

Technical Key Specifications

Power Output		**1**
Channel(s) each output		2
Output voltage	DC 48 V	nominal
Adjustment range	48-56 V	
Power per output		
Continuous	1200 W	up to +45 °C
Short term	2000 W	up to 15 s
NEC Class 2 Outputs		**2**
Channel(s) each output		1
Output voltage	DC 24 V	nominal
Power per output		
Continuous	94 W	up to +45 °C
Short term	150 W	up to 4 s
Total Output Power		**1400 W**
Input voltage AC	3AC 380-500 V	
Power factor	0.93 / 0.94	at 3x 400 / 480 Vac
Input current	2.2 A / 1.9 A	at 3x 400 / 480 Vac
Efficiency	96.6 / 96.6 %	at 3x 400 / 480 Vac
Power losses	49.0 / 49.5 W	at 3x 400 / 480 Vac
Operational temperature	-30 °C to +70 °C	
Dimensions	290 x 268.6 x 60.5 mm	(w x h x d)
Weight	3700 g	

Product Highlights

Powerful & Efficient
- High efficiency for reduced energy consumption
- 15 second BonusPower capability

Reliable & Robust
- Integrated brake chopper
- High MTBF for maximum system availability
- Maintenance free convection cooling
- Long term warranty

Easy & Flexible
- Daisy chaining for reduced wiring effort and space requirements
- Two output channels plus two isolated NEC Class 2 channels
- Integrated Maintenance Switch with LockOut/TagOut option

Safe & Transparent
- Clear LED status indicators
- Safe Torque Off and Safe Discharge (SIL 2, PL d)
- Branch protected outputs

Intelligent & Enabling
- DC OK communication
- NEC Class 2 always on outputs

ORDER NUMBERS

FPT1403.481-01-DC	Power supply

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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The information given in this document is correct to the best of our knowledge and experience at the time of publication. If not expressly agreed otherwise, this information does not represent a warranty in the legal sense of the word. As the state of our knowledge and experience is constantly changing, the information in this data sheet is subject to revision. We therefore kindly ask you to always use the latest issue of this document (available under www.pulspower.com).

No part of this document may be reproduced or utilized in any form without our prior written permission.

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

Intended Use

This device is designed for indoor use and is intended for commercial applications, such as in industrial control, process control, monitoring and measurement equipment.

Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Terminology and Abbreviation

PE and ⏚ Symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚ .
Earth, Ground	This document uses the term “earth” which is the same as the U.S. term “ground”.
t.b.d.	To be defined, value or description will follow later.
3AC 400 V	A figure displayed with the AC or DC before the value represents a nominal voltage with tolerances (usually ±15 %) included. E.g.: DC 12 V describes a 12 V battery disregarding whether it is full (13.7 V) or flat (10 V)
3x 400 Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50 Hz vs. 60 Hz	As long as not otherwise stated, 3AC 400 V parameters are valid at 50 Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.
Output	Single converter inside the device
Channel	Physical interface of an output

Symbols Explained

⚠	Warning: risk of serious injury or death
ⓘ	NOTE: additional information
⇨	Action step
✓	Positive result

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

1 Technical Data and Performance

1.1 Input

The device is suitable to be supplied from TN, TT, IT or corner grounded delta mains networks with AC voltage.

AC input voltage rated range AC input voltage operating range		nom.	3AC 380-500 V 3x 342-550 Vac	-10 %...+10 %
Input to PE		max.	3x 550 Vac	according to EN 61010-1
Input frequency		nom.	50-60 Hz	±6 %
Input frequency range			47-63 Hz	
Turn-on voltage		typ.	3x 320 Vac	steady-state value, see Fig. 1.1-1
Shut-down voltage		typ.	3x 300 Vac	steady-state value, see Fig. 1.1-1
External input protection		up to 30 A (UL) & 32 A (IEC), see Chapter 2		
		3AC 400 V	**3AC 480 V**	
Input current	typ.	2.2 A	1.9 A	at 1400 W, symmetrical phase voltages
Power factor	typ.	0.93	0.94	at 1400 W
Turn-on overshoot	max.	500 mV	500 mV	see Fig. 1.1-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.

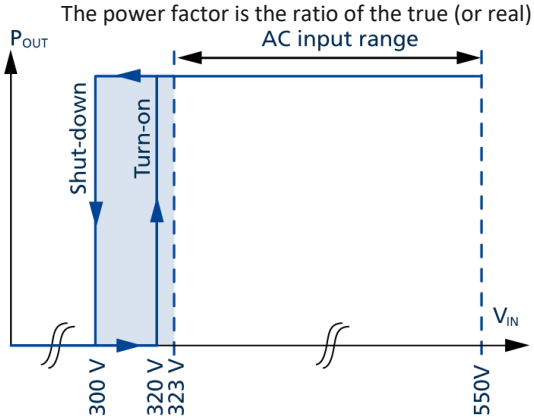


Fig. 1.1-1: Input voltage range

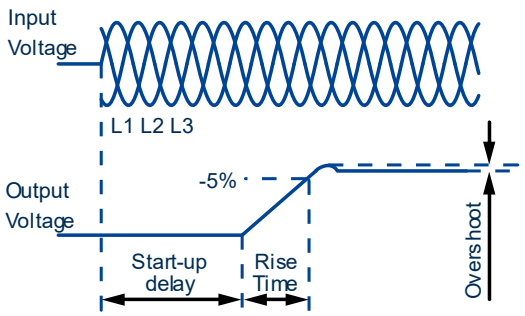


Fig. 1.1-2: Turn-on behavior, definitions

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

1.1.1 Input Inrush Current

The power supply is equipped with an active inrush current limitation circuit. This circuit limits the input inrush current during turn-on to a negligibly low value. The input current is usually lower than the steady-state input current, see Fig. 1.1.1-1.

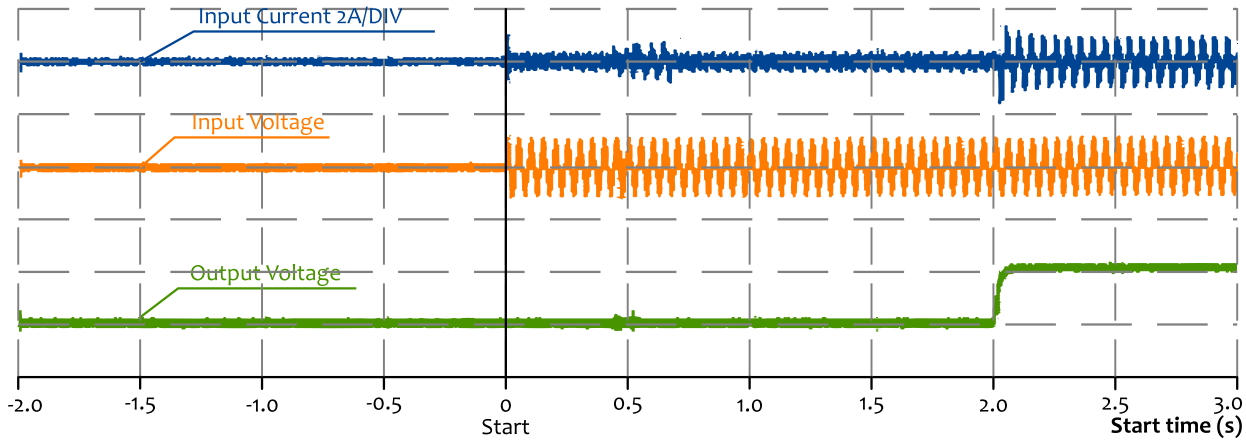
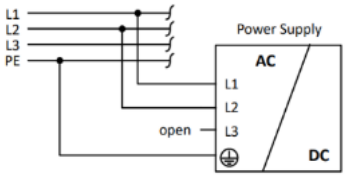


Fig. 1.1.1-1: Typical turn-on behavior at nominal load and +25 °C ambient temperature

1.1.2 2-phase Operation



No external protection devices are required to protect against a phase loss failure. This power supply can also be permanently operated on two legs of a 3-phase system. However, it is not recommended for this power class since the supplying 3-phase network can become unbalanced. The output power must be reduced according to the curves below when operation on only two legs of a 3-phase system. A long-term exceeding of these limits will result in a thermal shut-down of the unit.
A use below 400 Vac with more than 1100 W output power can also result in a thermal shut-down. During power-on, some start-up attempts can occur until a permanent output power is available. EMC performance, hold-up time, losses and output ripple differ from a three phase operation. Therefore, check the suitability of your individual application. Such use is not included in the UL approval. Additional tests might be necessary when the complete system has to be approved according to UL 508, UL 61010-2-201 or UL60950-1.

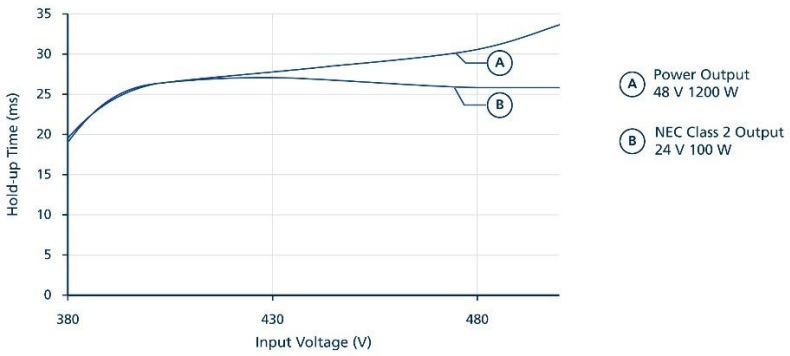


Fig. 1.1.2-1: Hold-up time 2-phase operation

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

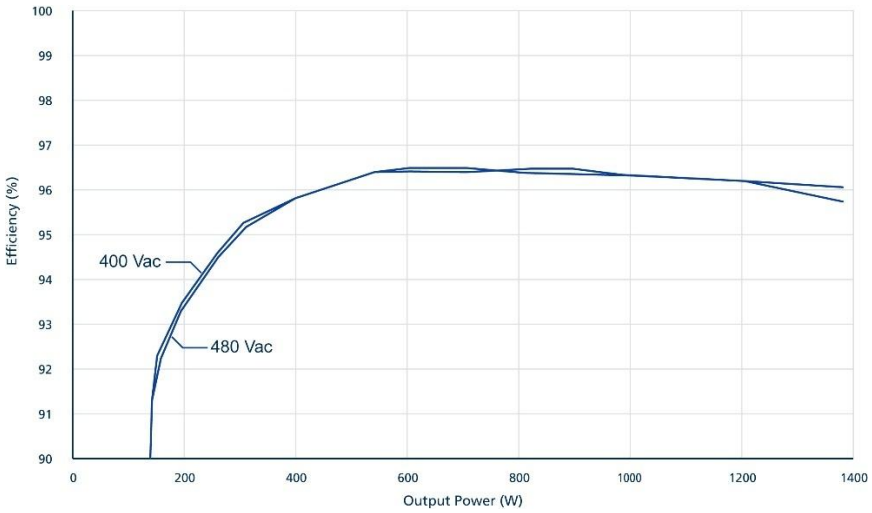


Fig. 1.1.2-2: Efficiency 2-phase operation

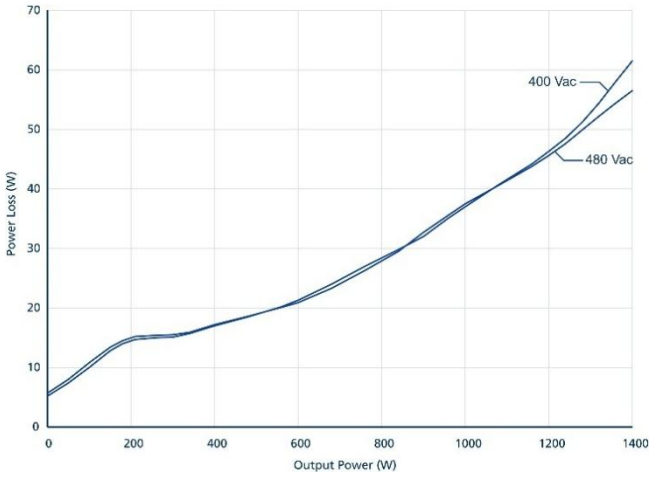


Fig. 1.1.2-3: Power losses 2-phase operation

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

1.2 Output

The outputs provide a PELV (ES1) rated voltage, which is galvanically isolated from the input voltage. The negative potential of the outputs is permanently connected to PE within the unit. Do not connect any output to PE (Ground).

The output is designed to supply capacitive and inductive loads. If very large capacitors, such as EDLCs (Electric Double Layer Capacitors or “UltraCaps”) with a capacitance > 0.1 F are connected to the output, the unit might charge the capacitor in Hiccup Mode.

The output is electronically protected against overload, no-load and short-circuits. In case of a protection event, audible noise may occur.

1.2.1 Power Output Ua 48 V DC

Number of channels		2	
Output voltage	nom.	48 V	factory setting 49 V
Adjustment range		48-56 V	adjustable
Line regulation	max.	10 mV	between 3x 323 Vac and 550 Vac
Load regulation	typ.	300 mV	between 0 and 1400 W output load, static value
Ripple and noise voltage	max.	150 mVpp	bandwidth 20 Hz to 20 MHz, 50 Ohm
Output power	nom. nom.	1200 W 720 W	up to +45 °C at +70 °C
Short term, up to 15 s	nom. nom. Derate linearly between +45 °C and +70 °C	2000 W 1200 W	up to +45 °C at +70 °C
Start-up delay	typ.	2.8 s	at 1400 W symmetrical phase voltages, see Fig. 1.1.1-1
Rise time	typ. typ.	5 ms 25 ms	at 1400 W constant current load, 0 mF load, see Fig. 1.1.1-1 at 1400 W constant current load, 20 mF, see Fig. 1.1.1-1
Overload behaviour	typ.	Branch Circuit Protection	see Chapter “Output Branch Circuit Protection”
Output capacitance	typ.	2 790 µF	included inside the power supply, common for all outputs
Parallel Use ⚠			Do not parallel units for higher output currents. Units with decoupling MOSFET optionally available.
Back-feeding loads	max.	60 V | 50 J	The unit is resistant and does not malfunction when a load feeds back voltage to the device.

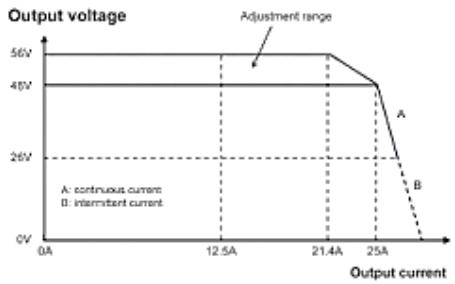


Fig. 1.2.1-3: Output voltage vs. output current, for continuous load, typ.

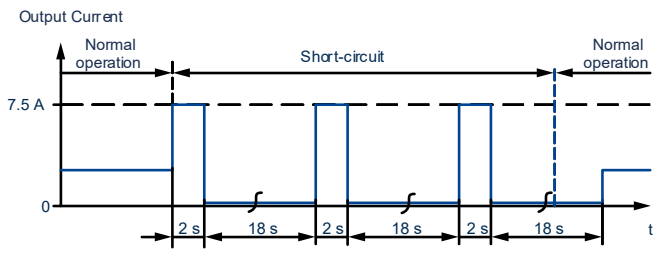


Fig. 1.2.1-4: Short-circuit on output, HiccupPLUS mode, typ.

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Brake chopper

Loads such as decelerating motors and inductors can feed voltage back to the power outputs. This feature is also called return voltage immunity or resistance against Back- E.M.F. (**E**lectro **M**otive **F**orce).
This energy is fed back into the system, where it can be converted into heat by the integrated braking resistor. The chopper is activated when the output voltage exceeds the set output voltage by an adjustable threshold.

Resistor value	typ. 2.3 Ohm
Single pulse	50 J
Continuous power	12 W
Trigger threshold	typ. 1.5 V above the set output voltage
Chopper disable	not applicable
Hysteresis	typ. 0.5 V below the trigger threshold

The integrated chopper is protected against thermal overload. If thermal protection is activated, the converter OUT1 is disabled to prevent further back EMF events. The converter restarts automatically after cool down phase. The brake resistor energy is continuously monitored. If the permissible energy limit is reached during a single or repeated braking operation, the brake chopper is inhibited to protect the resistor against thermal overload. The brake chopper is automatically re-enabled as soon as the resistor has cooled down sufficiently and its energy absorption capacity is restored. Maximum allowed average back EMF according graph below.

Output branch circuit protection

The FPT1400.481-01-DC provides two 15 A branch circuit protection fuses at the power output. These fuses are rated as Class CC fuses and not replaceable. Each one protects one channel. To prevent the fuses from tripping, the maximum output current is limited by the device software. This limitation switches off the entire power output, not only the affected branch.

Integrated fuse	17.5 A time delayed Class CC fuse acc. UL 248-4
Certified trip current	15 A due to thermal derating and software limitation of the output current

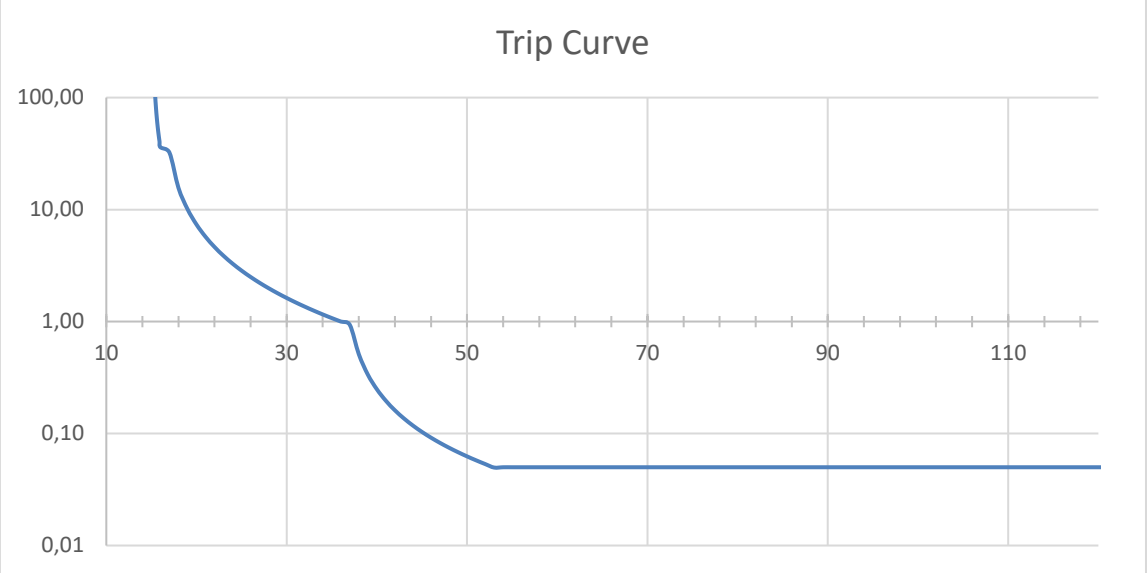


Fig 1.2.1-4: Internal Current limitation

1.2.2 NEC Class 2 Output Us

Number of outputs		2	
Output voltage	nom.	24 V	factory setting 24.05 V ±1.0 %
Line regulation	max.	10 mV	between 3x 323 Vac and 550 Vac
Load regulation	typ.	75 mV	between 0 A and NEC Class 2 output load, static value
Ripple and noise voltage	max.	50 mVpp	bandwidth 20 Hz to 20 MHz, 50 Ohm
Total output power	nom.	94 W	up to +45 °C
	nom.	60 W	at +70 °C
Short term, up to 4 s	nom.	150 W	up to +45 °C, between 3x 360 Vac and 550 Vac
	nom.	90 W	at +70 °C
	Derate linearly between +45 °C and +70 °C		
Overload behaviour	typ.	7.5 A / 0 A	In the event of a heavy overload, when the output voltage drops below 13 V, the power supply delivers continuous output current for 2 s. After this period, the output is switched off for approx. 18 s before a new start attempt is performed automatically. This cycle is repeated as long as the overload condition persists. Once the overload has been cleared, the device resumes normal operation; see Fig. 1.2.1-2. Load impedance 10 mOhm. Discharge current of output capacitors is not included.
Output capacitance	typ.	1 760 µF	included inside the power supply, for each output
Parallel use ⚠			do not parallel units for higher output currents
Back-feeding loads	max.	35 V / 0.5 J	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. This applies whether the device is on or off. The energy that can be absorbed can be calculated based on the built-in output capacitor.

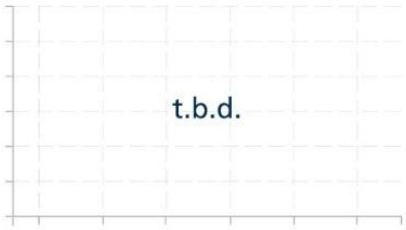


Fig. 1.2.2-1: Output voltage vs. output current, for continuous load, typ.

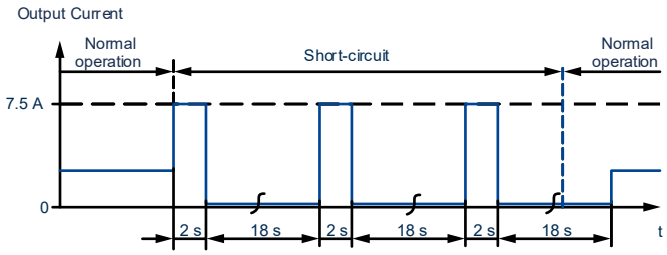


Fig. 1.2.2-2: Short-circuit on output, HiccupPLUS mode, typ.

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

1.3 Efficiency and Power Losses

		3AC 400 V	3AC 480 V	
Efficiency	typ.	96.6 %	96.6 %	at 48 V, 1400 W
Average efficiency	typ.	96.3 %	96.2 %	25 % at 350 W, 25 % at 700 W, 25 % at 1050 W, 25 % at 1400 W
Power losses	typ.	6.0 W	6.5 W	at 48 V, 0 W output load
	typ.	25.0 W	26.0 W	at 48 V, 700 W output load
	typ.	49.0 W	49.5 W	at 48 V, 1400 W output load

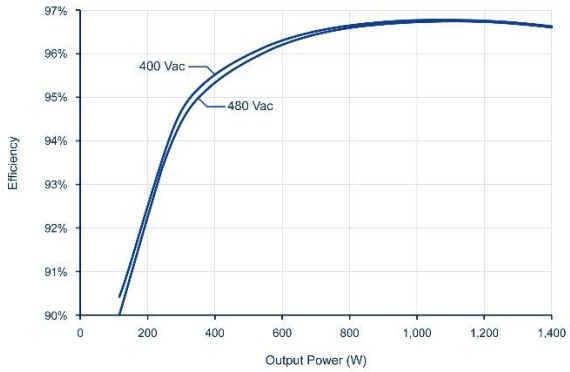


Fig. 1.3-1: Efficiency vs. output power, typ.

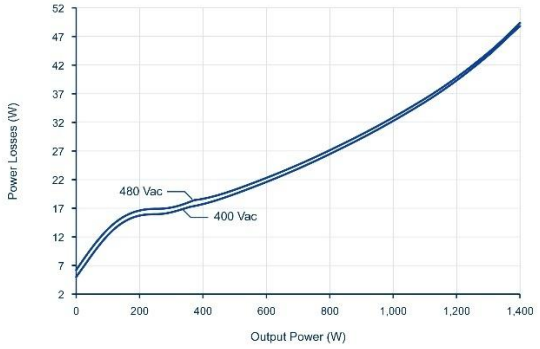


Fig. 1.3-2: Power losses vs. output power, typ.

1.4 Hold-up time

The hold-up time is defined as the period during which the output voltage of a power supply remains within specification after loss of input power. The hold-up time depends on the output load. At no load, the hold-up time can be up to several seconds. During this period, the status LED remains on.

		3AC 400 V	3AC 480 V	
Hold-up time	typ.	55.0 ms	55.0 ms	at 700 W output load, see Fig. 1.4-1
	min.	44.0 ms	44.0 ms	at 700 W output load, see Fig. 1.4-1
	typ.	27.0 ms	27.0 ms	at 1400 W output load, see Fig. 1.4-1
	min.	21.6 ms	21.6 ms	at 1400 W output load, see Fig. 1.4-1

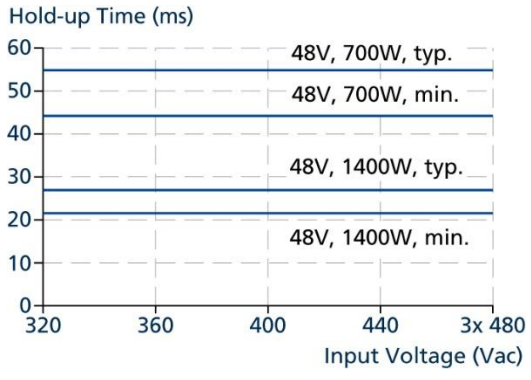


Fig. 1.4-1: Hold-up time vs. input voltage

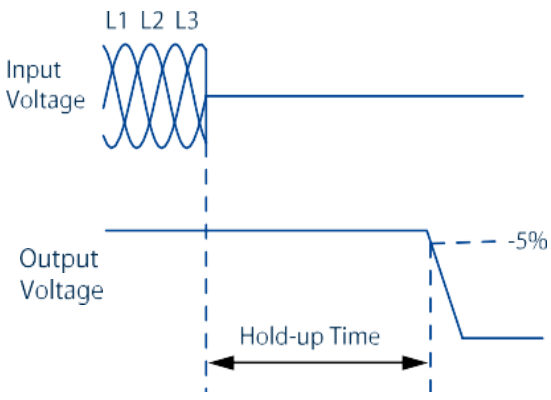


Fig. 1.4-2: Shut-down behaviour

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

1.5 Lifetime Expectancy

The Lifetime expectancy shown in the table indicates the theoretical minimum operating hours (service lifetime) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification.

The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131 400 h). Any number exceeding this value is a calculated theoretical lifetime which can be used to compare devices.

	3AC 400 V	3AC 480 V	
Calculated lifetime expectancy	120 100 h	95 500 h	at 48 V, 1400 W and +25 °C
	570 900 h	563 000 h	at 48 V, 700 W and +25 °C

1.6 MTBF

MTBF stands for **M**ean **T**ime **B**etween **F**ailures, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

An MTBF figure of e.g. 1 000 000 h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it cannot be determined if the failed unit has been running for 50 000 h or only for 100 h.

For these types of units the MTTF (**M**ean **T**ime **T**o **F**ailure) value is the same value as the MTBF value.

	3AC 400 V	3AC 480 V	
MTBF SN 29500, IEC61709	t.b.d h	t.b.d h	at 48 V, 1400 W and +25 °C
MTBF MIL HDBK 217F	t.b.d h	t.b.d h	at 48 V, 1400 W and +25 °C; Ground Benign GB25
	t.b.d h	t.b.d h	at 48 V, 1400 W and +25 °C; Ground Fixed GF25

1.7 FIT rate

FIT rate stands for Failures In Time and describes the statistical failure rate of a device. It indicates the expected number of failures per 1 000 000 000 operating hours. The FIT rate is a measure of reliability and does not represent the product lifetime. For example, 100 FIT means 100 failures are expected in 10^9 device hours. FIT is directly related to MTBF and is its inverse representation

	3AC 400 V	3AC 480 V	
FIT rate	t.b.d /10^9 h	t.b.d /10^9 h	at 48 V, 1400 W and +25 °C
	t.b.d / 10^9 h	t.b.d /10^9 h	at 48 V, 700 W and +25 °C

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2 Mounting and Wiring

Installation Instructions

⚠ DANGER Risk of electrical shock, fire, personal injury or death

Turn power off before working on the device. Protect against inadvertent re-powering.

Do not open, modify or repair the device.

Do not touch during power-on and immediately after power-off. Hot surfaces may cause burns.

Install the device on a large enough flat surface. Sharp edges on the back may cause injury.

If damages or malfunctioning occur during installation or operation, immediately turn power off and send unit to the factory for inspection.

The device is designed as “Class of Protection I” equipment according to IEC 61140. Do not use without a proper PE (Protective Earth) connection.

⚠ WARNING Risk of damages on the device

– Keep the following minimum installation clearances: 30 mm on top and bottom, 10 mm left and right side.

The maximum surrounding air temperature is +70 °C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2 cm below the device.

The device is designed to operate in areas between 5 % and 95 % relative humidity.

Clean only with a damp cloth.

Obey the following installation instructions:

This device may only be installed and put into operation by qualified personnel. This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect. Install the device onto a flat surface.

For wall mounting use 4 screws. Two on top and 2 on bottom mounting holes. Recommended screw size is M4 (UNC 8-32). The enclosure of the device provides a degree of protection of IP65/67 when installed with all mating connectors firmly connected. The device is designed for pollution degree 3 areas in controlled environments.

Assure that during installation no moisture or dirt gets into the connections. Operation in areas where moisture or condensation can be expected is possible.

The negative potential of the outputs is permanently connected to PE within the unit. Do not connect the negative potential of any output to PE outside the unit.

For TN,TT mains systems with earthed neutral and IT star mains systems with insulation monitoring the device is designed for overvoltage category III zones up to 2000 m and for overvoltage category II zones up to 5000 m.

For TN, TT, IT delta mains systems or IT star mains systems without insulation monitoring the device is intended for overvoltage category II zones up to 2000 m.

The device is designed for altitudes up to 5000 m. Above 2000 m a reduction in output current is required and the operation is limited according mains systems described above. The device is designed, tested and approved for branch circuits up to 30 A (UL) and 32 A (IEC) without additional protection device. If an external fuse is utilized, do not use circuit breakers less than 6 A (type B- or C-characteristic) to avoid a nuisance trip. A disconnecting means shall be provided for the input of the device. This must be suitably located and easily accessible. The disconnecting means must be marked as the such for the device.

2.1 Environment

Operational temperature	-30 °C to +70 °C	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2 cm below the unit.
Start-up temperature	-40 °C to +70 °C	
Storage temperature	-40 °C to +85 °C	for storage and transportation
Output derating	1.6 %/K 8%/1000 m	between +45 °C and +70 °C for altitudes >2000 m , see Fig. 16 2: Output power vs. altitude
	The derating is not hardware controlled. The user must ensure that the output current remains below the derated current limit.	
Humidity	5 to 95 % r.h.	according to IEC 60068-2-30
Atmospheric pressure	54-110 kPa	see Fig. 2.1-2: Output power vs. altitude for details
Altitude	up to 5000 m	see Fig. 2.1-2: Output power vs. altitude for details
Overvoltage category	III	according to IEC 60664-1 for TN, TT mains systems with earthed neutral and IT star mains systems with insulation monitoring for altitudes up to 2000 m
	II	according to IEC 60664-1 for TN, TT mains systems with earthed neutral and IT star mains systems with insulation monitoring for altitudes between 2000 m and 5000 m according to IEC 60664-1 for TN, TT, IT Delta mains systems or IT star mains systems without insulation monitoring for altitudes up to 2000 m
Degree of pollution	3	according to IEC 62477-1, not conductive
Vibration sinusoidal	2-17.8 Hz: ±1.6 mm; 17.8-500 Hz: 2 g 2 hours / axis	according to IEC 60068-2-6
Shock	30 g 6 ms, 20 g 11 ms 3 bumps / direction, 18 bumps in total	according to IEC 60068-2-27
LABS compatibility	Yes	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

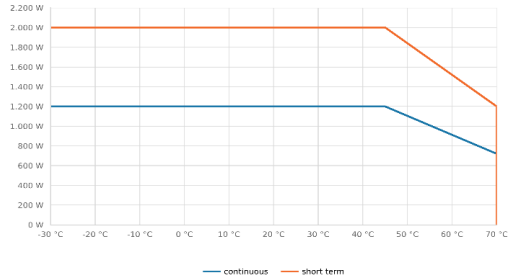


Fig. 2.1-1: Output power vs. ambient temp.

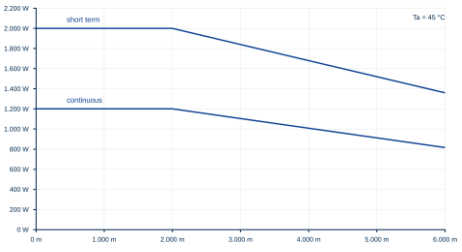


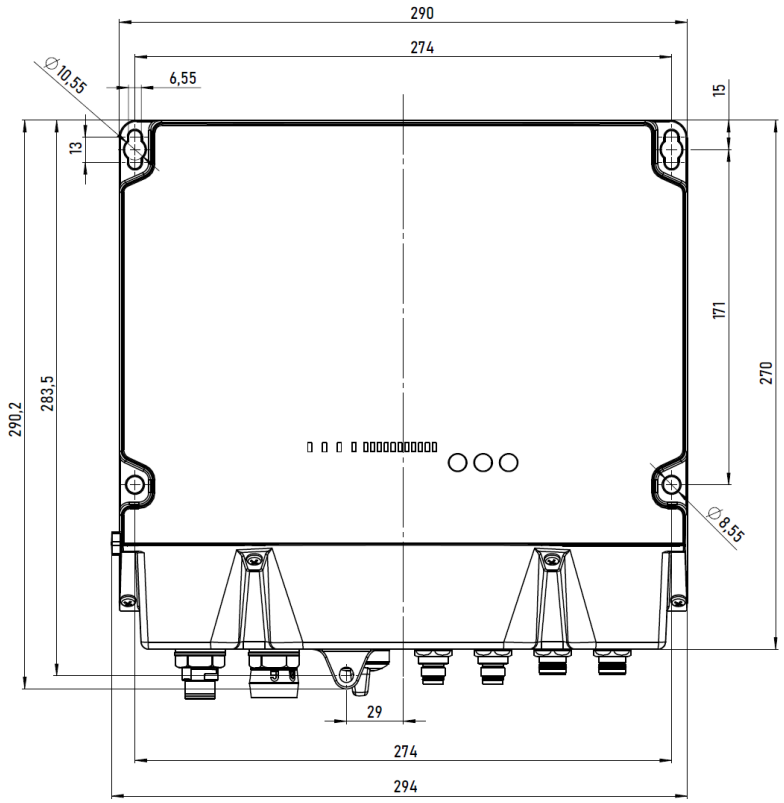
Fig. 2.1-2: Output power vs. altitude

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2.2 Mounting Orientations

The device can be mounted in various mounting orientations. No power derating is required in other mounting positions (upside down, horizontal, over-head and table-top mounting). The listed lifetime and MTBF values from this datasheet apply for all mounting orientations.

2.3 Physical Dimensions & Weight



Width:	290 mm	Housing body material:	Aluminum
Height:	268.6 mm	Housing cover material:	Aluminum
Depth:	60.5 mm	Installation clearances:	50 mm on top and bottom
Weight:	approx. 3700 g		10 mm on the front, left and right side

ⓘ Ensure adequate clearance below the device for mating connectors and cables.

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2.4 Functional Diagram

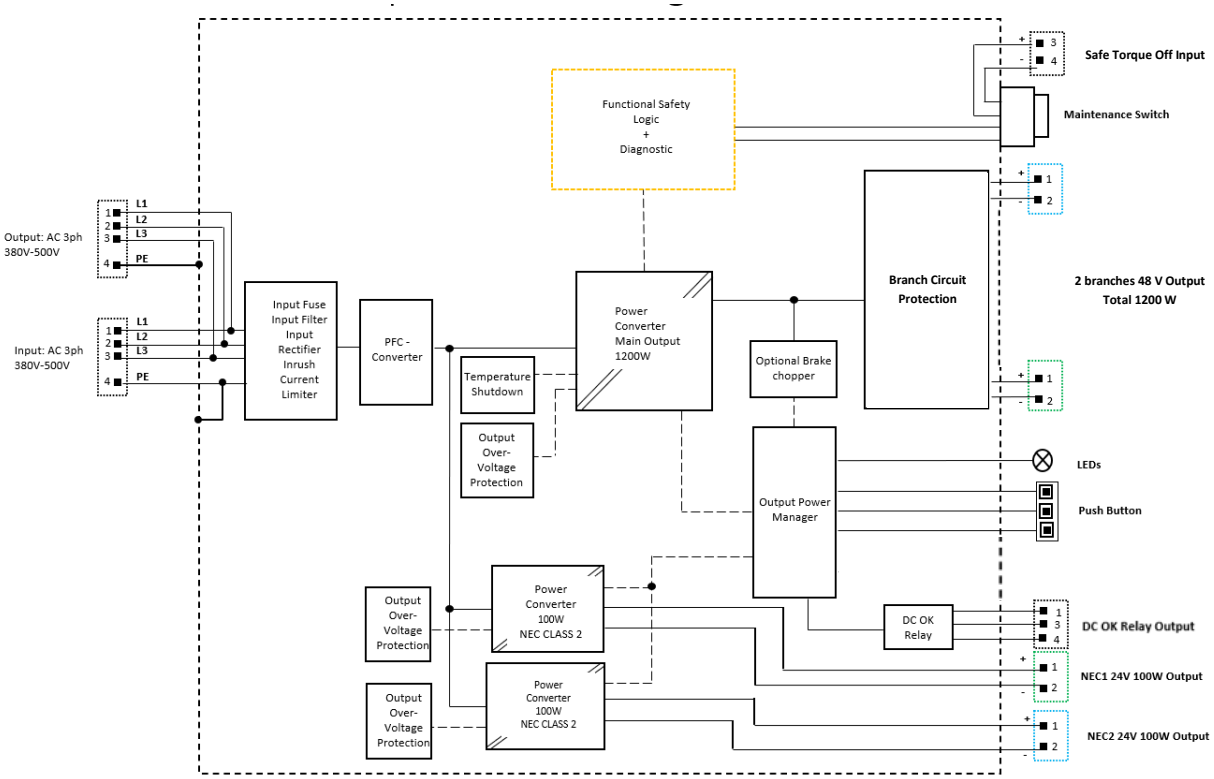


Fig. 2.4-3: Functional Diagram

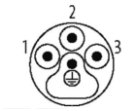
All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2.5 Connectors and Pinning

AC Input connector on power supply (X1):

M15 male

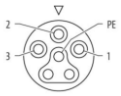
Pin 1 – L1
Pin 2 – L2
Pin 3 - L3
Pin PE - PE



AC Output connector on power supply (X2):

M15 female

Pin 1 – L1
Pin 2 – L2
Pin 3 – L3
Pin PE - PE



Functional Safety Input connector on power supply (X3):

M12-A 5pin male

Pin 1 - NC
Pin 2 - NC
Pin 3 - Functional Safety Input -
Pin 4 - Functional Safety Input +
Pin 5 - NC



Relay Output connector on power supply (X4):

M12-A 5pin male

Pin 1 – Relay In (Com)
Pin 2 - DC OK (NO)
Pin 3 – NC
Pin 4 - Maintenance Switch activated (NO)
Pin 5 -DC OK NEC1 + NEC2



Output connector on power supply (X5):

M12-L 5pin female

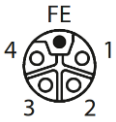
Pin 1 – GND NEC Class 2 OUT 2
Pin 2 - 24Vdc NEC Class 2 OUT 2
Pin 3 - 48Vdc OUT 1 – CH1
Pin 4 - GND OUT 1 – CH1
Pin 5 - FE



Output connector on power supply (X6):

M12-L 5pin female

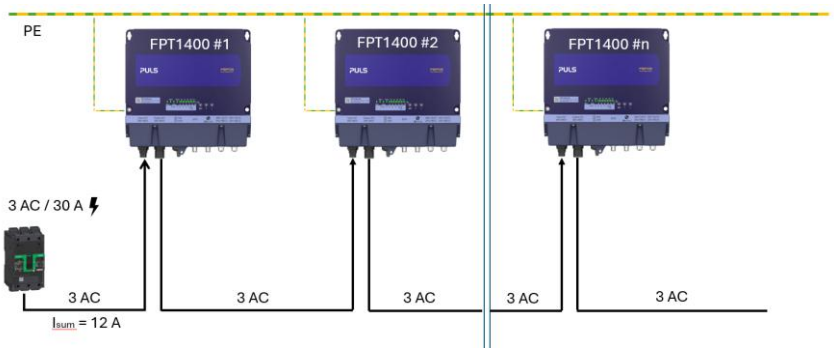
Pin 1 - GND NEC Class 2 OUT 3
Pin 2 - 24Vdc NEC Class 2 OUT 3
Pin 3 - 48Vdc OUT 1 – CH2
Pin 4 - GND OUT 1 – CH2
Pin 5 - FE



All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2.6 Daisy Chaining

The power supply allows AC feed-through (daisy chain) connection of the input supply via dedicated terminals. This function provides AC supply for FPT1400 devices only and does not constitute power distribution or branch-circuit protection. Daisy chaining is permitted within the specified input voltage range and up to maximum allowable loop-through current ≤12 A, including all downstream loads and inrush currents. Proper upstream protection, conductor sizing, and compliance with IEC 61010-1 and applicable regional standards like UL installation requirements have to be taken into consideration.



To ensure that the permissible voltage drop in the protective earth conductor is not exceeded, the FPT1400 is equipped with an earth screw on the outside of the housing. This screw can be used to connect the device to protective earth. This allows longer cable lengths to be used in a daisy-chain configuration

Grounding connection requirements:

The grounding point is designed for an M6 screw (including a suitable washer)

Maximum screw length: max. 10 mm

Tightening torque: 10 Nm



All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

2.7 Functional Safety

With the Safe Torque Off (STO) and Safe Discharge Function the power output can be safely switched off and discharge the output capacitance. These functions are activated or deactivated via the Safe Torque Off input (STO Input).

A low signal at the STO input safely disables the energy transfer in the DC-DC converter and discharges the converter's output capacitance as well as externally connected capacitances.

A high signal at the STO input activates the power output. The Safe Discharge Function cannot be triggered independently. It is automatically linked to the Safe Torque Off function.

The Safe Torque Off signal at the STO input must be provided by a fail-safe digital output of a safety PLC. The PLC must monitor the signal line for cross circuits. The internal STO circuit is tolerant of test pulses used for cross-circuit detection. Excessive activation of the safety functions may cause the internal discharge resistors to overheat and disable the power supply output.

The safety functions "Safe Torque Off" and "Safe Discharge" are automatically tested at regular intervals to ensure safe and proper operation. The safety functions cannot be deactivated, bypassed, or muted.

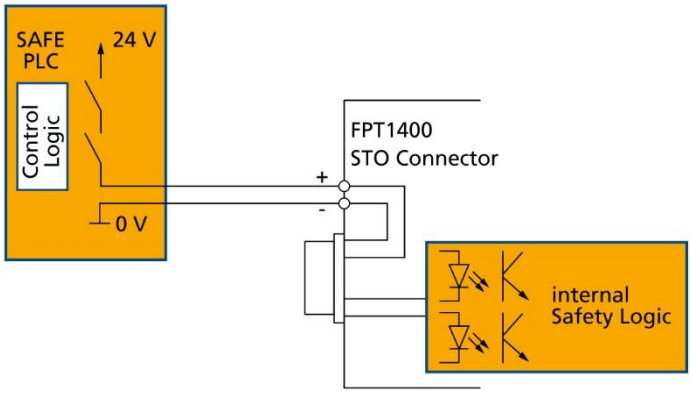
Warning: The discharge resistors of the Safe Discharge function remain active even when the output is disabled or the device is switched off. In these states, the output shall be protected against regenerative energy. Otherwise, the discharge resistors may be damaged.

Warning: Frequent activation and deactivation of the output voltage at high output capacitances may cause the discharge resistors to overheat. In this case, the device permanently disables the output until the resistors have cooled down again.

The output of the Safety PLC can either be high-side (PP) or low-side (PM) switching. The following table shows the input logic of the STO Input.

STO Input State	Output State of the 1200 W converter
Low	OFF
Open	OFF
High	ON

The following graphic shows a typical application of the FPT1400 with a pre-installed safety SPS with a PP-switching digital output to activate the Safe Torque Off function.



All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

STO Input voltage	typ. 24 V	18 V – 32 V input voltage range
STO Input high level	typ. > 18 V	
STO Input low level	typ. < 4V	
STO Input switching threshold	16 V	
STO Input current	typ. 11 mA	
Output test signal Safe PLC	max. 1.5 ms	The maximum time permitted for the safe PLC to test the STO input lines for cross circuits (min. 50 ms recovery between pulses)
Input delay	typ. 53 ms	
Output discharge time	275 ms at 56 Vdc	The time between the falling edge of the STO input signal and the output voltage discharging to less than 10% With max. allowed ext. capacitance
Max. allowed external output capacitance	10 mF	to guarantee specified discharge time
Reaction time	55 ms	The time between the falling edge of the STO input signal and the output voltage discharging to 95%

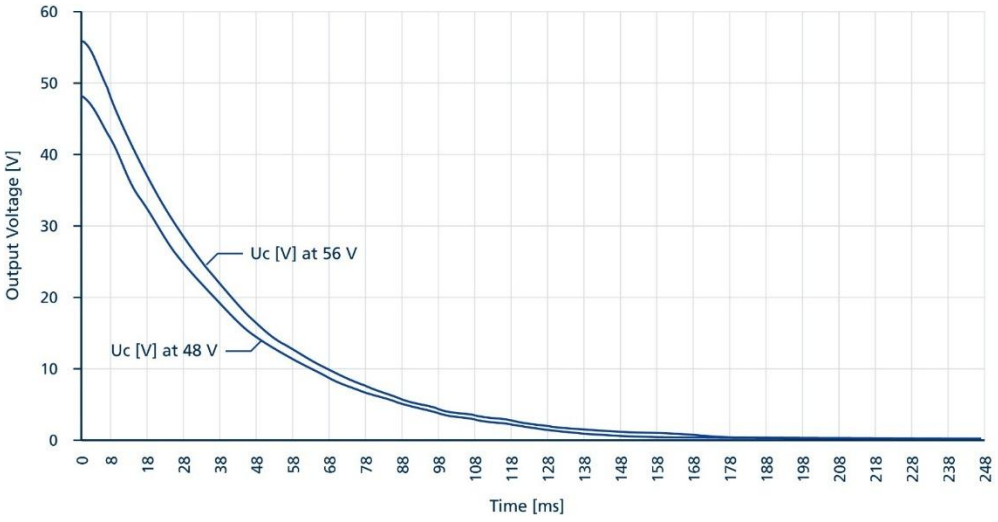


Fig. 2.7-1: Discharge characteristics of the output capacitance

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Maintenance Switch

The power supply is equipped with a **Maintenance Switch** that enables a safe and simple transition into **STO (Safe Torque Off) mode** for maintenance and service activities.

When the **Maintenance Switch is turned to the vertical position**, the following conditions apply:

- The device **automatically activates STO mode**
- The **output is safely de-energized**
- Any connected load **coasts down in a controlled manner**
- The switch can be **secured with a padlock** in this position

Locking the switch in the vertical position allows implementation of a **LOTO (Lockout/Tagout) procedure**, preventing unintended reactivation and ensuring maximum personnel safety during maintenance.

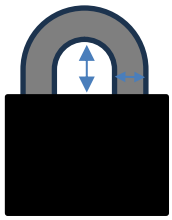
To return the device to normal operation:

1. **Remove the padlock** from the Maintenance Switch
2. Turn the switch back to the **horizontal position**

Only after these steps will the power supply exit STO mode and re-enable the output.

In order to use the lockout-tagout lock in combination with the FPT1400, the following mechanical dimensions must be met:

Shackle diameter: 6.35 mm / ¼”
Shackle height 25 mm / 1”



Safety relevant parameters

The following safety-relevant parameters are specified for an ambient temperature range from -40 °C to +70 °C and for any mounting position of the device.

PFH (Probability of Failure per Hour)	t.b.d t.b.d	Average probability of a dangerous failure of the safety function per hour of operation.
$MTTF_D$ (Mean Time to dangerous Failure)	t.b.d t.b.d	Average expected operating time until a dangerous failure of the safety-related function occurs.
DC (Diagnostic Coverage)	t.b.d t.b.d	Measure of the effectiveness of internal diagnostics in detecting dangerous failures of the safety function.
SSF (Safe State Fraction)	t.b.d t.b.d	Proportion of failures that lead the device into a defined safe state or are detected before a hazardous condition occurs.
Safety Level	t.b.d.	According to EN IEC 62061 an EN ISO 13849 Achieved functional safety level of the safety function (e.g. Performance Level or SIL), derived from the PFH, MTTF, DC and system architecture

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

3 Diagnostics and User Interface

3.1 Device Overview

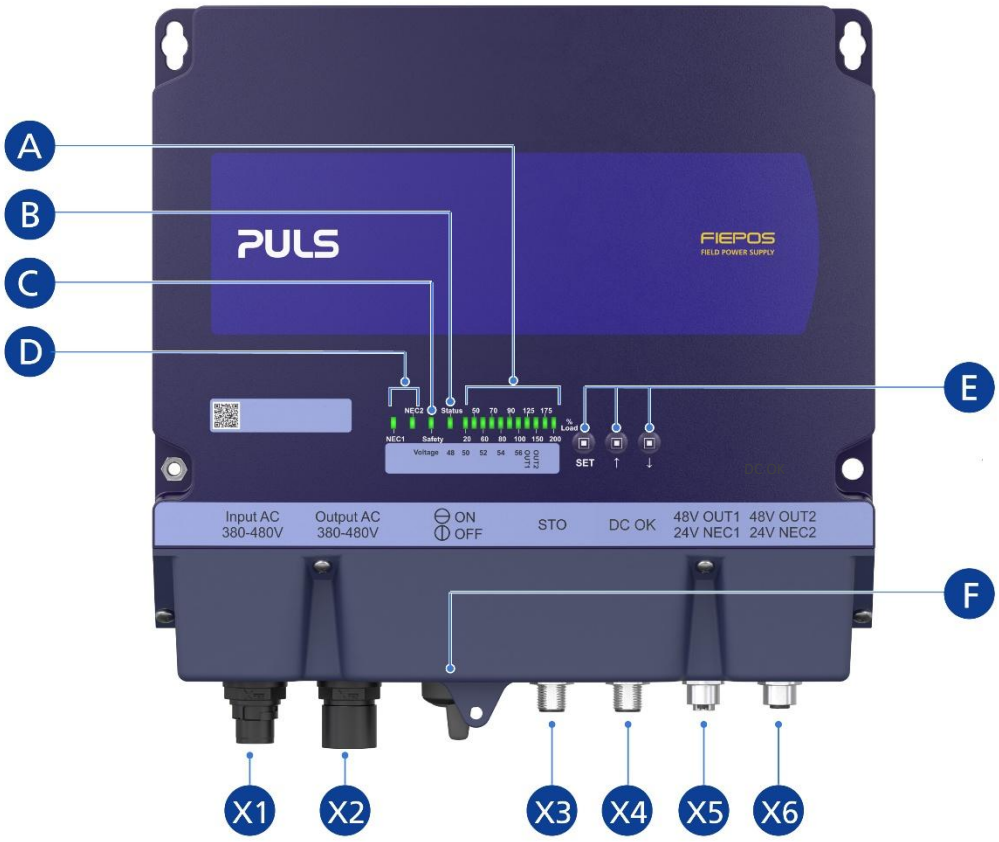


Fig. 3.1-1 Front view

A LED bar
Displays output power (%), output voltage (V), or output current (A)

B Status LED
Indicates the operating state of the device

C Safety LED
Indicates the status of the safety function

D NEC Class 2 LEDs
Indicates the status of NEC1 and NEC2

E Control buttons
SET: select mode / confirm
Up: increase value
Down: decrease value

F Maintenance Switch

X1 AC Input Connector

X2 AC Daisy-Chain Connector

X3 Functional Safety Input

X4 DC OK Connector

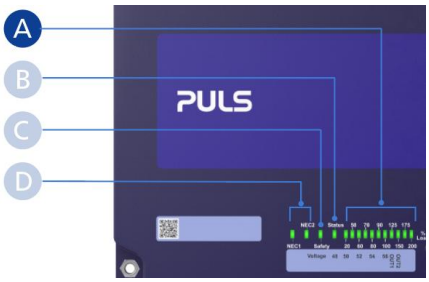
X5 48 V DC Output 1 / 24 V NEC Class 2 Output 1

X6 48 V DC Output 2 / 24 V NEC Class 2 Output 2

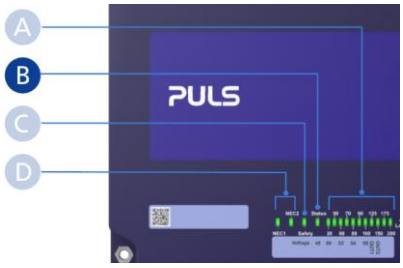
All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

3.1.1 LED Signaling

The LED Bar (A) is a multifunctional display. Its main function is to indicate the sum of all outputs on a percentage scale. It can also display the output voltage (voltage scale) and output current (ampere scale) for each output. The integrated Status LED displays different running conditions of the PSU in real-time.



3.1.2 Status LED (B)



Green: Output on

The DC output voltage exceeds 90% of the setpoint value.
All outputs are operating according to their configured settings.

Off: PSU is not powered

The DC voltage is below 90% of the setpoint value, or at least one output channel is tripped, or the PSU is not powered.

Flashing green: Output Remote off

The outputs are switched OFF via IO-Link process data (PDout).

Flashing orange/green: Installation fault detected

The PSU is automatically switched OFF to prevent exceeding the maximum current rating of the connectors.
One or more OUTx LEDs indicate the affected output(s).

Output returns (GND) must not be externally interconnected or grounded outside the PSU.
Ensure correct installation in accordance with the installation manual.

Orange: AC phase fail

One AC phase drops below the specified limits.

Flashing orange: Hiccup^{PLUS} mode or branch protection limit reached

The output is switched OFF for 18 s (see Fig. 1.2.1-6).

In case of branch protection limit is reached, at least one OUTx LED indicates the affected output.

Flashing orange/red: AC input failure

AC input drops below the specified levels and outputs turned off.

Flashing red: Overtemperature

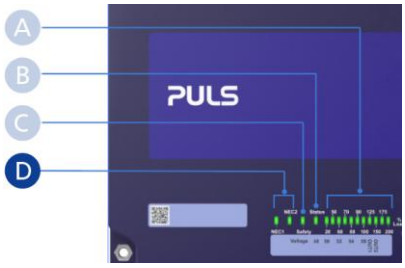
The PSU is switched OFF to prevent overheating.
Normal operation resumes automatically once the temperature returns to the permissible range and the LED returns to solid green.

Red: Branch protection fuse tripped (CC fuse)

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

At least one internal Class CC fuse has tripped.
The affected output is indicated by the orange Chx LED.
The power supply must be replaced.
For further information, see Chapter 6.

3.1.3 NEC Class 2 LED (D)



Green: NEC Output on

The NEC output voltage exceeds 90% of the setpoint value.
The output is operating according to the configured settings.

Off: NEC Converter is not powered

The NEC output is disabled or the PSU is not powered.

Orange: Output current exceeds 80% of limit

The NEC output voltage exceeds 90 % of the setpoint value, but the output current is above 80 % of the NEC Class 2 current limit.

Flashing orange (slow rate: 500ms ON/OFF): Overload trip

The output is switched OFF due to an overload condition.

Possible causes:

- Output current exceeds the configured trip threshold
- Internal temperature limit exceeded due to overload and/or high ambient temperature

The output automatically restarts after 18 s or after sufficient cooling.

Flashing orange (fast rate: 125ms ON/OFF): Short circuit trip

The output is switched OFF due to a short circuit.

Possible causes:

- Electrical short circuit
- Connection of a large capacitive load during operation

The output automatically restarts after 18 s.

Red: Fatal hardware fault

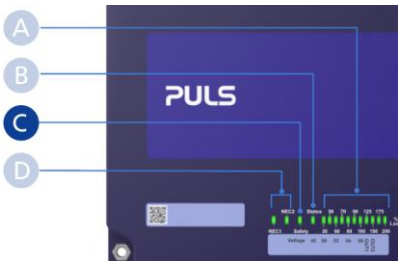
The NEC Class 2 output is switched OFF due to an internal hardware fault. The PSU remains disabled.
Possible causes:

- Internal fault detected by redundant NEC Class 2 limit monitoring (NEC Class 2 compliance cannot be guaranteed)
- Output overvoltage protection triggered by repetitive overvoltage events

Flashing red: Overtemperature

The NEC converter is switched OFF to prevent overheating.
Normal operation resumes automatically once the internal temperature returns to the permissible range and the LED returns to solid green..

3.1.4 Safety LED Signaling Overview (C)



Green: Safe Torque Off unlocked

The Safe Torque Off (STO) function is enabled. The output is permitted to switch on.

Orange: Safe Torque Off input signals different

The Safe Torque Off (STO) function is not enabled and the output is switched off. The two STO input signals are in different states.

Flashing orange: Safe Torque Off locked

STO input channel is low and/or the maintenance switch is switched off.

Red: Safety Fault

The output is disabled due to an error in the functional safety block or in the external Safe Torque Off (STO) signal.

Troubleshooting must only be carried out by qualified personnel. After troubleshooting of the fault, the error can be reset by cycling the AC input.

⚠ The device must not be opened or repaired by the user under any circumstances.

Failure to comply may result in electric shock. Repairs may only be carried out by the manufacturer or by authorized service personnel.

3.2 User Control Buttons

Output Level Controls (E)
The Output Level Controls consist of the Set Mode button and the UP/DOWN buttons. The Set Mode button is used to enter the tripping current settings. The UP/DOWN buttons are used to adjust different output levels or select different operating modes.

Operation Settings

Monitor Output Power Mode
The Output Power Mode displays the actual total output power of the Ua output after startup. It is the default mode of the LED Bar. The output Power is displayed in percentages of the nominal output power. For the 1200 W version, for example, an LED bar indication of 50 % corresponds to 600 W output power. If the output power exceeds 100 % (1200 W), the 125 % LED flashes orange. Refer to the percentage scale at the bottom of the device.

Monitor Output Current Mode
This mode displays the output current of each individual output channel.

To check every single value, please follow these steps:

- Press the UP or DOWN button. OUT1 in the LED bar lights up in orange and the output current OUT1 is displayed in real-time on the LED bar below. Refer to the ampere scale on the sidebar below.
- Use the UP/DOWN buttons to switch between outputs OUT1 to OUT4 and display their respective output currents.
- To return to the Output Power Mode/default mode, scroll beyond the highest (OUT4) or lowest (OUT1) output channel.

Set Output Voltage
To set a new output voltage:

- Press and hold the Set Mode button for 3 s. After all LEDs light up once, the LED bar displays the set voltage.
- To increase or decrease the set point, use the UP/DOWN buttons. Refer to the scale below the LED bar. (e.g. 20 %-LED indicates 49 V).
- New setpoint is applied automatically.
- After 15 s without any interaction, the PSU automatically returns to Output Power Mode.

Set Button Lock
To activate or deactivate the button lock:

- Press and hold the UP and DOWN buttons simultaneously for 3 s. The LED bar flashes for 5 s to indicate the change in button lock status.

Reset Output
In case of a fault condition with an unexpected load condition:

- Press and hold the corresponding ON/OFF button for more than 1 s to reset the channel.

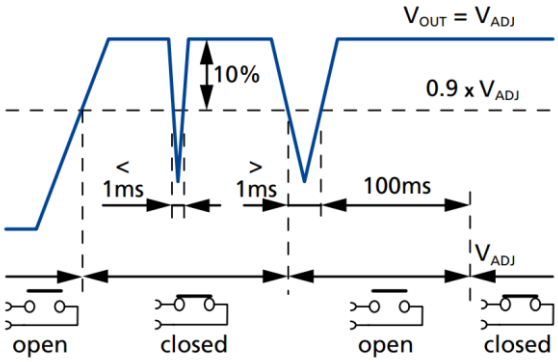
All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

3.3 Communication

3.3.1 DC OK Relay Contact

This feature monitors the output voltage, which is produced by the power supply itself. It is independent of any external voltage that may be present at the output of the power supply.

Contact closes	As soon as the output voltage falls below 90% of the set output voltage. The relay contact is synchronized with the status LED.
Contact opens	As soon as the output voltage dips below 90% of the set output voltage. Short dips will be extended to a signal length of 100 ms. Dips Shorter than 1 ms will be ignored.
Switching hysteresis	1 V
Contact ratings	maximum 60 Vdc 0.3 A, 30 Vdc 1 A, 30 Vac 0.5 A, resistive load minimum permissible load: 1 mA at 5 Vdc
Isolation voltage	see dielectric strength table in chapter 4.2.



3.3.2 Relay Outputs

The FPT1400 series offers optionally 3 additional relay outputs to indicate various operation states.

DC OK NEC Output	Contact closes: As soon as both NEC output voltages reaches typ. 21.6 Vdc. The DC OK NEC Relay Contact is synchronized with the NEC Status LED. Contact opens: As soon as one of the NEC output voltages dips below 21.6 Vdc. Short dips will be extended to a signal length of 100 ms. Dips Shorter than 1 ms will be ignored. Switching hysteresis: 1 V
Maintenance switch activated	Contact closes: as soon as the Safe Torque Off function gets activated via the Maintenance switch Contact opens: the power output of the power supply is running
Contact ratings	Maximum 60 Vdc 0.3 A, 30 Vdc 1 A, 30 Vac 0.5 A, resistive load Minimum permissible load: 1 mA at 5 Vdc
Isolation voltage	See dielectric strength table in chapter 4.2

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4 Compliance and Safety

4.1 Safety and Protection Features

Isolation resistance	min.	500 MOhm	at delivered condition between input and output, measured with 500 Vdc
	min.	500 MOhm	at delivered condition between input and PE, measured with 500 Vdc
PE resistance	max.	0.1 Ohm	resistance between PE terminal and the housing
Input/Output separation		PELV	IEC/EN/UL 61010-2-201, IEC/EN 62368-1, IEC/EN 60950-1
Output overvoltage protection	max.	60 V	In case of an internal defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Class of protection		1	according to IEC 61140 a PE (Protective Earth) connection is required
Ingress protection (Degree of protection)		IP65 and IP67	connected; according to EN/IEC 60529
Overtemperature protection		Included	Output shuts down with automatic restart. Temperature sensors are installed on critical components inside the unit and turns the unit off in safety critical situations, which can happen e.g. when ambient temperature is too high, ventilation is obstructed or the derating requirements are not followed. There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Input transient protection		MOV (Metal Oxide Varistor)	For protection values, see chapter 4.3, EMC.
Internal input fuse		Included	Not user replaceable slow-blow high-breaking capacity fuse
PE conductor current	max.	0.879 mA	At 3x 480 Vac, 60 Hz, TN-,TT-mains / IT-mains Lower currents at lower voltages and frequencies.

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4.2 Dielectric Strength

The negative terminal of the outputs is permanently connected to PE within the unit. The output is insulated from the input by a double or reinforced insulation.

Type and routine tests are conducted by the manufacturer. Field tests may be conducted using the appropriate test equipment that applies the voltage with a slow ramp (2 s up and 2 s down). Connect all input-terminals before conducting the test. When testing, set the cut-off current settings to the value in the table below.

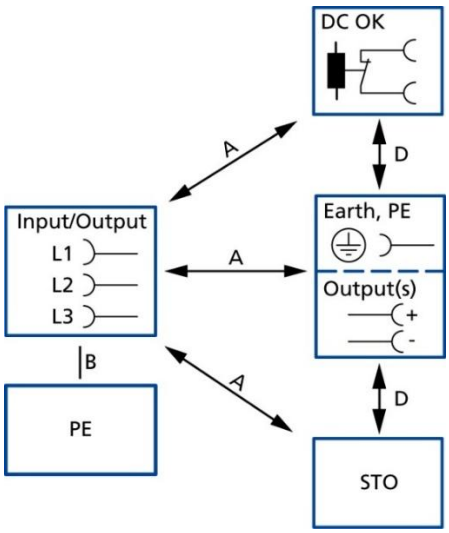


Fig. 4.2-1: Dielectric strength

		A	B	D
Type test	60 s	4990 Vac	2520 Vac	2150 Vac
Routine test	5 s	2200 Vac	2200 Vac	500 Vac
Field test	5 s	500 Vac	500 Vac	500 Vac
Cut-off current setting for field test		>10 mA	>10 mA	>10 mA

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4.3 EMC

The EMC behaviour of the device is designed for applications in industrial environment as well as in residential, commercial and light industry environments.

The device is investigated according to EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

EMC immunity

Electrostatic discharge	EN 61000-4-2	Contact discharge	8 kV	Criterion A
		Air discharge	15 kV	Criterion A
		Contact discharge	6 kV	Criterion DS
		Air discharge	8 kV	Criterion DS
Electromagnetic RF field	EN 61000-4-3	80 MHz - 2.7 GHz	20 V/m	Criterion A
		2.7 GHz – 6 GHz	10 V/m	Criterion A
		80 MHz - 2.7 GHz	20 V/m	Criterion DS
		2.7 GHz – 6 GHz	10 V/m	Criterion DS
Fast transients (Burst)	EN 61000-4-4	AC Input lines	4 kV	Criterion A
		DC Output lines	4 kV	Criterion A
		DC OK	4 kV	Criterion A
		STO Input	t.b.d.	t.b.d.
		AC Input lines	3 kV	Criterion DS
		DC Output lines	3 kV	Criterion DS
		DC OK	2 kV	Criterion DS
Surge voltage on AC input	EN 61000-4-5	L to N	2 kV	Criterion A
		L to PE, N to PE	4 kV	Criterion A
		L to N	2 kV	Criterion DS
		L to PE, N to PE	4 kV	Criterion DS
Surge voltage on DC output	EN 61000-4-5	+ to -	1 kV	Criterion A
		+/- to PE	2 kV	Criterion B
		+ to -	1 kV	Criterion DS
		+/- to PE	2 kV	Criterion DS
Surge voltage on DC OK	EN 61000-4-5	DC OK to PE	1 kV	Criterion A
		DC OK to PE	2 kV	Criterion DS
		STO Input	t.b.d.	t.b.d.
Conducted immunity	EN 61000-4-6	0.15 – 80 MHz	20 V	Criterion A
		0.15 – 80 MHz	10 V	Criterion DS
Magnetic field	EN 61000-4-8	50 Hz/60 Hz	30 A/m	Criterion A
		50 Hz/60 Hz	30 A/m	Criterion DS
Voltage dips	EN 61000-4-11	0 % of 380 Vac	0 Vac, 20 ms	Criterion A
		40 % of 380 Vac	152 Vac, 200 ms	Criterion A
		70 % of 380 Vac	266 Vac, 500 ms	Criterion A
		0 % of 500 Vac	0 Vac, 20 ms	Criterion A
		40 % of 500 Vac	200 Vac, 200 ms	Criterion A
		70 % of 500 Vac	350 Vac, 500 ms	Criterion A
		0 % of 380 Vac	0 Vac, 20 ms	Criterion DS
		40 % of 380 Vac	152 Vac, 200 ms	Criterion DS
		70 % of 380 Vac	266 Vac, 500 ms	Criterion DS
		0 % of 500 Vac	0 Vac, 20 ms	Criterion DS
		40 % of 500 Vac	200 Vac, 200 ms	Criterion DS
		70 % of 500 Vac	350 Vac, 500 ms	Criterion DS
Voltage interruptions	EN 61000-4-11	0 V	5000 ms	Criterion C
		0 V	5000 ms	Criterion DS
Voltage sags	SEMI F47	Dips on the input voltage according to SEMI F47 standard		
		80 % of 400 Vac (320 Vac)	1000 ms	Criterion A
		70 % of 400 Vac (280 Vac)	500 ms	Criterion A
		50 % of 400 Vac (200 Vac)	200 ms	Criterion A
Powerful transients	VDE 0160	Over entire load range	1550 V, 1.3 ms	Criterion A

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Performance criteria:
A: The device shows normal operation behavior within the defined limits.
C: Temporary loss of function is possible. The device may shut-down and restarts by itself. No damage or hazards for the device will occur.
DS: The functions of the device under test (DUT) that are intended for use in the safety application:

- shall not be affected beyond their specified limits, and
- may be temporarily or permanently degraded, provided that the DUT responds to a fault condition in such a way that a clearly defined and recognizable safe state is either:
  - maintained continuously, or
  - achieved within a defined time interval.
- Functions that are not intended for use in safety applications may be temporarily or permanently impaired.

EMC Emission

Conducted emission AC input lines	EN IEC 61000-6-3, EN 55032, EN 55011	Class B
Conducted emission DC output lines	EN IEC 61000-6-3	
Radiated emission	EN IEC 61000-6-3, EN 55032, EN 55011	Class A
Harmonics	EN 61000-3-2	Class A fulfilled between 0 A and 12 A load
Voltage fluctuations, flicker	EN 61000-3-3	Pass tested with constant current loads, non-pulsing

This device complies with FCC Part 15 rules.

Operation is subjected to 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.

Switching Frequencies	The power supply has up to five converters with three different switching frequencies. One is nearly constant, while the others are variable.	
PFC converter	20 kHz to 200 kHz	input voltage and output load dependent
Main converter	60 kHz to 140 kHz	output load dependent
NEC converter	60 kHz to 140 kHz	output load dependent
Auxiliary converter	54-66 kHz	
Microcontroller clocks	64 MHz	

4.4 Approvals and Fulfilled Standards

IEC 61010	Safety	CB Scheme Certificate IEC 61010-2-201 – Electrical Equipment for Measurement, Control and Laboratory Use – Particular requirements for control equipment
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR – UL 61010-2-201 – Electrical equipment for measurement, control and laboratory use – Particular requirements for control equipment Applicable for US and Canada E-File: E198865
SEMI F47	SEMI F47	Test Report Voltage Sag Immunity for Semiconductor Processing Equipment
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

4.5 Regulatory Product Compliance

EU Declaration of Conformity	CE	Trade conformity assessment for Europe The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
WEEE Directive		Manufacturer's Statement EU-Directive on Waste Electrical and Electronic Equipment (WEEE) registered in Germany as business to business (B2B) products. WEEE-Reg.-Nr. DE 55837529
REACH Regulation (EU)	REACH COMPLIANT	Manufacturer's Statement EU regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) fulfilled.
China RoHS	25	Manufacturer's Statement The device meets the Measures for Restriction of the Use of Hazardous Substances in Electrical & Electronic Products according the China-RoHS requirements. The device is marked with EFUP symbol 25 years (Environmentally Friendly Use Period)
IEC/EN 61558-2-16 (Annex BB)	Safety Isolating Transformer	Safety Isolating Transformers corresponding to Part 2-6 of the IEC/EN 61558

All parameters are specified at 48 V, 1400W, 400Vac, +25°C ambient and after a 5 minutes run-in time unless otherwise noted.

5 Accessories

5.1 T.b.d.

6 Maintenance, Service and Repair

The FPT1400 power supply is designed for maintenance-free operation.

If your device develops a fault, please send it to your responsible sales contact, dealer, branch office, or another authorized service point, together with a clear and easy-to-understand description of the problem. Please note that opening or repairing the device yourself is not permitted as there is a risk of electric shock and it will void the warranty.