

## DESCRIPTION

DDP400 and MDP400 SC series, are sealed, compact, high efficiency, small form factor AC-DC power supplies.

The series provide a steady 400 W of regulated DC power through the full input range of 90 to 264 V<sub>AC</sub>. Its 3.27" x 8.34" x 1.65" form factor, enable designers to integrate more advanced features into a system without compromising on its size.

By converting energy at 94% typical efficiency, the DDP400 and MDP400 SC series generate less heat facilitating thermal management in space constrained system and offering high reliability.

Both the DDP and MDP SC series are available in three standard output voltages: 12, 24, 48 V<sub>DC</sub> and offer an auxiliary 12 V<sub>DC</sub> and 5 V<sub>DC</sub> stand-by outputs. Available control signals include Power Good (P\_OK) and remote On/off (PS\_ON).

The sealed package offers IP67 ingress protection index, and can be installed in contact with thermo-conductive part of the system so to transfer heat by conduction, therefore, enhancing performances.

When conduction cooled, or convection cooled with its optional heat sink assembled, the SC series can deliver full output power from -20 to 50 °C. It can operate up to 70 °C with de-rating and is capable to start up from - 20 °C.

The MDP400 range comply with the 3<sup>rd</sup> edition of the UL/IEC 60601-1 safety standards for medical equipments and the DDP400 range comply with the 2<sup>nd</sup> edition of the UL/IEC 60950-1 standards for IT equipments. Both the series meets the EN55022 EMC limits of Class B for conducted and radiated emissions as well as the IEC/EN 61000-3 and IEC/EN 61000-4 EMC standards.

\* Test in progress for certification.

**3 YEAR WARRANTY**



## KEY FEATURES

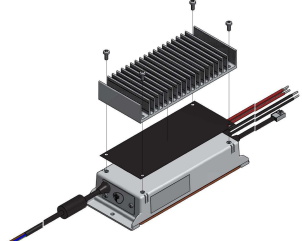
- Universal input voltage range
- 400 W rated power (440 W peak)
- Extremely high efficiency (94% typical)
- Low stand-by consumption (<0.5 W)
- 12V, 24V and 48V standard output variants
- Active PFC, EN61000-3-2 compliant (Class C)
- Low earth leakage current
- Over temperature protection
- OV, OC, and short circuit protections
- Stand-by +5 V Output
- Auxiliary fan +12 V output
- Remote On/off and power good signals
- ANSI/AAMI ES60601-1 3<sup>rd</sup> ed. compliant
- IEC/EN/UL 60601-1 2<sup>nd</sup>/3<sup>rd</sup> ed. compliant.
- RoHS 2 compliant (Directive 2011/65/EU).
- 4000 m altitude operation.

## MARKET SEGMENT AND APPLICATIONS

- Video Wall Display and Entertainment
- Industrial and Process Control
- Telecommunications
- Laboratory Equipment
- Test and Measurement Equipment
- Medical applications

## MODEL CODING AND OUTPUT RATINGS

Model Grade and Output Power	Output Nominal Voltage	Package/Fan Options
ITE: <b>DDP400-</b>	12 V <sub>DC</sub> : <b>US12-</b>	Sealed Conduction/Convection Cooling: <b>SC</b>
Medical: <b>MDP400-</b>	24 V <sub>DC</sub> : <b>US24-</b>	
	48 V <sub>DC</sub> : <b>US48-</b>	

<b>D</b>	<b>12</b>	<b>SC</b>	Heat sink can be ordered as an accessory using the code:  <b>DDP-HS</b>	
	<b>DP400 - US 24 - SC</b>			
<b>M</b>	<b>48</b>		Mounting kit includes 4X screws, M4x10, and the thermally conductive graphite sheet	

Model Number	V1 (V)	I1 <sup>1</sup> Convection W/O heat sink (A)	I1 <sup>2</sup> Conduction W Heat sink (A)	V1 <sup>3</sup> Ripple (mV)	V2 (V)	I2 <sup>1</sup> Rated (A)	V2 <sup>3</sup> Ripple (mV)	5V <sub>SB</sub> (V)	I5V <sub>SB</sub> <sup>1</sup> Rated (A)	5V <sub>SB</sub> <sup>3</sup> Ripple (mV)
<b>DDP/MDP400-US12-SC</b>	12	29.2 <sup>4</sup>	33.3	120	12	1	240	5	2	50
<b>DDP/MDP400-US24-SC</b>	24	14.6 <sup>4</sup>	16.7	240	12	1	240	5	2	50
<b>DDP/MDP400-US48-SC</b>	48	7.3 <sup>4</sup>	8.3	480	12	1	240	5	2	50

<sup>1</sup> The combined output power of V1, V2 and 5V<sub>SB</sub> for all models, when convection cooled and V<sub>IN</sub> ≥ 180 V<sub>RMS</sub>, must not exceed 350 W up to 50 °C, and 240 W at 70 °C ambient temperature. See de-rating curves below.

<sup>2</sup> The combined output power of V1, V2 and 5V<sub>SB</sub> for all models, when conduction cooled or convection cooled with heat sink mounted, must not exceed 400 W up to 50 °C, and 300 at 70 °C ambient temperature.

<sup>3</sup> Peak-to-Peak measured at 20 MHz Bandwidth.

<sup>4</sup> Convection / Conduction output current ratings, do refer to <50 °C ambient temperature and V<sub>IN</sub> ≥ 180 V<sub>RMS</sub>.

<sup>5</sup> In any case, the chassis hot spot temperature T<sub>C</sub> should never exceed 90 °C.

## INPUT SPECIFICATIONS

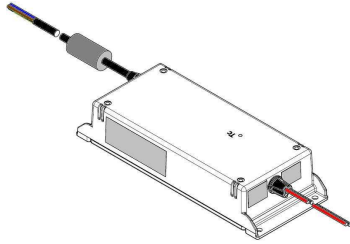
Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
<b>AC Input Voltage</b>	PS starts and operates at 90 V <sub>AC</sub> at all load conditions	90	100-240	264	V <sub>AC</sub>
<b>DC Input Voltage</b>		170	-	270	V <sub>DC</sub>
<b>Input Frequency</b>		47	50/60	440	Hz
<b>Input Current</b>	RMS at 180 V <sub>AC</sub> , maximum load	-	-	2.5	A
	RMS at 90 V <sub>AC</sub> , maximum load	-	-	5	A
<b>Inrush Current</b>	265 V <sub>AC</sub> , full load, cold start.	-	-	20	A
<b>Fusing</b>	2X Time Lag 6.3 A, 250 V on L and N	-	-	6.3	A
	230 V <sub>AC</sub> , From 50% to full load	-	94	-	
<b>Efficiency</b>	At 20% full load	-	90	-	%
	At 115 V <sub>AC</sub> , 20% rated load	-	90	-	
	At 100% load	-	92	-	
<b>Input Power Consumption</b>	Power on, 115-230 V <sub>RMS</sub> , no load	-	1	1.5	W
	Stand by, 115-230 V <sub>RMS</sub> , no load	-	0.5	-	
<b>Power Factor</b>	At full rated load, 115 V <sub>AC</sub> 60 Hz and 230 V <sub>AC</sub> 50 Hz input voltages	0.95	-	-	-
<b>Harmonic Current</b>	Complies with EN-61000-3-2 Class C at 230 V <sub>AC</sub> 50 Hz, >40 W load.				
<b>Fluctuations and Flicker</b>	Complies with EN-61000-3-3 at nominal voltages and full load.				
<b>Leakage Current</b>	Normal conditions, 240 V <sub>RMS</sub> , 60 Hz.	-	-	300	μA

## OUTPUT SPECIFICATIONS

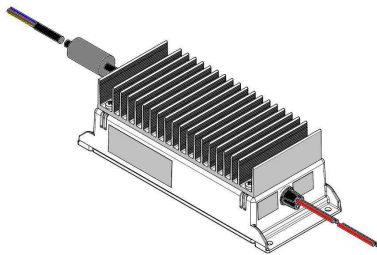
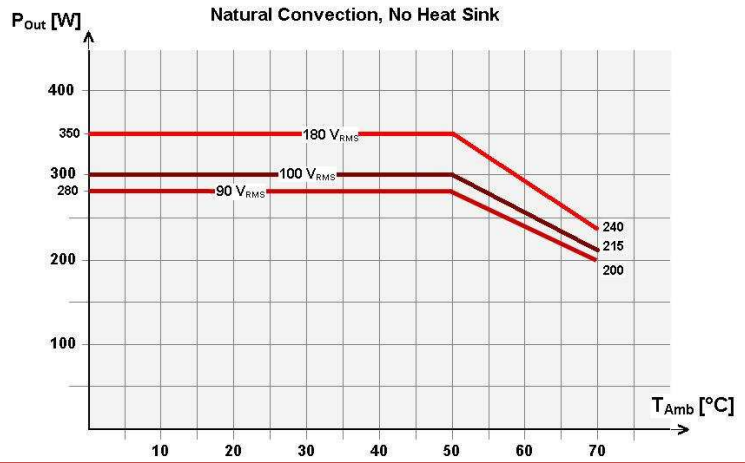
Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
<b>V1 Output Voltage</b>	12V	-	12	-	
	24V (0.5% set point accuracy)	-	24	-	V
	48V (0.5% set point accuracy)	-	48	-	
<b>V1 Output Power Rating</b>	All models, convection cooling	-	-	350	
	All models, conduction cooling / heat sink	-	-	400	W
	All models, peak power ( $\leq 10$ s)	-	-	440	
<b>V2 Output Voltage</b>	All versions.				
	Load on V2: from 5 to 1000 mA Load on V1: from 0.1 to 16.7 A	11.25	12.5	13.75	V
<b>V2 Output Current</b>	All models, convection/forced air cooling	-	-	1	A
<b>5V<sub>SB</sub> Output Voltage</b>	All models (3% set point accuracy)	-	5	-	V
<b>5V<sub>SB</sub> Output Current</b>	All models, convection cooling	-	-	1.5	
	All models, conduction cooling / heat sink	-	-	2	A
<b>V1 Voltage Adjustment Range</b>		$\pm 5$	-	-	%V1
<b>V1 Load-Line-Cross Regulation</b>	V <sub>AC</sub> : 90 – 264 V <sub>RMS</sub>				
	V1 Load: 0 – 33.3 A (12V) 0 – 16.7 A (24V) 0 – 8.3 A (48V)	-	-	$\pm 2$	%V1
	V2 Load: 0 – 1 A				
	5V <sub>SB</sub> Load: 0 – 2 A				
<b>5V<sub>SB</sub> Load-Line-Cross regulation</b>	V <sub>AC</sub> : 90 – 264 V <sub>RMS</sub>				
	V1 Load: 0 – 33.3 A (12V) 0 – 16.7 A (24V) 0 – 8.3 A (48V)	-	-	$\pm 5$	%5V <sub>SB</sub>
	V2 Load: 0 – 1 A				
	5V <sub>SB</sub> Load: 0 – 2 A				
<b>V1 Line Regulation</b>	V <sub>AC</sub> : 90 – 264 V <sub>RMS</sub>	-	-	$\pm 0.1$	%V1
	25% load changes at 1 A/ $\mu$ s				
<b>Transient Response (Voltage Deviation) V1, 5V<sub>SB</sub></b>	12V at 2200 $\mu$ F Load / I <sub>OUT</sub> > 0.5 A				%V1
	24 V at 1000 $\mu$ F Load / I <sub>OUT</sub> > 0.5 A	-	-	$\pm 5$	%5V <sub>SB</sub>
	48V at 560 $\mu$ F Load / I <sub>OUT</sub> > 0.5 A				
	5V <sub>SB</sub> at 560 $\mu$ F Load / I <sub>OUT</sub> > 0.1 A				
<b>V1 Ripple &amp; Noise</b>	All models, Peak-to-peak, 20 MHz BW. 100 nF ceramic and 10 $\mu$ F tantalum caps at the load.	-	-	1	%V1
<b>Start-up Rise Time</b>	90 < V <sub>IN</sub> < 264, any load conditions.	5	-	85	ms
<b>Start-up Delay</b>	V1 in regulation after PS_ON is asserted			200	
	V1 in regulation after AC is applied	-	-	750	ms
	5V <sub>SB</sub> in regulation after AC is applied			500	
<b>Turn-on Overshoot</b>	At 500 mA output current, V1 in regulation within 50 ms.	-	10	-	%V1
			10		%V2
			10		%V <sub>SB</sub>
<b>Hold-up Time</b>	At nominal V <sub>IN</sub> , 365 W, for all outputs	-	16	-	
	At nominal V <sub>IN</sub> , 350 W, for all outputs	-	20	-	ms
	At nominal V <sub>IN</sub> , 200 W, for all outputs	-	35	-	
<b>Minimum Load *</b>	All models; V1, V2 and 5V <sub>SB</sub>	0	-	-	A
<b>Maximum Load Capacitance</b>	At nominal V <sub>IN</sub> , 25 °C ambient				
	12 V	-	-	33000	$\mu$ F
	24 V	-	-	16000	
	48 V	-	-	8000	
<b>Temperature Drift</b>		-1.2	-	+1.2	mV/°C

\*- When the load on the main output is less than 100 mA, V2 output voltage might regulate below its minimum value. Contact ROAL Electronics for details.

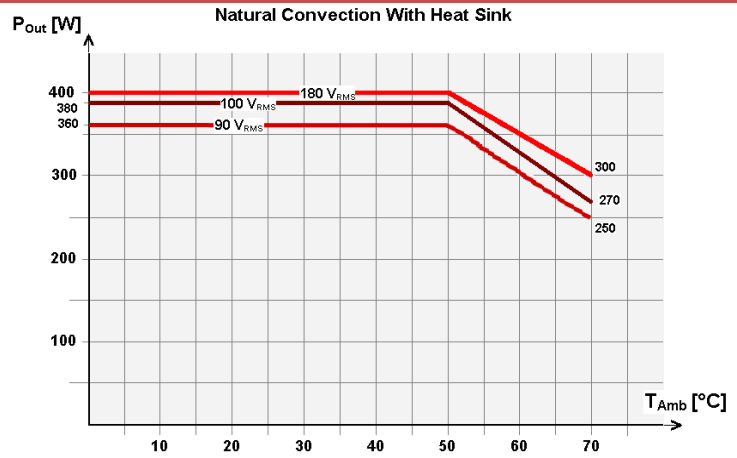
**Output Power De-rating Curves**



**Sealed Box w/o Heat Sink**  
DDP400-USxy-SC

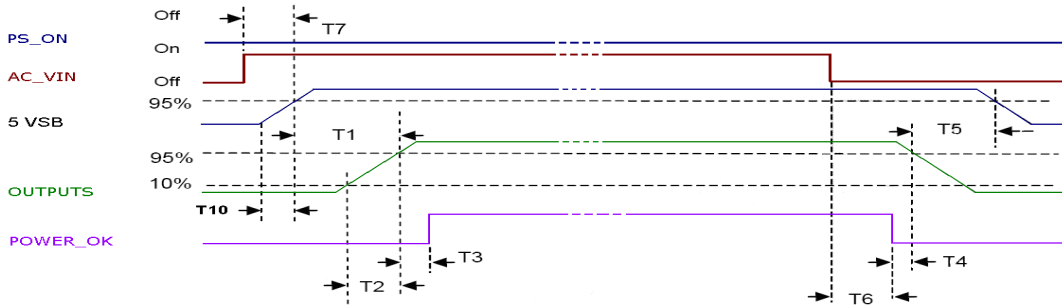


**Sealed Box w Heat Sink**  
DDP400-USxy-SC + DDP-HS



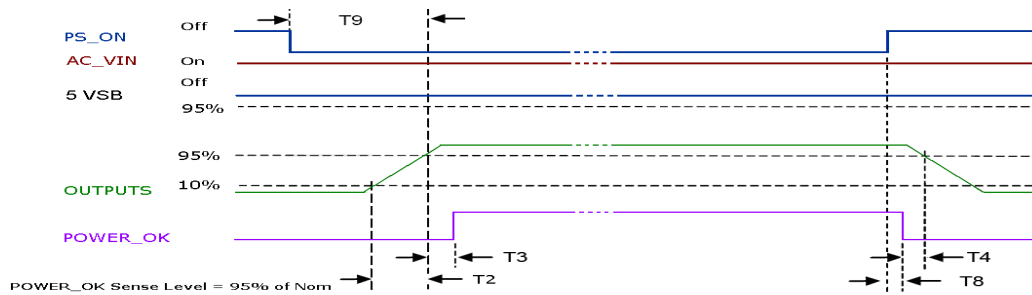
Signal	Notes	Min	Typ	Max	Unit
<b>PS_ON</b>	Active low, +5 V TTL signal compatible. Input low voltage	0	-	2.0	V
	Input high voltage ( $I_{IN} = 200 \mu A$ )	3.0	-	-	V
	V1 and V2 disabled when PS_ON is open				
	5V <sub>SB</sub> not affected by PS_ON				
<b>P_OK</b>	V1 and V2 enabled with PS_ON connected to RTN				
	+5 V TTL compatible				
	Logic level low (<10 mA sinking)	-	-	0.7	V
	Logic level high (100 $\mu A$ sourcing)	2.4	-	5	V
<b>5V<sub>SB</sub> output</b>	Low to high time after V1 in regulation	0.05	-	0.1	S
	Power down warning time	1	-	-	Ms
	Active and in regulation after a $90 < V_{AC} < 264$ is applied	-	-	200	Ms
	5V <sub>SB</sub> not affected by PS_ON				

## SIGNAL TIMINGS



### Above waveforms are expected with AC Input ON/OFF:

Standby on - Main outputs on	$50 \text{ ms} \leq T1 \leq 250 \text{ ms}$
Main output Rise Time	$5 \text{ ms} \leq T2 \leq 85 \text{ ms}$
5 VSB Rise Time	$4 \text{ ms} \leq T10 \leq 20 \text{ ms}$
Main outputs On - P_OK delay	$40 \text{ ms} \leq T3 \leq 100 \text{ ms}$
Power down warning <sup>1</sup>	$T4 \geq 1 \text{ ms}$
Main Output off - Standby off <sup>2</sup>	$T5 \geq 1.2 \text{ s}$
Hold-up time (AC off - P_OK low)	$T6 \geq 15 \text{ ms (115/ 230 VAC)}$
AC_ON - Standby turn on time	$T7 \leq 500 \text{ ms}$



### Above waveforms are expected with PS\_ON Signal ON/OFF state change:

Main Output Rise Time	$5 \text{ ms} \leq T2 \leq 85 \text{ ms}$
Main Outputs on - P_OK delay	$50 \text{ ms} \leq T3 \leq 100 \text{ ms}$
Power down warning <sup>1</sup>	$1 \text{ ms} \leq T4 \leq 5 \text{ ms}$
PS_ON - Main Output (off) Timing	$T8 \leq 1 \text{ ms}$
PS_ON - Main Output (on) Timing	$T9 \leq 200 \text{ ms}$

<sup>1</sup> T4 parameter measurement setup will assume at least 10% of the maximum load on each output.

<sup>2</sup> T5 parameter measurement setup will assume at least 50% of the maximum load on main output.

## PROTECTION FEATURES

Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
<b>Input Under Voltage Lockout</b>	Auto Recovery, Hiccup Mode	60	75	-	V <sub>AC</sub>
<b>Input Fuse</b>	2X Time Lag 6.3 A, 250 V on L and N	-	-	6.3	A
<b>Over Current</b>	At nominal input voltages. V1: Hiccup mode, auto-recovery. V2: PTC limiting, auto-recovering. 5 VSB: Hiccup mode, auto-recovering.	110	-	150	%I <sub>1MAX</sub>
<b>Short Circuit</b>	At nominal input voltages. V1: Hiccup mode, auto-recovery. V2: PTC limiting, auto-recovering 5 VSB: Hiccup mode, auto-recovering.	-	-	-	
<b>Over Voltage</b>	12V 24V 48V 5V <sub>SB</sub> Unit shut down and latch off	110	-	136	%V <sub>NOM</sub>
<b>Over Temperature (on primary stage)</b>	Shut down, latch off.	-	-	-	
<b>Over Temperature (on secondary side)</b>	Hiccup mode with auto recovery	-	-	-	
<b>Isolation Primary to Secondary</b>	Reinforced	4000	-	-	V <sub>AC</sub>
<b>Isolation Input to Earth</b>	Basic	1500	-	-	V <sub>AC</sub>
<b>Isolation V1 to V2</b>		100	-	-	V <sub>DC</sub>
<b>Isolation Output to Earth</b>		500	-	-	V <sub>DC</sub>

## ENVIRONMENTAL SPECIFICATIONS

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
<b>Operating Temperature Range</b>	No de-rating up to 50°C PS starts up at -30 °C	-20	-	50	°C
<b>De-rated Operating Temperature Range</b>	Convection cooling: Linearly de-rate from 350 W at 50 °C, to 240 W at 70 °C Conduction cooling / heat sink: Linearly de-rate from 400 W at 50 °C, to 300 W at 70 °C. See graphs above.	-	-	70	°C
<b>Storage Temperature Range</b>		-40	-	85	°C
<b>Humidity</b>	RH, Non-condensing Operating Non-operating	-	-	90 95	% %
<b>Operating Altitude</b>		-	-	4000	m
<b>Shock</b>	<b>EN 60068-2-27</b> Operating: Half sine, 30 g, 18 ms, 3 axes, 6x each (3 positive and 3 negative). Non-Operating: Half sine, 50 g, 11 ms, 3 axes, 6x each (3 positive and 3 negative).				
<b>Vibration</b>	<b>EN 60068-2-64</b> Operating: Sine, 10 – 500 Hz, 1 g, 3 axes, 1 oct/min., 60 min. Random, 5 – 500 Hz, 0.02 g <sup>2</sup> /Hz, 1 g <sub>RMS</sub> , 3 axes, 30 min. Non-Operating: 5 – 500 Hz, 2.46 g <sub>RMS</sub> (0.0122 g <sup>2</sup> /Hz), 3 axes, 30 min.				
<b>MTBF</b>	Full Load, 120 V <sub>AC</sub> , 50 °C ambient 70% Duty cycle, Telcordia Issue 1	4000000	-	-	Hours
<b>Useful Life</b>	Low line range, 200 W, 40 °C ambient, natural convection.	-	4	-	Years
<b>Cooling</b>	Convection with or without heat sink and conduction providing an adequate thermal path between the unit and the external environment. Case hot spot temperature, T <sub>c</sub> , should not exceed 90 °C in any working condition.				

## ELECTROMAGNETIC COMPATIBILITY (EMC) - EMISSIONS

Phenomenon	Conditions / Notes	Standard	Equipment/Performance Class
<b>Conducted</b>	115 V <sub>RMS</sub> , 230 V <sub>RMS</sub> . Maximum load. 4 dB minimum margin	EN 55022 (ITE) EN 55011 (ISM) EN 60601-1-2 (Medical)	B
<b>Radiated</b>	At 10 m distance	EN 55022 (ITE) EN 55011 (ISM) EN 60601-1-2 (Medical)	B
<b>Line Voltage Fluctuation and Flicker</b>	At 20%, 50% and 100% maximum load. Nominal input voltages.	EN 61000-3-3	
<b>Harmonic Current Emission</b>	Nominal input voltages. All load conditions > 40 W.	EN 61000-3-2	C

## ELECTROMAGNETIC COMPATIBILITY (EMC) - IMMUNITY

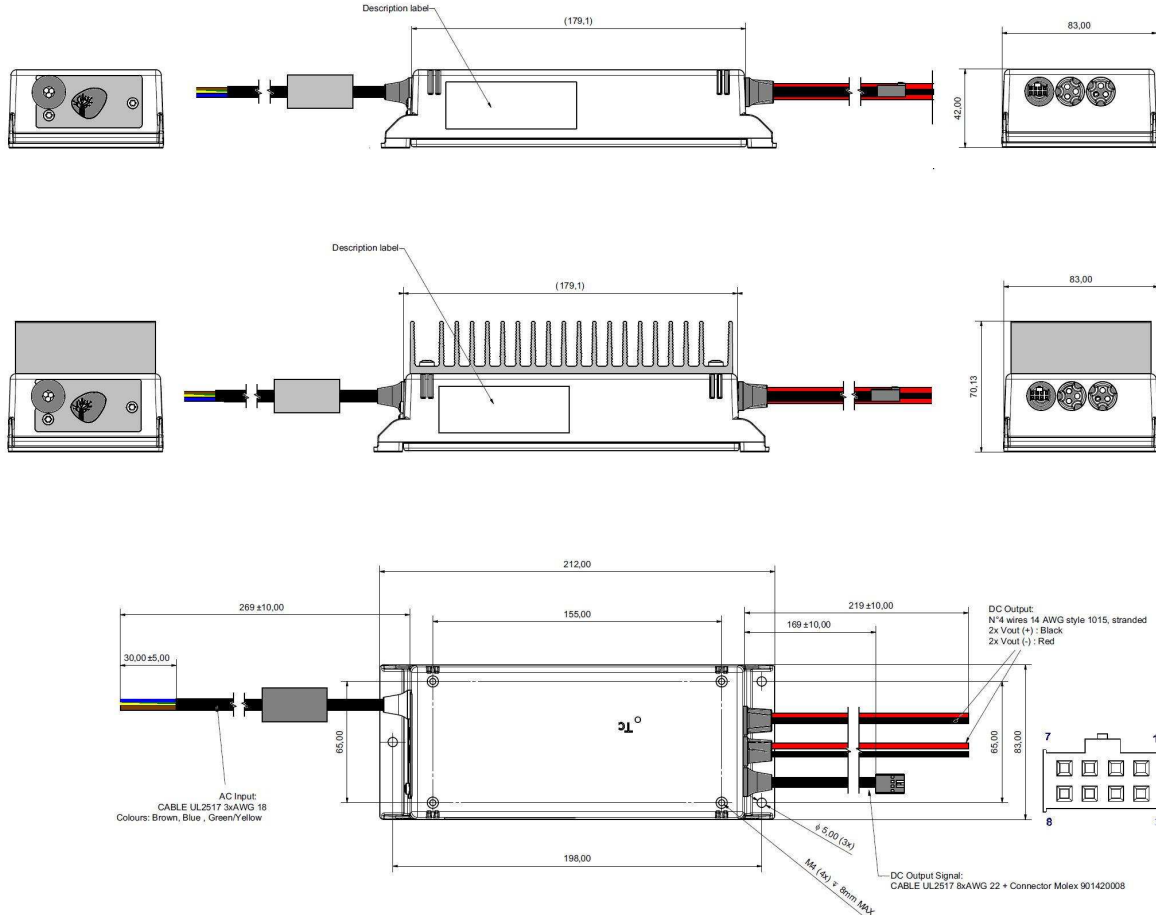
Phenomenon	Conditions / Notes	Standard	Test Level	Performance criteria
	<b>Reference standard for the medical version</b>	<b>EN 60601-1-2</b>		
<b>ESD</b>	15 kV air discharge, 8 kV contact, at any point of the system.	EN 61000-4-2	4	A
<b>Radiated Field</b>	3 V/m, 80-1000 MHz, 1 KHz/2 Hz 80% AM. Dwell time is 3 sec for 2 Hz modulation Dwell time is 1 sec for 1KHz modulation	EN 61000-4-3	3	A
<b>Electric Fast Transient Surge</b>	±2 kV on AC power port for 1 minute; ±1 kV on signal/control lines	EN 61000-4-4	3	A
<b>Conducted RF Immunity</b>	± kV2 line to line; ± 4 KV line to earth on AC power port; ±0.5 kV for outdoor cables	EN 61000-4-5	3	A
<b>Dips and Interruptions</b>	3 V <sub>RMS</sub> , 0,15-80 MHz, 1 KHz/2 Hz 80% AM	EN 61000-4-6	3	A
	Dip to 30% for 5 cycle (10 ms)	EN61000-4-11		A
	Dip to 40% for 5 cycles (100 ms)	EN61000-4-11		B
	Dip to 70% for 25 cycles (500 ms)	EN61000-4-11		B
	Drop-out to 5% for 10 ms	EN61000-4-11		B
	Interrupts > 95% for 5 s	EN61000-4-11		C

## SAFETY AGENCIES APPROVAL

Certification Body	Safety Standards and file numbers	Category
<b>CSA/UL</b>	CSA C22.2 No. 60950-1, UL 60950-1; 2007, 2 <sup>nd</sup> edition	Information Technology Eq.
	CSA C22.2 No.601.1, ANSI/AAMI ES60601-1 3 <sup>rd</sup> edition	Medical
<b>IEC IECEE CB Certification</b>	IEC/EN 60950-1 2 <sup>nd</sup> edition	Information Technology Eq.
	IEC/EN 60601-1 3 <sup>rd</sup> edition	Medical
<b>CE</b>	Low Voltage Directive (LDV) 2006/95/EC	Information Technology Eq.
	Low Voltage Directive (LDV) 2007/47/EC MDD	Medical

## OUTLINE DRAWING AND CONNECTIONS

Overall dimensions: (83.0 X 212.0 X 42.0/70.1) mm; (3.27 X 8.34 X 1.65/2.76) in  
 Weight: 1300 (1665) g; 2.87 (3.67) lb



Connections	Wires Gauge and Length	Assignment	Colour / Pin
<b>AC Input</b>	3X 18AWG, black external insulation, 300V, 105°C, UL2517 cord, 310 ± 10 mm extension from grommet.	Live (L)	Brown
		Neutral (N)	Blue
		Protective Earth (PE)	Green Yellow
<b>DC Output</b>	12 V version: 6X 14AWG, Style 1015, 600V, 105°C, 260±10 mm	3X (2X) +V1 Output (+V1)	Red
	24, 48 V versions: 4X 14AWG, Style 1015, 600V, 105°C, 260±10 mm	3X (2X) V1 Return (RTN)	Black
<b>Auxiliary Voltages Control Signals</b>	Wires: 8X 22AWG, black external insulation, 300V, 105°C, UL2517 cord, 220 ± 10 mm extension from grommet to connector.  Housed by Connector: Molex 90142-0008 Terminals: Molex 90119-0109 (Tin plating)  Mates with Molex 90130-1106 or equivalent. Terminals: Tin plating termination	+5 V Stand-by Output (+5V <sub>SB</sub> )	Red / 1
		Output Power Good (P_OK)	Green / 2
		- Fan Voltage (-V2)	Brown / 3
		Remote On/Off (PS_ON)	Grey / 4
		+ Terminal Remote Sense (+RS)	Yellow / 5
		Stand-by/Signals Return (RTN)	Blue / 6
		+ Fan Voltage (+V2)	White / 7
		Stand-by/Signals Return (RTN)	Black / 8

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