COMPACT, EFFICIENT, SEALED, 400 W AC-DC POWER SUPPLY
ITE AND MEDICAL RATED DDP/MDP400 SC SERIES

DS_DDP-MDP400 SC SERIES REV03 _ JULY 2015

DESCRIPTION

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

The series provide a steady 400 W of regulated DC power through the full 90 to 264 V_{AC} input range. A 3.27" x 8.34" x 1.65" form factor, enable designers to integrate it into 1U applications.

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

Both the DDP and MDP SC series are available in four standard output voltages: 12, 24, 36, 48 $V_{DC,}$ offer an auxiliary 12 V_{DC} and a stand-by 5 V_{DC} outputs. Available control signals include Power Good (Power_OK), remote On/off (PS_ON) and remote sense (+RS).

The sealed and full potted package allows an 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 – 30 °C.

Protection features do include fuse on each AC lines, input under-voltage lockout (IUV), output over-current (OC), output short-circuit (SC), output over-voltage (OV) and over-temperature (OT).

The MDP400 range comply with the 3rd edition of the UL/IEC 60601-1 safety standards for medical equipment offering 2x MoPP protection grade and the DDP400 range comply with the 2nd 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.

KEY FEATURES

- 90 – 264 V_{AC} Universal input voltage range
- 400 W rated power (440 W peak for <10s)
- High efficiency (94% typical)
- Low stand-by consumption (<0.5 W)
- 12, 24, 36 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, 2 A; Auxiliary fan +12 V, 1 A
- Remote On/off and power good signals
- ANSI/AAMI ES60601-1 3rd ed. compliant
  IEC/EN/UL 60601-1 2nd/3rd ed. compliant
- 2x MoPP protection grade
- RoHS 2 compliant (Directive 2011/65/EU)
- 4000 m altitude operation without de-rating

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

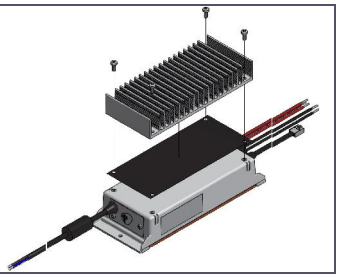
Model Grade and Output Power	Output Nominal Voltage	Package/Fan Options	Medical protection grade
ITE: **DDP400-** *Medical:* **MDP400-**	*12 V_{DC}:* **US12-** *24 V_{DC}:* **US24-** *36 V_{DC}:* **US36-** *48 V_{DC}:* **US48-**	*Sealed Conduction/Convection Cooling:* **SC-**	*Means of Patient Protection* **PP** *(Only applicable on medical range)*

D **DP400** **M**	**-**	**US** **12** **24** **36** **48**	**-**	**SC**	**-**	**PP**

Heat sink can be ordered as an accessory using the code:

DDP-HS

Mounting kit includes 4X screws, M4x10, and the thermally conductive graphite sheet



Model Number	V1 [V]	I1 [1] Convection No heat sink (A)	I1 [2] Conduction Heat sink (A)	V1 [3] Ripple (mV)	V2 (V)	I2 [1] Rated (A)	V2 [3] Ripple [mV]	5V_{SB} (V)	I5V_{SB} [1] Rated (A)	5V_{SB} [3] Ripple (mV)
DDP/MDP400-US12-SC (-PP)	12	29.2 [4]	33.3	120	12	1	240	5	2	50
DDP/MDP400-US24-SC (-PP)	24	14.6 [4]	16.7	240	12	1	240	5	2	50
DDP/MDP400-US36-SC (-PP)	36	9.7 [4]	11.1	360	12	1	240	5	2	50
DDP/MDP400-US48-SC (-PP)	48	7.3 [4]	8.3	480	12	1	240	5	2	50

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

[2] The combined output power of V1, V2 and 5V_{SB} 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.

[3] Peak-to-Peak measured at 20 MHz Bandwidth.

[4] Convection / Conduction output current ratings, do refer to <50 °C ambient temperature and V_{IN} ≥ 180 V_{RMS}.

[5] In any case, the chassis hot spot temperature T_C should never exceed 90 °C.

Input Specifications

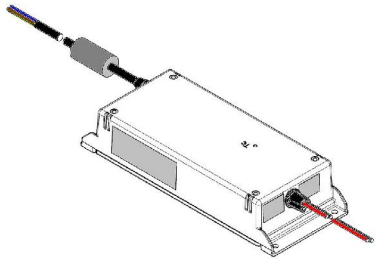
Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
AC Input Voltage	PS starts and operates at 90 V_{AC} at all load conditions	90	100-240	264	V_{AC}
DC Input Voltage		170	-	270	V_{DC}
Input Frequency		47	50/60	440	Hz
Input Current	RMS at 180 V_{AC}, maximum load RMS at 90 V_{AC}, maximum load	-	-	2.5 5	A
Inrush Current	265 V_{AC}, full load, cold start.	-	-	20	A
Fusing	2X Time Lag 6.3 A, 250 V on L and N	-	-	6.3	A
Efficiency	230 V_{AC}, From 50% to full load At 20% full load At 115 V_{AC}, 20% rated load At 100% load	- - - -	94 90 90 92	- - - -	%
Input Power Consumption	Power on, 115-230 V_{RMS}, no load Stand by, 115-230 V_{RMS}, no load	- -	1 0.4	1.5 0.5	W
Power Factor	At full rated load, 115 V_{AC} 60 Hz and 230 V_{AC} 50 Hz input voltages	0.95	-	-	-
Harmonic Current Fluctuations and Flicker	Complies with EN-61000-3-2 Class C at 230 V_{AC} 50 Hz, >50 W load. Complies with EN-61000-3-3 at nominal voltages and full load.				
Leakage Current	Normal conditions, 240 V_{RMS}, 60 Hz.	-	-	300	µA

OUTPUT SPECIFICATIONS

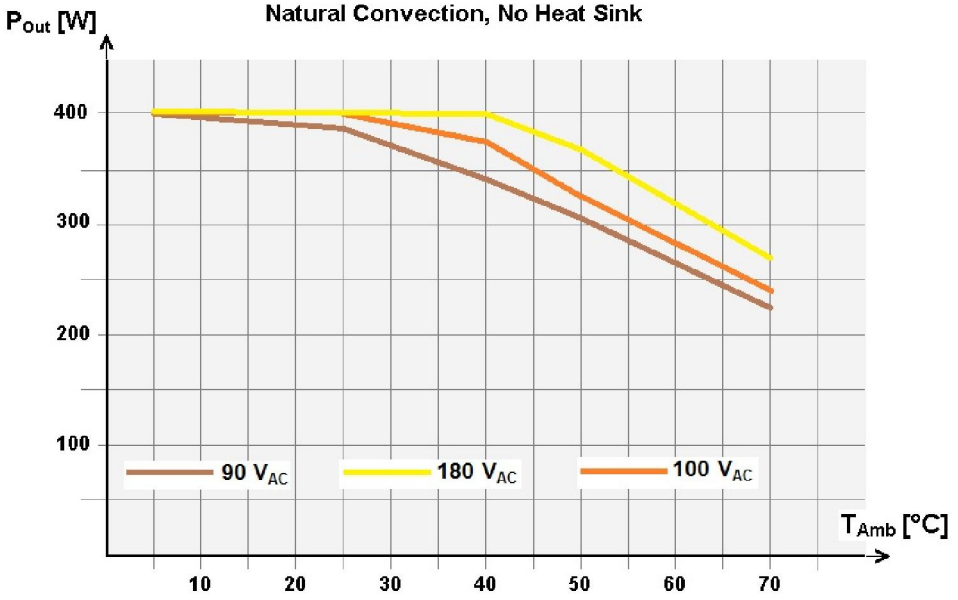
Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
V1 Output Voltage	12V 24V 36V 48V ±0.5% set point accuracy on all outputs	- - - -	12 24 36 48	- - - -	V
V1 Output Power Rating	All models, convection cooling All models, conduction cooling / heat sink All models , peak power (≤ 10 s)	- - -	- - -	350 400 440	W
V2 Output Voltage	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
V2 Output Current	All models, convection/forced air cooling	-	-	1	A
$5V_{SB}$ Output Voltage	All models (3% set point accuracy)	-	5	-	V
$5V_{SB}$ Output Current	All models, convection cooling All models, conduction cooling / heat sink	- -	- -	1.5 2	A
V1 Voltage Adjustment Range		±5	-	-	%V1
V1 Load-Line-Cross Regulation	V_{AC}: 90 – 264 V_{RMS} V1 Load: 0 – 33.3 A (12V) 0 – 16.7 A (24V) 0 – 11.1 A (36V) 0 – 8.3 A (48V) V2 Load: 0 – 1 A $5V_{SB}$ Load: 0 – 2 A	-	-	±2	%V1
$5V_{SB}$ Load-Line-Cross regulation	V_{AC}: 90 – 264 V_{RMS} V1 Load: 0 – 33.3 A (12V) 0 – 16.7 A (24V) 0 – 11.1 A (36V) 0 – 8.3 A (48V) V2 Load: 0 – 1 A $5V_{SB}$ Load: 0 – 2 A	-	-	±5	%$5V_{SB}$
V1 Line Regulation	V_{AC}: 90 – 264 V_{RMS}	-	-	±0.1	%V1
Transient Response (Voltage Deviation) V1, $5V_{SB}$	25% load changes at 1 A/µs 12V at 2200 µF Load / I_{OUT}> 0.5 A 24 V at 1000 µF Load / I_{OUT}> 0.5 A 36 V at 820 µF Load / I_{OUT}> 0.5 A 48V at 560 µF Load / I_{OUT}> 0.5 A $5V_{SB}$ at 560 µF Load / I_{OUT}> 0.1 A	-	-	±5	%V1 %$5V_{SB}$
V1 Ripple & Noise	All models, Peak-to-peak, 20 MHz BW. 100 nF ceramic and 10 µF tantalum caps at the load.	-	-	1	%V1
Start-up Rise Time	90<V_{IN}<264, any load conditions.	5	-	85	ms
Start-up Delay	V1 in regulation after PS_ON is asserted V1 in regulation after AC is applied $5V_{SB}$ in regulation after AC is applied	-	-	200 750 500	ms
Turn-on Overshoot	At 500 mA output current, V1 in regulation within 50 ms.	-	10 10 10	-	%V1 %V2 %V_{SB}
Hold-up Time	At nominal V_{IN}, 400 W, for all outputs At nominal V_{IN}, 365 W, for all outputs At nominal V_{IN}, 200 W, for all outputs	- - -	16 20 35	- - -	ms
Minimum Load *	All models; V1, V2 and $5V_{SB}$	0	-	-	A
Maximum Load Capacitance	At nominal V_{IN}, 25 °C ambient 12V 24V 36V 48V	- - - -	- - - -	33000 16000 10000 7000	µF
Temperature Drift		-1.2	-	+1.2	mV/°C

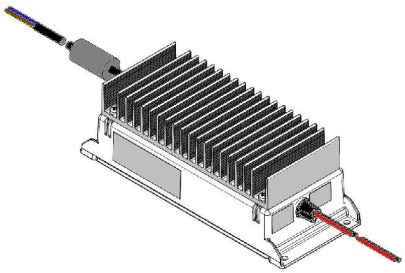
*- When the load on the main output is less than 100 mA, V2 output voltage might regulate below its minimum value. Contact ROAL Electronics for details.

Output Power De-rating Curves

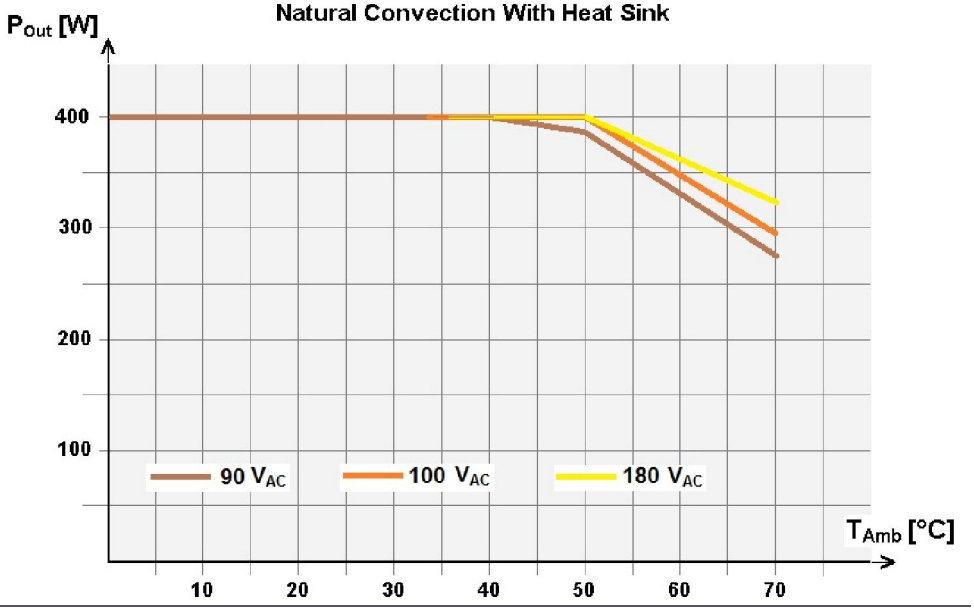


Sealed Box w/o Heat Sink
DDP400–USxy–SC





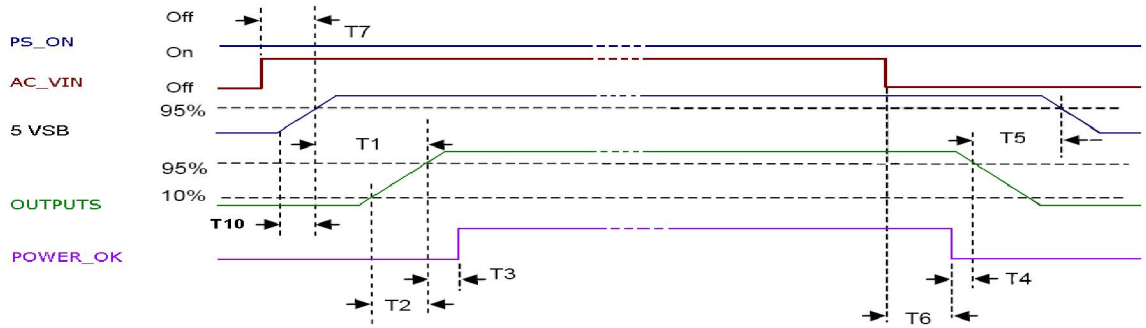
Sealed Box w Heat Sink
DDP400–USxy–SC + DDP-HS



Signals / Controls

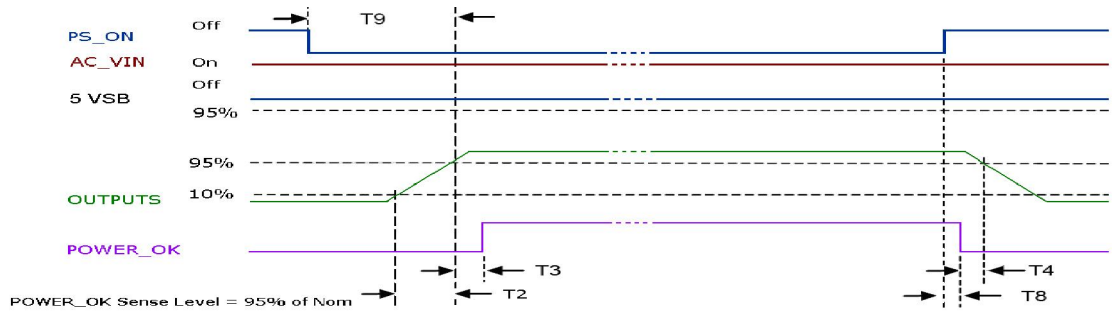
Signal	Notes	Min	Typ	Max	Unit
PS_ON	Active low, +5 V TTL signal compatible. Input low voltage	0	-	2.0	V
	Input high voltage (I_{IN}= 200 µA)	3.0	-	-	V
	V1 and V2 disabled when PS_ON is open				
	$5V_{SB}$ not affected by PS_ON				
	V1 and V2 enabled with PS_ON connected to RTN				
P_OK	+5 V TTL compatible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

Signal Timings



Above waveforms are expected with AC Input ON/OFF:

Standby on - Main outputs on	50 ms ≤ T1 ≤ 250 ms
Main output Rise Time	5 ms ≤ T2 ≤ 110 ms
5 VSB Rise Time	4 ms ≤ T10 ≤ 20 ms
Main outputs On – P_OK delay	25 ms ≤ T3 ≤ 100 ms
Power down warning[1]	T4 ≥ 1 ms
Main Output off – Standby off[2]	T5 ≥ 1.2 s
Hold-up time (AC off – P_OK low)	T6 ≥ 15 ms (115/ 230 VAC)
AC_ON - Standby turn on time	T7 ≤ 500 ms



Above waveforms are expected with PS_ON Signal ON/OFF state change:

Main Output Rise Time	5 ms ≤ T2 ≤ 110 ms
Main Outputs on – P_OK delay	25 ms ≤ T3 ≤ 100 ms
Power down warning[1]	1 ms ≤ T4 ≤ 5 ms
PS_ON - Main Output (off) Timing	T8 ≤ 1 ms
PS_ON - Main Output (on) Timing	T9 ≤ 200 ms

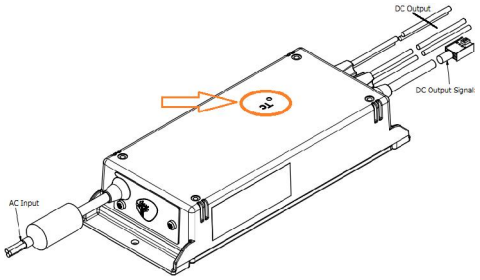
[1] T4 parameter measurement setup will assume at least 10% of the maximum load on each output.
[2] T5 parameter measurement setup will assume 50% of the maximum load on $5V_{SB}$.

Protection Features

Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
Input Under Voltage	Auto-recovering, hiccup mode.	60	75	-	V_{AC}
Input Fuse	2X Time Lag 6.3 A, 250 V on L and N	-	-	6.3	A
Over Current	At nominal input voltages. V1: Hiccup mode. auto-recovering. V2: PTC limiting, auto-recovering. $5V_{SB}$: Hiccup mode, auto-recovering.	110	-	155	$\%I1_{MAX}$
Short Circuit	At nominal input voltages. V1: Hiccup mode. auto-recovering. V2: PTC limiting, auto-recovering. $5V_{SB}$: Hiccup mode, auto-recovering.	-	-	-	
Over Voltage	12V 24V 48V $5V_{SB}$ Shut down, latch-off.	110	-	136	$\%V_{NOM}$
Over Temperature (on primary stage)	Shut down, latch off.	-	-	-	
Over Temperature (on secondary side)	Hiccup mode, auto-recovering.	-	-	-	
Isolation Primary to Secondary	Reinforced (2x MoPP)	5660 4000	- -	- -	V_{DC} V_{AC}
Isolation Input to Earth	Basic (1x MoPP)	1500			V_{AC}
Isolation V1 to V2	Functional	100	-	-	V_{DC}
Isolation Output to Earth	Basic (1x MoPP)	1500	-	-	V_{AC}

Environmental Specifications

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
Operating Temperature Range	PS starts up at -30 °C See graphs above for output power de-rating against ambient temperature and input voltage.	-20	-	70	°C
Storage Temperature Range		-40	-	85	°C
Humidity	RH, Non-condensing Operating Non-operating	-	-	90 95	% %
Operating Altitude		-	-	4000	m
Shock	**EN 60068-2-27** 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).				
Vibration	**EN 60068-2-64** Operating: Sine,10 – 500 Hz, 1 g, 3 axes, 1 oct/min., 60 min. Random, 5 – 500 Hz, 0.02 g^2/Hz, 1 g_{RMS}, 3 axes, 30 min. Non-Operating: 5 – 500 Hz, 2.46 g_{RMS} (0.0122 g^2/Hz), 3 axes, 30 min.				
MTBF	Full Load, 120 V_{AC}, 50 °C ambient 70% Duty cycle, Telcordia Issue 1	400000	-	-	Hours
Useful Life	Low line range, 200 W, 40 °C ambient, natural convention.	-	4	-	Years
Cooling	Convection with or without heat sink and conduction providing an adequate thermal path between the unit and the external environment. Case hot spot temperature, Tc, should not exceed 90 °C in any working condition.				



Electromagnetic Compatibility (EMC) – Emissions

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

Electromagnetic Compatibility (EMC) – Immunity

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

Safety Agencies Approval

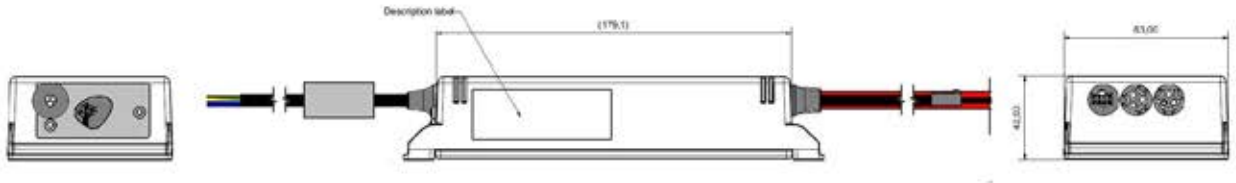
Certification Body	Safety Standards and file numbers	Category
CSA/UL	CSA C22.2 No. 60950-1, UL 60950-1; 2007, 2nd edition	Information Technology Eq.
	CSA C22.2 No.601.1, ANSI/AAMI ES60601-1 3rd edition	Medical
IEC IECEE CB Certification	IEC/EN 60950-1 2nd edition	Information Technology Eq.
	IEC/EN 60601-1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

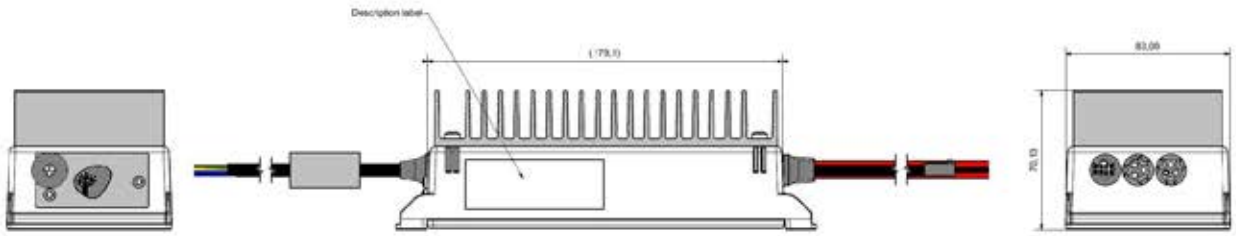
ROAL
LIVING ENERGY

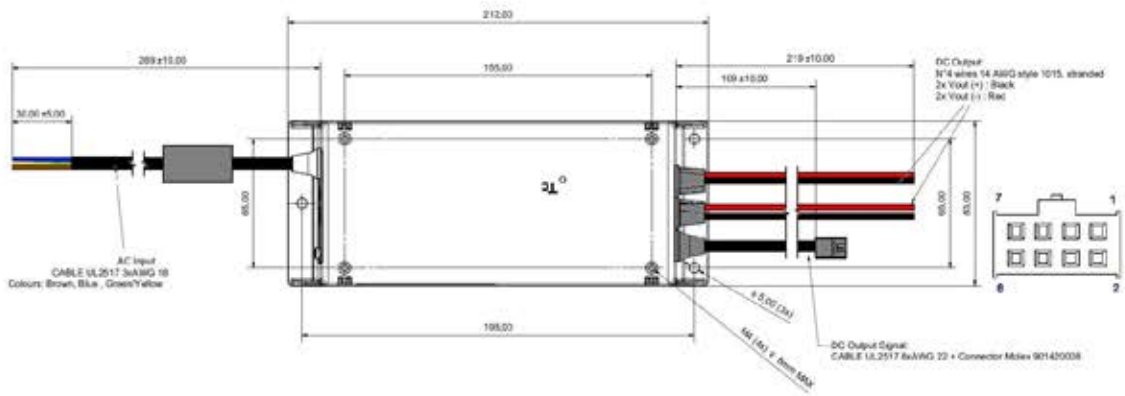
OUTLINE DRAWING AND CONNECTIONS

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







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Connections	Wires Gauge and Length	Assignment	Colour/Pin
AC Input	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
DC Output	12 V version: 6X 14AWG, Style 1015, 600V, 105°C, 260±10 mm 24, 48 V versions: 4X 14AWG, Style 1015, 600V, 105°C, 260±10 mm	3X (2X) +V1 Output (+V1)	Red
		3X (2X) V1 Return (RTN)	Black
Auxiliary Voltages Control Signals 	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 (+$5V_{SB}$)	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