



CAPACITOR-BASED DC-UPS

- Built-in capacitors as energy source (EDLC Electrochemical Double Layer Capacitors)
- Wide temperature range from -25°C to +70°C
- >10 years operational lifetime expectancy
- Regulated output voltage in back-up mode
- No ventilated cabinets are required, as the capacitors do not generate hydrogen like VRLA batteries
- Short charging time, the unit is rapidly back in ready mode
- Prewarning signal in case that specified back-up capacity may not be available due to aging or failure
- 3-year warranty

PRODUCT DESCRIPTION

The UC1400.2401 uses electrochemical double-layer capacitors (EDLCs), commonly known as ultracapacitors or supercapacitors, which are installed inside the DC-UPS. They can bridge power failures or voltage fluctuations and supply voltage to the DC 24V bus for a certain period, which allows for a safe shut-down of the system. Expensive downtimes, long restart cycles and loss of data can be avoided.

In times when the power supply provides sufficient voltages, the DC-UPS stores energy in the capacitors. In case of a mains voltage fault, this energy is released to the DC bus in a regulated process.

The DC-UPS units are maintenance-free and have a comparable service life to that of power supplies. Unlike battery-based DC-UPS systems, regular capacitor replacement is not required.

The wide temperature range from -25°C to +70°C makes the unit suitable for many applications.

SHORT-FORM DATA

Input voltage	DC 24V	-20%/+25%
Minimum input voltage to start charging	22.7Vdc	
Transfer voltage to switch into back-up mode	22.5Vdc	
Internal current consumption	0.6A	max. value, includes charging current
Capacitor size	1.4kW _s	
Output in power supply mode:		
Output current	1A	continuous
Input to output voltage loss	0.7V	max. value at 1A
Output in back-up mode:		
Output voltage	22.6V 22.5V	at no output load at 1A output load
Output current	1A	continuous
Back-up time	40s (min.) 60s	at 1A output current at 0.75A output current
Back-up time limitation	600s	shut-down output at >600s
Charging time	8min 30s 3min 30s	for initial charging after discharging with 1A until the unit shuts down
Power losses	1.5W	at 1A output load
Temperature range	-25°C to +70°C	

ORDER NUMBERS

DC-UPS **UC1400.2401** EDLC energy storage

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TERMINOLOGY AND ABBREVIATIONS

Normal mode	Describes a condition where the capacitor is charged, the input voltage is in range and the output is loaded within the allowed limits.
Back-up mode	Describes a condition where the input voltage is below the transfer threshold level, the unit is running on capacitor (buffering) and the output is loaded within the allowed limits.
Charging mode	Describes a condition where the capacitor is being charged, the input voltage is in range and the output is loaded within the allowed limits.
Inhibit mode	Describes a condition where buffering is disabled on purpose (e.g. for service actions).
t.b.d.	To be defined, value or description will follow later.
DC 24V	A figure displayed with the DC before the value represents a nominal voltage with standard tolerances included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
24Vdc	A figure with the unit (Vdc) at the end is a momentary figure without any additional tolerances included.
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.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for commercial use, such as in industrial control, process control, monitoring and measurement equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

2. INSTALLATION INSTRUCTIONS

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- Use caution to prevent any foreign objects from entering into the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on, and immediately after power-off. Hot surface may cause burns.

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.

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

Install the device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN rail according to EN 60715 with the input terminals on the top of the unit.

The voltage between the input and ground must not exceed 60Vdc continuously. The ripple voltage in the low frequency range between 50Hz and 10kHz must be negligible when used in marine applications.

For powering the input use PIM60.241, PIM60.245 power supply or an equivalent solution that either corresponds to the maximum overload current of 5A or uses an appropriate fuse or circuit breaker. The input must be powered from a PELV or SELV source or an "Isolated Secondary Circuit" in order to maintain a SELV or PELV output.

Check for correct input polarity. The device will not operate when the voltage is reversed.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +40°C, 80°C for ambient temperatures up to +60°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The device is designed as "Class of Protection III" equipment according to IEC 61140.

The enclosure of the device provides a degree of protection of IP20.

A disconnecting means shall be provided for the output of the device.

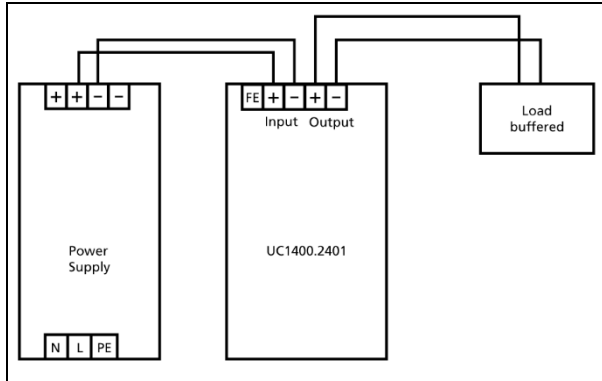
The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover the ventilation grid!

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides.

The device is designed for altitudes up to 2000m. The maximum surrounding air temperature is +70°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 25mm below the device.

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

Fig. 2-1 **Typical wiring diagram**



The EDLC (storage capacitors) contain Acetonitrile and Tetraethylammonium-tetrafluoroborate. These components are declared as non-dangerous goods in regards to shipment. A safety data sheet can be provided upon request.

3. DC INPUT

Input voltage	nom.	24Vdc	-20%/+25%
Input voltage range	typ.	22.5-30Vdc	continuous operation
	max.	30-35Vdc	temporarily allowed, no damage to the unit
Minimum input voltage to start charging	typ.	22.7Vdc	Below this voltage, only the input power is passed through to the output; the capacitors will not be charged, and back-up mode is not activated.
Transfer threshold voltage to switch into back-up mode	typ.	22.5Vdc	The transfer threshold voltage is the input voltage at which the unit switches to back-up mode and supplies the output from the capacitors, provided that the input voltage was previously above the turn-on level and all other back-up conditions are fulfilled.
Allowed voltage between input and earth (chassis)	max.	60Vdc or 42.4Vac	continuous, IEC 62103
Current consumption	typ.	20mA	capacitors charged, output current not included
	max.	0.6A	during charging, output current not included
	max.	1.6A	during charging, nominal output current included

Fig. 3-1 Input voltage range

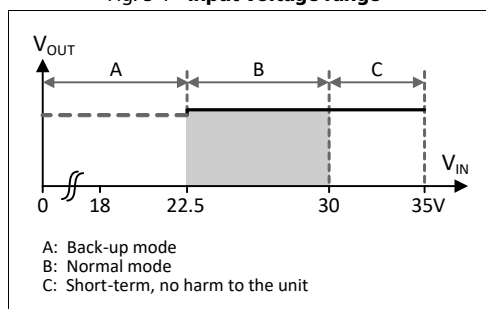
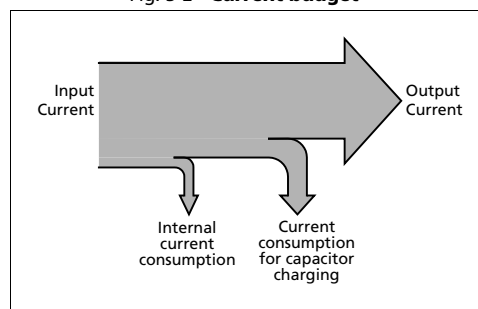


Fig. 3-2 Current budget



4. OUTPUT

Output in normal mode:

In normal mode (and also in charging mode), the output voltage is slightly lower than the input voltage. The output voltage follows the input voltage reduced by the input to output voltage drop.

Input to output voltage drop	max.	0.7V	at nominal output power
Output current	nom.	1A	continuously allowed for the entire voltage range
Output power	nom.	24W	
Current limitation		No	limited only by power supply ¹⁾
Return current protection		Yes	

¹⁾ Use PIM60.241, PIM60.245 power supply, or equivalent solution with suitable overload and short-circuit characteristics, to power the UC1400.2401.

Output in back-up mode:

The output voltage is fully regulated in back-up mode.

The unit switches into back-up mode when the input voltage falls below the transfer threshold input voltage level. The back-up voltage is slightly lower than this threshold input voltage. The unit switches back to normal mode as soon as the input voltage exceeds the transfer threshold voltage, which is specified in the input section.

Output voltage	typ.	22.5V	Measured at the output (including input/output voltage drop)
Output current	nom.	1A	continuously allowed
Output power	nom.	22.5W	continuously allowed
Overload behavior		Continuous current	see Fig. 4-1
Current limitation	typ.	1.2A	see Fig. 4-1
Short-circuit current	typ. max.	1.25A 1.5A	
Capacitive loads	max.	1000uF	limitation only for uncharged capacitors that can be switched onto the output in back-up mode
Inductive loads		no limitation	

Fig. 4-1 Output characteristic and overload behavior in back-up mode, typ.

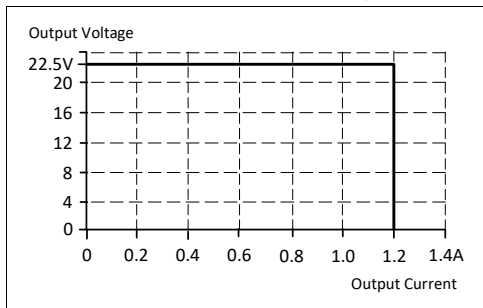


Fig. 4-2 Transition from back-up mode to normal mode and vice versa, definitions

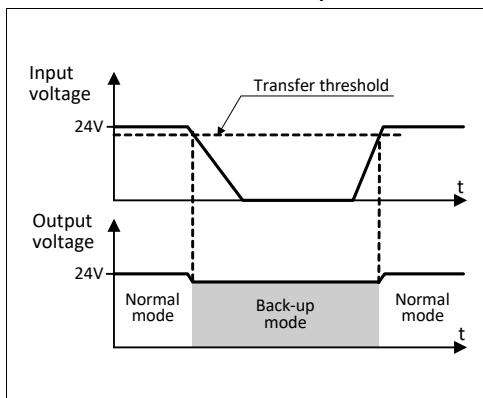
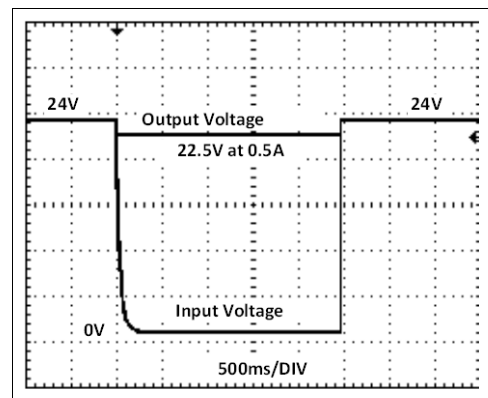


Fig. 4-3 Transfer behavior, typ.



5. CHARGING

During charging, the DC-UPS consumes additional current from the input, see chapter 3 "Input".

Charging time initial charging ¹⁾	typ.	8min 30s	when the capacitor is completely discharged
Charging time recharging ²⁾	typ.	3min 30s	after discharging with 1A until the unit shuts down
Allowed number of charging/ discharging cycles ³⁾	typ.	10 cycles/day	

- 1) Initial charging means that no input voltage was applied for several hours or longer and the capacitor is completely discharged by the internal electronics.
- 2) Recharging means that the electronics inside the DC-UPS has not completely discharged the capacitor. The values in the table apply when the input voltage is applied immediately after buffering has stopped.
- 3) The DC-UPS is designed for back-up buffering in case the mains voltage dips or the mains supply is switched off. Frequent or continuous back-up and recharging cycles may reduce the service life of the capacitors and the DC-UPS. An average of 10 cycles per day is not expected to significantly affect the service life of the DC-UPS.

6. BACK-UP TIME

Back-up time	min.	40s	at 1A back-up current
	typ.	60s	at 0.75A back-up current
Back-up time limitation	typ.	600s	

7. SIGNALING CONTACTS

The signal outputs use an open-collector NPN transistor with internal pull-up to the positive output and are referenced to the common negative potential (no galvanic isolation). These signals are generally suitable for interfacing with PLCs and other customer electronics powered by the output of the DC-UPS. If isolated signals are required, an optocoupler or similar device can be driven from the outputs.

Ready contact

This signal shows whether the DC-UPS is charged to approx. 80% and is ready for buffering.

Low level	0V, max. 25mA ³⁾	In case the capacitor is charged and the DC-UPS is powered by the power supply.
High level	22.5V - 28V ^{1) 2)}	In case the capacitor is not charged or the DC-UPS is in back-up mode or the back-up time has expired.

Diagnosis contact

The lifetime estimation is based on internal self-testing that measures the actual remaining capacitance and does not use time or event counts to determine device life.

Low level	0V, max. 25mA ³⁾	Lifetime expired, the specified back-up time / back-up energy may no longer be available, or the unit is defective.
High level	22.5V - 28V ^{1) 2)}	Lifetime is within the specification, and the self-test was successful.

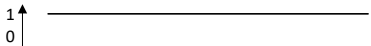
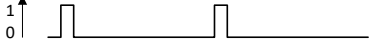
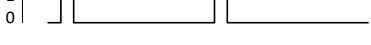
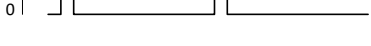
1) The voltage level is dependent on the voltage of the power supply.

2) The impedance of the internal pull-up resistor is 44.2kOhm, external pull-up is allowed within the maximum low level output current.

3) Voltage drop at 25mA: typ. 0.13V

8. LED SIGNAL PATTERNS

Signaling is provided for typ. 15 minutes with no input voltage after the unit has shut down after buffering.

LED Color	Pattern	Status
		Ready
green		Charging
		Buffering
yellow		Lifetime expired or internal error
		Back-up time expired
red		Overload only in back-up mode
		Overtemperature

9. LIFETIME EXPECTANCY AND MTBF

The lifetime expectancy of the DC-UPS is predominantly affected by the storage capacitors. The lifetime is primarily determined by the operating voltage and operating temperature of the capacitors. To maximize lifetimes, PULS does not utilize the fully allowed working voltage for these capacitors and therefore accepts a slightly shorter back-up time.

The capacitors have an almost unlimited shelf life (unlike batteries) when stored uncharged at +25°C.

The DC-UPS is designed for back-up operation and not for periodic charge/discharge cycling.

The number of charge/discharge cycles does not have an impact on the lifetime as long as the number of cycles does not exceed on average 10 times per day.

Lifetime

Lifetime expectancy ¹⁾	131 400h	at 24V, 1A, +25°C
	131 400h	at 24V, 1A, +40°C
	52 560h	at 24V, 1A, +50°C
	17 520h	at 24V, 1A, +60°C

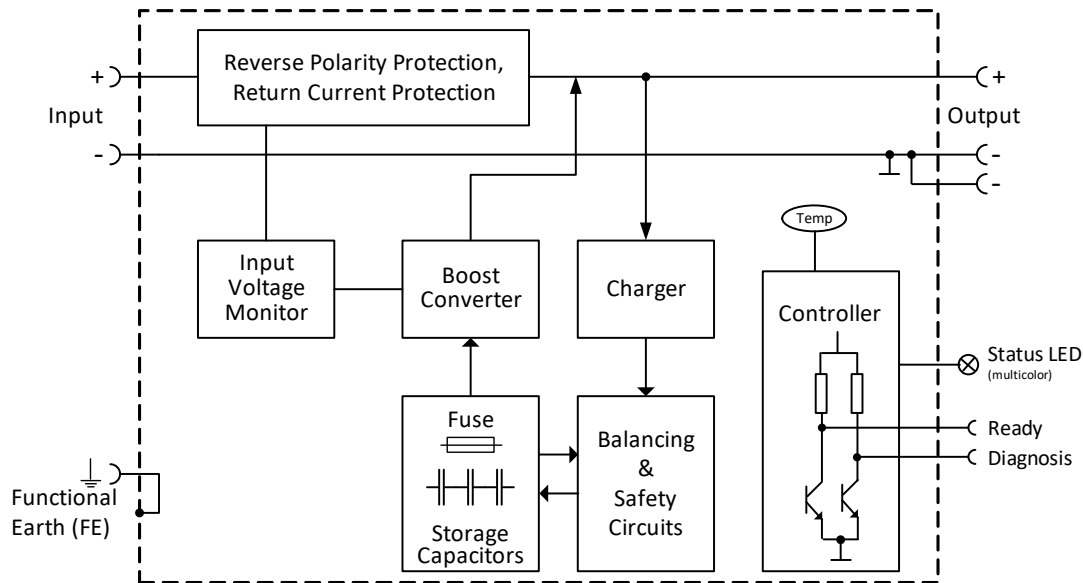
MTBF

MTBF ²⁾ SN 29500, IEC 61709	5 036 768h	at 24V, 1A, +25°C
	3 147 396h	at 24V, 1A, +40°C
MTBF ²⁾ MIL HDBK 217F	1 628 497h	at 24V, 1A, +25°C; Ground Benign GB25
	1 202 200h	at 24V, 1A, +40°C; Ground Benign GB40
	460 174h	at 24V, 1A, +25°C; Ground Fixed GF25
	357 068h	at 24V, 1A, +40°C; Ground Fixed GF40

- 1) The **Lifetime expectancy** shown in the table indicates the minimum operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors and storage capacitors (ultracapacitors). Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification.
- 2) **MTBF** stands for **Mean Time Between Failures**, 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 000h 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 000h or only for 100h.

10. FUNCTIONAL DIAGRAM

Fig. 10-1 Functional diagram



11. TERMINALS AND WIRING

The terminals are IP20 finger-safe constructed and are suitable for field and factory wiring.

	Input and output	Signals
Type	quick-connect spring-clamp terminals	push-in terminals
Solid wire	0.5-6mm ²	max. 1.5mm ²
Stranded wire	0.5-4mm ²	max. 1.5mm ²
American Wire Gauge	AWG 20-10	AWG 24-16
Max. wire diameter	2.8mm (including ferrules)	1.5mm (including ferrules)
Wire stripping length	10mm	8mm
Screwdriver	-	3mm slotted to open the spring

Instructions:

- Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient temperatures up to 40°C and
80°C for ambient temperatures up to 60°C and
90°C for ambient temperatures up to 70°C.
- Follow national installation codes and installation regulations.
- Ensure that all strands of a stranded wire enter the terminal connection.
- Unused terminal compartments should be securely tightened or closed.
- Ferrules are allowed.

12. EMC

The DC-UPS is suitable for applications in industrial environments as well as in residential, commercial and light-industrial environments without any restrictions.

EMC Immunity

According to generic standards: EN IEC 61000-6-1 and EN IEC 61000-6-2

Electrostatic discharge	EN 61000-4-2	contact discharge ¹⁾ air discharge ^{*)}	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines output lines signals ²⁾	2kV 2kV 1kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	+ → - + / - → chassis ground	500V 1kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → chassis ground	500V 1kV	Criterion A Criterion A
Surge voltage on ready- and diagnosis-contacts	EN 61000-4-5	signals → chassis ground	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A

1) Chassis ground connection earthed (grounded)

2) Tested with coupling clamp

Criteria:

A: DC-UPS shows normal operation behavior within the defined limits.

EMC Emission

According to generic standards: EN IEC 61000-6-3, EN IEC 61000-6-4 and EN IEC 61000-6-8

Conducted emission	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	input lines	limits for DC power ports acc. EN IEC 61000-6-3 fulfilled
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	output lines	limits for DC power ports acc. EN IEC 61000-6-3 fulfilled
Radiated emission	EN 55011, EN 55032		Class B

This device complies with FCC Part 15 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.

13. ENVIRONMENT

Operational temperature ¹⁾	-25°C to +70°C	
Storage temperature	-40°C to +70°C	for storage and transportation
Humidity ²⁾	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 5000m	approvals apply only up to 2000m
Degree of pollution	2	IEC 62477-1, not conductive

1) Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 25mm below the unit.

2) Do not operate while condensation is present.

14. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits ¹⁾	
Output overvoltage protection in back-up mode	typ. 30Vdc max. 32Vdc	In case of an internal DC-UPS defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Degree of protection	IP20	EN/IEC 60529 for use in a controlled environment according to CSA 22.2 No 107.1-01
Penetration protection	> 3.5mm	e.g. screws, small parts
Overtemperature protection	included	device will not provide back-up energy when maximum temperature is exceeded, no shutdown in normal mode
Input overvoltage protection	-	max. 35Vdc, no harm or defect of the unit

1) In case of a protection event, audible noise may occur.

15. SAFETY FEATURES

Output voltage	SELV	IEC/EN 61010-2-201, The input must be powered from a SELV power source.
	PELV	IEC / EN 61010-2-201, The input must be powered from a PELV power source.
Class of protection	III	A PE (Protective Earth) connection is not required
Isolation resistance	> 500MΩ	At delivered condition between input and FE, measured with 500Vdc
	> 500MΩ	At delivered condition between output and FE, measured with 500Vdc
	> 500MΩ	At delivered condition between signal contacts and FE, measured with 500Vdc
Dielectric strength	500Vac	Power port / signal port to housing
Touch current (leakage current)	The leakage current which is produced by the DC-UPS itself depends on the input voltage ripple and needs to be investigated in the final application. For a smooth DC input voltage, the produced leakage current should be less than 100μA.	

16. REGULATORY PRODUCT COMPLIANCE

EU Declaration of Conformity		The CE mark indicates conformance with the - EMC directive - RoHS directive
REACH Directive		Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Regulation		Manufacturer's Declaration EU Regulation on Waste Electrical and Electronic Equipment Registered as business to business (B2B) products

17. PHYSICAL DIMENSIONS AND WEIGHT

Width	48mm
Height	124mm
Depth	117.2mm
	The DIN rail depth must be added to the unit depth to calculate the total required installation depth.
Weight	540g
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Installation Clearances	see chapter 2

Fig. 17-1 **Front view UC1400.2401**

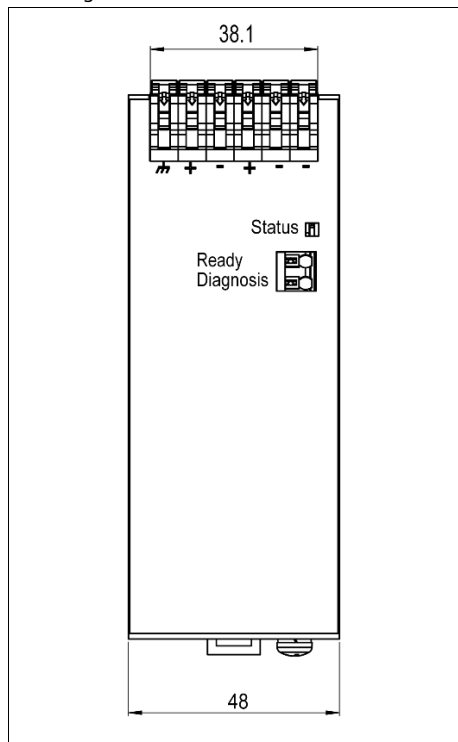


Fig. 17-2 **Side view UC1400.2401**

