

**HFE1600**  
**AC/DC Power Supply**  
**Modular 1600 – 8000 watts**



**HELIOS**  
POWER SOLUTIONS

## HFE1600 -Series Rectifier: Instruction Manual

HFE1600 SERIES SPECIFICATIONS:			HFE1600-12	HFE1600-24	HFE1600-48
1	Rated output voltage	V	12	24	48
2	Output voltage set point	V	12+/-1%	24+/-1%	48+/-1%
3	Output voltage range	V	9.6~13.2	19.2~29.0	38.4~58
4	Rated Output Current at $V_{in} \geq 170Vac$ (*1)	A	133	67	33
5	Rated Output Current at $100 \leq V_{in} \leq 132Vac$ (*1)	A	100	50	25
6	Rated Output Current at $85V \leq V_{in} < 100Vac$ (*1)	A	Linear derating 1% per 1VAC from output current at 100VAC:		
7	Rated output power $V_{in} \geq 170Vac$	W	1596	1608	1584
8	Rated output power $100 \leq V_{in} \leq 132Vac$	W	1200	1200	1200
9	Rated output power $85Vac \leq V_{in} < 100Vac$	W	Linear derating 1% per V		
10	Input voltage / frequency range (*2)	---	85~265VAC continuous, 47~63Hz, Single phase		
11	Maximum input current (at 100/230Vac)	A	14.2/8.1		
12	Power Factor (Typ)	---	>0.98 at 115/ 230V at full load.		
13	Efficiency at 75% rated load (Typ) (*3)	%	87/90%	88/90%	89/92%
14	Efficiency at 100% rated load (Typ) (*3)	%	87/90%	87/90%	88/91%
15	Inrush current (*4)	A	Less than 35A		
16	Hold-up time	mS	≥ 10mS typical at 100/230Vac input, rated output voltage and less than 80% of rated load.		
17	Maximum line regulation (*5)	%	0.25%		
18	Max load regulation (*6)	%	0.50%		
19	Output Ripple and noise P-P (*7)	0~+70°C	240	240	480
		-10~0°C	360	360	780
20	Temperature stability	%	0.05% of rated $V_{out}$ for 8hrs after 30min warm-up. Constant line, load and temperature.		
21	Temperature coefficient of output voltage	PPM/°C	+/-200		
22	Remote sensing (*8)	---	Refer to instruction manual.		
23	Parallel operation (*9)	---	Single wire current share, 10% accuracy of rated lout, up to 10 units.		
24	Series operation	---	(with external diodes), 2 units. Refer to instruction manual.		
25	Over current protection	%	105~120% of rated output current.		
26	Over voltage protection (*10)	V	Tracking OVP, range: 1.15x $V_{out}$ , accuracy: +/-3%		
27	Over temperature protection	---	Inverter shut down, automatic restart.		
28	Remote On/Off control	---	Two complementary inputs. By electrical signal or dry contact. Refer to instruction manual.		
29	"DC OK" signal (*13)	---	Tracking, On when $V_{out} > 90\%$ +/-5% of set output voltage.		
30	Over-Temperature warning (*13)	---	Refer to instruction manual.		
31	"AC FAIL" signal (*13)	---	On when $85Vac < V_{in} < 270Vac$ .		
32	Auxiliary power supply output	---	11.2~12.5V, 0.5A. 240mVp-p ripple and noise (*11)		
33	$V_{out}$ programming by external voltage	---	By 0~5V, equal to $V_{out} \text{ min} \sim V_{out} \text{ max}$ . Refer to Instruction Manual.		
34	$V_{out}$ programming by external resistor	---	By 1Kohm potentiometer. Refer to Instruction Manual.		
35	OCP programming by external voltage	---	By 0~5V. Refer to Instruction Manual.		
36	Front panel indicators	---	AC OK, DC OK/FAIL		
37	I <sup>2</sup> C Interface	---	Optional, PMBus compatible. Refer to Instruction Manual.		
38	Operating temperature	---	-10~+70°C. -10~+50°C. 100% load. +50°C to +60°C Derate Output by 2%/°C. +60°C to +70°C Derate Output by 2.5%/°C.		
39	Storage temperature	---	-30~85°C		
40	Operating humidity	---	10~90% RH, no condensation.		
41	Storage humidity	---	10~95% RH, no condensation.		
42	Cooling	---	By internal Fans. Variable speed control based on ambient temperature and power level.		
43	Vibration	---	Built to meet IEC60068-2-64 (Basic Transportation)		
44	Shock	---	Built to meet IEC60068-2-27 (Basic Transportation)		
45	Conducted emission	---	Built to meet EN55022 Class B, FCC part 15 Class-B, VCCI Class-B		
46	Radiated emission	---	Built to meet EN55022 Class A, FCC part 15 Class-A, VCCI Class-A		
47	Immunity	---	Built to meet IEC61000-4-2 (Level 2,3), -3 (Level 2), -4 (Level 2), -5 (Level 3,4), -6 (Level 2), -8 (Level 4), -11		
48	Applicable safety standards	---	UL60950-1 Second Edition, EN60950-1 Second Edition		
49	Withstand voltage	Input-Output:	3000Vrms, 1min.		
		Input-Ground:	2000Vrms, 1min.		
		Output - Ground:	500VAC 1min.	500VAC 1min.	1.5kVAC 1min (POE)
50	Insulation resistance	---	More than 100Mohm at 25°C and 70% RH. Output-Ground: 500Vdc		
51	Leakage current (*12)	mA	Less Than 0.75/1.5mA at 100/230Vac range		
52	Weight (Typ)	Kg	Max. 1.55		
53	Size (W*H*D)	---	85x41x300mm. Refer to Outline Drawing.		

**Notes:**

- \*1 Refer to Fig-1 below.
- \*2 In case where conformance to various safety standards is required, to be described as 100-240Vac (50/60Hz).
- \*3 100/230Vac, 25°C ambient temperature.
- \*4 Not applicable for the noise filter inrush current less than 0.2mS.
- \*5 From 85~132Vac, or 170~265Vac, constant load.
- \*6 From No-load to Rated load, constant input voltage.
- \*7 Measured with JEITA-RC9131A 1:1 probe with 2x270uF electrolytic capacitors and 1uF film capacitor on the test fixture. 20MHz B.W.
- \*8 Voltage drop on load wires: HFE1600-12: 0.5V/wire, HFE1600-24, and HFE1600-48: 1V/wire.
- \*9 Accuracy applicable for load current > 20% of rated output current. Derate maximum output power by 5%.
- \*10 Inverter shut down method. Reset by recycle AC voltage, or by On/Off control.
- \*11 Measured with JEITA-RC9131A 1:1 probe using 470uF electrolytic capacitor and 0.1uF film capacitor on the test fixture. 20MHz B.W.
- \*12 Measured according to UL/EN method at 60Hz 25°C ambient temperature.
- \*13 Open collector signal. Maximum sink current: 10mA, maximum voltage 15V.

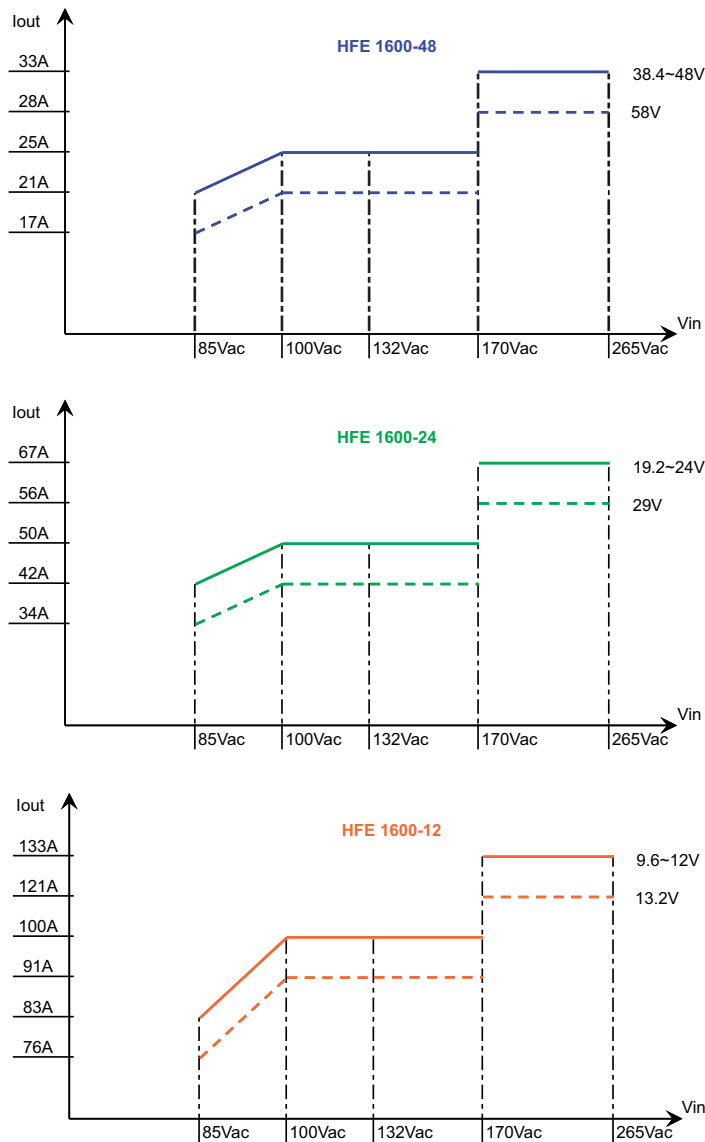
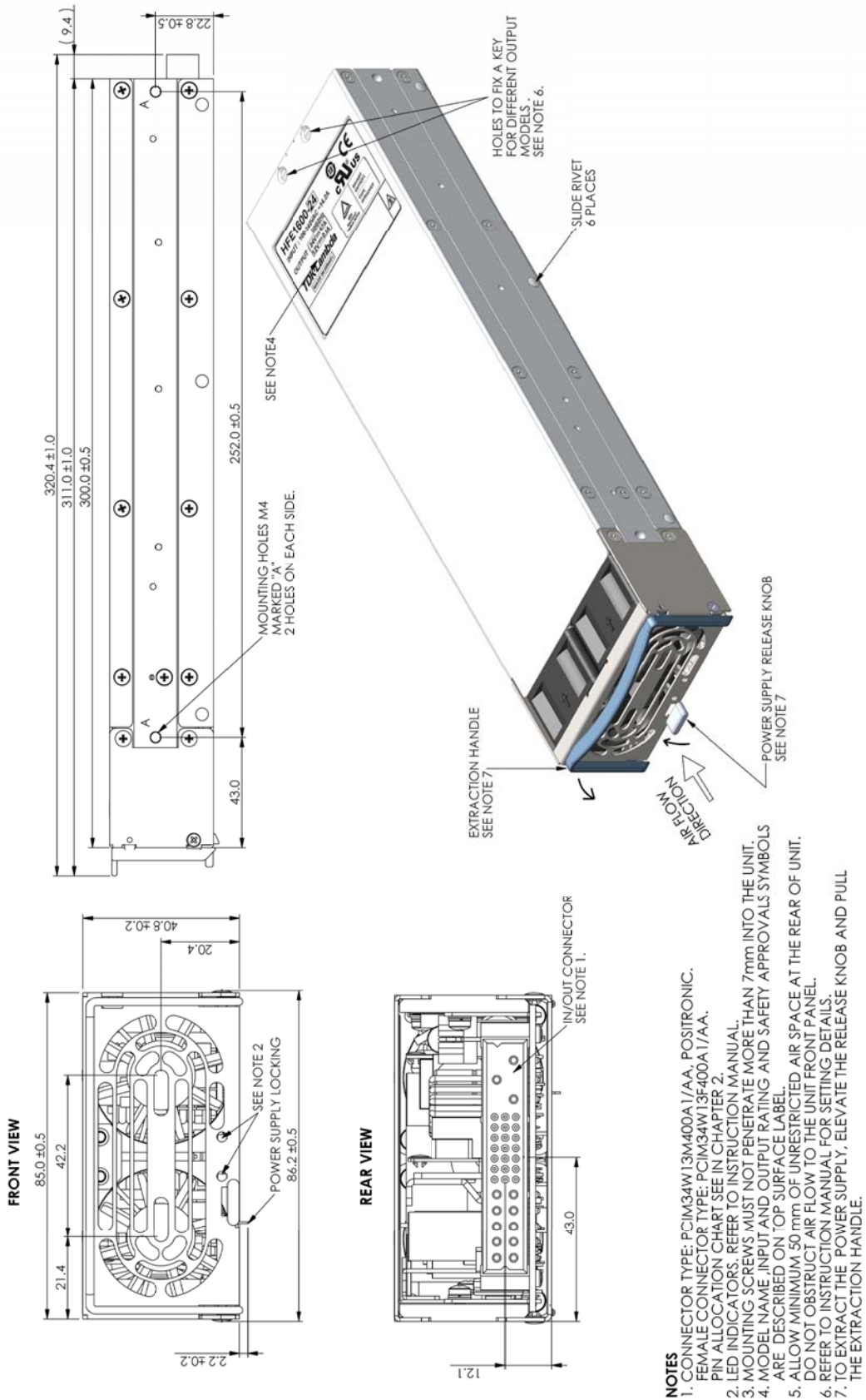


Fig-1 HFE1600 rated output Current and Voltage versus Line Voltage.

# HFE 1600 Series Outline Drawing



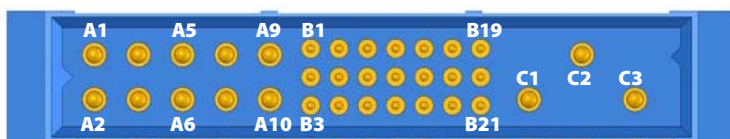
**NOTES**

1. CONNECTOR TYPE: PCIM34W13M400A1/AA, POSITRONIC. FEMALE CONNECTOR TYPE: PCIM34W13F400A1/AA. PIN ALLOCATION CHART SEE IN CHAPTER 2.
2. LED INDICATORS. REFER TO INSTRUCTION MANUAL.
3. MOUNTING SCREWS MUST NOT PENETRATE MORE THAN 7mm INTO THE UNIT.
4. MODEL NAME INPUT AND OUTPUT RATING AND SAFETY APPROVALS SYMBOLS ARE DESCRIBED ON TOP SURFACE LABEL.
5. ALLOW MINIMUM 50 mm OF UNRESTRICTED AIR SPACE AT THE REAR OF UNIT. DO NOT OBSTRUCT AIR FLOW TO THE UNIT FRONT PANEL.
6. REFER TO INSTRUCTION MANUAL FOR SETTING DETAILS.
7. TO EXTRACT THE POWER SUPPLY, ELEVATE THE RELEASE KNOB AND PULL THE EXTRACTION HANDLE.

**REAR PANEL IN/OUT CONNECTOR PINS FUNCTION DESCRIPTION**

Pin #	Function	Description	Referenced to
A1 ~ A5	-V	Main Negative Output Voltage	
A6 ~ A10	+V	Main Positive Output Voltage	
B1	SIGNAL RETURN	Return for the following control signals: ENABLE, INHIBIT; supervisory signals TEMP ALARM, AC FAIL, AUX, PS EXIST; and PMBus signals: SCL, SDA, SMB ALERT; SIGNAL RETURN and mentioned signals are isolated from the output terminals and -SENSE.	SIGNAL RETURN
B2	PS EXIST	Indicates that Power Supply module is inserted into the shelf. "Active Low" when connected to SIGNAL RETURN.	SIGNAL RETURN
B3	+12V AUX OUT	11.2~12.5V Auxiliary Voltage Output referenced to SIGNAL RETURN. The maximum load current is 0.5A. This output has a built in ORing diode, and is not affected by the INHIBIT/ENABLE signal or any other fault.	SIGNAL RETURN
B4	-SENSE	Negative sense, The -SENSE signal should be connected to -V on Power Supply, or Load side.	-SENSE
B5,B10,B14,B16	A2,A3,A1,A0 (optional PMBus)	PMBus Address lines. Refer to the PMBus interface description HFE Instruction Manual Chapter 3.	-SENSE
B6	CURRENT SHARE	Current sharing signal should be connected when Power Supplies are connected in parallel to allow accurate current share between units in Parallel operation.	-SENSE
B7 (short pin)	ENABLE	Turns ON the main output by electrical signal or dry contact (0~0.6v or short).	SIGNAL RETURN
B8	VOLTAGE PROGRAMMING	Input (0~5V) referenced to -S. Provides Vout programming by Voltage. Refer to Instruction Manual Chapter 1.5,1.6&1.7	-SENSE
B9	+SENSE	Positive sense. The +SENSE signal should be connected to +V on Power Supply, or Load side.	-SENSE
B11	CURRENT PROGRAMMING	Input (0~5V) referenced to -S. Provides Iout programming by Voltage. Refer to Instruction Manual Chapter 1.8	-SENSE
B12	INHIBIT	Turns OFF the main output by electrical signal or dry contact (0~0.6v or short).	SIGNAL RETURN
B13	SCL (optional PMBus)	Serial Clock signal. Refer to the PMBus interface description HFE Instruction Manual Chapter 3.	SIGNAL RETURN
B15	DC OK	DC OK signal. LOW when the output voltage is higher than 85~95% of Vout set. Open collector type (15V, 10mA).	SIGNAL RETURN
B17	SDA (optional PMBus)	Serial Data signal. Refer to the PMBus interface description HFE Instruction Manual Chapter 3.	SIGNAL RETURN
B18	TEMP ALARM	TEMP ALARM signal. LOW when the internal temperature is within safe limit, HIGH approx. 10°C below Thermal shut down. Open collector type (15V, 10mA).	SIGNAL RETURN
B19	+5V/V_REF	5V fix output for standard option unit. Variable when Voltage/Current programming is done with PMBus option. Refer to Instruction Manual Chapter 3.	-SENSE
B20	SMB ALERT (optional PMBus)	PMBus INTERRUPT signal. Refer to the PMBus interface description HFE Instruction Manual Chapter 3.	SIGNAL RETURN
B21	AC FAIL	Output AC FAIL, LOW when the input voltage is 85Vac<Vin<270Vac, HIGH when the input voltage is 85Vac>Vin or Vin>270Vac. Open collector type (15V, 10mA).	SIGNAL RETURN
C1 (long pin)	PROTECTIVE GROUND	AC GROUND connection. Refer to safety instructions for safety standards requirements	
C2 (long pin)	AC NEUTRAL	AC NEUTRAL refer to safety instructions for safety standards requirements	
C3 (long pin)	AC LINE	AC LINE refer to safety instructions for safety standards requirements.	

**REAR CONNECTOR PIN ALLOCATION CHART**



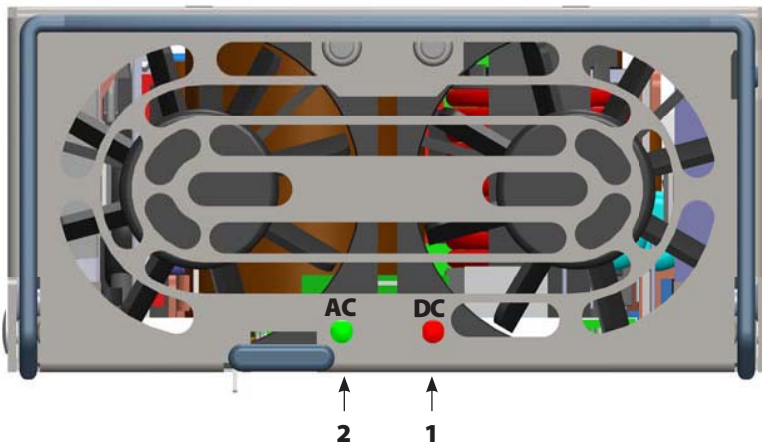
IN/OUTPUT CONNECTOR POSITRONIC P/N: PCIM34W13M40CA1/AA

**FRONT PANEL INDICATORS****1. DC OK – LED indicator:**

GREEN when Output Voltage above  $90\% \pm 5\%$  of set Output Voltage;  
RED when Output Voltage fallen below  $90\% \pm 5\%$  of set Output Voltage;

**2. AC OK – LED indicator:**

GREEN when Input Voltage is  $85\text{Vac} < V_{in} < 270\text{Vac}$ ;  
OFF when the Input Voltage is  $85\text{Vac} > V_{in}$  or  $V_{in} > 270\text{Vac}$ ;



## REGULATORY NOTICES

### CE NOTICE (European Union)

Marking by the CE Symbol indicates compliance to the Low Voltage Directive (2006/95/EC) of the European Union. Such marking is indicative that the HFE1600-xy units meet the following technical standard: EN 60950-1:2006 - "Safety of Information Technology Equipment."

A "Declaration of Conformity" in accordance with the preceding directives and standards has been made and is on file at our EU representative TDK LAMBDA UK, located at Kingsley Avenue, Ilfracombe, Devon EX34 8ES, UK.

### SAFETY APPROVALS

UL60950-1 Second Edition, UL Recognized, C-UL for Canada. IEC/EN 60950-1 Second Edition. CE marking, when applied to the HFE1600-xy units, indicates compliance with the Low Voltage Directive 2006/95/EC in that it complies with EN60950-1 Second Edition.

## SAFETY INSTRUCTIONS

**CAUTION:** The following safety precaution must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this document violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections within. TDK Lambda shall not be liable for user's failure to comply with these requirements.

### Vorsicht

Die folgenden Sicherheitsvorschriften müssen vor Inbetriebnahme und in jedem Betriebszustand bei Service oder Reparatur beachtet werden. Missachtung der Sicherheitsvorschriften und Warnhinweise aus diesem Handbuch führen zur Verletzung der bestehenden Sicherheitsstandards. Bei Betrieb des Gerätes ausserhalb dem bestimmungsgemässen Einsatz können die im Gerät integrierten Schutzfunktionen beeinträchtigt werden. TDK-Lambda ist nicht haftbar für Schäden, die durch Missachtung dieser Sicherheitsvorschriften entstehen können.

**CAUTION:** HFE1600-xy units are not authorized for use as critical component in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the managing director of TDK-Lambda.

### Vorsicht

Dieses Produkt ist nicht für die Verwendung als kritische Komponente in nuklearen Steuerungssystemen, lebenserhaltenden Systemen oder Geräte für den Einsatz in gefährlichen Umgebungen, ohne die ausdrückliche schriftliche Genehmigung durch TDK-Lambda zugelassen

## INSTALLATION (OVERVOLTAGE) CATEGORY & ENVIRONMENTAL CONDITIONS

The HFE1600-xy units have been evaluated to Overvoltage category II.

The HFE1600-xy units intended for use in the following operation conditions:

- \* Indoor use
- \* Pollution degree 2
- \* Max. operational altitude: 3000m above sea level
- \* Ambient temperature: -10°C-50°C at 100% load, up to 70°C with output de-rating applied (refer to Specification above).

## GROUNDING

HFE1600-xy units are Class I product. To minimize electrical shock hazard, the HFE1600-xy units must be connected to an electrical ground. The instruments must be connected to the AC power supply mains through a three conductor power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the supply mains, the protective earth terminal must be connected to the safety electrical ground before any other connection is made. Any interruption of the protective ground conductor or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

### Erdungskonzept

Dieses Produkt ist ein Gerät der Schutzklasse 1. Zur Vermeidung von gefährlichen Energiegehalten und Spannungen, ist das Gehäuse an eine Schutzterde anzuschliessen. Der PE-Anschluss ist an einen festen Erder anzuschliessen. Bei Festverdrahtung des Gerätes ist sicherzustellen, dass der PE Anschluss als erstes angeklemt wird. Jede mögliche Unterbrechung des PE-Leiters oder Trennung der PE Verbindung kann einen möglichen elektrischen Schlag hervorrufen, der Personenschäden zur Folge hätte.

## LIVE CIRCUITS

Operating personnel must not remove the HFE1600-xy unit cover.

No internal adjustment or component replacement is allowed by non-TDK Lambda qualified service personnel. Never replace components with power cable connected. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

### Spannungsführende Teile

Die Geräteabdeckung darf nicht durch Endanwender geöffnet werden. Interne Modifikationen, sowie Bauteilaustausch ist nur durch TDK-Lambda qualifiziertes Personal erlaubt. Vor Austausch von Bauteilen ist das Netzkabel bzw. die Versorgungsspannung zu trennen. Energieversorgungsanschlüsse sind immer zu trennen, um Personenschäden durch gefährliche Energieinhalte und Spannungen auszuschliessen. Die Stromkreise sind zu entladen, externe Spannungsquellen sind zu entfernen, bevor auf Bauteile bzw. Komponenten Ebene gearbeitet wird.

Restricted Access Area: HFE1600-xy units should only be installed in a Restricted Access Area. Access should be available to service personnel only.

#### **PARTS SUBSTITUTIONS & MODIFICATIONS**

Parts substitutions and modifications are authorized TDK Lambda service personnel only. For repairs or modifications, the instrument must be returned to TDK Lambda service facility.

#### **AC INPUT**

Do not connect HFE1600-xy unit to mains supply exceeding the input voltage and frequency rating. The input voltage and frequency rating is: 100-240V~, 50/60Hz. For safety reasons, the mains supply voltage fluctuations should not exceed +/-10% of nominal voltage.

#### **HEAT HAZARD**

WARNING: Top, bottom and side surfaces may become hot when operating the unit continuously. To reduce the risk of injury from a hot surface, allow the surface to cool before touching.

##### **Heisse Oberflächen**

WARNUNG: Im Dauerbetrieb erwärmen sich die Gehäuseoberflächen. Um das Verletzungs-Risiko durch heiße Oberflächen zu minimieren, sollte das Gerät einige Zeit abkühlen können, bevor weitere Arbeiten durchgeführt werden.

#### **ENERGY HAZARD**

The main output of HFE1600-xy units is capable of providing hazardous energy. Due to hazardous energy level the output and connections therefore must not be user accessible. Manufacturer's final equipment must provide protection to service personnel against inadvertent contact with output bus bars.

#### **FUSE**

Internal fuse is sized for fault protection and if a fuse was opened it would indicate that service is required. Fuse replacement should be made by qualified technical personnel.

HFE1600-xy unit fuse rating is described below. F101: F20A H 250Vac

##### **SICHERUNGEN**

Vor Anschluss an die Netzversorgung ist die Aufstellenleitung zu beachten!

1. Absicherung: F1 01: F20A H 250VAC
2. Die Gehäuseabdeckung darf nur im stromlosen Zustand geöffnet werden.

**ACHTUNG:** Sicherungen dürfen nur durch geschulte Service Personen getauscht werden.

#### **OVERCURRENT PROTECTION:**

A readily accessible branch circuit over-current protective device rated 30A max. must be incorporated in the building wiring.

##### **Überstromschutz**

Eine leicht zugängliche Vorsicherung mit 30A max.. pro Eingang muss in der Hausinstallation vorgesehen werden

#### **SYMBOLS**



CAUTION Risk of Electrical Shock.



Instruction manual symbol. The instrument will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltage.



This symbol indicates the presence of a hot surface or component. Touching this surface could result in bodily injury.



Indicates ground terminal.



Protective Ground Conductor Terminal

**WARNING**

Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in personal injury. A WARNING sign should not be skipped and all indicated conditions must be fully understood and met.

**CAUTION**

Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in damage to the equipment.



**1. SINGLE UNIT OPERATION**

**1.1 Basic configuration (Local Sense)**

For basic configuration:

- +/- SENSE have to be connected to the HFE1600 +/-V terminals prior to operating the supply.
- ENABLE input must be connected to SIGNAL RETURN in order for the supply to turn on.

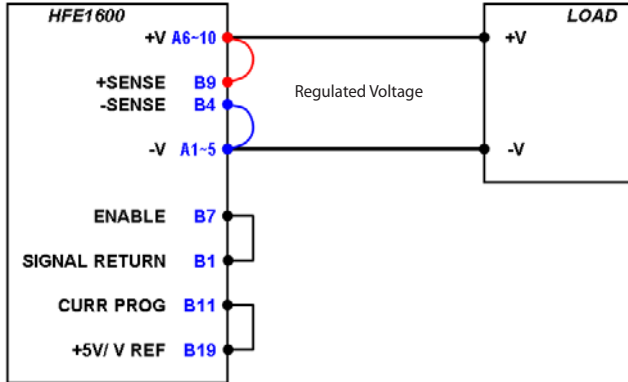


Fig-1.1

**1.2 Basic configuration (Remote Sense)**

For basic configuration:

- +/- SENSE have to be connected to the +/-V terminals on the Load side prior to operating the supply.
- ENABLE input must be connected to SIGNAL RETURN in order for the supply to turn on.

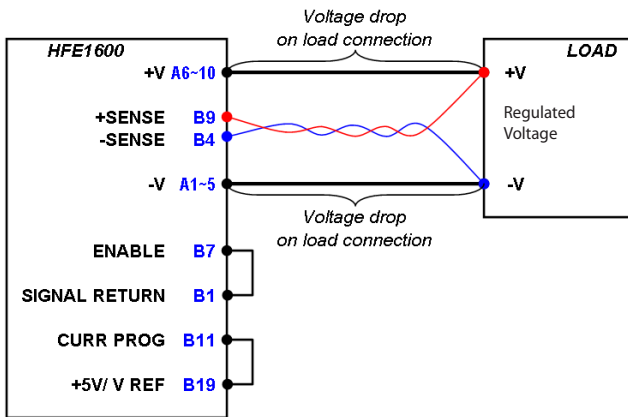


Fig-1.2

**ATTENTION:**

1. Maximum voltage drop on load connection: HFE1600-12: 0.5V/wire, HFE1600-24, 48: 1V/wire.
2. Twisted wires should be used for Remote Sensing connection.
3. If Remote Sensing is used do not break Main Output connection.

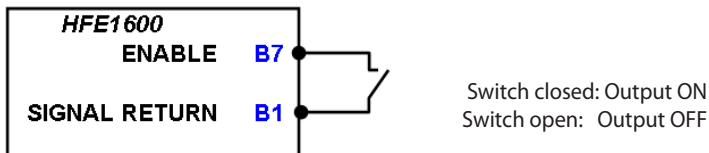


Fig-1.3

**SIGNAL RETURN and ENABLE control are isolated from the output terminals and "-SENSE".**

**1.4 ON/OFF control by INHIBIT**

- Power Supply operation requires the "ENABLE" signal to be connected to "Signal Return".
- Logic of the "INHIBIT" signal is reversed to logic of the "ENABLE" signal.

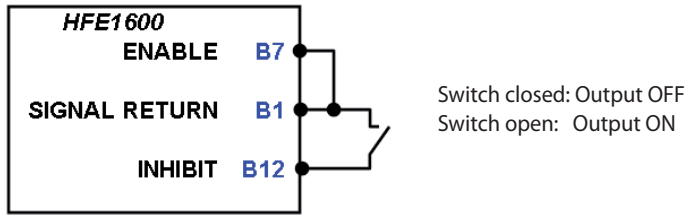


Fig-1.4

**SIGNAL RETURN, INHIBIT and ENABLE controls are isolated from the output terminals and -SENSE.**

**1.5 OUTPUT VOLTAGE PROGRAMMING by External Potentiometer (Not applicable for /S optional PMBus).**

- Output Voltage of HFE1600 Series can be trimmed by potentiometer between approximately 80%-120%
- of nominal output voltage (For Output voltage limits see Graph below).

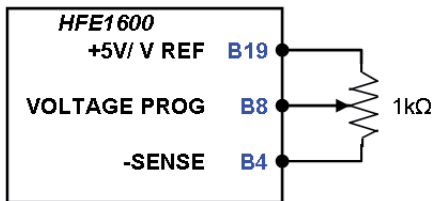
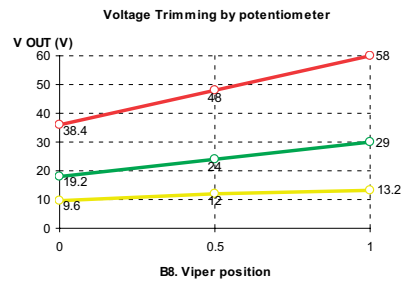


Fig-1.5



**1.6. OUTPUT VOLTAGE PROGRAMMING by External Voltage.**

- Output Voltage of HFE1600 Series can be programmed by external voltage source between approximately 80%-120% of nominal output voltage
- nominal output voltage (For Output voltage limits see Graph enclosed).

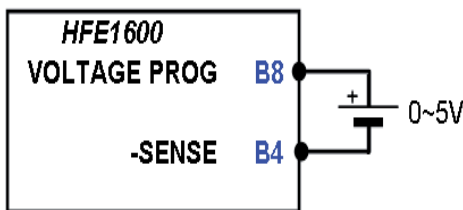
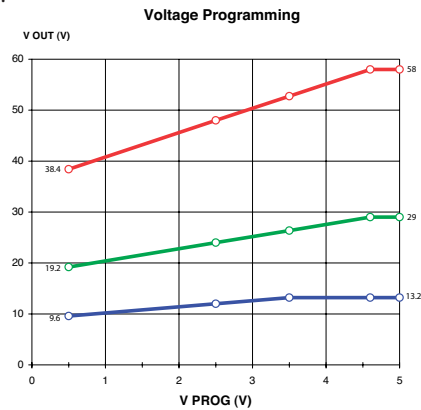


Fig-1.6



**1.7 OUTPUT VOLTAGE PROGRAMMING by PMBus (optional).**

- Output Voltage of HFE1600 Series can be programmed by PMBus between approximately 80%-120% of nominal output voltage
- voltage (limits see HFE1600 series specifications line 3).

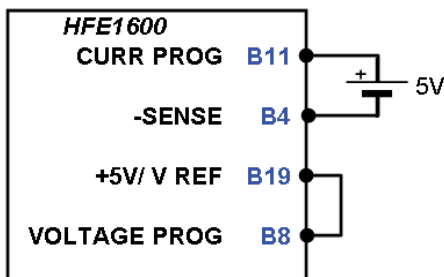


Fig-1.6

**ATTENTION:** If PMBus is used for voltage programming, the Reference voltage will not be fixed to 5V but variable. Additional 5V source is needed for Current Limit programming (5V~110% Iout).

**1.8 OVER CURRENT PROGRAMMING by External Voltage**

Over Current Protection (OCP) can be programmed by external voltage source 0~5V. Nominal OCP value is achieved by connecting to internal 5V source (+5V/V ref, B19) or to external voltage source. By changing the Current Programming Voltage OCP level could be decreased down to ~40% of Nominal Output Current.

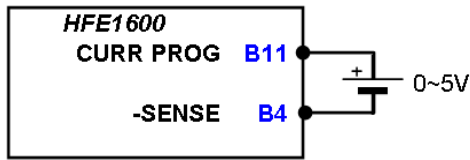
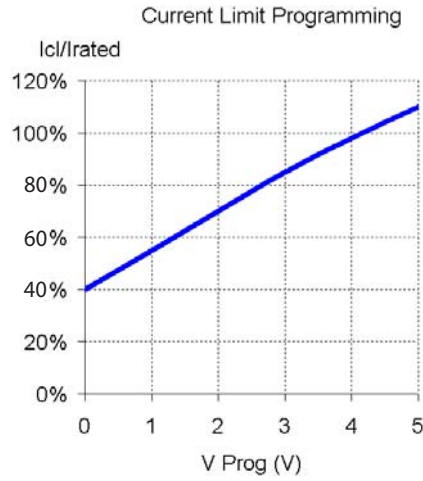


Fig-1.8



**1.9 SUPERVISORY SIGNALS (Typical Connection)**

The following supervisory signals are accessible:

- DC OK
- AC FAIL
- PS EXIST
- TEMP ALARM

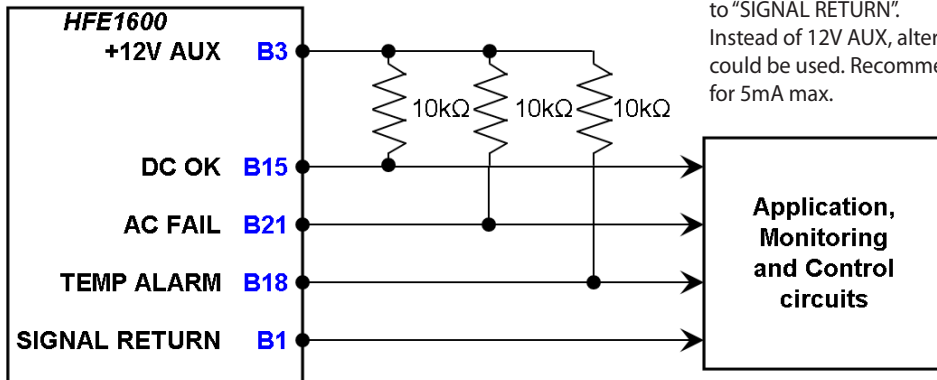


Fig-1.9

These signals are Open Collector type (max 15V, max 10mA), isolated from Output and referenced to "SIGNAL RETURN". Instead of 12V AUX, alternative Supply of 15V max could be used. Recommended Pull-up resistors for 5mA max.

**SIGNAL RETURN** and mentioned signals are isolated from the output terminals and -SENSE.

All outputs are Open Collector type  
(max 15V, max 10mA)

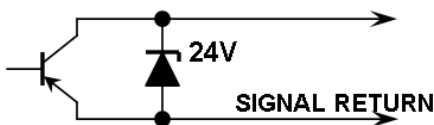
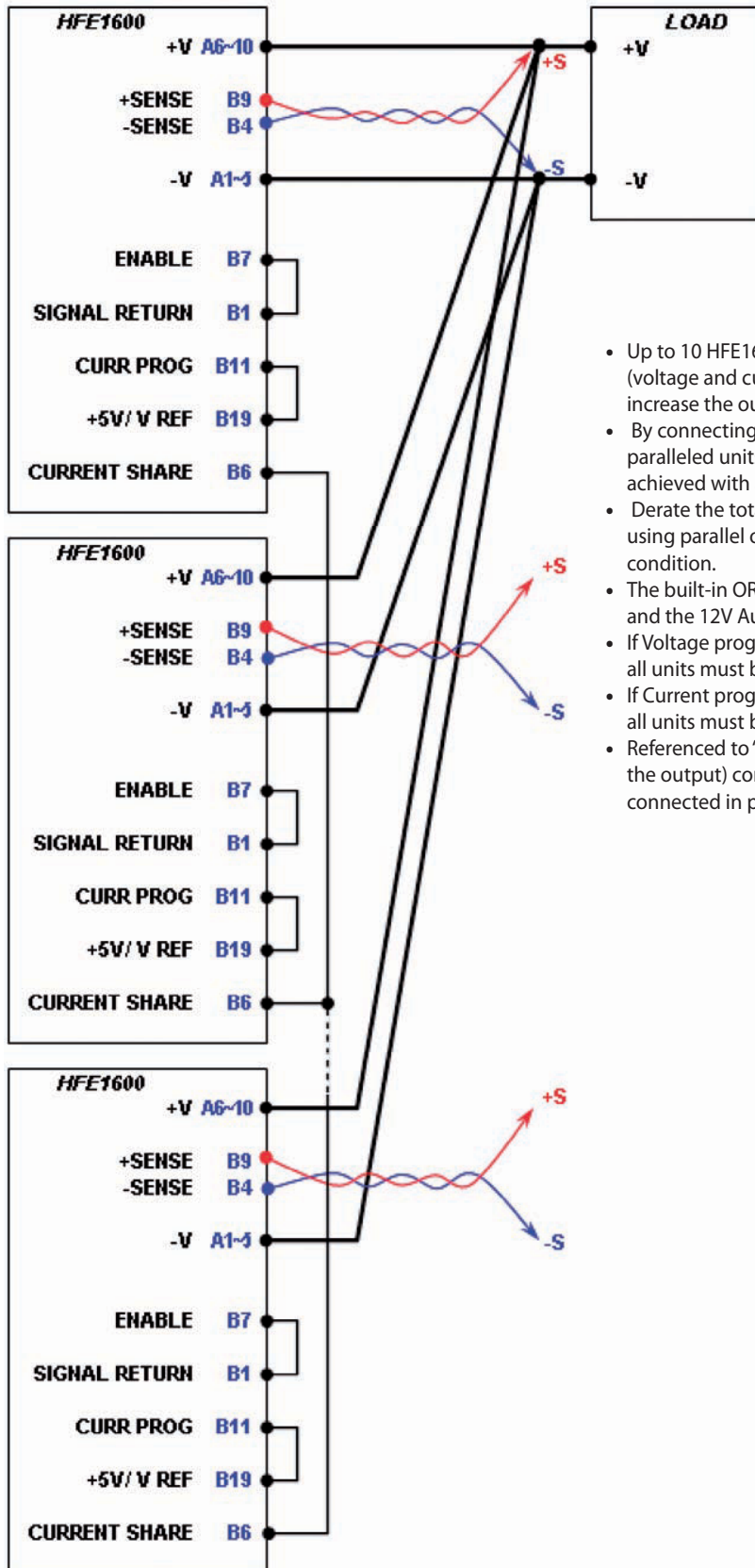


Fig-2.0

2. POWER SUPPLIES CONNECTION

2.1. PARALLEL OPERATION



- Up to 10 HFE1600 units with the same rating (voltage and current) can be used in parallel to increase the output current.
- By connecting the CS signal between the paralleled units, automatic current balance is achieved with accuracy of +/-10% of full rating.
- Derate the total output current by 5% when using parallel operation to prevent unit overload condition.
- The built-in ORing MOSFETs on the main output and the 12V Auxiliary output allow N+1 operation.
- If Voltage programming is used "V PROG" inputs of all units must be connected in parallel.
- If Current programming is used "I PROG" inputs of all units must be connected in parallel.
- Referenced to "SIGNAL RETURN" (floating from the output) controls/signals and +12V AUX can be connected in parallel.

Fig-2.1

2.2 SERIES OPERATION

- Up to 2 units with the same rating (voltage and current) can be used in series to increase the output voltage:
- Connect Main Outputs in series (as shown);
- Diodes should be connected in parallel with each unit output to prevent reverse voltage. Each diode should be rated to atleast the power supply rated output voltage and output current.
- Connect as shown : +Sense of positive unit and -Sense of negative unit (twisted pair) to Load point, or to +V and -V accordingly for Local Sense;
- In case PMBus is used Connect PMBus signals in parallel (PMBus is isolated from Output), and choose for the units different Addresses (see chapter 3.1);
- Current limit should be adjusted to the same value;
- Output Voltage can be adjusted independently for each unit.
- Controls Monitoring signals and +12V AUX are referenced to "SIGNAL RETURN" may be connected in parallel.

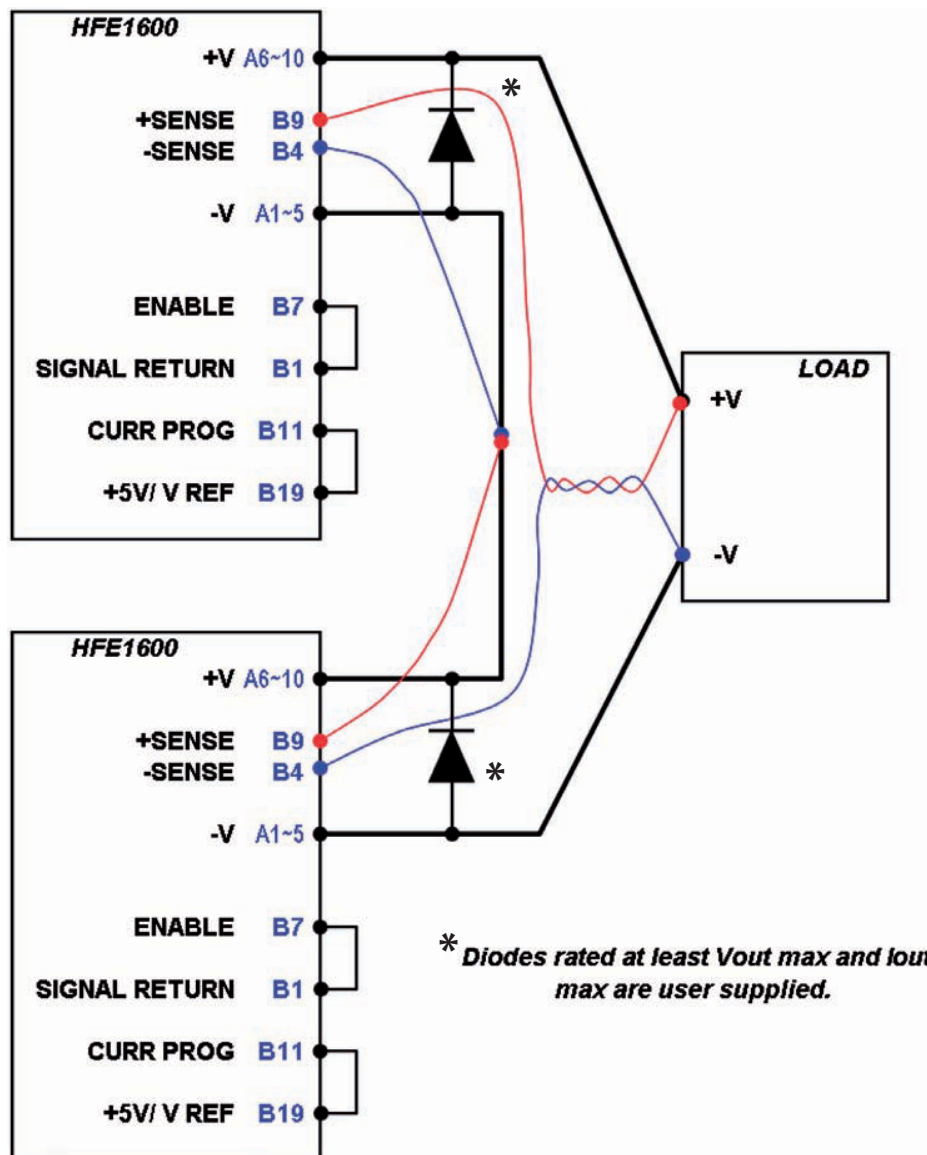


Fig 2.2 HFE1600 series connection (remote sense configuration)

### 3. PMBus Interface Option ( /S Option)

#### 3.1 HFE\_1600 may have optional Power Management Bus (PMBus) hardware.

The PMBUS interface in the HFE1600 (/S option) includes:

- Monitoring the Output Voltage, Current and Temperature
- Programming the Output Voltage, or Current.
- Programming the Supply On/OFF.
- Reading and Clearing Faults.
- Reading the Manufacturing Related Data (Model Name, Serial No, Manufacturing Data, etc)
- Storing the following conditions at AC Off
  - Set Output voltage
  - Max allowed programmable output voltage
  - ON/Off Status
- **ATTENTION:** If PMBus is used for voltage programming, the Reference voltage will not be fixed to 5V but can be variable. (Reference voltage will be used for voltage programming). Additional 5V source is needed for Current Limit programming (5V = 110% Iout).

The PMBUS supports:

- 100KHz Operation.
- Block Read Protocol
- Group Command Protocol
- Direct Command Format for Monitoring and Programming Functions

#### 3.2 Addressing (A3, A2, A1, A0 inputs)

Four variable address lines allow up to 16 Supplies to be connected on a single bus.

PMBus uses 7 bit addressing.

There is constant part of address and variable part of address:

Constant part of address consists of 3 Most Significant Bits A6, A5, A4 and always equals 001.

Variable part of address consists of 4 Least Significant bits: A3, A2, A1, A0.

Value of these four bits have to be assigned by hardware connections of 4 pins of the PS connectors.

The Address lines (A3, A2, A1, A0) are internally pulled up by resistors to +5V.

The address lines can be left open for <1> address or connected to -S for <0> address.

So, available Address Space contains 16 possible addresses: from 0010000 to 0011111.

**In case more than one unit is connected to PMBus, each unit must be set to its own unique address.**

**Duplicate addressing is not allowed.**

- |              |   |                    |
|--------------|---|--------------------|
| For example: | first unit -- A3(J1.B10), A2(J1.B5), A1(J1.B14), A0(J1.B16) are not connected | - ADDRESS 0011111; |
|              | second unit -- A0(J1.B16) is connected to -SENSE                              | - ADDRESS 0011110; |
|              | third unit -- A1(J1.B14) is connected to -SENSE                               | - ADDRESS 0011101; |
|              | and so on.  |                    |

**Attention: A0, A1, A2, A3 signals and -SENSE are NOT isolated from the Output Terminals.**

#### 3.3 SERIAL CLOCK

This line is clocked by the Controller which controls the PMBUS. It should be connected to +3.3V (referenced to "Signal RTN") via a 2.2kΩ pull-up resistor.

#### 3.4 SERIAL DATA

This is a Bi-Directional line which must be connected to +3.3V (referenced to Signal RTN) via a 2.2kΩ pull up resistor.

#### 3.5 SMBALERT

SMBALERT is used to indicate to the HOST about any Faults/Error Conditions.

This line must be connected to +3.3V (referenced to Signal RTN) via a 2.2kΩ pull up resistor.

This Signal is HIGH to indicate that no fault/error is present. If some fault/error occurs, the signal will go LOW.

#### 3.6 PMBus TYPICAL CONNECTION

"SIGNAL RETURN" and PMBus signals are isolated from the Output terminals and Senses.

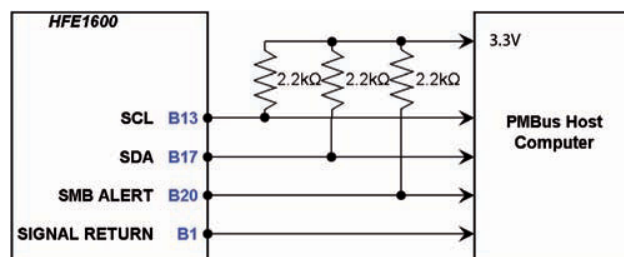


Fig-3.6 PMBus Typical connection

**4. PMBus COMMAND SET**

**4.1 READ\_STATUS**

This Command is used to read the status of the Power Supply. The Status information is stored in a special register called the "STATUS REGISTER".

The PMBUS reads 8 different types of Faults and Warnings.

Command Used	Type	#Data bytes
D0h	Read Byte	1

Fault is indicated by "1". No fault is indicated by "0".

For Example: If DC Fail occurs, READ\_STATUS will return 01h. SMBALERT will go "LOW"  
 If AC Fail occurs, READ\_STATUS will return 11h. SMBALERT will go "LOW"

Faults	Type	Bit No in Status Register	Meaning	Main output behavior
DC Fail	FAULT	0	Output Voltage < 85~95% of Set Vout	Output OFF/Output Low
Over Temperature Protection	FAULT	1	Internal temperature higher than safe limit	Output OFF
Over Temperature Alarm	WARNING	2	Internal temperature ~ 10°C below safe limit.	Output ON
Fan Fail	FAULT	3	One or both Fans are not working	Output OFF
AC Fail	FAULT	4	Input Voltage <85Vac / >270Vac	Output OFF/Output ON
Over Voltage Protection	FAULT	5	Output Voltage > 1.15xVset	Output OFF
Programmed Voltage more than allowed	WARNING	6	Programmed Voltage more than Max Allowed Voltage (*1)	Output ON
Command Error	WARNING	7	Command not understood by Power Supply (*2)	Output ON

(\*1) If Max Allowed Voltage is set to 48V and Programmed Voltage is set to 50V, Output will be programmed to 48V, Bit No 6 will be "1", and SMBALERT will become "LOW".

(\*2) If any Command sent is not understood by the Supply, bit no 7 will be "1" and SMBALERT will become "LOW".

**4.2 CLEAR\_FAULTS**

This command is used to clear the "STATUS REGISTER" after any fault occurs.

If the CLEAR\_FAULTS command is not sent after any fault occurs, the "STATUS REGISTER" will not be cleared.

SMBALERT signal will remain "LOW" until a "CLEAR\_FAULTS" command is sent.

If a Fault or Warning is still present after "CLEAR\_FAULTS" is sent, "STATUS REGISTER" will be updated and the SMBALERT signal will be "LOW" again.

Command code	Type	#Data bytes
03h	Send Byte	0

**4.3 OPERATION (ON/OFF)**

Command code	Type	Data sent
01h	R/W Byte	00h=OFF
01h	R/W Byte	80h=ON

**4.4 COMMANDS TO READ INVENTORY DETAILS**

Command Name	Command code	Type	#Data bytes
PMBUS_REVISION	98h	Read Byte	1
MFR_ID	99h	Read Block	16
MFR_MODEL	9Ah	Read Block	16
MFR_OUTPUT	D1h	Read Block	16
MFR_REVISION	9Bh	Read Block	16
MFR_LOCATION	9Ch	Read Block	16
MFR_DATE	9Dh	Read Block	16
MFR_SERIAL	9Eh	Read Block	20

Details are stored in ASCII Fornat

**4.5 PROGRAMMING AND MONITORING FUNCTIONS**

For Monitoring and Programming functions use the following equation

$$Y = (mX + b) * 10^R \quad X = (Y * 10^{-R} - b) / m$$

Where Y - digital value sent or received from the supply.

X is the normal value (V, A, °C)

m, b, R - coefficients that are explained in Table 1.

Voltage (V)	Physical value	Physical Unit	Min. Value	Max. Value	m	b	R
48	Voltage Programming	V	38.4	58	426	-15335	-1
	Voltage monitoring	V	0	60	1705	0	-2
	Current monitoring	A	0	40	25575	0	-3
	Temperature monitoring	°C	0	100	1023	0	-2
32	Voltage Programming	V	28.8	38.4	639	-15333	-1
	Voltage monitoring	V	0	40	25575	0	-3
	Current monitoring	A	0	60	1705	0	-2
	Temperature monitoring	°C	0	100	1023	0	-2
24	Voltage Programming	V	19.2	29	853	-15360	-1
	Voltage monitoring	V	0	30	341	0	-1
	Current monitoring	A	0	80	12787	0	-3
	Temperature monitoring	°C	0	100	1023	0	-2
12	Voltage Programming	V	9.6	13.2	1705	-15345	-1
	Voltage monitoring	V	0	15	682	0	-1
	Current monitoring	A	0	160	6394	0	-3
	Temperature monitoring	°C	0	100	1023	0	-2

m, b, R Co-efficients can also be recovered from the EEPROM  
Co-efficients are stored in ASCII Format

Command name	Command code	Type	#Data bytes
MFR_VOLTAGE_MON_COEFF	D2h	Read Block	16
MFR_CURRENT_MON_COEFF	D3h	Read Block	16
MFR_TEMP_MON_COEFF	D4h	Read Block	16
MFR_VOLTAGE PROG_COEFF	D5h	Read Block	17

**4.5.1 MONITORING THE OUTPUT VOLTAGE (READ\_VOUT)**

The accuracy of the voltage reading is +/-2%

The output voltage is read before the ORING Circuit (~50mV Voltage drop).

The read back Output Voltage can be calculated using the "Direct data Format".

Refer to Table 1 for the Coefficients for calculating the Output Voltage.

Command code	Type	#Data bytes
8Bh	Read Byte	2

Example: Power Supply HFE1600-48;

Hex read back = 032Ch;

Converted to Decimal = 812;

Using the required coefficients the Output Voltage  $812 \times 100 / 1705 = 47.62V$ .

Read the Actual Output Voltage on the Output Bus Bar (Ex: 47.90V). Add 0.05V to compensate ORing Circuit drop

So, the actual voltage is (Ex:  $47.90 + 0.05 = 47.95V$ ).

Accuracy is  $(47.95 - 47.62) / 60 (*1) \times 100 = 0.55\%$

Supply (*1)	Full Scale (*1)
HFE1600-12	15V
HFE1600-24	30V
HFE1600-32	40V
HFE1600-48	60V



**4.5.2 MONITORING THE OUTPUT CURRENT (READ\_IOUT)**

The accuracy of the current reading is +/-10%  
 The read back output current can be calculated using the "Direct data Format".  
 Refer to Table 1 for the Coefficients for calculating the Output Current.

Command Used	Type	#Data bytes
8Ch	Read Byte	2

Example: Hex read back = 0361h;  
 Converted to Decimal = 865;  
 Using the required coefficients the output current =  $865 \times 1000 / 25575 = 33.82A$ ;  
 Read the actual Output current (Ex: 33.05A) / Accuracy is  $(33.05 - 33.82) / 40 \times 100 = -1.92\%$

Supply (*1)	Full Scale (*1)	Supply (*1)	Full Scale (*1)
HFE1600-12	160A	HFE1600-32	60A
HFE1600-24	80A	HFE1600-48	40A

**4.5.3 MONITORING THE SUPPLY TEMPERATURE (READ\_TEMPERATURE\_1)**

The accuracy of the Temperature reading is +/-5°C  
 The read back supply temperature can be calculated using the "Direct data Format".  
 Please refer to table 1 for the Coefficients for calculating the Supply Temperature

Command Used	Type	#Data bytes
8Dh	Read Byte	2

Example: Hex read back = 01DCh;  
 Converted to Decimal = 476;  
 Using the required coefficients the Supply Internal Temperature =  $476 \times 100 / 1023 = 46.53°C$ .

**4.5.4 PROGRAMMING THE OUTPUT VOLTAGE (VOUT\_COMMAND)**

The output Voltage can be programmed using the "Direct data Format".  
 Please refer to table 1 for the Coefficients to be used for calculating the Voltage Programming.

Command Used	Type	#Data bytes
21h	R/W Byte	2

Example: Power Supply HFE1600-24;  
 To program the Output Voltage to 24V, send  $(853 \times 24 + (-15360)) / 10 = 511$  (DEC);  
 Read the actual set output Voltage (Ex: 24.05V) / Accuracy is  $(24.05 - 24) / 30 \times 100 = 0.16\%$

Supply (*1)	Full Scale (*1)	Supply (*1)	Full Scale (*1)
HFE1600-12	15V	HFE1600-32	40V
HFE1600-24	30V	HFE1600-48	60V

**4.5.5 PROGRAMMING THE MAXIMUM ALLOWED PROGRAMMABLE OUTPUT VOLTAGE (VOUT\_MAX)**

The Max Programmable output Voltage can be programmed using the "Direct data Format".  
 The coefficients used for Programming Output Voltage must be used for Setting Maximum Programmable Output voltage.

Command Used	Type	#Data bytes
24h	R/W Byte	2

Example: Power Supply HFE1600-24;  
 To program the maximum programmable output voltage to 29V  
 Send  $(853 \times 29 + (-15360)) / 10 = 938$  (DEC)

**4.5.6 PROGRAMMING THE OUTPUT CURRENT WITH VOUT\_COMMAND**

The output current can be programmed using the "Direct data Format".

Command Used	Type	#Data bytes
21h	R/W Byte	2

it is possible to program the OCP with the PMBUS. The OCP can be programmed between 45% to 110% of the nominal load current.  
 Please send full scale value to program the OCP to 110%. Please refer to fig. 1 for current limit for each supply under various conditions

**4.5.7 ENABLING / DISABLING THE MONITORING FILTER**

Command Used	Type	Data sent
D6h	R/W Byte	00h=OFF
D6h	R/W Byte	01h=ON

## HFE1600-S1U RACK INSTRUCTION MANUAL

### HFE1600 SERIES RACK SPECIFICATIONS

1	Number of power supply modules to be inserted	---	Maximum of 5 x HFE1600 of the same output voltage rating.
2	Maximum output power	W	7600W for 5 units inserted, refer to HFE1600 specifications for derating.
3	Maximum output current	A	200A per output (Total 400A)
4	Input voltage / frequency range (*2)	---	85~265Vac continuous, 47~63Hz, Single phase, separate input for each PS (*).
5	Maximum input current (at 100/200Vac)	A	14.2/8.1 for each HFE1600 power supply module.
6	AC input connector	---	Separate for each power supply. HFE1600-S1U: IEC inlet, type C16. HFE1600-S1U /TB: Terminal Block.
7	Output terminals	---	Two bus-bars outputs for each output terminal (two sides). Refer to outline drawing.
8	Remote sensing (*3)	V	Possible. Refer to Fig 3.2.
9	Parallel operation	---	Possible. Refer to Fig 3.10.
10	Series operation	---	Possible. Refer to Fig 3.11.
11	Remote On/Off control (INHIBIT)	---	Separate control for each PS unit, by electrical signal or dry contact. "OFF": 0~0.6V or short. "ON": 2~15V or open. Refer to Fig 3.4.
12	Remote On/Off control (ENABLE)	---	Common for all PS units, by electrical signal or dry contact. "ON": 0~0.6V or short. "OFF": 2~15V or open. Refer to Fig 3.3.
13	DC OK signal	---	Separate signal for each PS unit, Open collector signal. Maximum sink current: 10mA. Tracking output setting, "LOW" when $V_{out} > 90 \pm 5\%$ from output voltage setting. Refer to Fig 3.5
14	AC fail signal	---	Separate signal for each PS unit. Open collector signal. Maximum sink current: 10mA "LOW" when input voltage is $85Vac < V_{in} < 270Vac$ . Refer to Fig 3.5
15	Over Temperature alarm signal	---	Separate signal for each PS unit. Open collector signal. Maximum sink current 10mA "LOW" when the internal temperature of the unit is within safe limit, "HIGH" approximately 10°C below Thermal shut down. Refer to Fig 3.5
16	Output voltage trimming	---	Common for all PS units, by built-in potentiometer. Refer to Sec 1.3.
17	Output voltage programming	---	Common for all PS units, by 0~5V signal. Refer to Fig 3.6.
18	Output voltage programming via PMbus interface	---	Common for all PS units. Refer to Instruction Manual Fig 3.7.
19	OCP programming	---	Common for all PS units, by 0~5V signal. Refer to Fig 3.8.
20	Auxiliary power supply		11.2~12.5VDC. Maximum output current: 0.5A.
21	Operating temperature	---	-10~+50°C -- 100% load. +50°C to +60°C -- Derating 2%/°C. +60°C to +70°C -- Derating 2.5%/°C.
22	Storage temperature	---	-30~+85°C
23	Operating humidity	---	10~90% RH, no condensation.
24	Storage humidity	---	10~95% RH, no condensation.
25	Vibration	---	Built to meet IEC60068-2-64 (Basic Transportation)
26	Shock	---	Built to meet IEC60068-2-27 (Basic Transportation)
27	Applicable safety standards		UL60950-1 Second Edition, EN60950-1 Second Edition
28	Withstand voltage	Vac	Input-Output: 3000Vrms, 1min. Input-Ground: 2000Vrms, 1min. Output-Ground: 12V,24V models - 500Vrms, 1min. Output-Ground: 48V model - 1500Vrms, 1min.
29	Insulation resistance	---	More than 100Mohm at 25°C and 70% RH. Output-Ground: 500Vdc
30	Weight (Typ) (with accessories)	kg	4.8
31	Size (W*H*D)	mm	445x43.6x365 Refer to Outline Drawing.

\* PS. - Is abbreviation for "Power Supply Module".

#### Notes:

- \* 1. The Output of all the HFE 1600 Modules are connected in parallel in the Rack.
- \* 2. For cases where conformance to various safety standards (UL, EN etc.) is required, Input Voltage to be described as "100-240Vac (50/60Hz)".
- \* 3. Maximum voltage drop on load connection: HFE1600-12: 0.5V/wire, HFE1600-24, 48: 1V/wire.

## **REGULATORY NOTICES**

### **FCC NOTICE**

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**NOTE:** This equipment has been tested and found to comply with the limits for a Class A (Radiated Emission) digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

**WARNING:** Modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment under FCC Rules.

### **CE NOTICE (European Union)**

Marking by the CE Symbol indicates compliance to the EMC Directive and the Low Voltage Directive of the European Union. Such marking is indicative that the HFE1600-S1U rack meets the following technical standards:

EN 55022:2006 /A1:2007 - "Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment."

EN 55024:1998/A1:2001/A2:2003 - "Information Technology Equipment – Immunity characteristics - Limits and methods of measurement."

EN 60950-1:2006 - "Safety of Information Technology Equipment."

A "Declaration of Conformity" in accordance with the preceding directives and standards has been made and is on file at our EU representative TDK LAMBDA UK, located at Kingsley Avenue, Ilfracombe, Devon EX34 8ES, UK.

**WARNING:** This is a Class A (Radiated Emission) product. On a domestic environment this product may cause radio interference in which case user may be required to take adequate measures.

### **SAFETY APPROVALS**

UL60950-1 Second Edition, UL Listed, C-UL for Canada. IEC/EN 60950-1 Second Edition. CE marking, when applied to the HFE1600-S1U product, indicates compliance with the Low Voltage Directive 2006/95/EC in that it complies with EN60950-1 Second Edition.

**SAFETY INSTRUCTIONS**

**CAUTION:** The following safety precaution must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this document violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections within. TDK Lambda shall not be liable for user's failure to comply with these requirements.

**CAUTION:** HFE1600-S1U rack is not authorized for use as critical component in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the managing director of TDK-Lambda.

**INSTALLATION (OVERVOLTAGE) CATEGORY& ENVIRONMENTAL CONDITIONS**

The HFE1600-S1U has been evaluated to Overvoltage category II.

The HFE1600-S1U intended for use in the following operation conditions:

- \* Indoor use
- \* Pollution degree 2
- \* Max. operational altitude: 3000m above sea level
- \* Ambient temperature: -10°C-50°C at 100% load, up to 70°C with output de-rating applied (refer to Specification above).

**GROUNDING**

HFE1600-S1U rack is Class I product. To minimize shock hazard, the HFE1600-S1U rack must be connected to an electrical ground. The instruments must be connected to the AC power supply mains through a three conductor power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the supply mains, the protective earth terminal must be connected to the safety electrical ground before any other connection is made. Any interruption of the protective ground conductor or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

**LIVE CIRCUITS**

Operating personnel must not remove the HFE1600-S1U rack cover.

No internal adjustment or component replacement is allowed by non-TDK Lambda qualified service personnel. Never replace components with power cable connected. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

Restricted Access Area: HFE1600-S1U rack should only be installed in a Restricted Access Area. Access should be available to service personnel only.

**PARTS SUBSTITUTIONS & MODIFICATIONS**

Parts substitutions and modifications are allowed by authorized TDK Lambda service personnel only. For repairs or modifications, the instrument must be returned to TDK Lambda service facility.

**AC INPUT, AC INPUT RATING**

<b>CAUTION</b>
Risk of electrical shock and energy hazard. Disconnecting one power supply line disconnects only one power supply module. To isolate the unit completely, disconnect all power supply lines. Terminal blocks should only be used by professional workers to connect AC cables.

<b>ACHTUNG</b>
Spannungsfuehrende Teile - Gefahr durch elektrischen Schlag oder hohe Energieinhalte. Alle Netzstecker der einzelnen Komponenten bzw. der Einschuebe muessen getrennt werden, damit das System "spannungsfrei" ist. Die Eingangsklemme der Stromversorgung ist nur innerhalb eines Gesamtsystemes zu verwenden.

<b>ATTENTION</b>
Risque de choc et de danger electriques. Le debranchement d'une seule alimentation stabilisee ne debranche uniquement qu'un module «Alimentation Stabilisee». Pour isoler completement le module en cause, il faut debrancher toutes les alimentations stabilisees.

Do not connect HFE1600-S1U to mains supply exceeding the input voltage and frequency rating of HFE1600-S1U. The input voltage and frequency rating is: 100-240V~, 50/60Hz. For safety reasons, the mains supply voltage fluctuations should not exceed +/-10% of nominal voltage.

**HEAT HAZARD**

**WARNING:** Top, bottom and side surfaces may become hot when operating the unit continuously. To reduce the risk of injury from a hot surface, allow the surface to cool before touching.

**ENERGY HAZARD**

The main output of HFE1600-S1U is capable of providing hazardous energy. Due to hazardous energy level the output bus bars and connections therefore must not be user accessible. Manufacturer's final equipment must provide protection to service personnel against inadvertent contact with output bus bars.

**OVERCURRENT PROTECTION:**

A readily accessible branch circuit over current protective device rated 30A max. per each input must be incorporated in the building wiring.

## FUSES

There are no fuses in the HFE1600-S1U rack.

### SYMBOLS



CAUTION Risk of Electrical Shock.



Instruction manual symbol. The instrument will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltage.



This symbol indicates the presence of a hot surface or component. Touching this surface could result in bodily injury.



Indicates ground terminal.



Protective Ground Conductor Terminal

L1

Indicates first Line supply terminal

L2/N

Indicates second Line or Neutral supply terminal

**WARNING**

Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in personal injury. A WARNING sign should not be skipped and all indicated conditions must be fully understood and met.

**CAUTION**

Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in damage to the equipment.

## **SICHERHEITS - HINWEISE**

### **Vorsicht**

Die folgenden Sicherheitsvorschriften müssen vor Inbetriebnahme und in jedem Betriebszustand bei Service oder Reparatur beachtet werden. Missachtung der Sicherheitsvorschriften und Warnhinweise aus diesem Handbuch führen zur Verletzung der bestehenden Sicherheitsstandards. Bei Betrieb des Gerätes ausserhalb dem bestimmungsgemässen Einsatz können die im Gerät integrierten Schutzfunktionen beeinträchtigt werden. TDK-Lambda ist nicht haftbar für Schäden, die durch Missachtung dieser Sicherheitsvorschriften entstehen können.

### **Vorsicht**

Das HFE1600-S1U-Rack ist nicht für die Verwendung als kritische Komponente in nuklearen Steuerungssystemen, lebenserhaltenden Systemen oder Geräte für den Einsatz in gefährlichen Umgebungen, ohne die ausdrückliche schriftliche Genehmigung durch TDK-Lambda zugelassen

### **Betriebsbedingungen und Umweltbedingungen**

Das HFE1600-S1U-Rack ist zur Installation gemäss Überspannungs-Kategorie 2 evaluiert worden.

Das HFE1600-S1U-Rack ist gemäss den Sicherheitsabnahmen für folgende Betriebsbedingungen bestimmt.

\* Stationäre Einrichtungen in Gebäuden.

\* Verschmutzungsgrad 2.

\* Erlaubte Betriebshöhe: bis zu 3000m.

\* Umgebungstemperaturbereich: -10 bis +50° C, bis zu 70°C mit Derating (Details entnehmen Sie bitte dem Datenblatt)

### **Erdungskonzept**

Dieses Produkt ist ein Gerät der Schutzklasse 1. Zur Vermeidung von gefährlichen Energieinhalten und Spannungen, ist das Gehäuse an eine Schutz Erde anzuschliessen. Der PE-Anschluss ist an einen festen Erder anzuschliessen. Bei Festverdrahtung des Gerätes ist sicherzustellen, dass der PE Anschluss als erstes angeklemt wird. Jede mögliche Unterbrechung des PE-Leiters oder Trennung der PE Verbindung kann einen möglichen elektrischen Schlag hervorrufen, der Personenschäden zur Folge hätte.

### **Spannungsführende Teile**

Die Geräteabdeckung darf nicht durch Endanwender geöffnet werden. Interne Modifikationen, sowie Bauteilaustausch ist nur durch TDK-Lambda qualifiziertes Personal erlaubt. Vor Austausch von Bauteilen ist das Netzkabel bzw. die Versorgungsspannung zu trennen. Energieversorgungsanschlüsse sind immer zu trennen, um Personenschäden durch gefährliche Energieinhalte und Spannungen auszuschliessen. Die Stromkreise sind zu entladen, externe Spannungsquellen sind zu entfernen, bevor auf Bauteile bzw. Komponenten Ebene gearbeitet wird.

### **Änderungen und Bauteilersatz**

Ersatzteilaustausch - und Änderungen dürfen nur von autorisiertem TDK-Lambda SERVICE-PERSONAL durchgeführt werden. Für Reparaturen oder Änderungen ist das Gerät zur TDK-Lambda Service-Niederlassung zu retournieren.

### **Anschluss an Versorgungsstromkreis**

Der Betrieb des HFE1600-S1U ist nur für den dafür spezifizierten Wechselspannungsbereich und der angegebenen Frequenz erlaubt. Die Eingangsspannung und Frequenz ist: 100-240V ~ bei 50/60Hz. Aus Gründen der Sicherheit sollten die Netzspannungsschwankungen im Bereich von + / -10% der Nennspannung liegen.

### **Heisse Oberflächen**

WARNUNG: Im Dauerbetrieb erwärmen sich die Gehäuseoberflächen. Um das Verletzungs-Risiko durch heisse Oberflächen zu minimieren, sollte das Gerät einige Zeit abkühlen können, bevor weitere Arbeiten durchgeführt werden.

### **Gefährlicher Energieinhalt**

Der Hauptausgang des HFE1600-S1U liefert gefährlich hohe Energieinhalte. Aufgrund der gefährlichen Energieinhalte müssen die Stromschienen und die Ausgangsanschlüsse abgedeckt sein und dürfen für den Benutzer nicht zugänglich sein. Der Endgeräte Lieferant hat für die Berührungssicherheit der Ausgänge und Stromschienen Sorge zu tragen.

### **Überstromschutz**

Eine leicht zugängliche Vorsicherung mit 30A max.. pro Eingang muss in der Hausinstallation vorgesehen werden

### **SICHERUNGEN**

Das HFE1600 S1U-Rack selbst verfügt über keine Absicherung

### **MASCHINENLAERM**

Maschinenlaerminformations-Verordnung-3. GPSGV, der hoechste Schalldruckpegel betraegt 70 dB (A) oder weniger gemass ENISO7779.

## Sicherheits- und Warnsymbole



VORSICHT Spannungsführende Teile -Gefahr durch elektrischen Schlag bzw. Energieinhalte.



Handbuch-Symbol.Das Gerät bzw.Geräteteile warden mit diesem Symbol gekennzeichnet, wenn es für den Benutzer notwendig ist, sich auf die Anweisungen im Handbuch zu beziehen.



Zeigt «spannungsführendeTeile» mit gefährlicher Spannung an.



Dieses Symbol weist auf das Vorhandensein einer heißen Oberfläche oder Komponente. Durch Berühren dieser Oberfläche kann zu Verletzungen führen.



ZeigtMasse-Anschluss an, keine Schutz Erde.( z.B.Masseanschluss an einen Verbraucher).



Schutzleiter-Anschlussklemme.

### WARNING

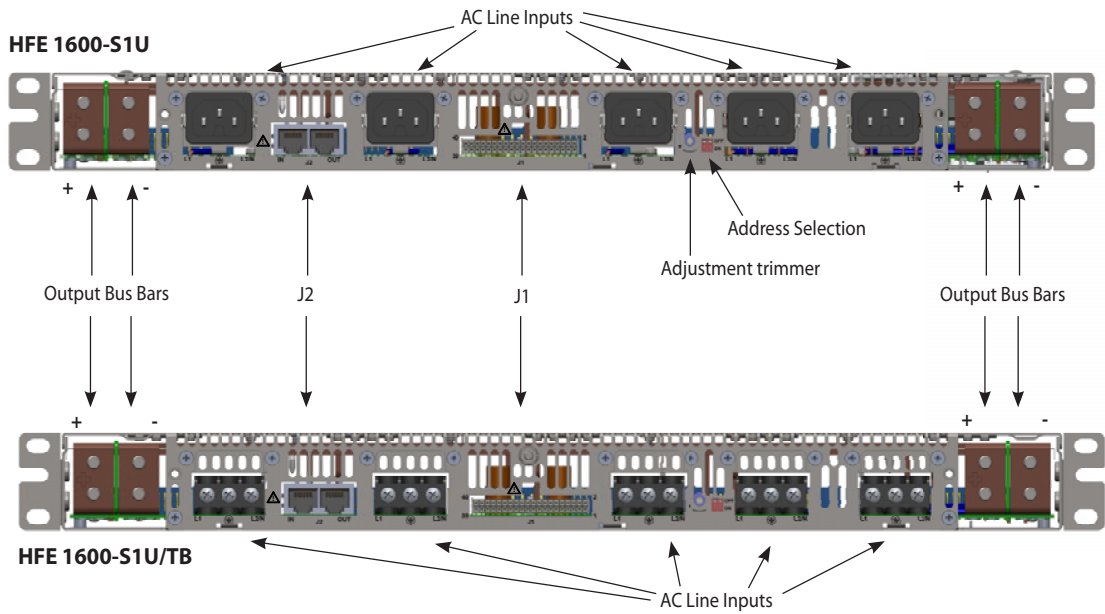
Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in personal injury. A WARNING sign should not be skipped and all indicated conditions must be fully understood and met.

### CAUTION

Denotes hazard. An attention to a procedure is called. Not following the procedure correctly could result in damage to the equipment.

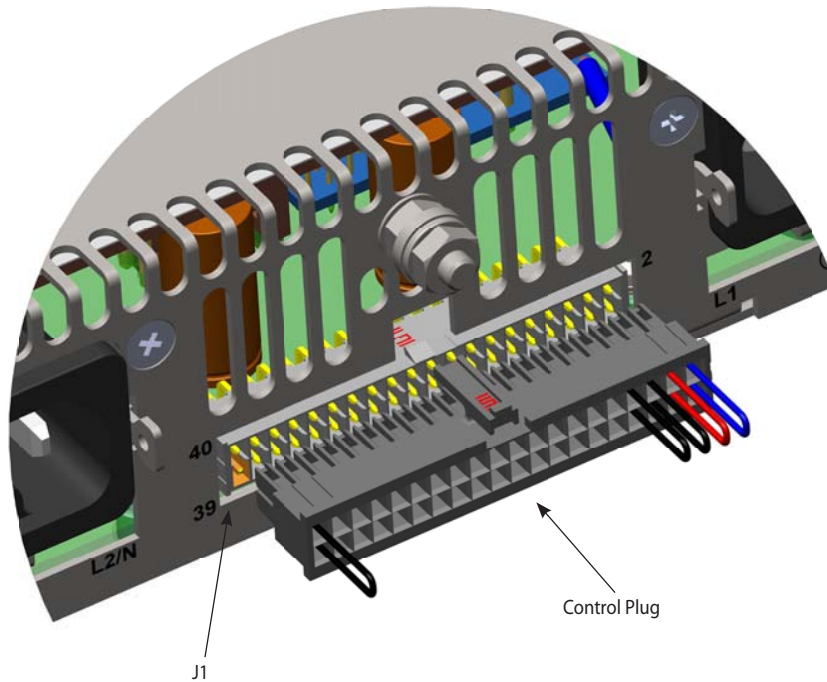
## 1. REAR PANEL CONNECTIONS AND CONTROLS

Fig 1.1 Rear view of HFE1600-S1U series

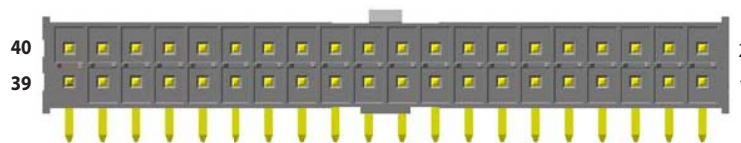


### 1.1. J1 Connector for Control and Monitoring

Mating for J1 Control Plug (provided) or custom made plug/ cable should be inserted to J1 for proper HFE1600 rack operation. Refer to Chapter 3 for connection diagrams.



J1 Pin Allocation Chart see Table 1.1





**Table 1.1 Pin Allocation Chart**

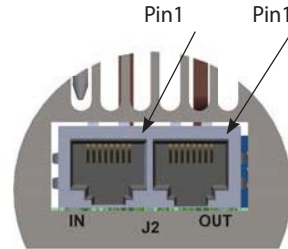
Pin #	Name	Description	Pos. #	Control plug J1	Referenced to
1	-SENSE	Negative sense Connected to –LS for local sensing, or –V on Load side.	All	Short	-SENSE
2	-LS	Connected to Negative Output bus bar through 3 Ohm resistor.	All		-SENSE
3	+SENSE	Positive sense Connected to +LS for local sensing, or +V on Load side.	All	Short	
4	+LS	Connected to Positive Output bus bar through 3 Ohm resistor.	All		
5	V_RPOG	Input (0~5V) referenced to –S. Provides Vout programming by Voltage. Refer to Fig 1.4, 3.6, 3.7.		Short	
6	TRIM	Output of Rear Panel potentiometer, for manual adjustment of Output Voltage.	All		-SENSE
7	I_PROG	Input (0~5V) referenced to –S. Provides Current limit programming by Voltage. Refer to Fig 3.8.	All	Short	-SENSE
8	+5V/V_REF	5V fix output for standard option unit. Voltage/Current programming when PMBus option is being used. Refer to Instruction Manual Chapter 3.	All		-SENSE
9	+5V/V_REF	In parallel with pin 8.	All		-SENSE
10	-SENSE	In parallel with pin 1.	All		
11	TEMP_ALM_1	Output signal of PS in position A. "LOW" when the internal temperature is within safe limit, "HIGH" approximately 10°C below Thermal shut down. Open collector type (15V, 10mA).	A		SIGNAL RETURN
12	TEMP_ALM_2	Output signal of PS in position B. Same as 11.	B		SIGNAL RETURN
13	TEMP_ALM_3	Output signal of PS in position C. Same as 11.	C		SIGNAL RETURN
14	TEMP_ALM_4	Output signal of PS in position D. Same as 11.	D		SIGNAL RETURN
15	TEMP_ALM_5	Output signal of PS in position E. Same as 11.	E		SIGNAL RETURN
16	AC_FAIL_1	Output signal of PS in position A. "LOW" when the input voltage is 85Vac<Vin<270Vac, "HIGH" when the input voltage is 85Vac>Vin or Vin>270Vac. Open collector type (15V, 10mA).	A		SIGNAL RETURN
17	AC_FAIL_2	Output signal of PS in position B. Same as 16.	B		SIGNAL RETURN
18	AC_FAIL_3	Output signal of PS in position C. Same as 16.	C		SIGNAL RETURN
19	AC_FAIL_4	Output signal of PS in position D. Same as 16.	D		SIGNAL RETURN
20	AC_FAIL_5	Output signal of PS in position E. Same as 16.	E		SIGNAL RETURN
21	DC_OK_1	Output signal of PS in position A. "LOW" when the output voltage is higher than 85~95% of Vout setting. Open collector type (15V, 10mA).	A		SIGNAL RETURN
22	DC_OK_2	Output signal of PS in position B. Same as 21.	B		SIGNAL RETURN
23	DC_OK_3	Output signal of PS in position C. Same as 21.	C		SIGNAL RETURN
24	DC_OK_4	Output signal of PS in position D. Same as 21.	D		SIGNAL RETURN
25	DC_OK_5	Output signal of PS in position E. Same as 21.	E		SIGNAL RETURN
26	SIGNAL RETURN	Reference for: ENABLE, INHIBIT, TEMP ALARM, AC FAIL, DC OK, +12V AUX, SCL, SDA, SMB ALERT. <b>The SIGNAL RETURN is isolated from the output.</b>	All		
27	INHIBIT_1	Input for PS in position A. Turns OFF the Main Output by electrical signal or dry contact. "SHORT" or 0~0.6V – Output OFF. "OPEN" or 2~15V – Output ON.	A		SIGNAL RETURN
28	INHIBIT_2	Input signal for PS in position B. Same as 27.	B		SIGNAL RETURN
29	INHIBIT_3	Input signal for PS in position C. Same as 27.	C		SIGNAL RETURN
30	INHIBIT_4	Input signal for PS in position D. Same as 27.	D		SIGNAL RETURN
31	INHIBIT_5	Input signal for PS in position E. Same as 27.	E		SIGNAL RETURN
32	PS_EXIST_1	Output signal of PS in position A. SHORT to Signal Return when PS is inserted into the Rack.	A		SIGNAL RETURN
33	PS_EXIST_2	Output signal of PS in position B. Same as 32.	B		SIGNAL RETURN
34	PS_EXIST_3	Output signal of PS in position C. Same as 32.	C		SIGNAL RETURN
35	PS_EXIST_4	Output signal of PS in position D. Same as 32.	D		SIGNAL RETURN
36	PS_EXIST_5	Output signal of PS in position E. Same as 32.	E		SIGNAL RETURN
37	SIGNAL RETURN	In parallel with pin 26.	All		
38	+12V_AUX	Output. Auxiliary supply 11.2~12.5VDC. Not affected by any signal or fail state.			
39	ENABLE	Input for entire rack. Turns ON the Main Output by electrical signal or dry contact. "SHORT" or 0~0.6V – Output ON. "OPEN" or 2~15V – Output OFF.	All	Short	SIGNAL RETURN
40	SIGNAL RETURN	In parallel with pin 26.	All		

**1.2. J2 Pin Allocation Chart**

J2 connector is used for parallel connection of two Racks.

Table 1.2

IN		OUT	
Pin #	Name	Pin #	Name
1	CURRENT SHARE	1	CURRENT SHARE
2	I_PROG	2	I_PROG
3	V_PROG	3	V_PROG
4	-SENSE	4	-SENSE
5	SCL (PMBus)	5	SCL (PMBus)
6	SIGNAL_RETURN	6	SIGNAL_RETURN
7	SDA (PMBus)	7	SDA (PMBus)
8	SMB_ALERT	8	SMB_ALERT



**1.3. Output Bus Bar Connections**

The HFE1600-S1U has two identical Output Bus Bar connections on both sides of Rear Panel.

They are connected in parallel in the Rack.

Each of them or both can be used for output connections.

**ATTENTION:** Maximum allowable current for each pair of Output Bus Bars – 200A. Total Output Current: 400A

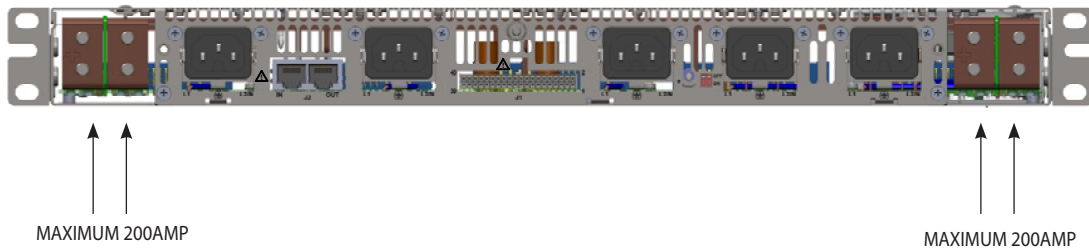


Fig 1.3a Output Bus-Bars.



Fig 1.3b Installation of Output Bus-Bars Protection Cover.

**1.4. Output Voltage adjustment potentiometer**

Output Voltage may be adjusted by the Rear Panel Potentiometer.

Model	HFE1600-12	HFE1600-24	HFE1600-48
Output voltage range (V)	9.6~13.2	19.2~29.0	38.4~58



**1.5. PMBus address**

Each slot in the Rack (see fig-2.2) has its own address for PMBus communication Valid only if /S option power supply is being used. In case parallel connection of two racks is used, the SW1 is used to differentiate between addresses for the same slots (see table 1.5).

Position In Rack	SW1-1	SW1-2	Address (Bin)
A	ON	ON	0010000
B			0010001
C			0010010
D			0010011
E			0010100
A	OFF	OFF	0011000
B			0011001
C			0011010
D			0011011
E			0011100

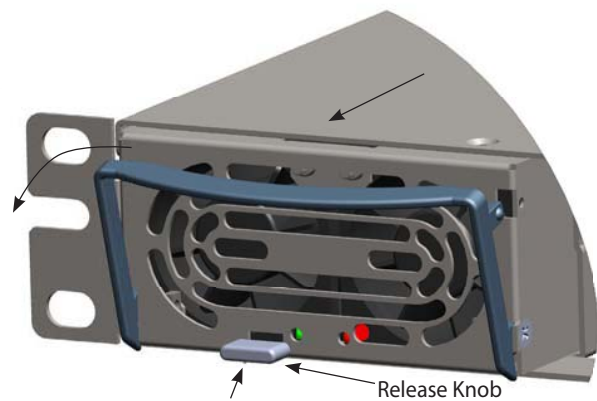


**2. Rack mechanical features**

**2.1. Insertion and extraction of the PS**



To insert the power supply push unit into the rack with extraction handle closed.



To extract power supply, elevate the release knob and pull the extraction handle.

**2.2. Definition of Power Supplies Position**

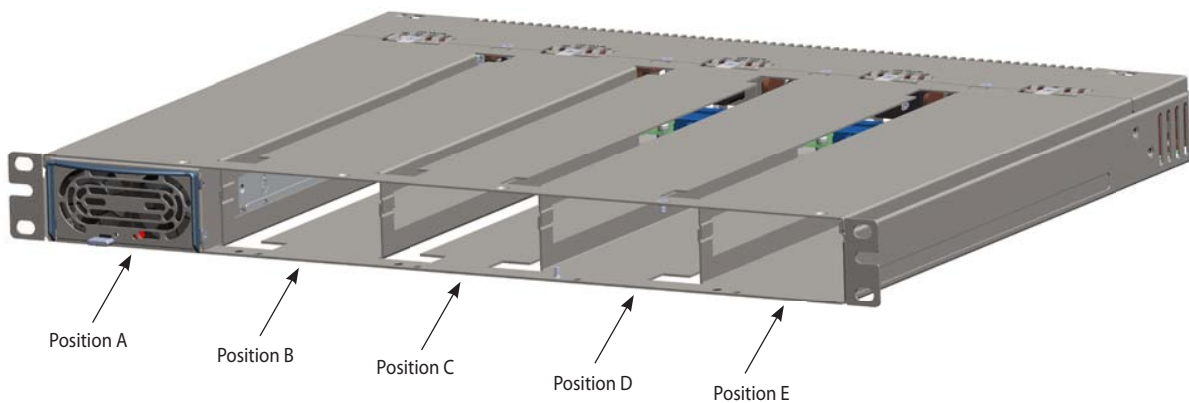


Fig 2.2 Power supply positions

**2.3 Keying Option to define the Rack's Voltage**

Keying Option can be installed to ensure that only the correct Power Supply can be inserted into the Rack. The Key Option consists of two parts: Power Supply Key (one per unit Fig 2.3a) and Rack Keys (5 per Rack Fig 2.3b). Power Supply Key and Rack Keys should be fixed (by Flat head screws M3x6) in position corresponding to Output Voltage.

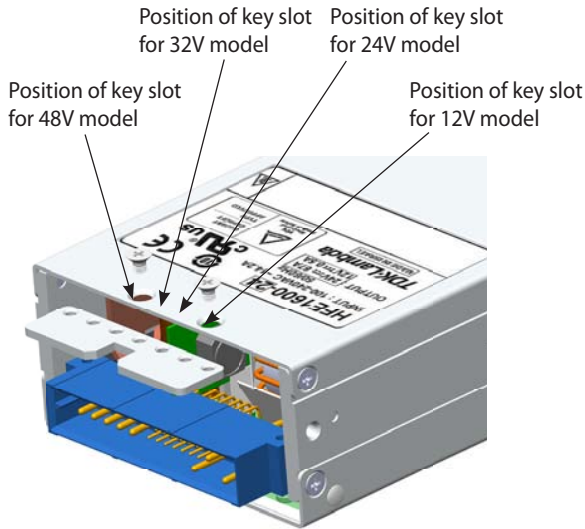


Fig 2.3a

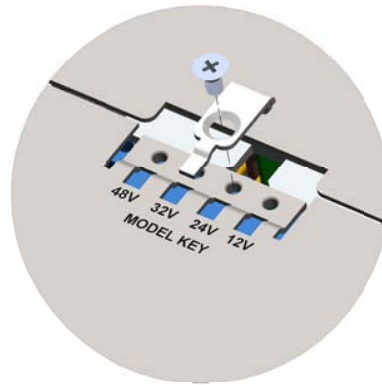


Fig 2.3b

Voltage positions for PS are shown in Fig 2.3a, for Rack silkscreen on top of the cover.

**Example:** PS and Rack position with 24V keys set.

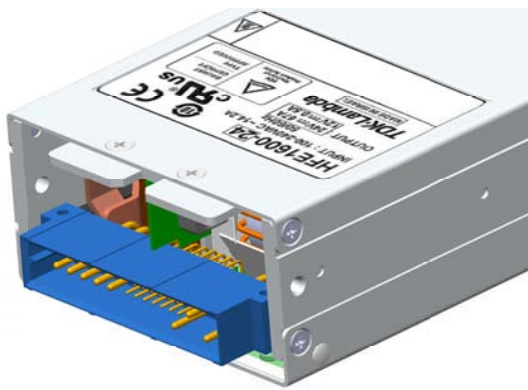


Fig 2.3c

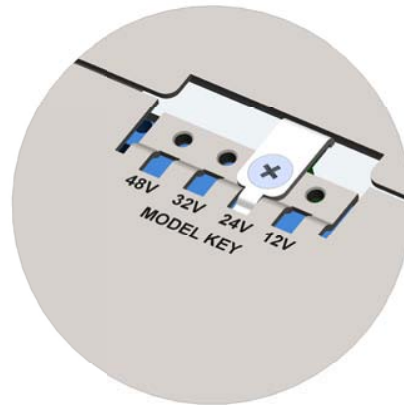


Fig 2.3d

**Rack's mounting options**

Rack can be mounted into 19" Rack Cabinet which suits both USA and European Standards:

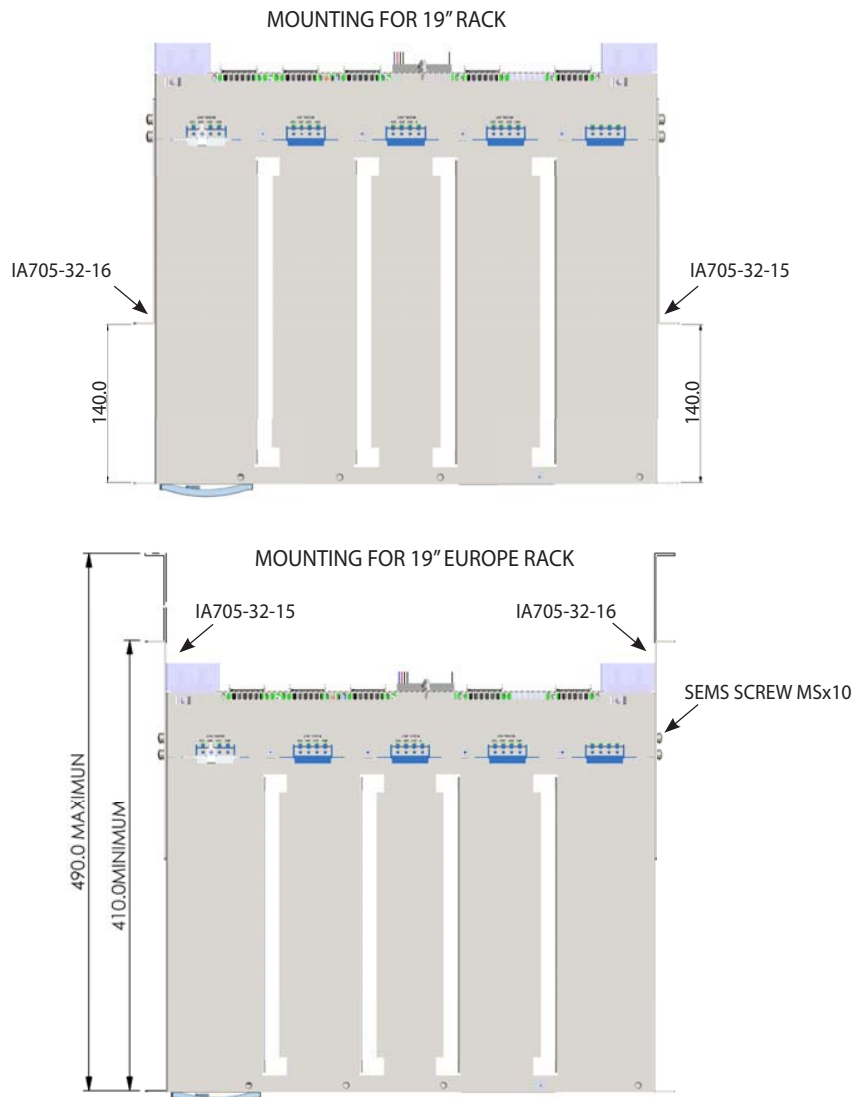


Fig 2.4 Mounting options, brackets and screws are included.

**2.4 Blank Panel**

In case all positions of the Rack are not filled with supplies, Blank Panel should be used to ensure proper Air Flow. It is recommended to interleave supplies and Blank Panels wherever possible.

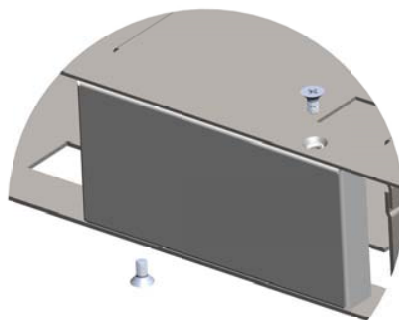


Fig 2.5 Blank Panel mounting

### 3. Typical applications

#### 3.1 Basic connection

For basic connection the supplied Control Plug should be inserted to J1.

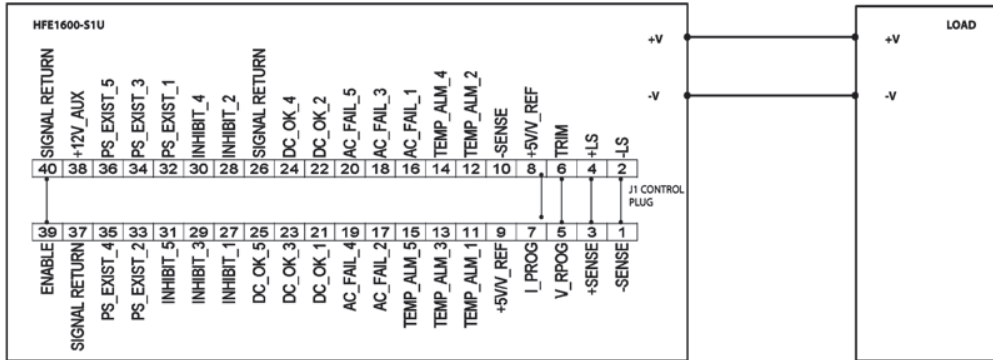


Fig 3.1 Basic connection diagram.

#### 3.2 Remote sensing

**ATTENTION:**

1. Maximum voltage drop on load connection: HFE1600-12: 0.5V/wire, HFE1600-24, 48: 1V/wire.
2. Twisted wires should be used for Remote Sensing connection.
3. If Remote Sensing is used do not break Main Output connection.

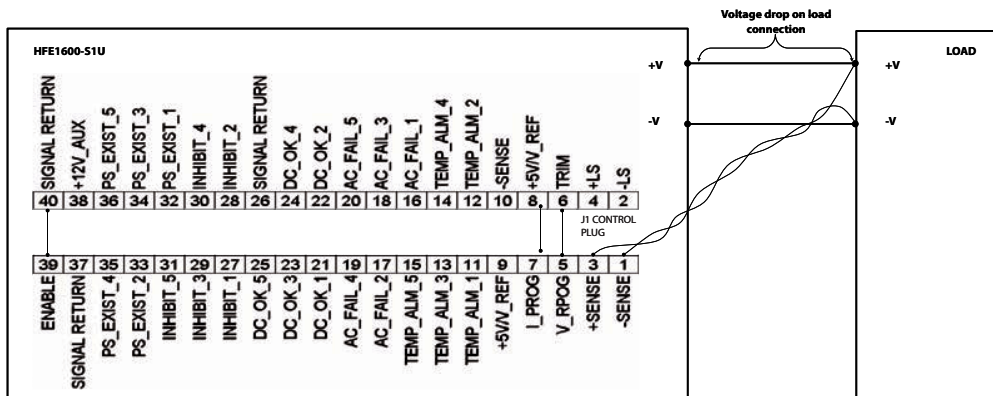


Fig 3.2 Remote Sensing connection diagram

#### 3.3 On/Off control for the entire Rack

Switch closed: Output ON  
 Switch open: Output OFF

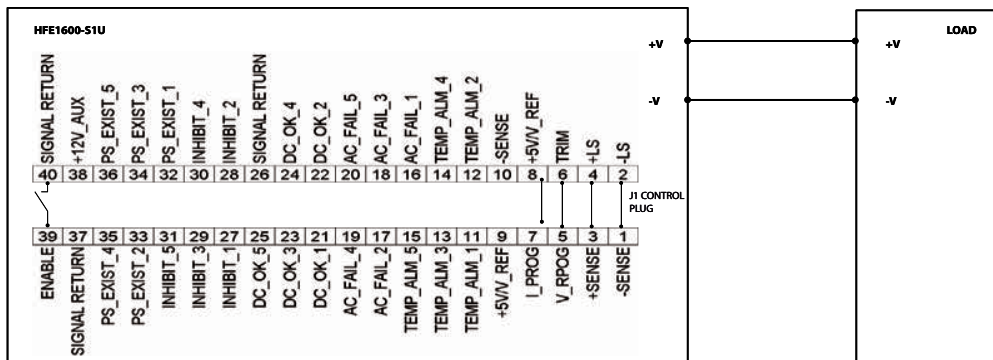


Fig 3.3 Entire rack On/Off control diagram.

**3.4 Individual On/Off control for each PS**

Switch closed: Output OFF  
 Switch open: Output ON

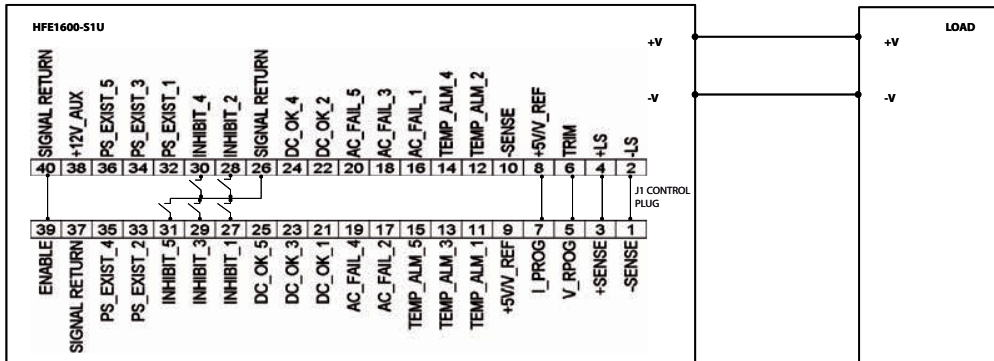


Fig 3.4 individual units On/Off diagram.

**3.5 Supervisory signals.**

Following signals are accessible from each power supply at J1:

- DC OK
- AC FAIL
- PS EXIST
- TEMP ALARM

These signals are Open Collector type (max 15V, max 10mA), isolated from Output and referenced to SIGNAL RETURN.

Fig 3.5 presents example of the typical connection for DC OK signal of power supply in position E.

Instead of 12V AUX, alternative Supply of 15V max. could be used with recommended Pull-up resistors for 5mA max.

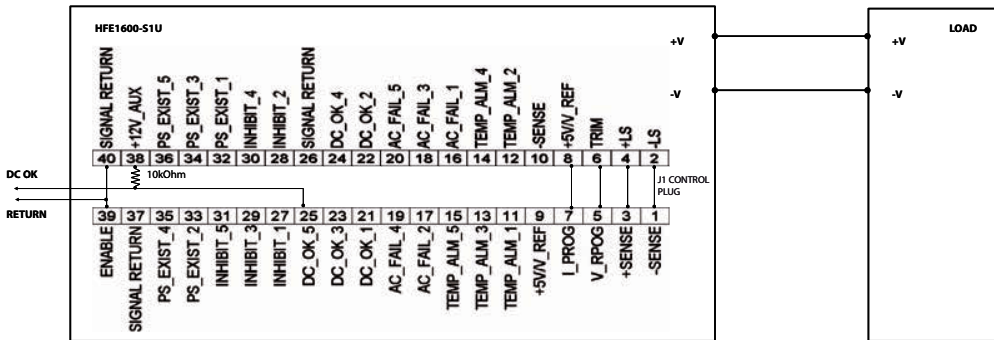


Fig 3.5 "DC OK" signal connection diagram for Power Supply in Position E.

**3.6 Output Voltage programming by External Voltage.**

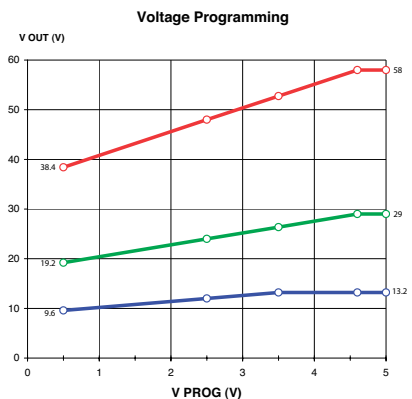
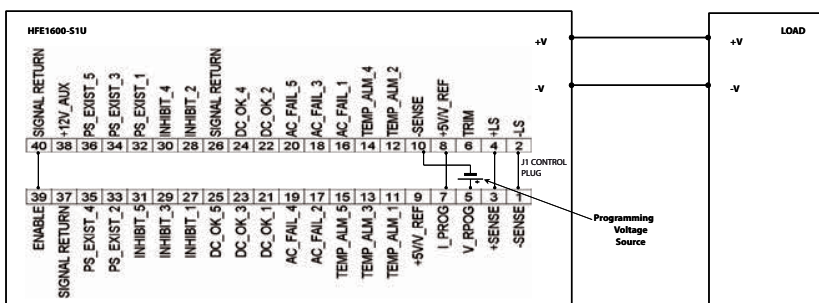


Fig 3.6 Output Voltage programming by External Voltage.

### 3.7 Output Voltage programming by PMBus.

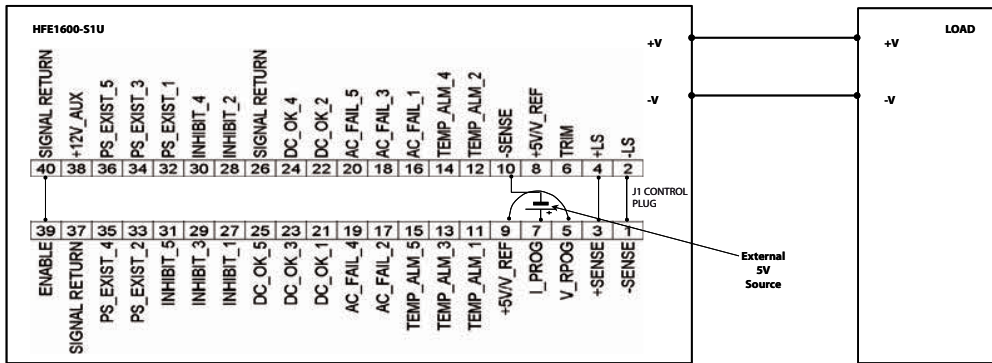


Fig 3.7 Output Voltage programming by PMBus (Additional 5V source needed for I\_PROG).

### 3.8 Current Limit programming by External Voltage.

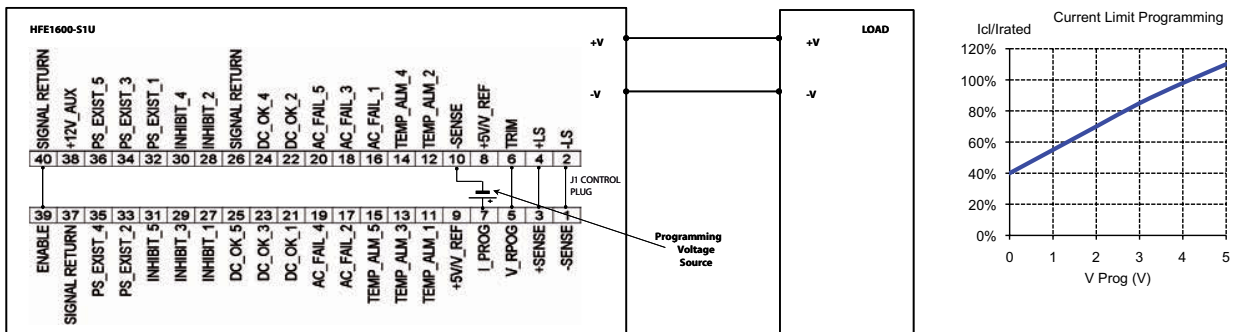


Fig 3.8 Current Limit programming by External Voltage

### 3.9 PMBus Host connection

To connect the rack to the Host computer connect custom made cable between J2 and computer:

Table 3.9 PMBus Cable.

Signal Name	From pin	Wire (AWG)	To Host	Note
SCL	5	22~24	-	Twisted pair
SIGNAL_RETURN	6	22~24	-	
SDA	7	22~24	-	Twisted pair
SMB_ALERT	8	22~24	-	

RJ45 Shielded Male Connector should be used.

Cable must be shielded; only connector shield is connected to cable shield.



**3.10 Parallel connection of two Racks**

To connect two Racks in parallel for higher Output Current:

- Connect Main Outputs (Bus-Bars) in parallel.
- Connect Senses (twisted pairs) to Load point.
- Connect J2 connectors of both Racks by Cable (cable construction see Table 3.10).
- Slave - Disconnect connection between VPROG and TRIM (J1.5 and J1.6).
- Slave - Switch SW1 to "OFF" position (applicable for HFE1600-xx /S PMBus option). For addressing refer to Table 1.5.
- Output Voltage could be adjusted by potentiometer on Master Rack.

Table 3.10 Rack Interconnection Cable.

Signal Name	From pin	Wire (AWG)	To Pin	Note
CURRENT SHARE	1	22~24	1	Twisted pair
I_PROG	2	22~24	2	
V_PROG	3	22~24	3	Twisted pair
-SENSE	4	22~24	4	
SCL	5	22~24	5	Twisted pair
SIGNAL_RETURN	6	22~24	6	
SDA	7	22~24	7	Twisted pair
SMB_ALERT	8	22~24	8	

RJ45 Shielded Male Connectors should be used.

Cable must be shielded; only connector shields are connected to cable shield.

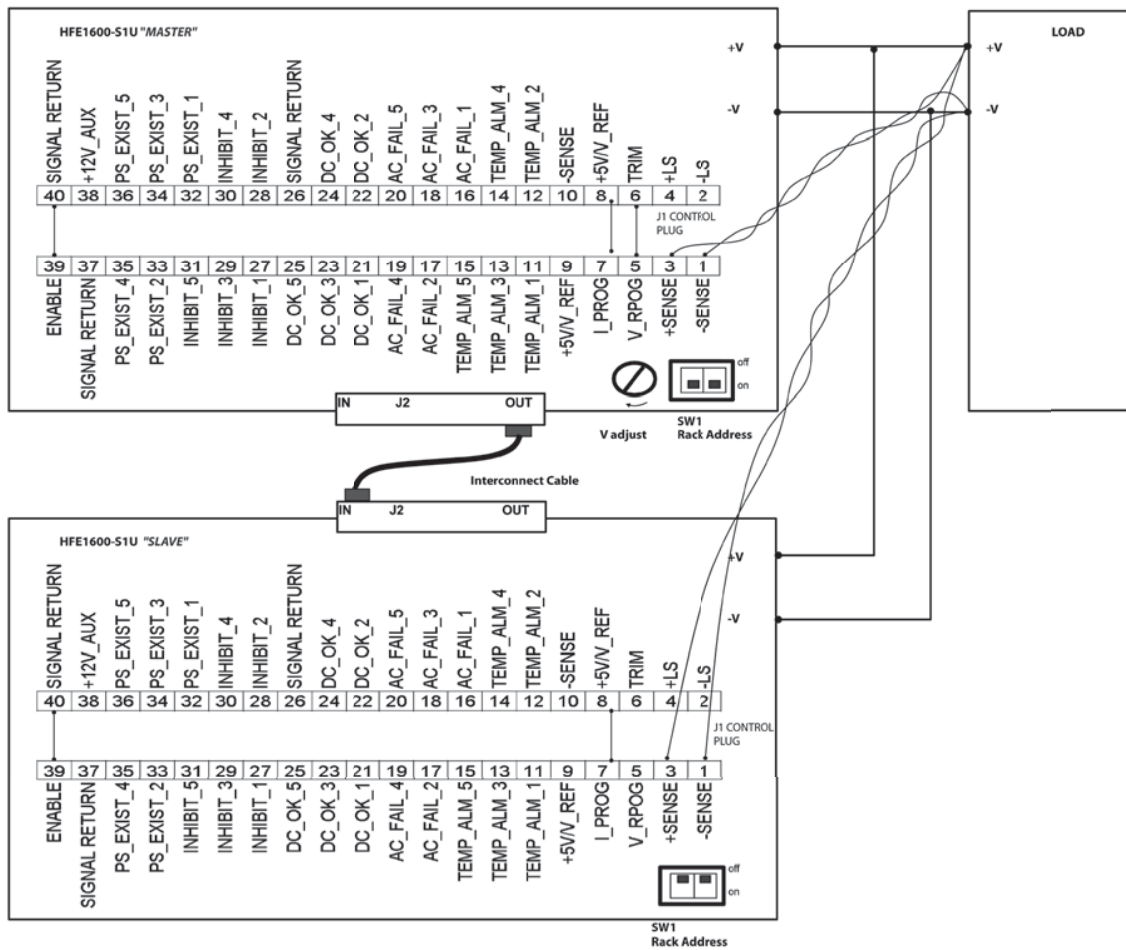


Fig 3.10 Racks parallel connection diagram.

**3.11 Series Rack connection**

Up to 2 racks with the same number of power supplies and rating (voltage and current) can be used to increase the output voltage.

To connect two Racks in series:

- Connect Main Outputs (bus bars) in series;
- Connect Senses (twisted) to Load point (as shown in fig-3.11), or Local Sensing using supplied Control Plugs.
- In case PMBus is used Connect J2 connectors of both Racks by Interconnect Cable for Serial connection (cable construction see Table 3.11);

**CAUTION**

**Do not use Cable as of Table 3.10.**

- On one Rack Switch SW1 up to OFF position (only for HFE1600-xx /S PMBus option), Addressing see Table 1.5;
- Output Voltage can be adjusted by potentiometers on both Racks.

Table 3.11 Rack Interconnection Cable for Serial connection.

Signal Name	From pin	Wire (AWG)	To Pin	Note
CURRENT SHARE	1	Open	1	Do not connect!
I_PROG	2	Open	2	
V_PROG	3	Open	3	
-SENSE	4	Open	4	Do not connect!
SCL	5	22~24	5	
SIGNAL_RETURN	6	22~24	6	Twisted pair
SDA	7	22~24	7	Twisted pair
SMB_ALERT	8	22~24	8	

RJ45 Shielded Male Connectors should be used. Cable must be shielded; only connector shields are connected to cable shield. Diodes should be connected in parallel with each unit output to prevent reverse voltage. Each diode should be rated to at least the power supply rated output voltage and output current.

**WARNING**

**Do not connect -SENSE and any signals referenced to -SENSE between two Racks. Only signals referenced to SIGNAL RETURN can be connected between Racks.**

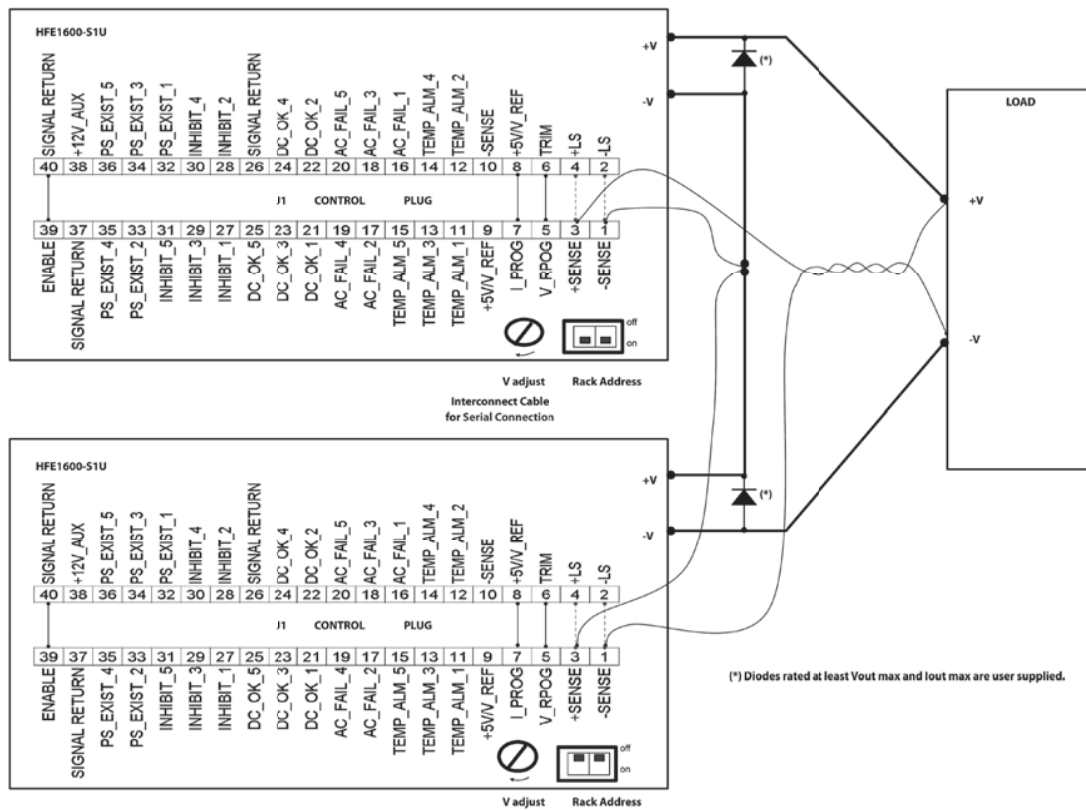
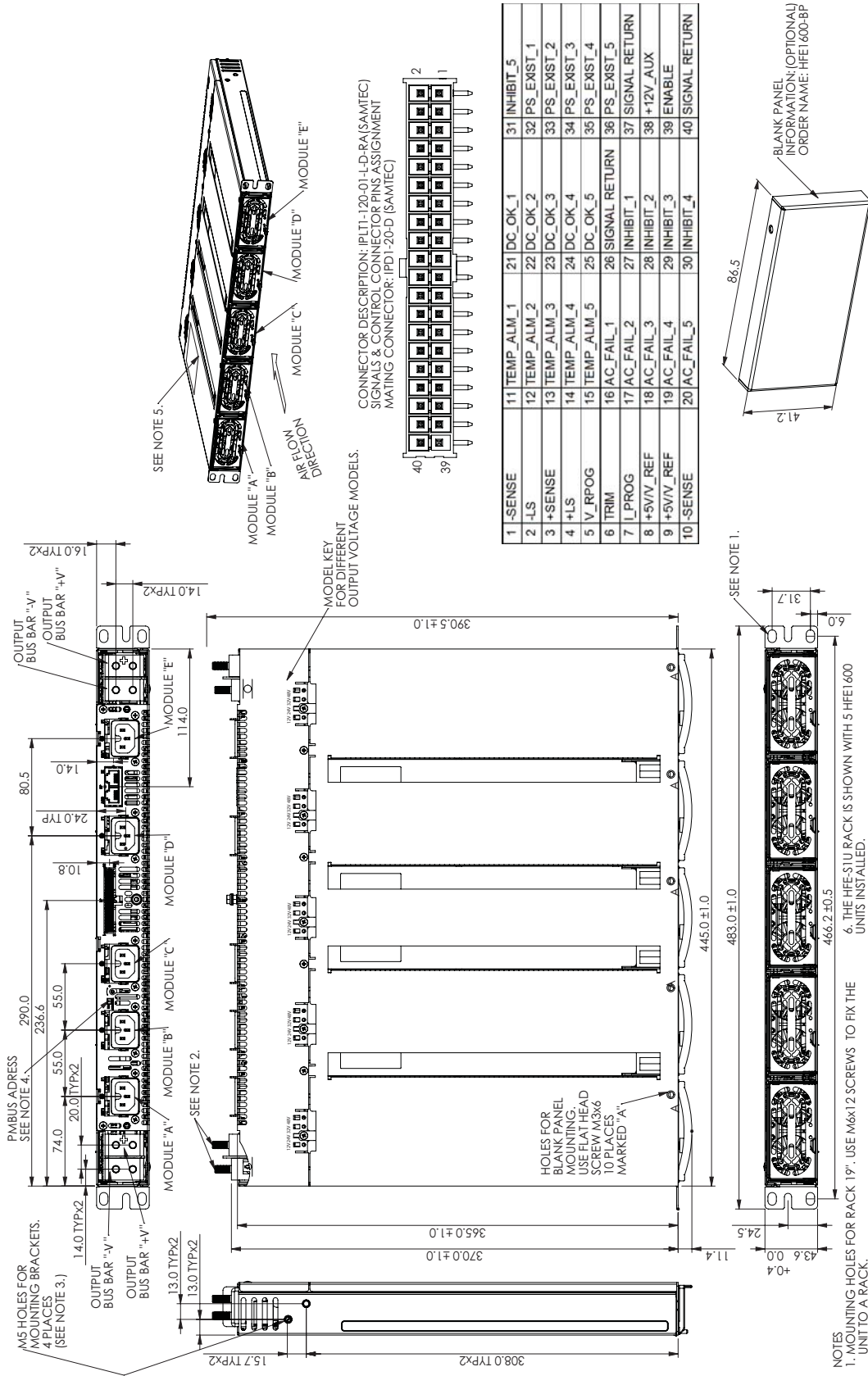


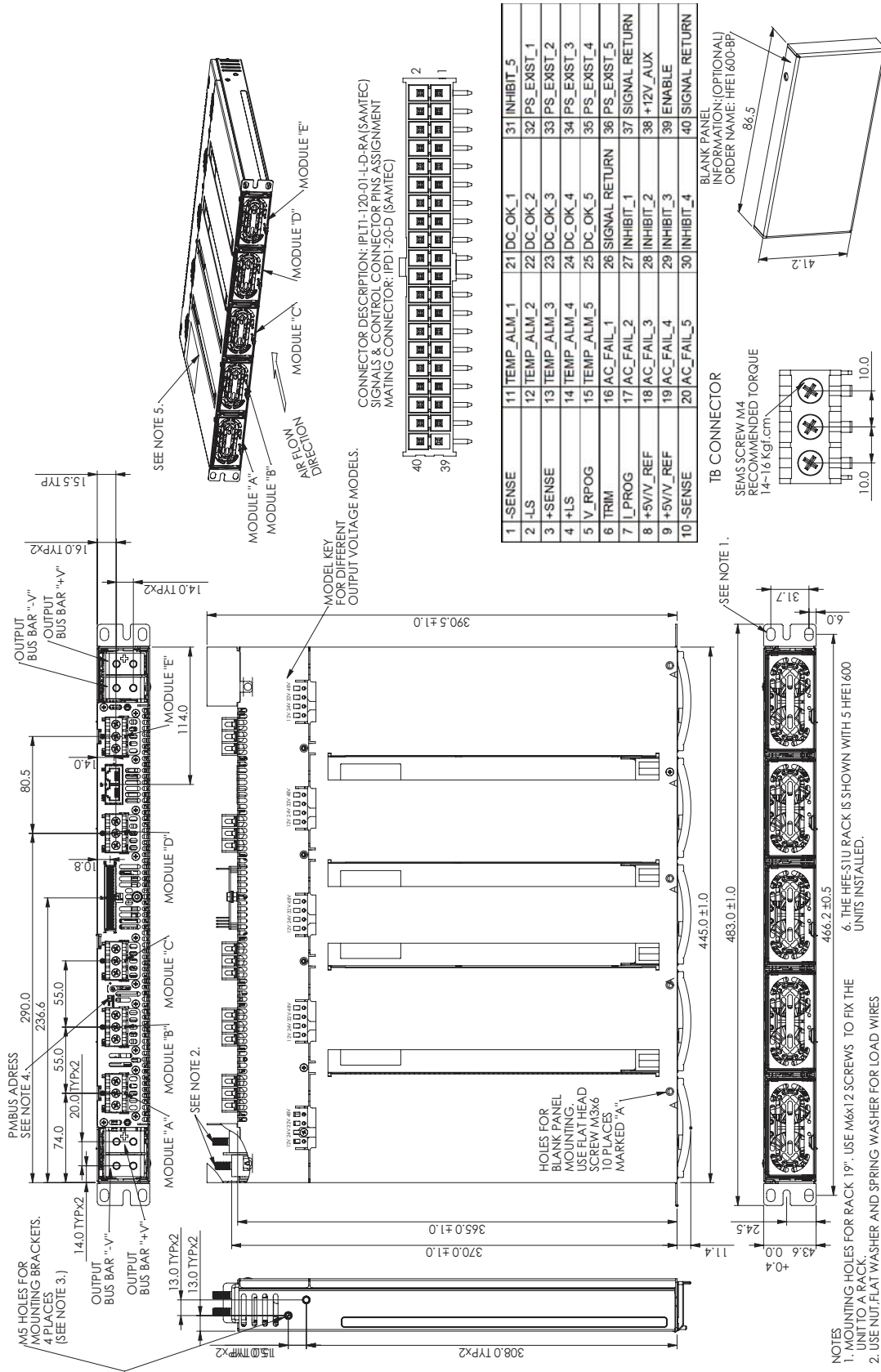
Fig 3.11 Serial connection diagram (remote sense).

HFE 1600 - S1U Outline Drawing



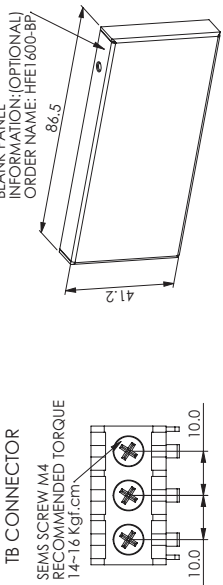
- NOTES
1. MOUNTING HOLES FOR RACK 19". USE M6x12 SCREWS TO FIX THE UNIT TO A RACK.
  2. USE NUT FLAT WASHER AND SPRING WASHER FOR LOAD WIRES FIXING. USE M6 LUG FOR LOAD WIRES RECOMMENDED TORQUE: 42-56 Kgf.cm
  3. TO FIX THE MOUNTING BRACKET TO THE CHASSIS USE M5x1.0 SEMS SCREWS. RECOMMENDED TIGHTENING TORQUE 27-31 Kgf.cm. SCREWS MUST NOT PENETRATE THE CHASSIS MORE THAN 6.0 mm.
  4. REFER TO INSTRUCTION MANUAL FOR SETTING DETAILS.
  5. MODEL NAME, VOLTAGE AND CURRENT RATING AND SAFETY APPROVALS SYMBOLS WILL BE SHOWN HERE ACCORDING TO THE SPECIFICATION.
  6. THE HFE-S1U RACK IS SHOWN WITH 5 HFE1600 UNITS INSTALLED.

# HFE 1600 - S1U-TB Outline Drawing



CONNECTOR DESCRIPTION: IPLT1-120-01-LD-RA (SAMTEC)  
SIGNALS & CONTROL CONNECTOR PINS ASSIGNMENT  
MATING CONNECTOR: IPD1-20-D (SAMTEC)

1	-SENSE	11	TEMP_ALM_1	21	DC_OK_1	31	INHIBIT_5
2	-LS	12	TEMP_ALM_2	22	DC_OK_2	32	PS_EXST_1
3	+SENSE	13	TEMP_ALM_3	23	DC_OK_3	33	PS_EXST_2
4	+LS	14	TEMP_ALM_4	24	DC_OK_4	34	PS_EXST_3
5	V_RPOG	15	TEMP_ALM_5	25	DC_OK_5	35	PS_EXST_4
6	TRIM	16	AC_FAIL_1	26	SIGNAL_RETURN	36	PS_EXST_5
7	L_PROG	17	AC_FAIL_2	27	INHIBIT_1	37	SIGNAL_RETURN
8	+5V/REF	18	AC_FAIL_3	28	INHIBIT_2	38	+12V_AUX
9	+5V/REF	19	AC_FAIL_4	29	INHIBIT_3	39	ENABLE
10	-SENSE	20	AC_FAIL_5	30	INHIBIT_4	40	SIGNAL_RETURN



- NOTES
1. MOUNTING HOLES FOR RACK 1". USE M6x12 SCREWS TO FIX THE UNIT TO A RACK.
  2. USE NUT FLAT WASHER AND SPRING WASHER FOR LOAD WIRES FIXING. USE M4 LUG FOR LOAD WIRES. RECOMMENDED TORQUE: 42-56 Kgf.cm
  3. TO FIX THE MOUNTING BRACKET TO THE CHASSIS USE M5x10 SEMS SCREWS. RECOMMENDED TIGHTENING TORQUE 27-31 Kgf.cm. SCREWS MUST NOT PENETRATE THE CHASSIS MORE THAN 6.0 mm.
  4. REFER TO INSTRUCTION MANUAL FOR SETTING DETAILS
  5. MODEL NAME, VOLTAGE AND CURRENT RATING AND SAFETY APPROVALS SYMBOLS WILL BE SHOWN HERE ACCORDING TO THE SPECIFICATION.
  6. THE HFE-S1U RACK IS SHOWN WITH 5 HFE1600 UNITS INSTALLED.