menu.

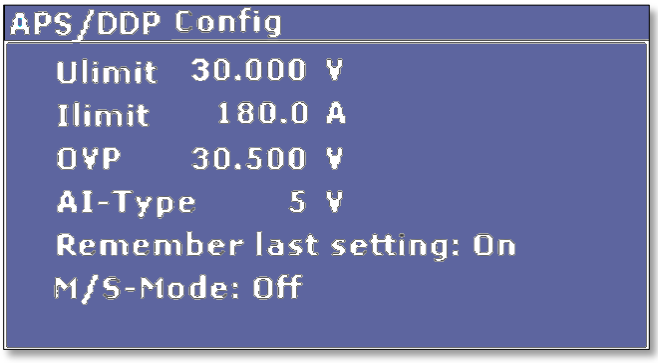



*Figure 6-2: CONFIGURATION Menu*

Use the shuttle knob to scroll to a specific entry in the Configuration menu. Once selected, pushing the shuttle knob in selects the individual parameter. Once selected, turning the shuttle knob changes the value.

Available settings parameters contained in the CONFIGURATION menu are shown in the table below.

| Parameter | Description | Notes |
|---|---|---|
| **$U_{limit}$** | User defined maximum voltage | $U_{limit}$ limits the maximum output voltage. The output voltage is limited to the set value, irrespective of the values that have been set at the front panel or via one of the interfaces. The adjustment range is 0 V up to the maximum rated voltage of the unit. This setting can only be changed in the CONFIGURATION menu and applies to all interfaces. |
| **$I_{limit}$** | User defined maximum current | $I_{limit}$ limits the maximum output current. The output current is limited to the set value, irrespective of the values that have been set at the front panel or via one of the interfaces. The adjustment range is 0 A up to the maximum rated current of the unit. This setting can only be changed in the CONFIGURATION menu and applies to all interfaces. |

| | | |
|---|---|---|
| **OVP** | OVP Trip level | The output is shut off immediately if the output voltage exceeds the OVP set value. The display indicates this status with the word "**OVP**". To clear this error, push the "**OUTPUT**" button. The OVP value setting in the CONFIGURATION menu applies to front panel operation only. There may be different values set for the AI-interface (pin 17) and the digital interface. The digital interface OVP value is initialized with the value which set in the CONFIGURATION menu.<br>The adjustment range for the OVP setting is 0 V up to the maximum rated voltage of the unit + 20%. |
| **AI-Type** | 5V or 10V full-scale range | This feature adjusts the voltage scaling of analog input signals and analog output signals. Selectable ranges are 0-5 V and 0-10 V for full-scale. |
| **Remember Last Setting** | Recall last setup | If this option is enabled ("**On**"), programmed parameters will be retained after power down. If this option is deactivated ("**Off**"), default settings (0V/0A/UI-Mode) will be loaded after the power supply is powered up. |
| **M/S Mode** | Master/Slave Mode | The following adjustments can be made if M/S-Mode is activated (Master/Slave-Mode):<br>Off: Stand-alone mode (single power supply)<br>Parallel: Parallel connected outputs<br>Serial: Series connected outputs<br>Independent: Independent outputs, change of settings via bus commands only |

*Table 6-1: CONFIGURATION Menu Parameters*

### 6.3.2 Interface Configuration Menu

Pushing the "DISPLAY" button a second time, opens digital interface configuration menu.

The display shows all available digital interfaces and their programmable parameters. These parameters can be selected by pushing the shuttle knob and changed by turning the knob.

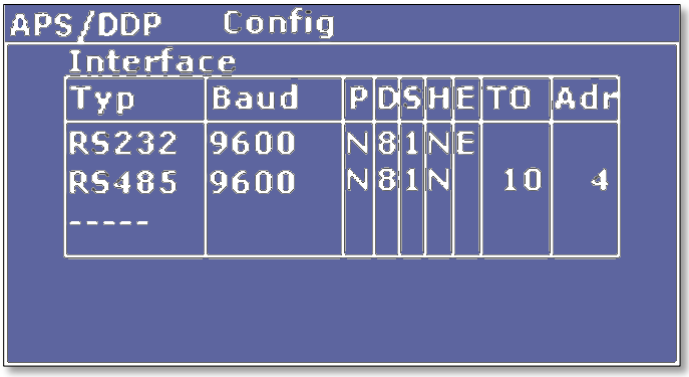



*Figure 6-3: DIGITAL INTERFACE CONFIGURATION Menu*

Available interface setting parameters for RS232 and other installed digital interface options are described in section 5.11,"Interface Options" and section 8.6.4, "System Commands".

### 6.3.3 LCD Contrast Adjustment

After the unit has been switched on, the display shows the Adaptive Power Systems logo. While the APS logo is visible, the LCD contrast of the display can be adjusted by using the shuttle knob. Afterwards, the new contrast setting will be saved automatically in non-volatile memory.

## 6.4 Display Modes

The following display screens are available:

- Main Display
- UI Graph Display

The "**DISPLAY**" button is used to toggle between these two display screens.

### 6.4.1 Main Display

The main display shows current measure and set values. On the left side of this screen, present voltage and current measurement values are displayed as well as the resulting power (P = U * I) and resistance (R = U ÷ I).

The set values are displayed on the right side of the screen ("Preset") and vary according to the operation mode of the unit.

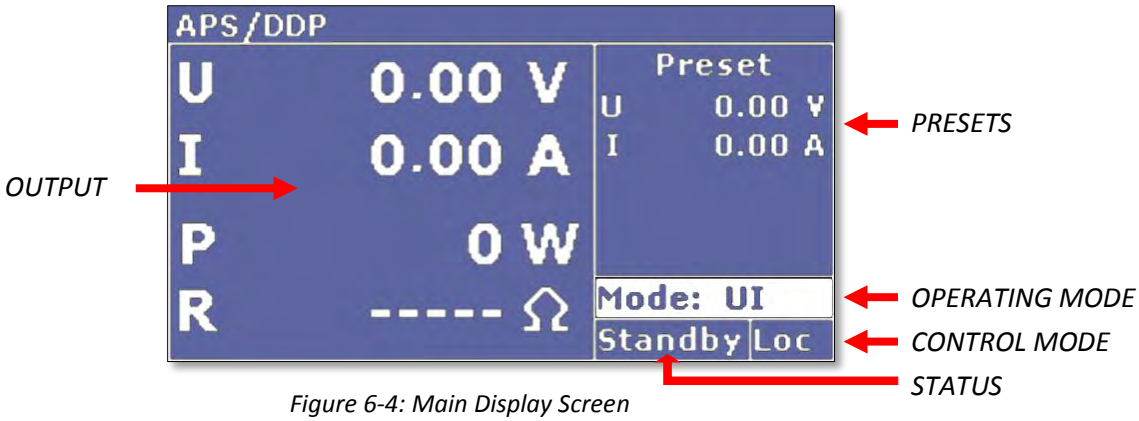



*Figure 6-4: Main Display Screen*

Main Display Readouts:

| Parameter | Description |
|---|---|
| **U** | Output voltage (measurement) |
| **I** | Output current (measurement) |
| **P** | Output power (UIP mode only) |
| **$R_i$** | Internal resistance (UIR mode only) |
| **$U_{mpp}$** | MPP voltage ($PV_{sim}$ mode only) |
| **$I_{mpp}$** | MPP current ($PV_{sim}$ mode only) |

The lower right section of the screen shows the current **Control Mode** of the unit:

| Status | Description |
|---|---|
| **Loc** | LOCAL: Front panel operation |
| **Scr** | SCRIPT: Memory card operation |
| **AI** | AI: Analog interface operation |
| **Rem** | REMOTE: Digital Interface operation |
| **LLO** | LOCAL LOCKOUT: Interface operation only. Front panel operation locked out |
| **Dis** | DISABLED: Unit locked via remote Output Interlock input |

The section to the left of the control mode display shows the current **Operating Status** of the unit:

| Status | Description |
|---|---|
| **Standby** | Standby mode |
| **U-Limit** | Voltage limitation mode |
| **I-Limit** | Current limitation mode |
| **P-Limit** | Power limitation mode |
| **OVP** | Output shutdown by over voltage protection mode |

The section above the operating status display shows the current **Operating Mode** of the unit:

| Mode | Description |
|---|---|
| **UI** | Voltage and current limit control |
| **UIP** | Voltage, current and power limit control |
| **UIR** | Voltage and current limit control with simulated internal resistance |
| **$PV_{sim}$** | Simulation of a photovoltaic UI operating characteristic |
| **User** | Simulation of a user-defined UI operating characteristic |

### 6.4.2 UI Graph Display

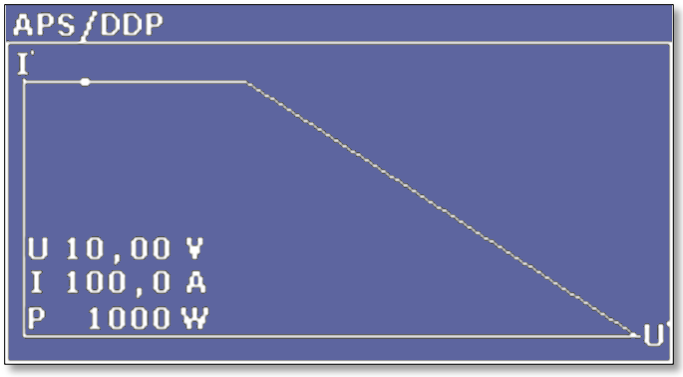



*Figure 6-5: UI Graph Display Screen*

The UI Graph screen displays an output diagram as an UI characteristic operating curve. The picture above shows the UIR operating mode. A small dot shows the actual operating point of the unit. The diagram illustrates that once the output current reaches a certain value, the output voltage will start to decrease as a function $R_{int}$ due to the UIR mode.

Note that the displayed diagram is always relative to the programmed voltage and current values. For example, if the current limit setting is changed from 100 A to 50 A, the internal resistance value would be doubled but the diagram would stay the same. The horizontal part of the diagram then corresponds to a 50 A scale and not to a 100 A scale.

## 6.5 Operating Modes

Operating modes can only be selected when the main display is visible. Pushing the shuttle knob switches the focus (selected mode is inverted) through the available modes. Once the mode field has focus, the operating mode can be selected by turning the rotary pulse encoder.

**Note:** The unit needs to be in standby mode (output off), otherwise the "**Mode**" field is not selectable.

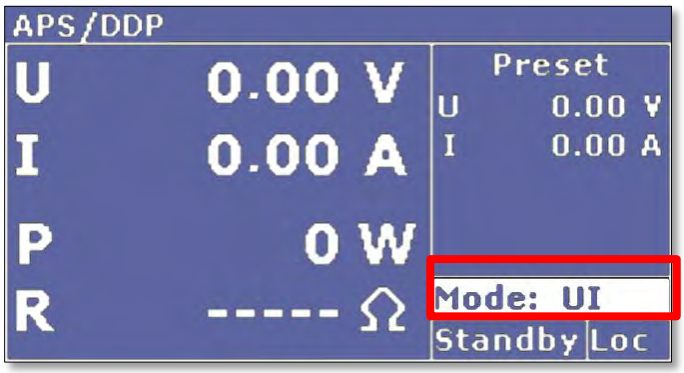



*Figure 6-6: Operating Mode Selection*

### 6.5.1 UI Mode

In UI mode, the settings for voltage and current are transferred directly to the power output stage of the DC supply. There is no additional digital control or manipulation involved.

### 6.5.2 UIP Mode

In UIP mode, the set values for voltage and current are transferred directly to the power output stage of the DC supply. If the output power exceeds the set power limit value, the current set point will be regulated to maintain this power level.

### 6.5.3 UIR Mode

In UIR mode, the output voltage is regulated in a way that a power supply unit with (adjustable) internal resistance is simulated. The set value for current limit is transferred directly to the power output stage of the DC supply.

### 6.5.4 PVsim Mode

In PVsim mode, the diagram of a PV solar panel is simulated. Refer to section 3.3.5, “Photo-voltaic Simulation (PVsim) Mode” on page 17 for more information.

### 6.5.5 Script Mode

In script mode, the unit is controlled by memory card. The display “**Mode**” shows the operating mode as “**UI**”. The lower right corner of the display shows the word “**Scr**”, which indicates that script operation was selected. If there is no memory card in the slot, this option cannot be selected. For detailed information about memory card control and how to create scripts, see section 11, “SD-Card Option Script Mode”.

## 6.6 Initial Power-on Settings

At power up of the DDP power supply, the initial settings are determined by the Power On setting in the configuration menu.

Available settings are:

- Remember last setting: Off
  - Factory defaults: Vout = 0V, Iout = 0A, Mode = UI, Output = Off
- Remember last setting: On
  - Last settings before power down takes effect at power on.

The Power settings in the configuration menu are non-volatile and remain in effect until changed from the front panel.

The remote control mode in effect after power on is determined by the last GTR (Go To Remote) command parameter sent before power down. This state is non-volatile and remains in effect till a new GTR command is sent. Note that this state cannot be queried so if the setting is unknown, it must be set to make sure the unit will power up in the desired remote state.

Available Remote States are shown in the table below.

| Remote State | Command | Description |
|---|---|---|
| **0** | GTR,0 | Front panel control. Remote state is off at power up. To enable remote control using any available digital interface, the GTR command (no parameter needed) must be explicitly sent.<br>This mode is most appropriate when the power supply has to be manually operated but remote queries of measurement data may be needed. |
| **1** | GTR,1 | Front panel control with interface enabled. Unit powers up with front panel enabled but will switch to remote control with front panel lockout as soon as any command is received over one of the available digital interfaces. The only exception to this is the GTL command which will place the unit in front panel control mode.<br>All units are shipped with this mode set from the factory. |
| **2** | GTR,2 | Remote control mode. At power up, the unit is in remote control mode with the front panel controls locked out.<br>This mode is most appropriate for ATE applications where all interactions are through software control. |

# 7 Rear Panel Overview, Connectors and Protection Features

This section describes the rear panel layout of the DDP Series DC power supply.

## 7.1 DC OUTPUT Terminals

The positive and negative terminals for load connection are located on the left side of the rear panel when facing the back of the unit.

**Note:** Always refer to Section 2.3 “Safety Information” and Section 2.4 “Safety Notices” before making any load connections.

### 7.1.1 Wire Size

A major consideration in making load connections is the wire size. The minimum wire size is required to prevent overheating and to maintain good regulation. It is recommended that the wires are sized large enough to limit the voltage drop at the maximum current rating of the DC power supply to less than 0.5V per lead.

### 7.1.2 Connecting a UUT

When setting up for a new test and connecting any equipment to the DC power supply, proceed as follows:

1. Always make sure the DC power supply is turned OFF at the POWER switch when making any wire connections.
2. Check that the output of the equipment under test is **OFF**.
   **Note:** Some power equipment’s output may still be energized even if the equipment has been turned off or its output is turned off. This is especially true for DC power supplies.

   **Note:** When working with batteries, it is recommended to provide a suitable disconnect relay or switch so the DC power supply can be physically disconnected from the battery for handling purposes.

3. Connect one end of the load wires to the DC output terminals on the rear panel.
4. Check the polarity of the connections and connect the other end of the load wires to the input terminals of the equipment under test.
5. When connecting multiple loads to the same power supply, make sure the wire lengths to each load are the same.

## 7.2 Voltage Sense Input Terminals

This section covers voltage sensing. This feature improves voltage accuracy at the point of load when used correctly.

### 7.2.1 Load Connection without Remote Voltage Sense

DDP Series power supplies are provided with external voltage sense wire connectors to compensate for any voltage drop between the DC supply and the load. In case, these connectors are not in use, they ***must be short-circuited*** with correct polarity to the load output connectors. Under no circumstances is current allowed to flow through the sense connectors.

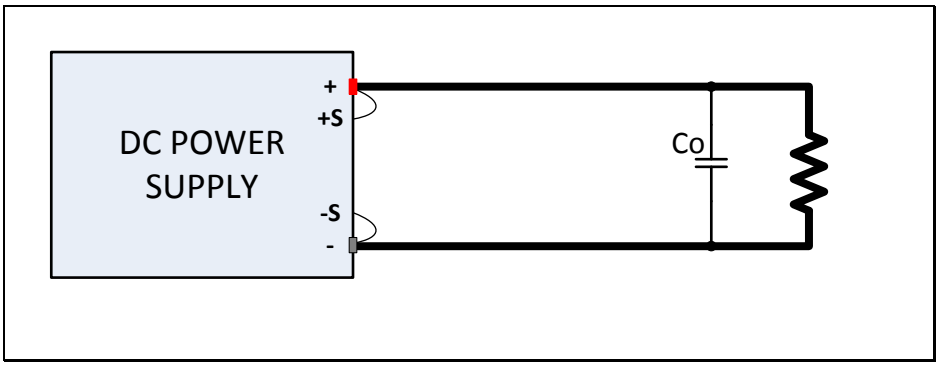



*Figure 7-1: Local Voltage Sense Connection*

In case of multiple parallel loads, the user has to provide a central power distribution point. To reduce peak loads and for a high frequency impedance terminator, a 1 to 10 µF capacitor should be connected to the output.

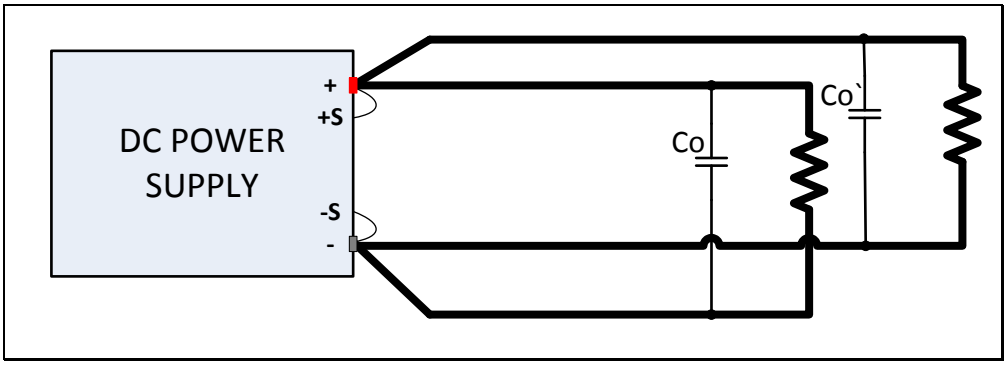



*Figure 7-2: Multiple Loads Local Voltage Sense Connection*

### 7.2.2 Load Connection with Remote Voltage Sense.

The following points must be considered, when existing sense cables are connected directly to the load or to the central load distribution point:

1. Minimize the distance between the DC power supply and the load as much as possible to keep load wire length to a minimum.
2. Remove existing sense cable jumpers from the power supply's external sense connector
3. Directly connect **+ Sense** and **- Sense** with ***correct polarity*** to the load distribution point
4. Connect a 1 µF to 47 µF capacitor across **+ Sense** and **- Sense** conductors near the load
5. Shield the sense cables or at least twist the **+ Sense** and **– Sense** wires together.
6. Select load wire gauge sizes, so that load wire voltage drop is less than 0.4 V
7. Avoid overload of power wires (voltage drop per line x current).

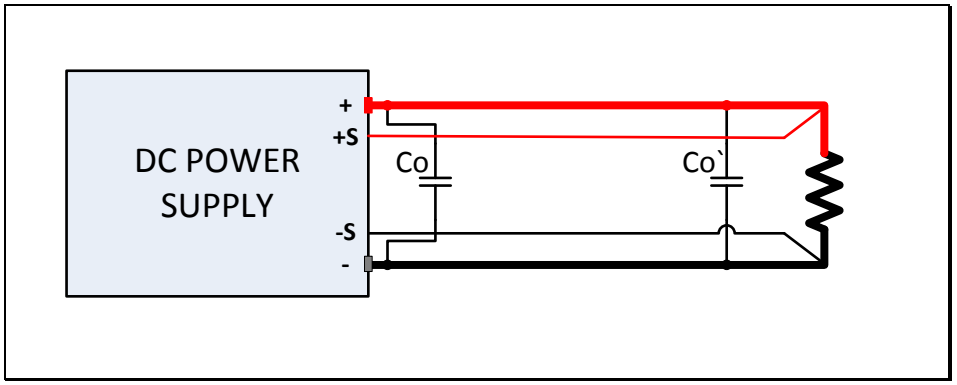



*Figure 7-3: Remote Voltage Sense Load Connection*

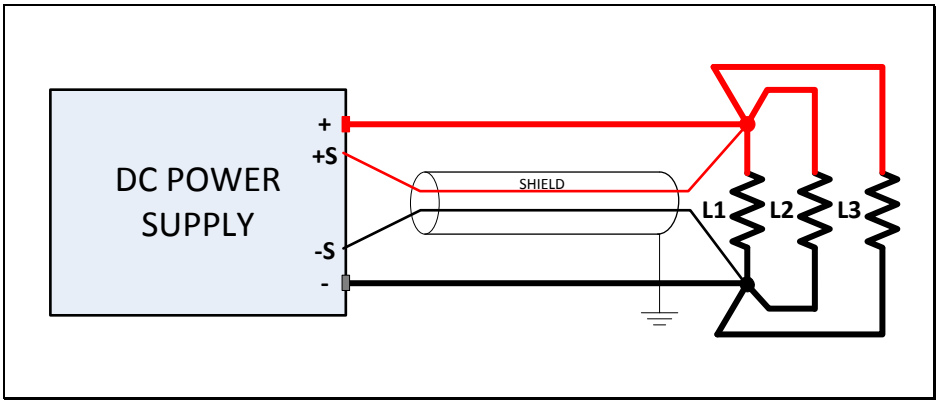



*Figure 7-4: Power Distribution Point Multiple Load Connection*

If in spite of paying attention to the points stated above, some oscillation occurs as a result of load wire induction and/or complex load conditions, please contact Adaptive Power Systems for technical support.

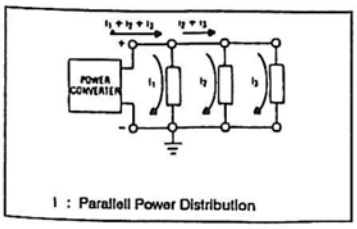
### 7.2.3 Load Distribution without Remote Voltage Sense

To ensure a proper use, a central load distribution situation is essential.

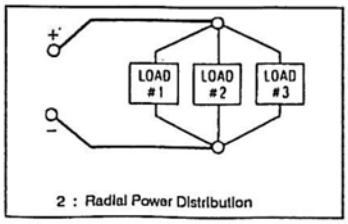
Illustration 1 shows an insufficient supply connection to load 2 and load 3 using parallel load conductors. This will result in a non-optimal distribution of current to each load.

Illustration 2 shows a correct load distribution. Load cable lengths to all loads are equal in length ensuring equal current distribution.

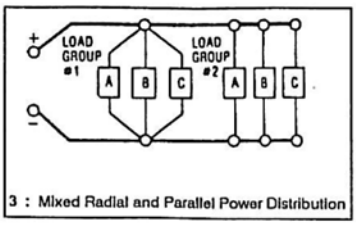
Illustration 3 shows a mixed distribution, where at least the largest power consumers are supplied through a center power distribution point.



1 : Parallell Power Distribution



2 : Radial Power Distribution



3 : Mixed Radial and Parallel Power Distribution

## 7.3 External Control Interface (AI)

The DC power supply is equipped with a variety of analog and digital I/O connections on the rear panel. The connections are concentrated on a single DB25 connector.

This section describes the use of these external input and output functions.

### 7.3.1 I/O Connector Pin Assignments

The following pins assignments apply to the DB25 Analog I/O connector.

| No (BD25) | Type | I/O | Name | Function |
|---|---|---|---|---|
| **1** | Analog | Output | $U_{mon}$ | Monitor set point U |
| **2** | Analog | Output | $I_{mon}$ | Monitor set point I |
| **3** | Analog | Output | $P_{mon}$ | Monitor measured Power |
| **4** | Analog | Output | $U_{OVPmon}$ | Monitor actual value OVP |
| **5** | Digital | Input | Unit Interlock | Output Disable ***(Input is not SELV)*** |
| **6** | -nc- | -nc- | - | - |
| **7** | Digital | Output | CV | Signals Constant Voltage mode |
| **8** | Analog | Output | $U_{meas}$ | Monitor measured output voltage |
| **9** | Gnd | Common | Common | - |
| **10** | Digital | Output | Output Off | Indicates output is OFF |
| **11** | Gnd | Common | Common | - |
| **12** | -nc- | -nc- | - | - |
| **13** | REF10 | Output | 10 V-$V_{ref}$ | Output 10 V reference voltage |
| **14** | Analog | Input | $U_{set}$ | Set point U |
| **15** | Analog | Input | $I_{set}$ | Set point I |
| **16** | Analog | Input | Reserved | - |
| **17** | Analog | Input | $OVP_{set}$ | Set point OVP |
| **18** | Analog | Input | Reserved | - |
| **19** | Digital | Input | Ext. Control | Enables analog control inputs |
| **20** | Digital | Input | Standby | Output Disable, enter standby mode |
| **21** | Analog | Output | $I_{meas}$ | Monitor measured output current |
| **22** | Pwr | Output | + 5 V | Output 5 V supply voltage |
| **23** | Gnd | Common | Common | - |
| **24** | Digital | Output | Error | Signals shut down by OVP |
| **25** | Gnd | Common | Common | - |

*Table 7-1: Analog and Digital DB25 Connector Pin Assignments*

All digital outputs are open-collector outputs with an internal pull-up resistance to + 5 V. All analog inputs and outputs can be operated in either 0-5 V or 0-10 V full-scale mode.

On the analog outputs, measurement values are displayed as dc voltage values (regardless of the actual measured parameter). Therefore the AI interface can be used for monitor purposes. Maximum voltage is 5 V / 10 V.

The following diagram shows a configuration where analog voltage and current control is used to program the DC supply. The unit is enabled unless the switch shown is closed. This feature may be used as a safety interlock in a cabinet system.

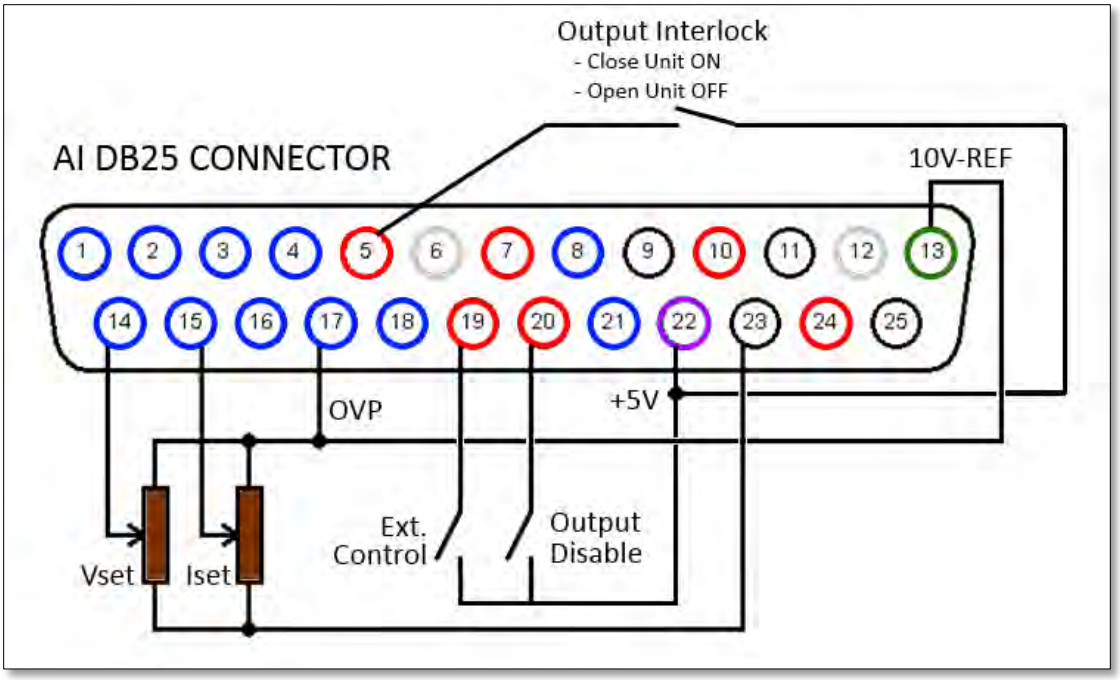



*Table 7-2: Analog and Digital I/O Connector Pins*

The pins in the diagram are color coded for reference:

| Signal Category | Diagram Color |
|---|---|
| • Analog | Blue |
| • Digital | Red |
| • Vref | Green |
| • 5V PWR | Purple |
| • Common | Black |
| • No Connect | Grey |

### 7.3.2 Analog Inputs

Set points may be adjusted using a DC voltage (0-5 V or 0-10 V for full-scale output) on the analog inputs. The voltage range can be chosen in the configuration menu. This function will only be active if pin 19 digital input "Ext. Control" is held low.

**Set Point U ($U_{Set}$)**

Sets the output voltage. The set point refers to the rated voltage of the unit so either 5V in or 10V in results in full-scale voltage output.

**Example:**

Model DDP600-5 has a 600 V voltage range. If AI is configured for 10 V full-scale and the desired output voltage = 100 V, then the required analog input DC for $U_{Set}$ is:

$$Uset = \frac{10V * 100V}{600V} = 1.667\,Vdc$$

**Set Point I ($I_{Set}$)**

Sets the current limit. The set point refers to the maximum current of the unit so either 5V in or 10V in results in full-scale current output.

**Example:**

Model DDPD100-100 has a 100 A current capability. If AI is configured for 5V full-scale and the desired current limit is 2A, then the required analog input DC level for $I_{set}$ is:

$$Iset = \frac{5V * 2A}{100A} = 0.10\,Vdc$$

**Set Point OVP ($U_{OVP}$)**

The output is deactivated immediately if the output voltage exceeds the adjusted value. This error is indicated on the display with the word "Error". To reset this error, the OUTPUT must be turned off. Adjustment range is 0 V up to the maximum rated voltage of the device + 20%.

**Example:**

Model DDP600-5 has 600 V voltage range. If AI is configured for 10 V full-scale and the desired OVP trip voltage is 650 V, then the required analog input DC level for $U_{OVP}$ is:

Adjustment range:

600 V + 20% * (600) = 720 V

$$Uovp = \frac{10V * 650V}{720V} = 9.028\,Vdc$$

### 7.3.3 Analog Outputs

On the analog outputs, output measurement values are presented as dc voltage values (regardless of the actual measured parameter). As such, the AI interface can be used for monitor purposes. Maximum voltage is either 5 V or 10 V.

**Monitor Set Point U ($U_{mon}$)**

Present set point of the output voltage. Measurement value refers to the rated voltage of the device.

**Example:**

Model DDP600-5 has a 600 V voltage range. If AI is configured for 10 V full-scale and the output voltage at $U_{mon}$ = 2.0 V, then the voltage set point is:

$$Uset = \frac{2V * 600V}{10V} = 120\ Vdc$$

**Monitor Set Point I ($I_{mon}$)**

Present set point of the output current. Measurement value refers to the rated current of the device.

**Example:**

Model DDP100-100 has a 100 A current capability. If AI is configured for 10 V full-scale and the output voltage at $I_{mon}$ = 2.0 V, then the current limit set point is:

$$Iset = \frac{2V * 100A}{10V} = 20\ Adc$$

**Monitor Actual Value P ($P_{mon}$)**

Present set point for output power. It is calculated by the controller from measurement values of output voltage and output current. Measure value refers to the rated power of the device.

**Example:**

Model DDP100-100 has a 10KW power capability. If AI is configured for 10 V full-scale and the output voltage at $P_{mon}$ = 5.0 V, then the power set point is:

$$Pset = \frac{5V * 10KW}{10V} = 5\ KW$$

**Analog Output OVP ($U_{OVPmon}$)**

Present set point for over voltage protection. Measurement value refers to the rated voltage of the device + 20%.

**Example:**

Model DDP600-5 has a 600 V voltage range. If AI is configured for 10 V full-scale (OVP full-scale is 120% of voltage range) and the output voltage at $U_{OVPmon}$ = 2.0 V, then the voltage protection set point is:

$$Uovpmon = \frac{2V * 1.2 * \ 600V}{10V} = 144\ Vdc$$

**Monitor Output Voltage ($U_{meas}$)**

Present measure value point value for output voltage. Measurement value refers to the rated voltage of the device.

**Example:**

Model DDP600-5 has a 600 V voltage range. If AI is configured for 10 V full-scale and the output voltage at $U_{meas}$ = 6.0 V, then the output voltage is:

$$Umeas = \frac{6V * 600V}{10V} = 360\ Vdc$$

**Monitor Output Current (Imeas)**

Present measure value for output current. Measurement value refers to the rated current of the device.

**Example:**

Model DDP100-100 has a 100 A current capability. If AI is configured for 10 V full-scale and the output voltage at $I_{meas}$ = 4.0 V, then the output current is:

$$Imeas = \frac{4V * 100A}{10V} = 40\ Adc$$

### 7.3.4 Digital Inputs

The digital inputs can be used to adjust the operation mode for the analog control. Inputs are active low.

**Note:** Input levels are consistent with negative logic.

| | | |
|---|---|---|
| *Set* | *logic 0* | *True* |
| *Reset* | *logic 1* | *False* |

**Ext. Control (AI)**

The “Ext. Control” input can be used to select the analog control operation mode (AI). The AI interface is activated by an applied voltage of + 5 V up to + 10 V. When asserted, front panel operation is disabled. This operation mode is indicated as “AI” on the display.

The digital interface takes priority over the AI interface however. The settings from the AI interface have no effect if the device is toggled to “Remote” state.

Thus, the control priority is as follows:

1. Digital Interface
2. Analog Interface
3. Front Panel

**Unit Interlock (Unit Off)**

The unit is disabled (unit off) by an applied voltage of + 5 V up to + 10 V. The unit is enabled (unit on), if the “Output Interlock” input is toggled to inactive.

**Note:** This is a soft-interlock and does not conform to the machinery directive.

**Standby (Output Off)**

The standby mode (output off) is activated by an applied voltage of + 5 V up to + 10 V. The output is enabled (on), if the “Standby” input is toggled to inactive.

### 7.3.5 Digital Outputs

On the digital outputs, actual power supply status is reported (irrespective of the programmed or selected operation mode). Therefore the AI interface may be used for monitoring purposes.

**Note:** Output levels are consistent with negative logic.

| | | |
|---|---|---|
| *Set* | *logic 0* | *True* |
| *Reset* | *logic 1* | *False* |

A set output has a voltage level of < 0.6 V. A reset output has a voltage level of > 1.2 V.

**Output Off (Standby)**

If the "Output Off" signal is set, the power supply is in standby mode.

**Constant Voltage Mode (CV)**

Constant voltage mode is set when the unit is operating in constant voltage mode.

**Error**

An error is set if the unit has been shut down by an OVP condition. To clear this error condition, the output must be turned off using the OUTPUT key, the Standby Input signal or a bus command.

## 7.4 Protection Features

The DDP Series power supplies include the following protection features:

- Over Voltage
- Over Current
- Over Power
- Over Temperature

### 7.4.1 Over Voltage Protection

The over voltage protection trip level can be programmed up to 120% of the available voltage range of the power supply model. If the over voltage circuit has tripped, the output is disabled prevent damaging the power supply and/or the load. When an over voltage trip condition has occurred, the LCD display will indicate "OVP Fault"

### 7.4.2 Over Current Protection

The power supply always monitors the output current. When the current exceeds the set Imax level, the power supply will transition to constant current mode by reducing the output voltage to maintain the current at the set Imax level.

### 7.4.3 Over Temperature Protection

As soon as the temperature of power supply's internal heat sinks reaches its maximum safe temperature level, the over temperature protection is triggered. The digital current meter's LCD display will indicate "OTP". The power supply will turn to the output off state.

Please check environmental conditions such as the ambient temperature and distance between the rear panel of the power supply and any wall is greater than 15cm / 6 inches.

# 8 Remote Control Programming

## 8.1 Overview

If your unit is fitted with a computer interface option then a GPIB, RS232, RS485, USB or LAN connector will be present on the rear panel based on the order configuration. The interface allows the powers supply settings to be configured remotely and measurement data to be retrieved for analysis and test report generation.

## 8.2 Interface Precedence

All interfaces present have the same priority and accept the same command syntax so there is no interface hierarchy. Thus, it is possible to send one command to the GPIB interface and the next one to the LAN interface. Query command responses are returned via the interface to which the query was sent.

Note: While it is permissible to alternate between different available digital interfaces, for practical reasons this is not recommended. Using one interface at a time requires few resources from the controller computer and leads to less confusion.

## 8.3 Command Syntax

All DDP Series DC power supplies use of proprietary compact command syntax composed of a short command mnemonic, one or more parameters (if required) separated from the command by commas and a command terminator character. Commands are not case sensitive so any combination of upper and lower case characters is permissible.

For consistency, this document will use UPPER CASE command syntax for consistency and to differentiate commands from regular text.

### 8.3.1 Command Terminators

Allowable terminator characters are:

| Character | ASCII | Dec value | Hex value |
|---|---|---|---|
| **Carriage Return** | <CR> | 13 | 0x0d |
| **Line Feed** | <LF> | 10 | 0x0a |

### 8.3.2 ESC characters

Commands will be ignored if they contain a <DEL> or <ESC> character. When using a terminal program, this feature may be used to cancel a command that is being typed and sent to the power supply character by character. Enter <DEL> or <ESC> followed by <CR> to cancel the command.

| Character | ASCII | Dec value | Hex value |
|---|---|---|---|
| **Escape** | <ESC> | 27 | 0x1b |
| **Delete** | <DEL> | 127 | 0x7f |

### 8.3.3 Numeric Parameters

If a command requires a parameter, it may be entered as a real number using a period as the decimal separator. The number of position after the decimal is unlimited. For example, the following command all have the same effect:

UA,10
UA,10.00
UA,10.000000
UA,00010
UA,0010.00

The actual parameter value used by the DC supply controller is generally defined by a resolution of 0.1% or 1/1000$^{th}$ of the parameter value. For example:

UA,600.45 processed as 600.5 as 0.1% of 600.45 is 0.6 or 1 position after the decimal point.

UA,23.451 processed as 23.451 as 0.1% of 23 = 0.023 or 3 positions after the decimal point.

### 8.3.4 Parameter Unit Options

When sending a parameter value, it is permissible to include a unit character such as V for voltage or A for amps. This will make program code easier to under read or understand but the unit character sent is ignored by the DC power supply and is thus a don't care.

For example, the following three commands are identical:

UA,100

UA,100V

UA,100d

### 8.3.5 Command Example

A valid command syntax and its ASCII and HEX code values are shown in the table below.

**UA,10.2**

| U | A | , | 1 | 0 | . | 2 | <CR> |
|---|---|---|---|---|---|---|---|
| 55 h | 41 h | 27 h | 31 h | 30 h | 46 h | 32 h | 0 dh |

## 8.4 Syntax Notation Convention

The following parentheses are used in the command descriptions to indicate whether a command is necessary or optional and whether a choice has to be made. The symbols { }, [ ], | are not actually used in the programming commands. The symbols { }, [ ] and | are merely used to illustrate the command syntax.

[ ] - Optional: The contents of the [ ] symbol indicates that the command is optional. The use of the contents depends on the test application.

{ } - Selection: The contents between the { } symbols is a list of available parameter values.

| - Required Choice: This symbol acts as a separator between multiple parameter options. It means a choice must be made between the stated parameter key words. For example, “LOW|HIGH” Means a LOW or HIGH choice needs to be made as part of the command.

<> - Parameter Value: Indicates a numeric value.

**Example:**

GTR[,{1|2|3}] Means that the command GTR can be used with or without a parameter. If a parameter is needed, available options are 1, 2 or 3. Thus, valid commands are:

GTR
GTR,1
GTR,2
GTR,3

## 8.5 Remote Control Command Summary Table

The following table lists all available remote control commands in alphabetical order. Each command is described in more detail in subsequent sections.

| Command | Description | Result |
|---|---|---|
| **CLS* or CLS** | Clear Status | Clears the status byte register |
| **DAT,<U>,<I>** | DIP | Data for user-defined characteristic |
| **DCL** | Device Clear | Initializes all settings including interface to reset state |
| **GTL** | Go To Local | Activates front panel operation |
| **GTR[,{0\|1\|2}]** | Go To Remote | Activates remote operation (digital interface) |
| **IA[,<Imax>]** | Set $I_{max}$ | Adjusts current limit setting |
| **ID or *IDN?** | Identification | Returns identification string |
| **IMPP[,<Impp>]** | Set $I_{mpp}$ | Adjusts MPP current during PVsim mode. |
| **LLO** | Local Lockout | Disables LOCAL button |
| **LIMI** | Limit $I_a$ | Returns maximum adjustable current limitation |
| **LIMP** | Limit $P_a$ | Returns maximum unit output. |
| **LIMR** | Limit R | Returns adjustable range for $R_i$ within UIR mode. |
| **LIMRMAX** | Limit $R_{max}$ | Returns maximum adjustable range for $R_i$ within UIR mode. |
| **LIMRMIN** | Limit $R_{min}$ | Returns minimum adjustable range for $R_i$ within UIR mode. |
| **LIMU** | Limit $U_a$ | Returns maximum adjustable voltage limitation |
| **MI[,<Nr>]** | Measure $I_a$ | Measures output current |
| **MODE[,{UI\|UIP\|UIR\|PV SIM\| USER\|Skript}]** | Set Mode | Selects operation mode |
| **MU[,<Nr>]** | Measure $U_a$ | Measures output voltage |
| ***OPT?** | Optional Identification Query | Displays units hardware/software version |
| **OVP[,<$U_{ovp}$>]** | Overvoltage Protection | Adjusts over voltage protection trip level |
| **PA[,<$P_{limit}$>]** | Set $P_{max}$ | Adjusts power limit |
| **PCx[,<baud>,<parity>,<data bits>,<stop bits>,<handshake>,<echo>,<timeout>]** | Program Communication | Adjusts interface parameters. Applies to RS232, RS485 or USB only. |
| **RA[,<$R_i$>]** | Set $R_i$ | Adjusts internal resistance |
| **REGLER[,<Nr>,<Kp>,<Ki>, <Kd>]** | Controller Parameters | Adjusts controller parameters for UIP, UIR and PVsim mode |
| **RI or *RST** | Reset Instrument | Resets hardware (no return value) |
| **SB[,{S\|R\|1\|0}]** | Standby | Enables/Disables the output |
| **SCR[,<CMD>[,<value>]]** | Load Script | Programming of script memory |
| **SS or *PDU** | Save Setup | Saves previously made channel and interface parameter adjustments (no return value) |
| **STATUS** | Status | Query of the units status (return values in binary format) |
| **STB or *STB?** | Interface Status | Status Byte Register query command |

| Command | Description | Result |
|---|---|---|
| **UA[,<Ua>]** | Set $U_a$ | Adjusts output voltage (if there are no parameters, present set point is displayed) |
| **UMPP[,<Umpp>]** | Set $U_{mpp}$ | Adjusts MPP voltage in $PV_{sim}$ mode (if there are no parameters, present set point is displayed) |
| **WAVE** | End Userwave Data | Ends transfer of user-defined output characteristic (gradual interpolation of intermediate values) |
| **WAVELIN** | End Userwave Data | Ends transfer of user-defined output characteristic (linear interpolation of intermediate values) |
| **WAVERESET,<Um>,<Im>** | Start Userwave Data | Starts transfer of user-defined output characteristic |

## 8.6 Remote Control Command Descriptions by Category

This section covers detailed description of the available commands by category. The following command categories are defined.

| Command Category | Description |
|---|---|
| **SETTING** | These commands are used to change instrument setting. |
| **LIMIT** | These commands are used to query or set limits for voltage, current, power and other operating parameters |
| **STATUS** | These commands are used to control or query status and error messages. |
| **SYSTEM** | These commands are used to control system level setting such as interfaces, special operating modes or other special instrument specific functions. |
| **MEASUREMENT** | These commands are used to measure voltage, current, power and any other measurement parameters from the instrument. |

### 8.6.1 Setting Commands

Setting commands are used to control the state of the power supply. They control settings and operating modes.

The following SETTINGS Commands are supported.

| Command | Description | Result |
|---|---|---|
| **DAT,<U>,<I>** | DIP | Data for user-defined characteristic |
| **IA[,<Imax>]** | Set $I_{max}$ | Adjusts current limit setting |
| **IMPP[,<Impp>]** | Set $I_{mpp}$ | Adjusts MPP current during PVsim mode. |
| **MODE[,{UI\|UIP\|UIR\|PV SIM\| USER\|Skript}]** | Set Mode | Selects operation mode |
| **OVP[,<$U_{ovp}$>]** | Overvoltage Protection | Adjusts over voltage protection trip level |
| **PA[,<$P_{limit}$>]** | Set $P_{max}$ | Adjusts power limit |
| **RA[,<$R_i$>]** | Set $R_i$ | Adjusts internal resistance |
| **REGLER[,<Nr>,<Kp>,<Ki> , <Kd>]** | Controller Parameters | Adjusts controller parameters for UIP, UIR and PVsim mode |
| **SB[,{S\|R\|1\|0}]** | Standby | Enables/Disables the output |
| **SCR[,<CMD>[,<value>]]** | Load Script | Programming of script memory |
| **UA[,<Ua>]** | Set $U_a$ | Adjusts output voltage (if there are no parameters, present set point is displayed) |
| **UMPP[,<Umpp>]** | Set $U_{mpp}$ | Adjusts MPP voltage in $PV_{sim}$ mode (if there are no parameters, present set point is displayed) |
| **WAVE** | End Userwave Data | Ends transfer of user-defined output characteristic (gradual interpolation of intermediate values) |
| **WAVELIN** | End Userwave Data | Ends transfer of user-defined output characteristic (linear interpolation of intermediate values) |
| **WAVERESET,<Um>,<Im>** | Start Userwave Data | Starts transfer of user-defined output characteristic |

**DAT**

**Command Syntax:**

DAT, <U> , <I>

**Purpose:** This command sets a user defined voltage and current operating point for the USER mode of operation. For details on the use of this command, refer to the WAVEREST command.

**Query response:** N/A

**Example:** DAT, 100, 5.0 (send)

**Alias:** none

**IA**

**Command Syntax:**

IA [, $I_{max}$> ]

**Purpose:** This command sets the current limit value. Entering the command without a parameter returns the set value. If the set value is higher than the maximum current capability of the unit, the range-error-bit within the ESR register of the interface is set. In that case, the present set value remains unchanged. If the set value is higher than the $I_{limit}$ value, which was set as part of the by the user's settings in the configuration menu, but lower than the maximum current of the unit, the current is truncated to the $I_{limit}$ value. No error message is generated in this case.

**Query response:** The query format of this command uses no parameter and returns the current limit setting that is in effect.

| | | |
|---|---|---|
| **Example:** | IA, 250.0 | (send) |
| | IA | (send) |
| | IA, 200.0A | (returns setting. $I_{limit}$ must be set to 200A) |

**Alias:** none

**IMPP**

**Command Syntax:**

IMPP [, <$I_{mpp}$>]

**Purpose:** This command adjusts the MPP current for PVsim mode. Entering the command without parameters returns the set value. If the set value is higher than the maximum current of the unit, the range-error-bit within the ESR register of the interface is set. In that case the present set value remains unchanged. If the set value is higher than the $I_{limit}$ value, which was adjusted by the user's settings in the configuration menu, but lower than the maximum current capability of the unit, the current is limited to the $I_{limit}$ value. No error message follows.

**Query response:** The query format of this command uses no parameter and returns the current limit setting that is in effect.

| | | |
|---|---|---|
| **Example:** | IMPP, 150.0 | (send) |
| | IMPP | (send) |
| | IMPP, 120.0A | (returns setting. $I_{limit}$ must be set to 200A) |

**Application Example:**

| | |
|---|---|
| GTR | Remote operation |
| OVP,200 | Over voltage protection |
| UA,50.5 | Open circuit voltage of a 50.5 V simulated PV generator |
| IA,10 | Short circuit current of a simulated 10 A PV generator |
| UMPP,40.4 | MPP voltage of a simulated 40.4 V PV generator |
| IMPP,8.2 | MPP current of a simulated 8.2 A PV generator |

| | |
|---|---|
| MODE,PVSIM | Activates PV simulation mode |
| SB,R | Enable output |

**Alias:** none

**MODE**

**Command Syntax:**

MODE [,{ UI | UIP | UIR | PVSIM | USER | Skript | 0 | 1 | 2 | 3 | 4 | 5 } ]

**Purpose:** This command selects the operation mode. Entering the command without a parameter returns the presently selected operation mode. Entering the command with parameter activates the relevant operation mode. Alternatively, the operation mode parameter can be sent as number.

**Query response:** The query format of this command uses no parameter and returns the operation mode that is in effect.

The table below lists the available operating mode parameters and equivalent number.

| Command | Function |
|---|---|
| **MODE,UI**<br>**MODE,0** | UI mode is activated |
| **MODE,UIP**<br>**MODE,1** | UIP mode is activated |
| **MODE,UIR**<br>**MODE,2** | UIR mode is activated |
| **MODE,PVSIM**<br>**MODE,3** | $PV_{sim}$ mode is activated |
| **MODE,USER**<br>**MODE,4** | User-defined UI characteristic is activated. The characteristic U/I profile for this mode is defined with the commands ***DAT***, ***WAVE***, ***WAVELIN*** and ***WAVERESET***. |
| **MODE,SKRIPT**<br>**MODE,5** | Script mode is activated. The script is read from the memory card or loaded after the SCR command has been sent. |

| | | |
|---|---|---|
| **Example:** | MODE, UI | (send) |
| | MODE | (send) |
| | MODE,UI | |

**Alias:** none

**OVP**

**Command Syntax:**

OVP, [,<$U_{ovp}$>]

**Purpose:** This command sets the over voltage protection trip level. Entering the command without a parameter displays the present set point. If the set point is higher than a maximum of 1.2 times the maximum voltage range of the unit (120%), the range error bit within the ESR register of the interface is set. In that case the present OVP set point remains unchanged.

**Query response:** The query format of this command uses no parameter and returns the OVP trip level that is in effect.

| | | |
|---|---|---|
| **Example:** | OVP, 220 | (send) |
| | OVP | (send) |
| | OVP, 220 | (response) |

**Application Example:**

| | |
|---|---|
| GTR | Enable remote operation mode |
| OVP,200 | Set over voltage protection to 200 V |
| UA,100 | Set output voltage to 100 V |
| IA,10 | Set output current limit to 10 A |
| SB,R | Enable output |

**Alias:** none

**PA**

**Command Syntax:**

PA [,<$P_{limit}$>]

**Purpose:** This command sets the power limitation for the UIP mode. Entering the command without a parameter returns the present PA set point. If the set point is higher than the maximum power rating of the unit, the range error bit within the ESR register of the interface is set. In that case, the present set point remains unchanged..

**Query response:** The query format of this command uses no parameter and returns the power limit setting that is in effect.

| | | |
|---|---|---|
| **Example:** | PA, 8000 | (send) |
| | PA | (send) |
| | PA,8000W | |

**Application Example:**

| | |
|---|---|
| GTR | Enable remote operation mode |
| MODE,UIP | UIP mode activated |
| OVP,200 | Set over voltage protection to 200 V |

| | |
|---|---|
| UA,100 | Set output voltage to 100 V |
| IA,10 | Set output current limit to 10 A |
| PA,500 | Set the power limitation to 500 W |
| SB,R | Enable output |

**Alias:** none

**RA**

**Command Syntax:**

RA [, <$R_i$ >]

**Purpose:** This command sets the internal resistance for the UIR mode. Entering the command without a parameter returns the present $R_i$ set point. If the set point is out of adjustment range(see LIMR), the range error bit of the interface is set in the ESR register. In that case, the present set point remains unchanged. Adjustment range can be queried with the LIMR, LIMRMAX and LIMRMIN commands.

**Query response:** The query format of this command uses no parameter and returns the resistance setting that is in effect.

| | | |
|---|---|---|
| **Example:** | RA, 0.50 | (send) |
| | RA | (send) |
| | RA,0.50R | (response) |

**Application Example:**

| | |
|---|---|
| GTR | Enable remote operation mode |
| MODE,UIR | UIR mode activated |
| OVP,200 | Set over voltage protection to 200 V |
| UA,100 | Set output voltage to 100 V |
| IA,10 | Set output current limit to 10 A |
| RA,0.1 | Set internal resistance 100 mOhm |
| SB,R | Enable output |

**Alias:** none

**REGLER**

**Command Syntax:**

REGLER [, <Nr> , <Kp> , <Ki> , <Kd> ]

**Purpose:** This command sets values for controller parameters in UIP, UIR and $PV_{sim}$ modes. The <Nr> parameter refers to the PID mode for which these parameters are to be applied. ( 0 = UIP, 1 = UIR and 2 = $PV_{sim}$).

Entering the command without any parameters returns the present settings as a table. The number of the parameter determines the parameter set which is to be adjusted.

**Query response:** The query format of this command uses no parameter and returns the control parameter settings that are in effect for UIP, UIR and PVsim mode in that order.

| | | |
|---|---|---|
| **Example:** | REGLER, 0, 20,10,3 | (send) |
| | REGLER | (send) |
| | TYPE<sp>PID | (response, <sp> = space 0x20) |
| | P<sp>10<sp> 20<sp> 5 | (response) |
| | Ri<sp> 20 <sp>20 <sp>2 | (response) |
| | Pv <sp>10 <sp>5<sp>5 | (response) |

**Application Example:**

| | |
|---|---|
| REGLER | Read present settings |
| Type P I D | Unit answers: |
| P 10 20 5 | UIP Mode Kp = 20 Ki = 10 Kd = 5 |
| Ri 20 20 2 | UIR Mode Kp = 20 Ki = 20 Kd = 5 |
| Pv 10 5 5 | PV Mode Kp = 10 Ki = 5 Kd = 5 |
| REGLER,0,10,10,5 | Send new controller parameters for UIP mode |
| REGLER,1,22,18,5 | Send new controller parameters for UIR mode |
| SS | Save new settings |

**Alias:** none

**SB**

**Command Syntax:**

SB [, { S | R | 1 | 0 } ]

**Purpose:** This command enables or disables the power supply output. Entering the command without a parameter returns the present output status. The commands SB, S and SB, 1 switch the unit to standby mode with the output disabled. The commands SB, R and SB, 0 disable the standby mode which means the output is enabled.

**Query response:** The query format of this command uses no parameter and returns the current output state that is in effect.

| | | |
|---|---|---|
| **Example:** | SB, 0 | (send) |
| | SB | (send) |
| | SB, R | (returns output enabled setting) |

**Note:** 0 = Output ON
1 = Output OFF

**Alias:** R, S

**SCR**

**Command Syntax:**

SCR [, <CMD> [, <value> ] ]

**Purpose:** This command is used to program the scripting feature memory. The command SCR without any parameters initializes the programming procedure. The same SCR command with parameters writes the commands into the script memory. The order of the commands corresponds to the order of commands of the script. Thus, they will be executed in the same order they were entered. Script commands and their parameters are described in more detail in the "Script Control" section of this manual. Refer to this section for the list of available script command parameters.

**Note:** This feature requires the SD Memory Card (-SD) option to be installed in the power supply.

**Query response:** N/A.

**Application Example:**

| | |
|---|---|
| GTR | Enable remote operation mode |
| OVP,200 | Over voltage protection 200 V |
| SCR | Initialize script programming |
| SCR,U,12 | 1. script command: U = 12 V |
| SCR,I,15 | 2. script command: I = 15 A |
| SCR,UI | 3. script command: mode UI |
| SCR,RUN | 4. script command: activate output |
| SCR,LOOPCNT,10 | 5. start address loop |
| SCR,U,12 | 6. script command: U = 12 V |
| SCR,DELAY,8 | 7. script command: wait 8 msecs |
| SCR,U,1 | 8. script command: U = 1 V |
| SCR,DELAY,1000 | 9. script command: wait 1 s |
| MODE,SKRIPT | Select script mode of operation |
| SB,R | Enable output to start script execution |

**Alias:** none

**UA**

**Command Syntax:**

UA [, <V> ]

**Purpose:** This command sets the voltage limit. As long as the load impedance is high enough not to exceed the set current limit value, the output voltage will regulate to this set point. Entering the command without a parameter returns the present set point. If the set point exceeds the maximum voltage capability of the unit, the range error bit within the ESR register of the interface is set. In that case, the present set point remains unchanged. If the set point is higher than the selected value for $U_{limit}$, but lower than the unit's maximum voltage, voltage limitation is restricted to $U_{limit}$. There is no error generated in this case.

**Query response:** The query format of this command uses no parameter and returns the voltage limit setting that is in effect.

| | | |
|---|---|---|
| **Example:** | UA, 250.0V | (send) |
| | UA | (send) |
| | UA, 200.0V | (returns setting. $U_{limit}$ must be set to 200A) |

**Note:** In Master/Slave mode, the voltage of the programmed device is set. In master/slave serial connection the total voltage will be n x UA, where n is the number of power supplies in series.

**Example:**

Three devices are connected in series while in Master/Slave mode. With UA,10 an output voltage of 10V is programmed. Therefore all connected devices are adjusted to 10V. Since three devices are connected in series, the total voltage is 3 x 10 V = 30 V.

**Alias:** none

**UMPP**

**Command Syntax:**

UMPP [, <Umpp> ]

**Purpose:** This command sets the MPP voltage for the $PV_{sim}$ mode of operation. Entering the command without a parameter returns the present set point. If the set point is higher than the maximum voltage capability of the unit, the range error bit within the ESR register of the interface is set. In that case the present set point remains unchanged. If the set point is higher than the $U_{limit}$ value which was adjusted in the configuration menu, but lower than the maximum voltage of the unit, the voltage limitation is restricted to $U_{limit}$. There is no error generated in this case.

**Query response:** The query format of this command uses no parameter and returns the MPP voltage setting that is in effect.

| | | |
|---|---|---|
| **Example:** | UMPP, 80.0V | (send) |
| | UMPP | (send) |
| | UA, 80.0V | (returns setting) |

**Application Example:**

| | |
|---|---|
| GTR | Enable remote operation mode |
| OVP,200 | Set over voltage protection to 200 V |
| UA,50.5 | Set open circuit voltage of a simulated PV generator to 50.5 V |
| IA,10 | Set short-circuit current of a simulated PV generator to 10 A |
| UMPP,40.4 | Set the MPP voltage of the simulated PV generator to 40.4 V |
| IMPP,8.2 | Set the MPP current of the simulated PV generator to 8.2 A |
| MODE,PVSIM | Activate $PV_{sim}$ mode |
| SB,R | Enable output |

**Alias:** none

**WAVE**

**Command Syntax:**

WAVE

**Purpose:** This command ends the transfer of a user defined output characteristic. Interpolation of interim values is layered. For detailed information about the function of this command see the “WAVERESET” command.

**Query response:** N/A

**Example:** WAVE (send)

**Alias:** none

**WAVELIN**

**Command Syntax:**

WAVELIN

**Purpose:** This command ends the transfer of a user defined output characteristic. Interpolation of interim values is linear. For detailed information about the function of this command see the “WAVERESET” command.

**Query response:** N/A

**Example:** WAVELIN (send)

**Alias:** none

**WAVERESET**

**Command Syntax:**

WAVERESET, <Um> , <Im>

**Purpose:** This command starts the transfer of a user defined set of output characteristic data points. The parameters $U_{max}$ and $I_{max}$ define the maximum voltage and current of the output characteristic. Immediately following this command, the pivot points of the UI profile can be entered using the DAT command. The profile definition ends with the commands WAVE or WAVELIN which determine how the interpolation between the provided pivot points is to be implemented.

**Query response:** N/A

**Example:** WAVELIN (send)

**Note:** For more information and examples of user defined UI characteristics refer to the WAVE, WAVELIN and the “Programming of UI characteristics” (Script Operation) sections of this manual.

**Alias:** none

### 8.6.2 Limit Commands

All limit commands are query only commands and start with the "LIM" prefix followed by the parameter limit value they return. Limit values default to rated maximum values but may be set to lower user limits from the front panel in the Configuration menu. Once set and saved to non-volatile memory, they will be in effect each time the unit is powered on. User limits allow maximum voltage, current and power to be defined by the user rather than the units maximum capability.

The LIMIT commands may be used to query the limit values in effect so an application program does not send setting values that are out of range resulting in range errors.

The following LIMIT commands are supported.

| Command | Description | Result |
|---|---|---|
| **LIMI** | Limit $I_a$ | Returns maximum adjustable current limitation |
| **LIMP** | Limit $P_a$ | Returns maximum unit output. |
| **LIMR** | Limit R | Returns adjustable range for $R_i$ within UIR mode. |
| **LIMRMAX** | Limit $R_{max}$ | Returns maximum adjustable range for $R_i$ within UIR mode. |
| **LIMRMIN** | Limit $R_{min}$ | Returns minimum adjustable range for $R_i$ within UIR mode. |
| **LIMU** | Limit $U_a$ | Returns maximum adjustable voltage limitation |

**LIMI**

**Command Syntax:**

LIMI

**Purpose:** Returns maximum current limit setting range in amps.

**Query response:** The query response consist of the command echo "LIMI" followed a floating point value for the current limit. **Note** that this value may be less than the rating of the power supply model if this limit was set to a lower value in the configuration menu.

**Example:** LIMI (send)
LIMI,25.0A (response)

**Alias:** none

**LIMP**

**Command Syntax:**

LIMP

**Purpose:** Returns maximum power setting range in watts.

**Query response:** The query response consist of the command echo "LIMP" followed a floating point value for the power limit. **Note** that this value may be less than the rating of the power supply model if this limit was set to a lower value in the configuration menu.

**Example:** LIMP (send)
LIMP,10000W (response)

**Alias:** none

**LIMR**

**Command Syntax:**

LIMR

**Purpose:** Returns minimum and maximum internal resistance setting range for the UIR mode in ohms.

**Query response:** The query response consist of the command echo “LIMR” followed by two floating point value for the resistance limit. (min, max)

**Example:** LIMR (send)
LIMR,0.015R,1.00R (response)

Min. set value = 15 mOhm, max. set value is 1.0 Ohm.

**Alias:** none

**LIMRMAX**

**Command Syntax:**

LIMRMAX

**Purpose:** Returns maximum internal resistance setting range for the UIR mode in ohms.

**Query response:** The query response consist of the command echo “LIMRMAX” followed by a floating point value for the resistance limit. (max)

**Example:** LIMR (send)
LIMR,,1.00R (response)

Max. set value is 1.0 Ohm.

**Alias:** none

**LIMRMIN**

**Command Syntax:**

LIMRMIN

**Purpose:** Returns minimum internal resistance setting range for the UIR mode in ohms.

**Query response:** The query response consist of the command echo “LIMR” followed by a floating point value for the resistance limit. (min)

**Example:** LIMR (send)
LIMR,0.015R (response)

Min. set value = 15 mOhm.

**Alias:** none

**LIMU**

**Command Syntax:**

LIMU

**Purpose:** Returns maximum voltage setting range in volts.

**Query response:** The query response consist of the command echo "LIMU" followed a floating point value for the voltage limit. **Note** that this value may be less than the rating of the power supply model if this limit was set to a lower value in the configuration menu.

**Example:** LIMU (send)
LIMU,300.0V (response)

**Alias:** none

### 8.6.3 Status Commands

Status commands allow access to status and error registers that define the state of the power supply and the interfaces used. The following status commands are supported.

| Command | Description | Result |
|---|---|---|
| **CLS** | Clear Status | Clears the status byte register |
| **DCL** | Device Clear | Initializes all settings including interface to reset state |
| **GTL** | Go To Local | Activates front panel operation |
| **GTR[,{0\|1\|2}]** | Go To Remote | Activates remote operation (digital interface) |
| **LLO** | Local Lockout | Disables LOCAL button |
| **RI** | Reset Instrument | Resets hardware (no return value) |
| **STATUS** | Status | Query of the units status (return values in binary format) |
| **STB** | Interface Status | Status Byte Register query command |

**CLS**

**Command Syntax:**

CLS

**Purpose:** CLear Status command. Clears the status byte register. For details on the status register, refer to the STB command.

**Query response:** N/A

**Example:** CLS (send)

**Alias:** *CLS

**DCL**

**Command Syntax:**

DCL

**Purpose:** Device CLear command. This command initializes all settings to power on conditions. Equivalent to sending a reset command (RI).

**Query response:** N/A

**Example:** DCL (send)

**Alias:** none

**GTL**

**Command Syntax:**

GTL

**Purpose:** Go To Local command. This command takes the power supply out of remote state and returns control to the front panel. If the local lock out state (LLO) was set before, it will be reset.

**Query response:** N/A

**Example:** GTL (send)

**Alias:** none

**GTR**

**Command Syntax:**

GTR [, { 0 | 1 | 2 } ]

**Purpose:** Go To Remote command. This command enables any of the available remote control interfaces. The optional parameters determine the power on state of the power supply after it has been power cycled. Available Remote States are shown in the table below.

| Remote State | Command | Description |
|---|---|---|
| **none** | GTR | Enable remote control interface. Power on state remains as it was set before. |
| **0** | GTR,0 | Front panel control. Remote state is off at power up. To enable remote control using any available digital interface, the GTR command (no parameter needed) must be explicitly sent.<br>This mode is most appropriate when the power supply has to be manually operated but remote queries of measurement data is may be needed. |
| **1** | GTR,1 | Front panel control with interface enabled. Unit powers up with front panel enabled but will switch to remote control with front panel lockout as soon as any command is received over one of the available digital interfaces. The only exception to this is the GTL command which will place the unit in front panel control mode.<br>All units are shipped with this mode set from the factory. |
| **2** | GTR,2 | Remote control mode. At power up, the unit is in remote control mode with the front panel controls locked out.<br>This mode is most appropriate for ATE applications where all interactions are through software control. |

**Query response:** N/A

**Examples:** GTL (send, last GTL state remains in effect)
GTL,2 (send, next time unit will power up in Remote state)

**Alias:** none

**LLO**

**Command Syntax:**

LLO

**Purpose:** Local Lock Out command. This command disables the front panel. This means the unit cannot be taken out of remote mode from the front panel keypad. When not in Local Lockout, pressing the OUTPUT button from more than one second will return control to the front panel as long as the LLO command has not been sent.

**Query response:** N/A

**Example:** LLO (send)

**Alias:** none

**RI**

**Command Syntax:**

RI

**Purpose:** Reset Instrument command. This command resets the power supply to its power on state.

**Query response:** N/A

**Example:** RI (send)

**Alias:** *RST

**STATUS**

**Command Syntax:**

STATUS

**Purpose:** Status query command. This command returns the power supplies Device Status Register. Note that this register is different from the Status Byte Register returned by the STB command. (See next).

**Query response:** The Status register provides information about the power supplies hardware status and hardware configuration.

The following bits are defined in the Device Status Register.

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

**Query response:** N/A

**Example:** STATUS (send)
STATUS,0000000100010000 (response, msb to lsb)

Device status = Remote operation mode (b4), power limit mode (b8).

**Alias:** none

**STB**

**Command Syntax:**

STB

**Purpose:** STatus Byte Register query command. This command returns the contents of the Status Byte Register.

**Query response:** The Status register provides information about the interface status of the power supply.

**Note:** The format and configuration of the Status Byte Register is a function of the selected remote control interface. (See PC command for interface selection). Refer to section 8.7.7, "*STB?" for details on Status Byte Register configurations by interface type. For GPIB, 8 bits will be returned. For serial interfaces, 16 bits will be returned.

| | | |
|---|---|---|
| **Example:** | STB | (send) |
| | STB,00000001 | (response, msb to lsb) |

**Alias:** *STB?

### 8.6.4 System Commands

Systems control system level function or return model and revision information on the connected unit. The following system commands are supported.

| Command | Description | Result |
|---|---|---|
| **ID** | Identification | Returns identification string |
| ***OPT?** | Optional Identification Query | Displays units hardware/software version |
| **PCx[,<baud>,<parity>,<data bits>,<stop bits>,<handshake>,<echo>,<timeout>]** | Program Communication | Adjusts interface parameters. Applies to RS232, RS485 or USB only. |
| **SS or *PDU** | Save Setup | Saves previously made channel and interface parameter adjustments (no return value) |

**ID**

**Command Syntax:**

ID

**Purpose:** This command displays the identification string. Return value: <ID-String>.

**Query response:** Unit ID String.

**Example:** ID (send)
ID, APS,DDP100-10,1.0 (response)

**Alias:** *IDN?

***OPT?**

Refer to section 8.7.4, “*OPT?” on page 89.

**PCx**

**Command Syntax:**

PCx [, <baud> , <parity> , <data bits> , <stop bits> , <handshake> , <echo> , <timeout> ]

**Purpose:** Program Communications command**.** This command sets the interface parameters for the selected interface type. The DDP Series supports a maximum of three (3) digital interfaces (x = 1, 2 or 3). The corresponding commands are PC1, PC2 or PC3. Type and number of parameters depends on the type of interface selected. Currently there are no programmable settings required for GPIB and LAN interfaces. Entering the command without any parameters displays available interface parameters.

**Note:** If the interface parameters must be changed permanently, the data has to be saved after sending the PCx command with the command “SS”.

**Query response:** EMPTY or Interface parameters.

Available parameters by interface type are:

| Parameter | Function |
|---|---|
| **<baud>** | Baud rate in bps |
| **<parity>** | Data parity<br>O = Odd = Uneven parity<br>E = Even = Even parity<br>N = None = No parity bit |
| **<data bits>** | Number of data bits |
| **<stop bits>** | Number of stop bits |
| **<handshake>** | Handshake<br>H = Hardware<br>S = Software<br>N = None (no handshake) |
| **<echo>** | Character echo<br>E = Echo = echo on<br>N = None = echo off |
| **<timeout>** | Timeout in ms when switching between sending and receiving (RS485 only) |

Allowable parameters by interface type are:

**RS232 or USB**

PCx,<baud>,<parity>,<data bits>,<stop bits>,<handshake>,<echo>

| Parameter | Function |
|---|---|
| **Baud:** | 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 62500, 115200 |
| **Parity:** | O, E, N |
| **Data bits:** | 7, 8 |
| **Stop bits** | 1, 2 |
| **Handshake:** | H, S, N |
| **Echo:** | E, N |

**Note:** The USB interface of the PC is controlled like a virtual COM port and therefore the parameters correspond to those of the RS232 interface.

**RS485**

PCx,<baud>,<parity>,<data bits>,<stop bits>,<timeout>

| Parameter | Function |
|---|---|
| **Baud:** | 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 62500, 115200 |
| **Parity:** | O, E, N |
| **Data bits:** | 7, 8 |
| **Stop bits** | 1, 2 |
| **Timeout:** | 0…100 |

**Example:** PC1 (send)
PC1, RS232,9600,N,8,2,N,E (response)

**Application Example:**

| | |
|---|---|
| PC1 | Query of first interface parameters |
| PC1,RS232,9600,N,8,2,N,E | Unit returns: PC1 is a RS232 interface, 9600 bauds, 8 data bits, 2 stop bits, no handshake, no parity, echo on. |
| PC1,115200,N,8,2,N,E | Adjust baud rate to 115200 baud. The new baud rate is active immediately after the command has been sent. |
| PC2 | Query of second interface parameters |
| PC2,RS485,9600,N,8,1,1 | Unit returns: PC2 is a RS485 interface, 9600 bauds, 8 data bits, 1 stop bit. Timeout applies when switching between receiving and sending. Value is in msecs. |
| PC2,9600,N,8,1,50 | Increase timeout to 50msecs. |
| PC3 | Query of third interface parameters |
| PC3, EMPTY | Unit returns: Interface 3 is not available in this unit. |
| SS | Save settings. |

**Alias:** none

**SS**

**Command Syntax:**

SS

**Purpose:** This command saves present unit parameters (interface parameters and controller parameters) to non-volatile memory. No return value.

**Query response:** NA.

**Example:** SS (send)

**Alias:** *PDU

### 8.6.5 Measurement Commands

The measurement commands return voltage and current read back data in floating point format. The resolution is determined by the value measured and is generally down to 0.1% of measured value. The following measurement commands are supported.

| Command | Description | Result |
|---|---|---|
| **MI[,<Nr>]** | Measure $I_a$ | Measures output current |
| **MU[,<Nr>]** | Measure $U_a$ | Measures output voltage |

**MI**

**Command Syntax:**

MI [, <Nr> ]

**Purpose:** Returns measurement of the current sourced by the power supply. In Master/Slave parallel operation, if the <Nr> parameter is omitted, the total current of the configured units is displayed. With the parameter <Nr> the values of each connected unit can be queried. The numbering starts with 0 (Master).

**Query response:** Floating point number.

**Example:** MI (send)
MI, 25.254A (response)

**Alias:** none

**MU**

**Command Syntax:**

MU [, <Nr> ]

**Purpose:** Returns measurement of the voltage present at external sense point of the power supply. In Master/Slave series operation, if the <Nr> parameter is omitted, the total voltage of the configured units is displayed. With the parameter <Nr> the values of each connected unit can be queried. The numbering starts with 0 (Master).

**Query response:** Floating point number.

**Example:** MU (send)
MU, 240.5V (response)

**Alias:** none

## 8.7 IEEE488.2 Common Commands

The following IEEE488.2 common commands (a.k.a. star commands) are supported by the DC power supply. These commands are provided for compatibility with the IEEE488.2 standard. They are aliases to the relevant proprietary command and can be used interchangeably.

### 8.7.1 *CLS

**Command Syntax:**

*CLS

**Purpose:** The *CLS command (clear status) resets the power supply status byte.

**Alias:** CLS

### 8.7.2 *ESR?

**Command Syntax:**

*ESR?

**Purpose:** Reads the contents of the Status Event Register (ESR). After this query, the content of the ESR register is reset.

**Query response:** The query response consist of “ESR” followed by 8 binary digits separated by a comma.

**Example:** ESR,bbbbbbbb (msb..lsb)

**Alias:** none

**ESR Register Configuration:**

| Bit | Function |
|---|---|
| **D7** | Power on |
| **D6** | Command error |
| **D5** | User request |
| **D4** | Execution error |
| **D3** | Device dependent error |
| **D2** | Query error |
| **D1** | Request control |
| **D0** | Operation complete |

*Table 8-1: Event Status (ESR) Register Content*

### 8.7.3 *IDN?

**Command Syntax:**

*IDN?

**Purpose:** Returns the units Identity string. The ID string response contains several fields separated by a comma.

**Query response:** Manufacturer, model, firmware revision

**Example:** APS,DDP100-10,1.0

**Alias:** ID

### 8.7.4 *OPT?

**Command Syntax:**

*OPT?

**Purpose:** This command performs an optional identification query, which means it displays the firmware version of the power supply.

**Query response:** firmware revision

**Example:**

| | |
|---|---|
| *OPT? | (send) |
| 08.06.2012 V42 | (response) |

Unit returns: Version 42, dated 08.06.2012

**Alias:** none

### 8.7.5 *PDU

**Command Syntax:**

*PDU

**Purpose:** The *PDU command save the present interface and controller configuration values to non-volatile memory. Use this command or its alias (“SS”) to save settings made to any of the remote control interfaces so the unit will power up with the same settings.

**Alias:** SS

### 8.7.6 *RST

**Command Syntax:**

*RST

**Purpose:** The *RST command (reset) has the same effect as an IEEE-488 Device Clear bus command but can be used over the RS232C, USB or LAN interface as well. This command resets the unit to its power on default state.

**Alias:** RST

### 8.7.7 *STB?

**Command Syntax:**

*STB?

**Purpose:** The *STB? query returns the contents of the status byte register (STB). After this query, the content of the STB register is reset.

**Query response:** The query response consist of "STB" followed by 8 binary digits separated by a comma.

**Example:** STB,bbbbbbbb (msb..lsb)

**Alias:** STB

**STB Register Configurations:**

**GPIB Interface**

| Bit | Function |
|---|---|
| **D7** | n/a |
| **D6** | SRQ is set, if SRQ was requested |
| **D5** | ESB is set, if a byte was set within the SES register |
| **D4** | MAV is set, if a message is available |
| **D3** | Error bit 3 (See error table) |
| **D2** | Error bit 2 (See error table) |
| **D1** | Error bit 1 (See error table) |
| **D0** | Error bit 0 (See error table) |

*Table 8-2: Status Byte Register (STB) Content – GPIB Interface*

**RS232 Interface**

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

*Table 8-3: Status Byte Register (STB) Content – RS232 & USB Interface*

### RS485 Interface

| Bit | Function |
|---|---|
| **D15** | Parity error |
| **D14** | Over run error |
| **D13** | Framing error |
| **D12** | Timeout error |
| **D11** | n/a |
| **D10** | n/a |
| **D9** | n/a |
| **D8** | n/a |
| **D7** | Parity enable |
| **D6** | Parity mode (1 = odd, 0 = even) |
| **D5** | Stop bit (1 = 2 Stop bits; 0 = 1 Stop bit) |
| **D4** | Data format (1 = 8 bit; 0 = 7 bit) |
| **D3** | n/a |
| **D2** | → Table |
| **D1** | → Table |
| **D0** | → Table |

*Table 8-4: Status Byte Register (STB) Content – RS485 Interface*

### Error Table

The error register decoding is shown in the table below

| D3 | D2 | D1 | D0 | Error Type | Description |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | Syntax Error | Incorrect syntax error in command |
| 0 | 0 | 1 | 0 | Command Error | Unable to execute command received |
| 0 | 0 | 1 | 1 | Range Error | Parameter value out of range |
| 0 | 1 | 0 | 0 | Device Error | Device specific error |
| 0 | 1 | 0 | 1 | Hardware Error | Hardware fault occurred |
| 0 | 1 | 1 | 0 | Query Error | Invalid query |

*Table 8-5: Error Message Decoding*

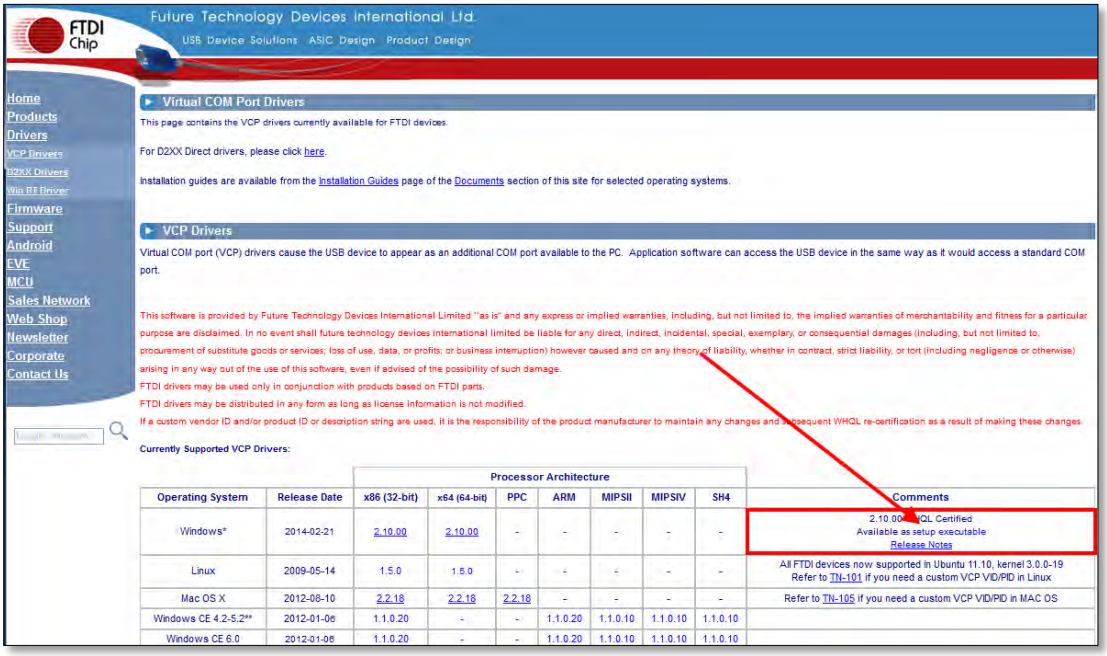
# 9 USB Driver Installation

## 9.1 Overview

The USB interface provides a virtual COM port for the PC. Via this port, the unit can be controlled as a normal RS232 interface, e. g. with a terminal program or user application program. Corresponding virtual com drivers (VCP drivers) for all current operating systems are available for download at the following URL:

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

Refer to the RS232 sections for further setup and configuration information.

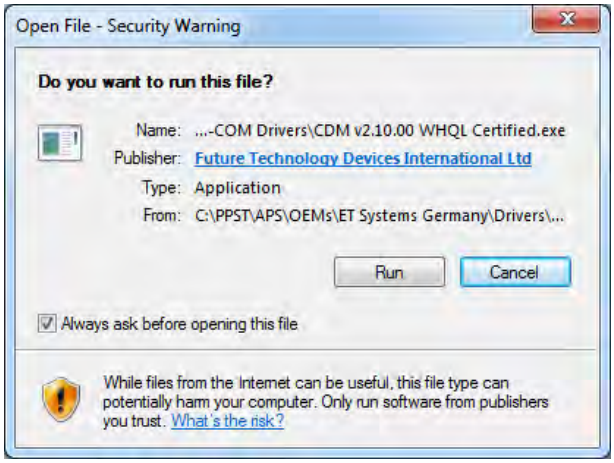


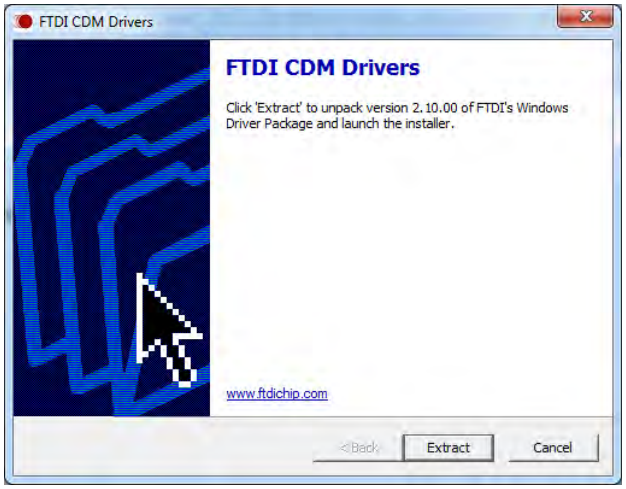

## 9.2 USB Driver Installation

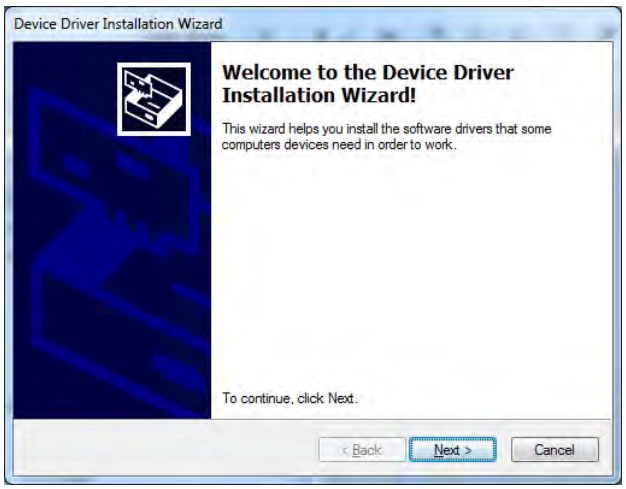
To install the USB device driver, proceed as follows:

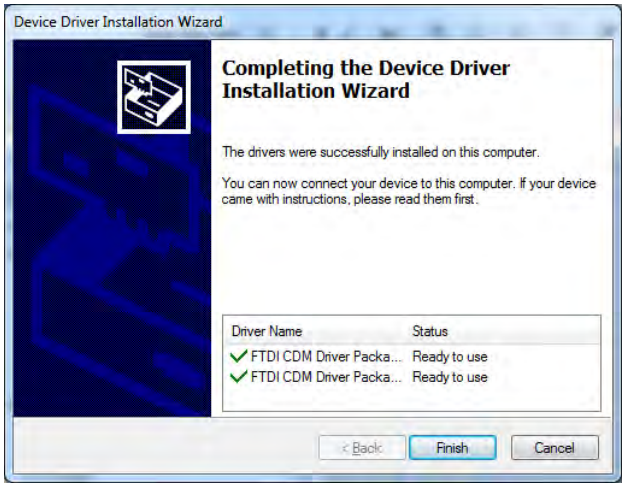
1. Download the VCP driver for Windows from the FDTI webpage.
   http://www.ftdichip.com/Drivers/VCP.htm
2. Save the executable driver installation file to a temporary folder on your drive.
3. Once saved, navigate to the driver installation folder assigned and locate the file named:
   **CDM v2.10.00 WHQL Certified.exe**
4. Select the file with the mouse and double click to launch the extraction of the installation program

5. Follow the on-screen prompts shown below to complete the driver installation.

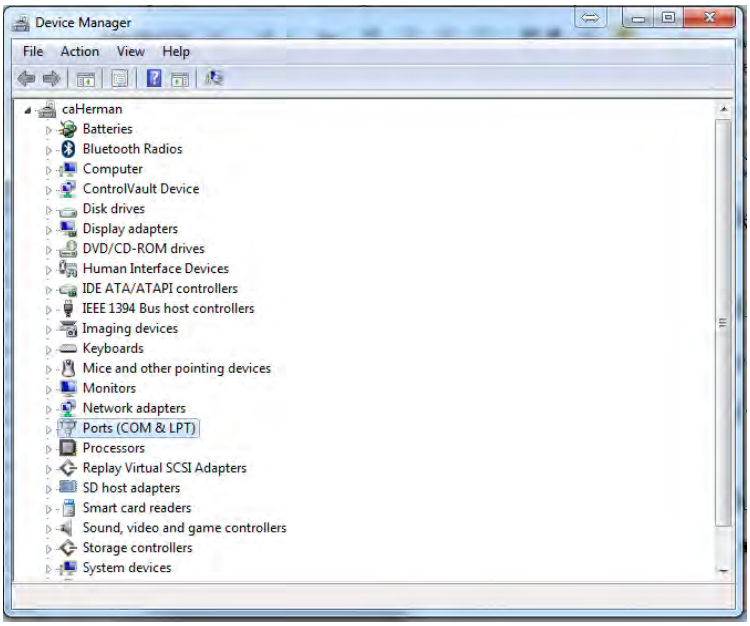


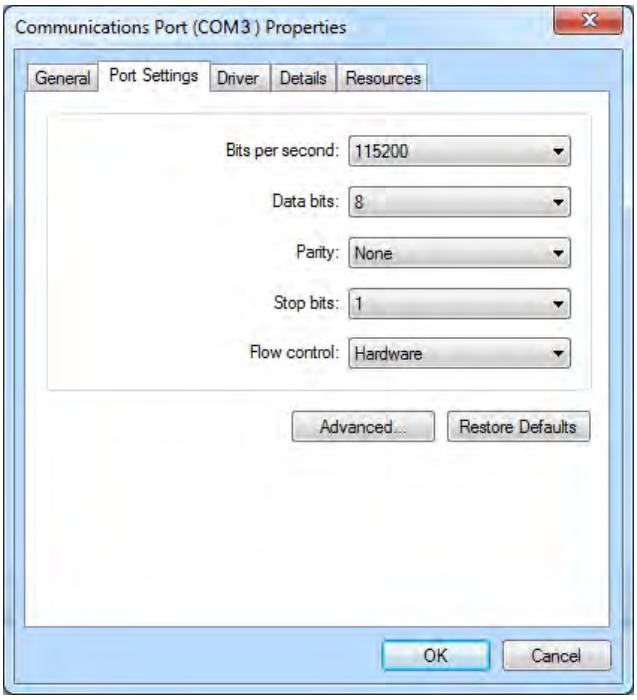






5. After the installation completes, open the Windows Control Panel from the Start menu and select “Device Manager”.
6. In the Device Manger Listing, locate the “Ports (COM & LPT)” entry




7. One of the entries should show “USB to Serial Port (COMx) with x any value higher than 2.
8. Note the Com port number at which the USB device is located. Right click on this Com port and select “Properties”.
9. In the Properties dialog box, select “Port Settings”.
10. Select the relevant COM port and set Bit per second (baud rate) to the same setting the as the DC power supply.




11. Connect the DC power supply to the PC using a suitable USB cable. (not supplied with the unit).
12. You should now be able to communicate with the power supply through COMn.

# 10 LAN Interface Configuration

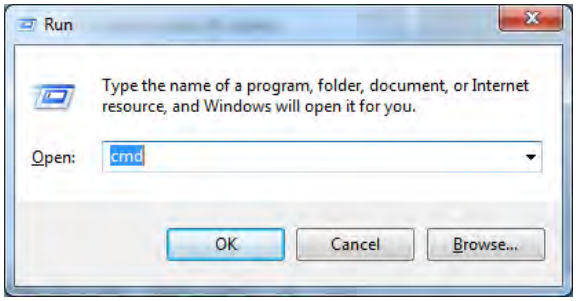
## 10.1 Overview

The power supply may be equipped with a LAN (Ethernet) interface.

To communicate with the power supply via a network, it is necessary to assign an IP address to the device first. As shipped, the device automatically obtains an IP address from the network using the DCHP protocol. In day to day operation, this behavior may be undesirable as after each activation, the device may have a new IP address. Therefore, it is recommended to assign a permanent IP address to each device.

## 10.2 Assigning Static IP Address

To assign a static IP address to the power supply under Windows 7/8, proceed as follows:




From the Start menu, select Run (Press Alt + R key) and enter “cmd” without quotes. This will bring up a DOS window.

At the DOS command prompt, enter:

arp -s xxx.xxx.xxx.xxx yy-yy-yy-yy-yy-yy

yy-yy-yy-yy-yy-yy is the MAC address of the power supply’s LAN interface. The MAC address can be found on a label on the rear panel of the power supply.

xxx.xxx.xxx.xxx is the IP address.

This adds the IP address entry to the ARP table.

Next, we need to assign the same IP address to power supply’s interface using the Telnet protocol.

Execute telnet using the new IP address on port 1:

telnet xxx.xxx.xxx.xxx 1

xxx.xxx.xxx.xxx is the desired new IP address. The Telnet connection will fail but this causes the new IP address to be assigned to the device.

## 10.3 Saving Static IP Address

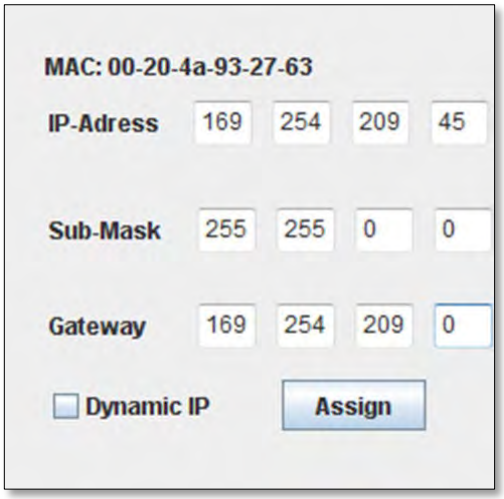
The assignment of the IP is still dynamic, which means that these settings will be lost after the device has been disconnected from the network. The LAN user interface can be loaded by entering the new IP address as the url in a browser window

http://xxx.xxx.xxx.xxx

By selecting the menu item "**Config**", the IP address can be adjusted.

Note that Java must be supported by your browser to adjust the IP setting.

Do not check the "**Dynamic IP**" checkbox.




## 10.4 LAN Browser Interface

The LAN user interface can be accessed via direct request of the IP address in a browser:
http://xxx.xxx.xxx.xxx

### 10.4.1 LAN Control

The "**Control**" menu opens the control window of the unit. Java must be supported by your browser to control the device. Basic functions like selecting the mode of operation, voltage and current settings can be changed in the control window.

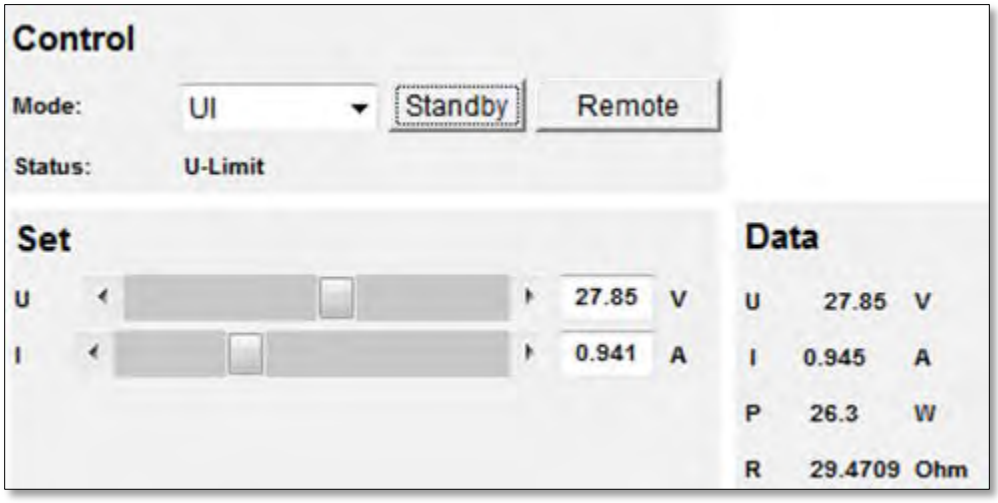



*Figure 10-1: LAN Browser Control Window*

**Note:** While controlling the DC supply via its LAN interface from a browser window, no other Telnet sessions can be active at the same time.

### 10.4.2 LAN Monitoring

The "**Display**" menu opens the monitoring window of the unit. Again, Java must be supported by your browser to monitor the device. The monitor window displays all measurement values, which are updated every 2 seconds. When using the monitoring function, the automatic toggle to remote operation when receiving a command mode of the LAN interface should be deactivated using the "GTR,0" command so the front panel is not locked out.

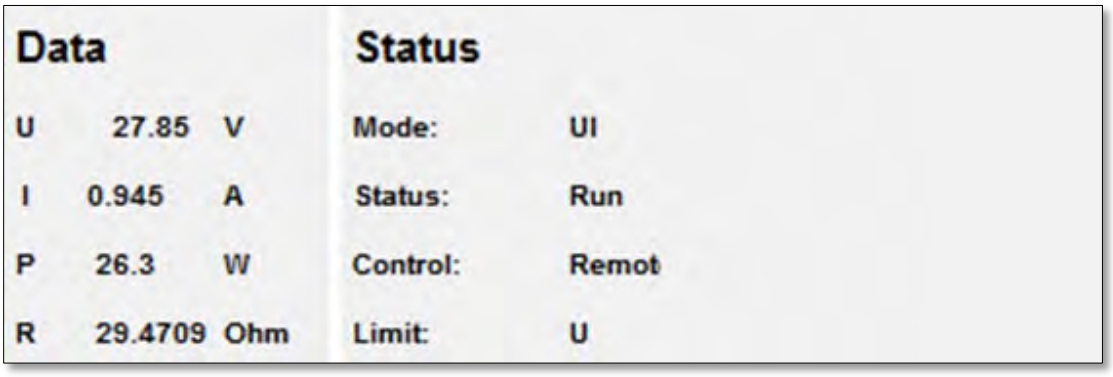
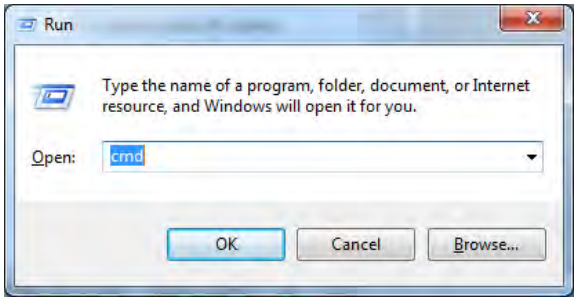



*Figure 10-2: LAN Browser Monitor Window*

## 10.5 Telnet Communications

The device can be controlled directly via port 10001 using the Telnet protocol.

Open a DOS window by pressing ALT+R or clicking on Windows Start and Execute and enter "cmd" in the run field.




In the DOS window, enter:

telnet xxx.xxx.xxx.xxx 10001.

Where xxx.xxx.xxx.xxx is the IP address of the unit. Alternatively, many terminal programs offer the possibility to establish a TCP/IP or telnet connection.

**Note:** While controlling the DC supply using Telnet, the browser window for the same device must be closed.

# 11 SD-Card Option Script Mode

## 11.1 Overview

Operation sequences may be programmed in a script which can be read from a memory card. A script is a text file, which includes a sequence of commands. Alternatively, the script memory can be programmed via one of the digital interfaces using the SCR command. For more information about the use of this command see section 8.6.1, “Setting Commands”. The device is able to process up to 250 script commands.

Using the script function, the need for external control computers and software to perform repetitive test routines can easily be eliminated. Scripts can be developed off-line and run directly from the front panel.

**Note:** The scripting feature requires the presence of the –SD (SD-Card) option.

## 11.2 Executing and Loading a Script

The script must be saved on a MMC or SD card as text file with .txt or .scr ending.

The “Scr” mode must be selected from the main display. **Pushing** the shuttle knob will open the file selection menu. The script file can be selected from this menu. An error message appears if the file could not be read correctly or if the file’s setup info is invalid (e. g. IA 40 at a 10 A unit).

To return to the file selection menu, the shuttle knob or the “DISPLAY” button must be pushed again. The script has been loaded and can be started by pushing the “OUTPUT” button.

The last five commands of the script are displayed in the “Preset” field. The active command is placed on top. The script ends when “OUTPUT” button is pushed and unit is toggled to output off mode.

## 11.3 Script Commands

This section covers available script commands and syntax for creating scrip files.

### 11.3.1 Syntax

Script commands are not case-sensitive so upper and lower case are not relevant. Thus, the following commands deliver the same results:

PMAX 100
Pmax 100
pMaX 100

Delimiters must be placed between two commands or between command and parameter. Valid delimiters are:

blank <SP>
tab <TAB>
LineFeed <LF>
Carriage Return <CR>
equal sign (=)

Numerical values must be formatted as basic units and may not be followed by characters. Valid delimiters for decimal places are:

point (.)
comma (,)

No characters must be appended at the end of a parameter, e.g:

U 12,345 U 10.00 U 12.

The command UAC 12.114V is invalid, because it is followed by a character (V).

All commands may be written consecutively, but must be separated by blanks, e.g:

U 10 I 1 UIP LOOP RUN.

However, due to the difficulty in reading such script files, this practice is not recommended.

### 11.3.2 Script Command Summary

The following table shows all supported scrip commands.

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

*Table 11-1: SD-Card Script Command Summary Table*

## 11.4 Script Command Details

**; or #**

Comment prefix. All characters from ; or # up to end of line will be ignored. This function is not available when programming via the digital remote control interface.

**Example:**
# This is a comment
UIP  # This command activates the UIP mode
; Comments can also start with a semicolon

**DELAY, DELAYS**

Time delay: The commands DELAY and DELAYS delay the execution of the script. The number that follows defines the duration of the delay in msecs (milliseconds). Maximum duration of delay is 65535 msecs.

**Example:**

| Command | Description |
|---|---|
| UI | # UI mode |
| U 10 | # Output voltage 10 V |
| I 1 | # Output current 1 A |
| RUN | # Activate output |
| DELAY 200 | # Wait 200 msecs |
| U 100 | # Adjust output voltage to 100 V |
| DELAYS 10 | # Wait 10 seconds |
| STANDBY | # Deactivate output |

**I**

Set point output current: This command adjusts the set point for the output current in amps.

**Example:**
I 9.8  # Output current 9.8 A

**IMPP**

Set point MPP current: This command adjusts the set point for the MPP current for PV simulation in amps.

**Example:**
IMPP 8.123  # MPP current 8.123 A

**LOOP, LOOPCNT**

Return Loop: Usually the script ends with the last command. A return address can be defined with the command <LOOP>. From this point on, script processing will continue after the last command of the script by jumping back to the <LOOP> position. To interrupt the program, the "POWER" button must be pushed. The command <LOOPCNT> is similar to the <LOOP> command <LOOP> but it defines the number of loops. The maximum number is 65535.

**Example:**

```
# This example activates the output for 10s, then deactivates it for 2s
# and starts from the beginning. This will continue until the user interrupts the
# process by pushing the "POWER" button.
UI              # UI mode
U 100           # Output voltage 100 V
I 10            # Output current 10 A
LOOP            # Start address
RUN             # Activate output
DELAYS 10       # Wait 10s
STANDBY         # Deactivate output
DELAYS 2        # Wait 2s
```

```
# This example works like the previous one.
# The cycle is executed only 10 times, and then the script ends.
UI              # UI mode
U 100           # Output voltage 100 V
I 10            # Output current 10 A
LOOPCNT 10      # Start address
RUN             # Activate output
DELAYS 10       # Wait 10s
STANDBY         # Deactivate output
DELAYS 2        # Wait 2s
```

**PMAX**

Sets the maximum output power for the UIP mode

**PV**

Pvsim mode: Activates the PVsim mode.

**Example:**

```
PVSIM   #Activate PV simulation
```

**RI**

Internal resistance UIR mode: This command adjusts the set point for the internal resistance in UIR mode.

**RUN**

Activate output: The command RUN resets the standby mode and activates the output.

**Example:**
RUN # Activate output

**STANDBY**

Deactivate output: The command STANDBY deactivates the output and activates standby mode.

**Example:**
STANDBY # Deactivate output

**U**

Set point output voltage: Set point for output voltage in V.

**Example:**

U 100 # Output voltage 100 V

**UI**

UI-Mode: This command activates the UI mode. Unit works current and voltage regulated.

**Example:**
UI # UI mode

**UIP**

UIP mode: This command activates the UIP mode. Unit works current, voltage and power regulated.

**UIR**

UIR mode: This command activates the UIR mode. Unit works current and voltage regulated. Additionally, an internal resistance is simulated.

**UMPP**

Set point UMPP voltage: Set point for MPP voltage for PV simulation in V.

**Example:**
UMPP 80.42 # MPP voltage 80.42 V

**USER**

Set points current and voltage: This command generates the set points for current and voltage by using the internal user data table. As such, different UI characteristics can be created. The tables can be created beforehand by using the remote control command WAVE (refer to section 8.6.1, “Setting Commands” on page 66).

**WAIT**

Waiting for user action: The program is stopped until the user pushes the “POWER” button.

Example:

```
; Starter characteristic:
UI                ; UI mode
I 10              ; Current limit 10 A
U 12              ; Output voltage 12 V (->100%)
RUN                ; Enable output
LOOP              ; Start address after end of the script
WAIT              ; Waits until user pushes the POWER button
U 10,5            ; Ramp #1
U 9               ; Command is processed within 1 msec. Therefore the
U 7,5             ; ramp has 5 interim values.
U 6
U 4,5
DELAY 15          ; 15 ms pause
U 4,8             ; Ramp #2
U 5,1             ; Command is processed within 1 msec. Therefore
U 5,4             ; the ramp has 5 interim values.
U 5,7
U 6
DELAY 2000        ; 2000 ms pause
U 6,6             ; Ramp #3
U 7,2             ; Command is processed within 1 msec. Therefor the
U 7,8             ; ramp has 10 interim values.
U 8,4
U 9
U 9,6
U 10,2
U 10,8
U 11,4
U 12
```

### WAVE, WAVELIN

Table programming: The command WAVE is used to start table programming. The command is followed by numerical values, which indicate the desired voltage and current table points. Finally, followed by the command with a "-" prefix character.

**Example:**

```
WAVE
<U1> <I1>
<U2> <I2>
<U3> <I3>
...
<Un> <In>
-WAVE
```

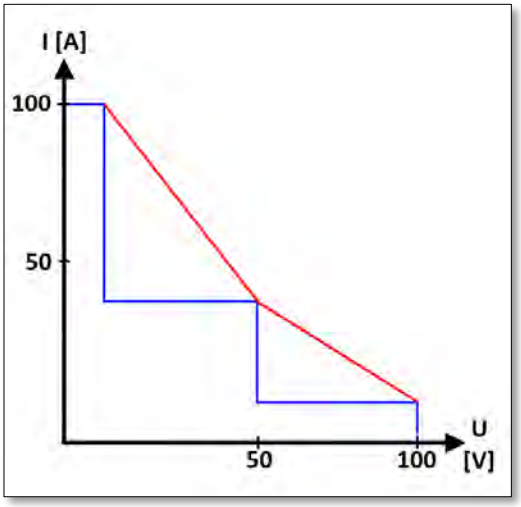
The WAVELIN command is similar to the WAVE command.

```
WAVELIN
<U1> <I1>
<U2> <I2>
<U3> <I3>
...
<Un> <In>
-WAVELIN
WAVELIN
```

With the WAVELIN command, the interim values between the data points are interpolated linearly. With the WAVE command they are layered (see example). Characteristics which are not constant or negative in their progressing are accepted but the behavior of the unit may not be predicable.

**Example:**

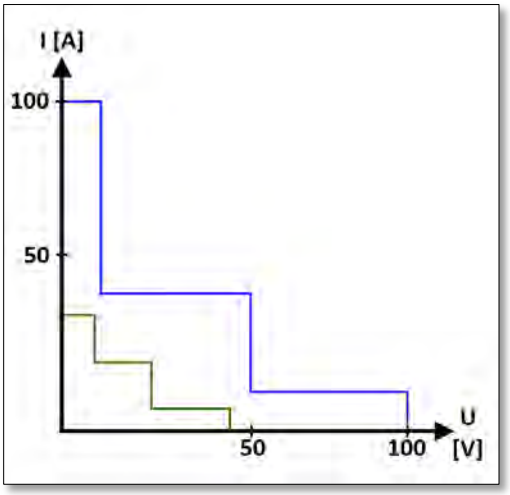
```
; Characteristic with layered interim values
; This script delivers the blue line in the diagram
WAVE                ; Start of the table
100  10             ; 100 V 10 A
50    25            ; 50 V 25 A
10  100             ; 10 V 100 A
-WAVE               ; End of the table
RUN                 ; Enable output


; Characteristic with linear interim values
; This script delivers the red characteristic
WAVE                ; Start of the table
100  10             ; 100 V 10 A
50    25            ; 50 V 25 A
10  100             ; 10 V 100 A
-WAVELIN            ; End of the table
RUN                 ; Output active
```



If output voltage or output current is changed afterwards, the characteristic keeps its profile although values are stretched or compressed to the new range.

**Example:**

```
# This script generates a blue characteristic
# After a 10 second delay it switches to the green line:
WAVE              # Start of the table
100 10            # 100 V   10 A
50 50             #   50 V   50 A
10 100            #   10 V 100 A
-WAVE             # End of the table
U 100             # Output Voltage 100 V
I 100             # Output Current 100 A
USER              # Select characteristic
RUN               # Output open
DELAY 10000       # Wait 10 seconds
U 50              # Output Voltage 50 V
I 50              # Output Current 50 A
```



# 12 Data Logging Function

## 12.1 Overview

This section explains the optional data logging function available a part of the SD-Card (Option - SD).

The device has a data log function. A memory card may be used as data logger. All measurement values will be saved in a text file, separated by tab characters. This file format is easy to import in MS Excel for analysis and charting.

## 12.2 Data Logging

The time interval between stored readings may be adjusted from 1 second to 4294967 seconds or 71 minutes. To activate the data log function, an SD memory card must be inserted. The root directory of the memory card must contain a text file named "**LABLOG.txt**". The new data will be written into this file.

**CAUTION**

**Memory cards must be inserted or removed ONLY when the DC power supply output is OFF.**

The first entry of the first line of the text file defines the sample interval using the following syntax:

"interval=xxxx"

Where xxxx is the time in seconds. The memory interval is adjusted accordingly. The entry must be written in lower case letters and without any space characters. If the interval remains unspecified, the sample interval defaults to 60 seconds.

**Example:**

*Interval = 30*

The data logging function is active whenever the power supply output is ON. (not in standby mode). Active data logging is indicated by a small memory card symbol in the upper right corner of the main LCD display. Whenever a new data set is written, the symbol will be displayed as filled for ca. 1 second. In case the memory card is full, the symbol will be crossed out.

## 12.3 Data Format

The “LABLOG.txt” data file is a Tab delimited ASCII text file that is easily readable using numerous programs.

The first entry in the data file shows the present mode operation mode of the power supply.

The second entry shows the present operation mode followed by ‚Udc‘ and ‚Idc‘.

**Example:**

| | | |
|---|---|---|
| *USER* | *I-Limit 1,0* | *10,02* |
| *USER* | *OVP 0,0* | *0,00* |
| *UI* | *U-Limit 100,01* | *0,10* |
| *UIP* | *U-Limit 100,0* | *0,10* |

# 13 Master/Slave (M/S) Operation

## 13.1 Overview

In master/slave mode, multiple DC power supply units are connected via the System-Bus. To establish the connection, any commercially available Type A USB cables can be used. However, the interface is **not** a USB interface and should not be connected to a PC's USB port.

**CAUTION**

**THE SYSTEM BUS SHOULD NOT BE CONNECTED TO A USB INTERFACE.**

The Master/Slave mode can be enabled from the CONFIGURATION menu. Refer to section 6.3.1, "Configuration Menu" on page 41.

Available Master/Slave operation modes are:

- M/S Off
- M/S Parallel Mode
- M/S Series Mode
- M/S Independent Mode

## 13.2 Master/Slave Mode Implementation

The interface has two connectors which are connected in parallel (daisy chain mode). Thus, multiple units can be easily connected in parallel. When multiple units are connected and active, each unit is assigned its own address. A "***M/S***" symbol in the upper right corner of the display indicates that the units are operating in Master/Slave mode.

There is no actual Master unit in the narrow sense. Settings are forwarded via the system bus to all connected units. Setting can be adjusted on any of the units. Changes made on any of the connected units are automatically forwarded via the system bus to all other units. It is also not relevant whether settings are adjusted using the front panel or via remote interface.

**Note** that in Master/Slave mode, the LLO command issued over a digital interface deactivates front panel operation for all connected units.

**Example:**

Two units connected to the bus, unit 1 with front panel operation and digital interface, unit 2 with front panel operation only:

| | |
|---|---|
| GTR | Remote operation mode, set points can be adjusted via digital interface or via front panel of unit 2. Unit 1 could be toggled to local mode by pushing the "**POWER**" button. The display of unit 1 shows the word "**Rem**" (Remote), the display of unit 2 shows the word "**Loc**" (Local). |
| LLO | Local lockout, both units cannot be operated via front panel. This status is indicated on both displays by the word ‚LLO'. |

**Note:** Master/Slave mode is currently not supported in combination with the SD memory card function.

**⚠ CAUTION**

**IF SETTING ARE CHANGED USING THE AI ANALOG INTERFACE, ONLY ONE UNIT MUST BE OPERATED USING AI MODE.**

## 13.3 M/S Off Mode

In this default mode, no active master/slave mode is enabled, regardless of whether units are connected or not.

## 13.4 M/S Parallel Mode

The control assumes that outputs are connected in parallel. Set points are respectively converted. Displays will show the total current as measured value. Current distribution between the individual units is not necessarily fully balanced. Thus, the total current may be limited to the adjusted value.

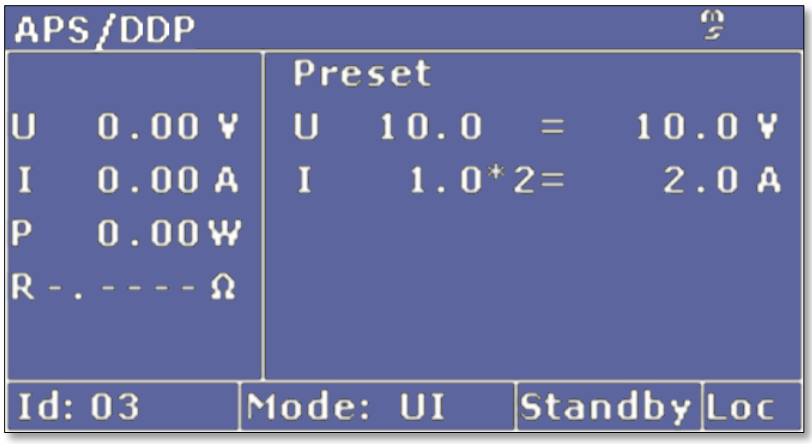



*Figure 13-1: Master/Slave Parallel Mode Screen*

For M/S parallel mode connection diagram, refer to Figure 13-3 on page 112.

## 13.5 M/S Series Mode

The M/S Series control mode assumes that DC outputs are connected in series. Set points are converted accordingly. The LCD display will show the total voltage as a measured value. Voltage distribution between the individual units is not necessarily equal. Thus, the total voltage may be limited to the adjusted value.

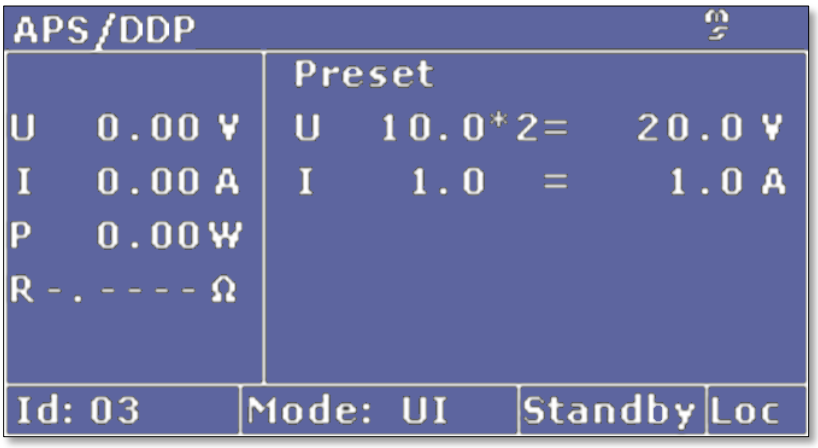



*Figure 13-2: Master/Slave Series Mode Screen*

For M/S series mode connection diagram, refer to Figure 13-3 on page 112.

## 13.6 M/S Independent Mode

The M/S independent control mode assumes that the outputs are independent and thus not tied together in any way. Set points are exchanged via bus only. The display equals the display for a single unit. This mode allows simultaneous output control of a multi-channel dc power system.

For M/S independent mode connection diagram, refer to Figure 13-3 on the next page.

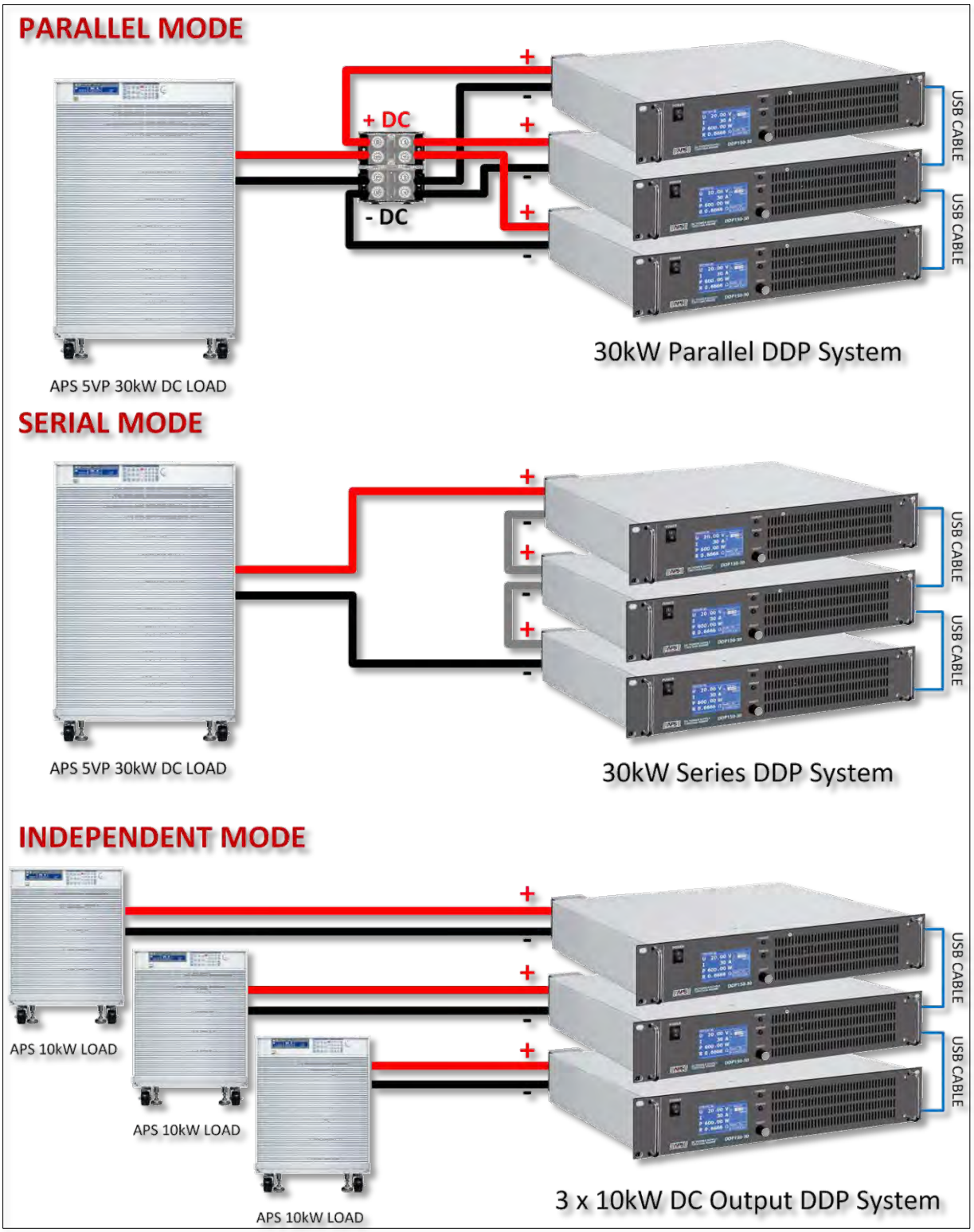



*Figure 13-3: Possible Master/Slave Connection Diagrams*

## 13.7 Connected Units Overview

When operating in Master/Slave mode, pushing the “DISPLAY” button twice will open a menu, which displays the data of the first four DC power supply units connected to the system bus. Shown are voltage, current and power of the individual units. Additionally, the complete system data will be displayed.

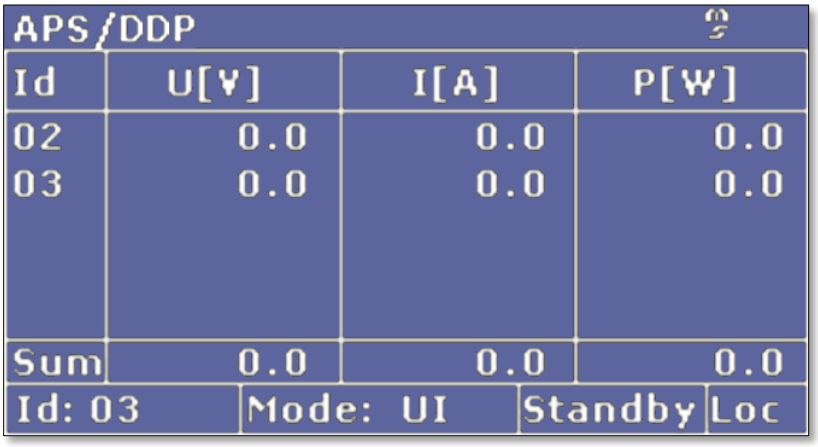



*Figure 13-4: Master/Slave Mode Overview Screen*

## 13.8 Remote Control of Master/Slave systems

Set points sent via any of the digital interfaces define the set points for the presently connected unit. These set points are also transmitted to the other devices on the system bus if M/S mode is on. This means that the total voltage and the total current for the entire system can be higher than those of individual units.

**Example: Three units the system bus**

| Command | Description |
|---|---|
| GTR | Enable remote control operation mode |
| OVP,30 | Adjust over voltage protection to 30 V |
| IA,10 | Adjust output current limit to 10 A |
| UA,15 | Adjust output voltage to 15 V |
| SB,R | Enable output |

All units connected to the system bus are adjusted to 15 V/10 A. When these units are connected in parallel, the resulting output voltage is 15 V and the current is 30 A ( = 3 x 10 A). When the units are connected in series, the resulting output voltage is 45 V ( = 3 x 15 V) and the current is 10 A.

The measurement values consider the selected configuration of the unit. The commands MU and MI can be used to read the total voltage and the total current of the whole system. Individual data for each device connected to the bus can be read using a parameter.

**Example: Three connected in parallel**

| Command | Description |
|---|---|
| GTR | Enable remote control operation mode |
| OVP,30 | Adjust Over Voltage Protection to 30 V |
| IA,10 | Adjust output current limit to 10 A |
| UA,15 | Adjust output voltage to 15 V |
| SB,R | Enable output |
| MI | Measures total current |
| MI,28.4A | Unit answers: 28,4 A |
| MI,0 | Measure present current of the first unit (0) |
| MI,9.1A | Unit answers: 9,1 A |
| MI,1 | Measure present current of the third unit (1) |
| MI,9.4A | Unit answers: 9,4 A |
| MI,2 | Measure present current of the third unit (2) |
| MI,9.9A | Unit answers: 9,9 A |

# 14 CE MARK Declaration of Conformity

**EU Directives:** **2006/95/EC and 93/68/EEC**

**Product Name** DDP Series DC Power supplies

**Serial Number** _____

**The manufacturer hereby declares that the products are in conformity with the following standards or other normative documents:**

**SAFETY**:

| | | |
|---|---|---|
| **Standard applied** | IEC 61010-1:2006 | Measure, Control Equipment and Laboratory Units |

**EMC:**

| | |
|---|---|
| **Standard applied** | EN 61326-1:2006 |

**Reference Standards:**

**EMISSIONS**:

EN 61000-6-4: 2007

**IMMUNITY**:

IEC 61000-6-2: 2005

**Supplemental Information:**

**When and Where Issued:** June 4, 2014
Irvine, California, USA

**Authorized Signatory** Quality Assurance Inspector
Adaptive Power Systems

**Responsible Person** Production Manager
Adaptive Power Systems
17711 Fitch
Irvine, California, 92649, USA

CE **Mark of Compliance**

# APPENDIX: VDE 0701

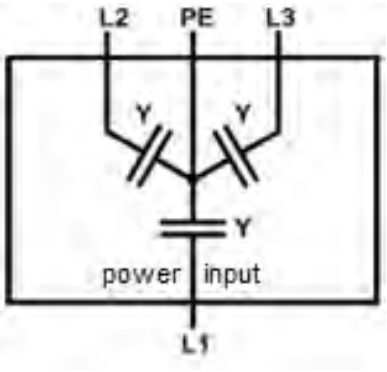
## EQUIVALENT LEAKAGE CURRENT MEASUREMENT ACCORDING TO VDE 0701

The equivalent leakage current measuring according to DIN VDE 0701-1 may deliver results beyond the norm.

Cause: Measurements are primarily performed on so-called EMC-filters at the AC input of the units. These filters are built symmetrical, that means capacitors are installed between L1/2/3 and PE. While measuring, L1, L2 and L3 are connected together and the current flow to PE is measured. Therefore up to 3 capacitors are connected parallel which doubles or triples the measured leakage current. This is permissible according to the norm.

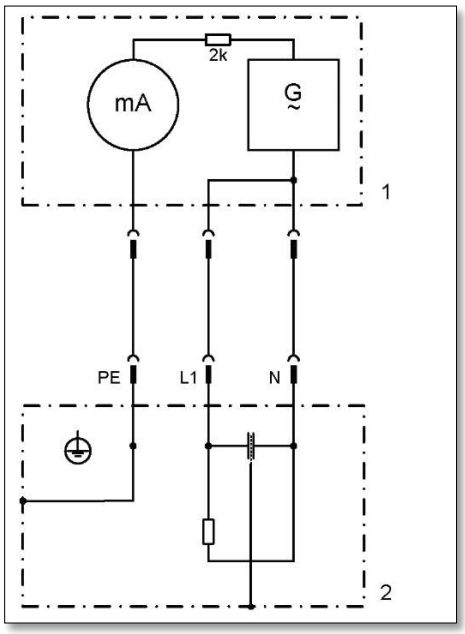
Quotation from the norm of 2008, appendix D:

*"When measuring protection conductor currents with the equivalent leakage current measuring method, it is important to note that devices with protective grounds and symmetrical circuits may have results, due to the wiring, that are up to three or four times higher than the leakage current of one phase."*




Graphical representation of a balanced circuit→:

Example illustration from the norm protective ground measuring - equivalent leakage current measuring method:




Note: The illustration shows the measurement method for two-phase power supplies. In the three-phase version, phase N is replaced by L2 and/or L3.

# Index

**ADAPTIVE** Power Systems

Worldwide Supplier of Power Equipment