Main Features

- Universal input voltage range (90 – 305 V_{AC})
- Input surge current limiting (< 20 A)
- 340 W at natural convection, 460 W forced air cooling, 520 W temporary (10 s)
- Open frame, 3 x 5" industrial standard footprint
- High efficiency up to 94.5%
- 24, 48 and 56 V_{DC} standard output voltages
- Low stand-by consumption (<0.35 W)
- Active PFC, EN61000-3-2 compliant (Class C, >20% load)
- Low earth / touch leakage current (<250 / 100 µA)
- Over temperature, OV, OC and SC protections.
- Stand by +5 V, 1 A output.
- Remote On / Off signal
- Power good and remote sense signals
- Medical IEC 60601-1 3rd edition certified, 2x MoPP rated and BF appliances compatible.
- IEC 60601-1-2 4th edition EMC compliant.
- RoHS 3 compliant (Directive EU 2015/863)
- Compatible with 5000 m altitude operation
- Protective cage option available

Description

The MDP520 series of medical grade AC-DC power supplies provide the compact form factor and high efficiency that the marketplace demands.

The series can provide 460 W of regulated DC power and 520 W peak operating over 90 to 305 V_{AC} input voltage range, in a 3.0 x 5.0 x 1.51" form factor. The MDP520 series comes in an open frame compact package to facilitate system integration and thermal management in space constraint and closed environments, thanks also to its 94% high efficiency which generate less heat.

The series comes in 24, 48 and 56 V_{DC} standard output voltages with additional 12, or 36 V_{DC} output voltages variants which will be available upon business case evaluation. It offers a +5 V_{DC} stand-by output capable of 1 A. Available control signals include Power Good (P_OK), Remote On / Off (PS_Inhibit) and Sense terminals (RS^+).

The series can be operated over the -40 to 70 °C ambient temperature range with output power derating factor applied above 50 °C and below -20 °C start up.

Protection features include slow blow fuses on both AC lines, input under voltage lockout (IUV), output over-current (OC), output short-circuit (SC), output over-voltage (OV) and over-temperature (OT).

The MDP520 Free Air series complies with the 3rd edition of the IEC60601-1 and ANSI/AAMI ES/EN 60601-1 safety standards for medical equipment requiring 2x MoPP protection grade. It is suitable for BF rated medical equipment under specific conditions.

The MDP520 Free Air series meets the EN 60601-1-2 EMC limits of Class B for conducted and radiated emissions as well as the IEC/EN61000-3 for flicker and harmonics content. It also meets the IEC 60601-1-2 4th edition for EMC immunity.

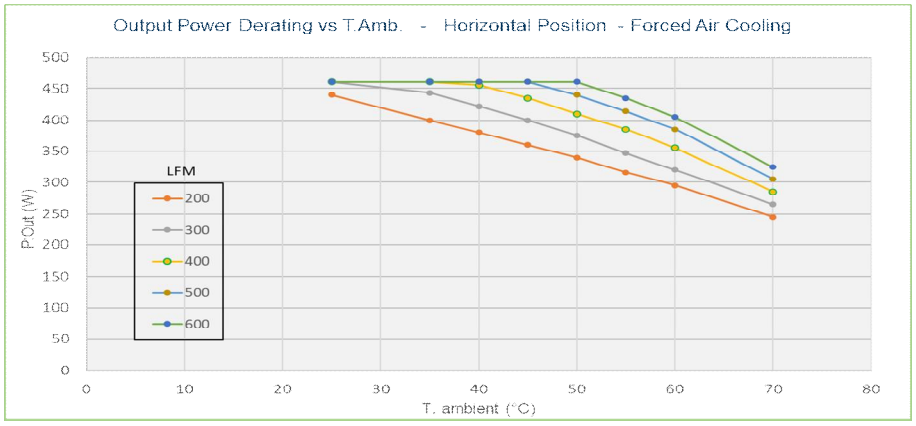
Market Segments and Applications

- Diagnostic Equipment
- Dialysis Equipment
- Surgical Device
- Monitoring Devices
- Hospital Beds
- Ultrasound / EM Therapy Devices
- Imaging Equipment
- Clinical Analyzer
- Ventilator
- Home health Care

MODEL CODING AND OUTPUT RATINGS

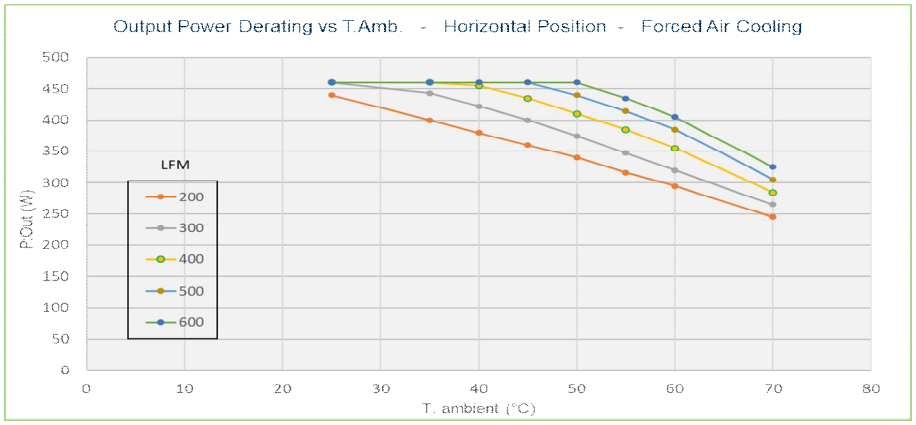
Model Code	V_{OUT} Nominal [V_{DC}]	V_{AC} Range [V]	I_{OUT} [A]	I_{SB} [A]	Cooling Mode	Max Combined Output Power [W]
MDP520-US12-OF	12	≥90	TBD	1.0	Natural Convection	TBD
		≥100	TBD	1.0		TBD
		≥180	TBD	1.0		TBD
		90-305	TBD	1.0	> 600 LFM forced air	TBD
MDP520-US12-PC	12	≥90	TBD	1.0	Natural Convection	TBD
		≥100	TBD	1.0		TBD
		≥180	TBD	1.0		TBD
		90-305	TBD	1.0	> 600 LFM forced air	TBD
MDP520-US24-OF	24	≥90	14.1	1.0	Natural Convection	340
		≥100	15	1.0		360
		≥180	17.3	1.0		415
		90-305	19.2	1.0	> 600 LFM forced air	460
MDP520-US24-PC	24	≥90	14.1	1.0	Natural Convection	310
		≥100	15	1.0		340
		≥180	17.3	1.0		390
		90-305	19.2	1.0	> 600 LFM forced air	460
MDP520-US36-OF	36	≥90	TBD	1.0	Natural Convection	TBD
		≥100	TBD	1.0		TBD
		≥180	TBD	1.0		TBD
		90-305	TBD	1.0	> 600 LFM forced air	TBD
MDP520-US36-PC	36	≥90	TBD	1.0	Natural Convection	TBD
		≥100	TBD	1.0		TBD
		≥180	TBD	1.0		TBD
		90-305	TBD	1.0	> 600 LFM forced air	TBD
MDP520-US48-OF	48	≥90	7.1	1.0	Natural convection	340
		≥100	7.5	1.0		360
		≥180	9.6	1.0		460
		90-305	9.6	1.0	>600 LFM forced air	460
MDP520-US48-PC	48	≥90	7.1	1.0	Natural convection	310
		≥100	7.5	1.0		340
		≥180	9.6	1.0		390
		90-305	9.6	1.0	>600 LFM forced air	460
MDP520-US56-OF	56	≥90	6.25	1.0	Natural convection	350
		≥100	6.6	1.0		370
		≥180	8.2	1.0		460
		90-305	8.2	1.0	>600 LFM forced air	460
MDP520-US56-PC	56	≥90	6.25	1.0	Natural convection	310
		≥100	6.6	1.0		340
		≥180	8.2	1.0		390
		90-305	8.2	1.0	>600 LFM forced air	460

OUTPUT POWER DERATING CURVES



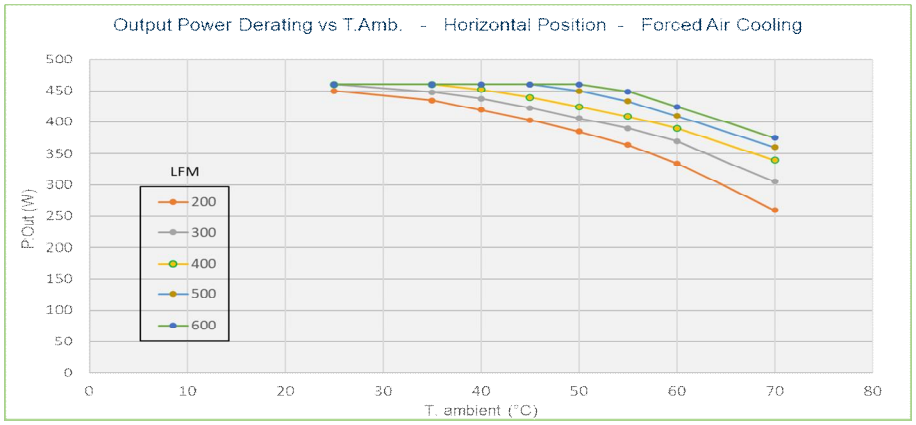
V_{OUT}: 24 V_{DC}

V_{IN}: ≥90V_{AC}



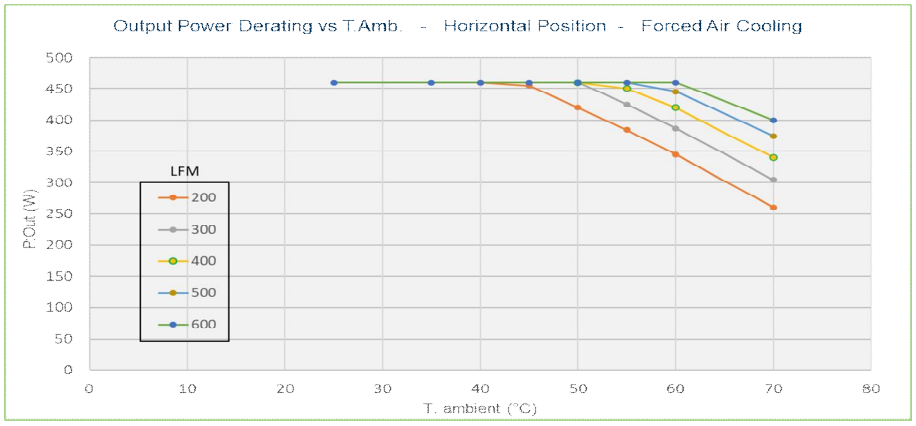
V_{OUT}: 48, 56 V_{DC}

V_{IN}: ≥90V_{AC}



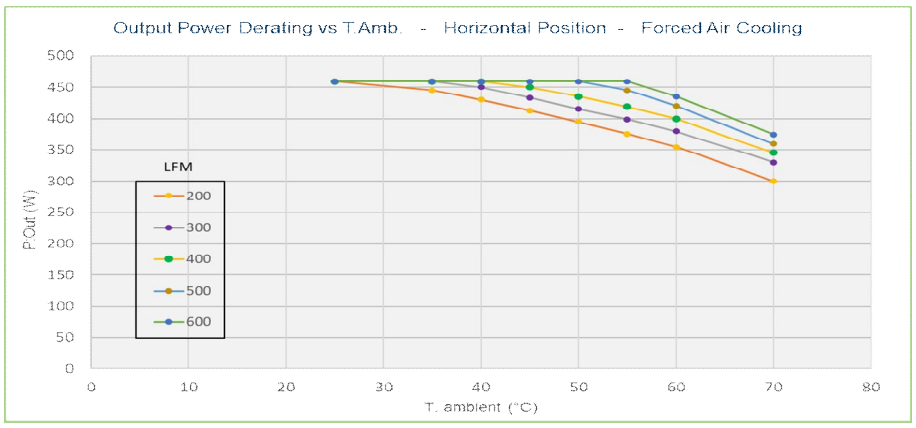
V_{OUT}: 24 V_{DC}

V_{IN}: ≥115V_{AC}



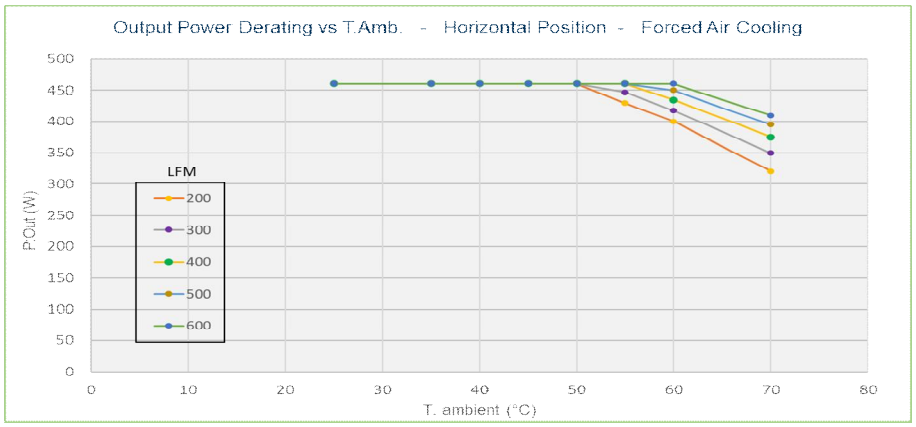
V_{OUT}: 48, 56 V_{DC}

V_{IN}: ≥115V_{AC}



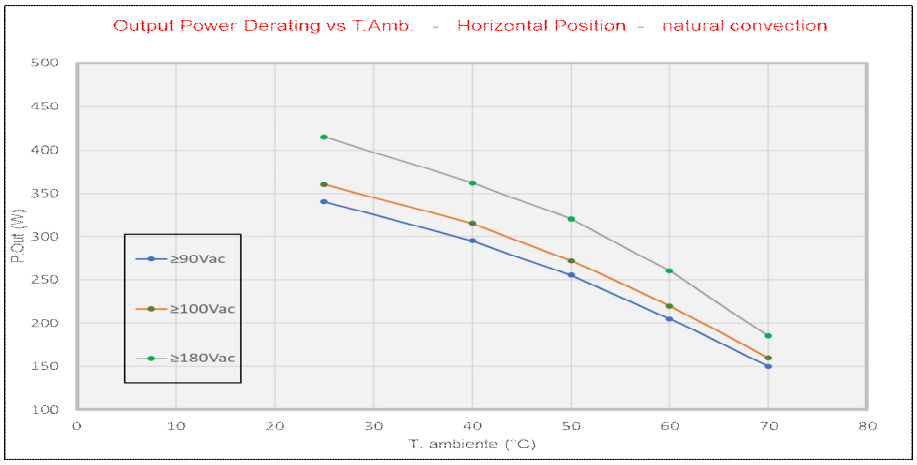
V_{OUT}: 24 V_{DC}

V_{IN}: ≥180V_{AC}

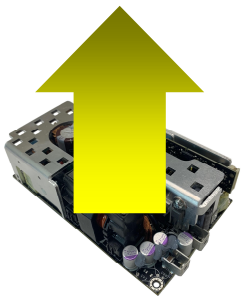


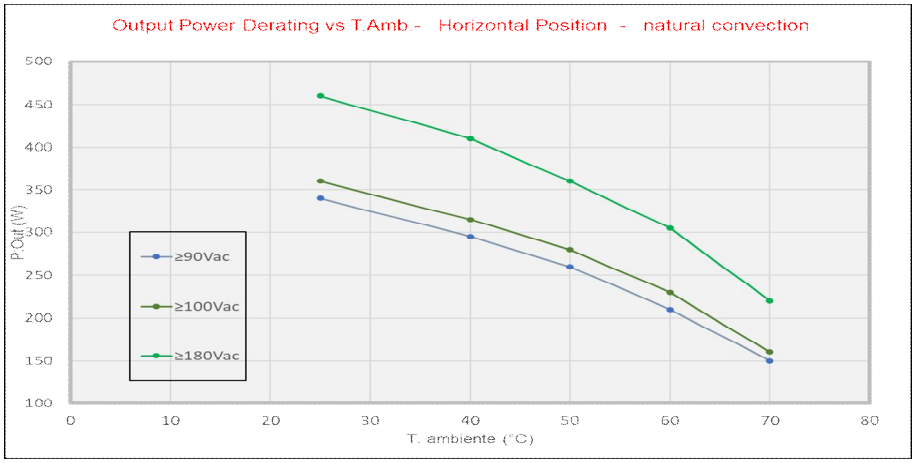
V_{OUT}: 48, 56 V_{DC}

V_{IN}: ≥180V_{AC}

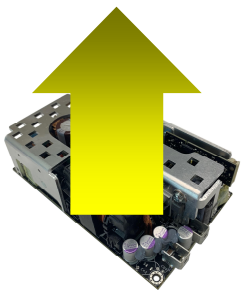


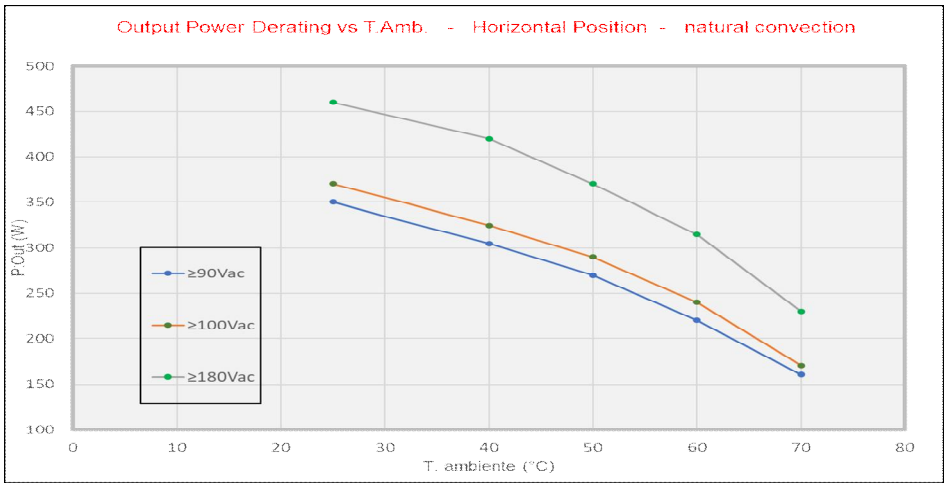
V_{OUT}: 24 V_{DC}



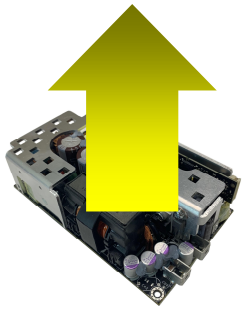


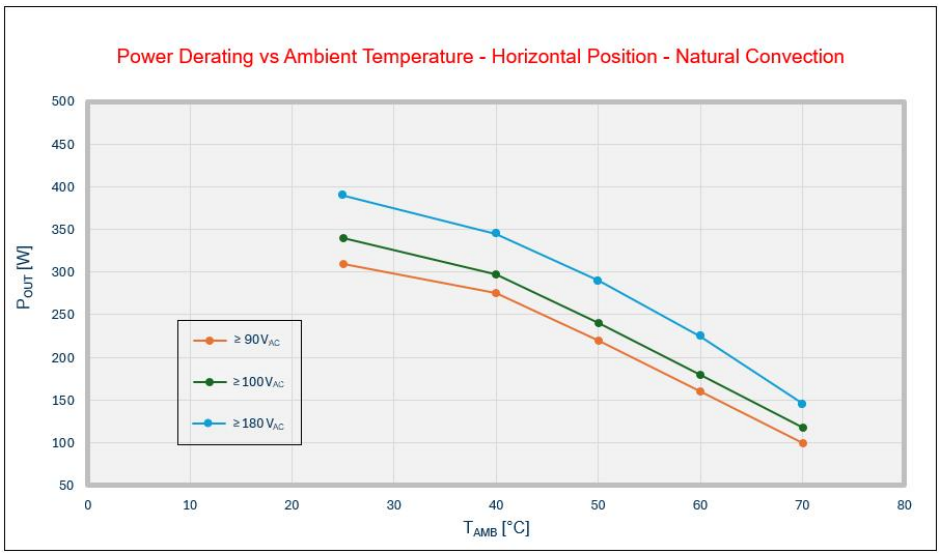
V_{OUT}: 48 V_{DC}



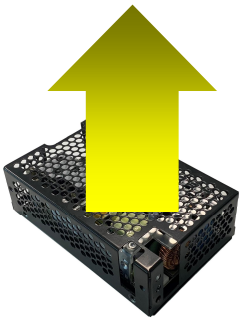


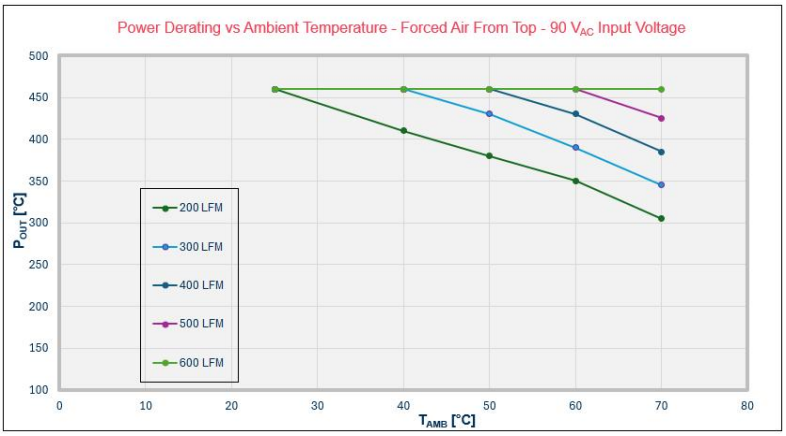
V_{OUT}: 56 V_{DC}

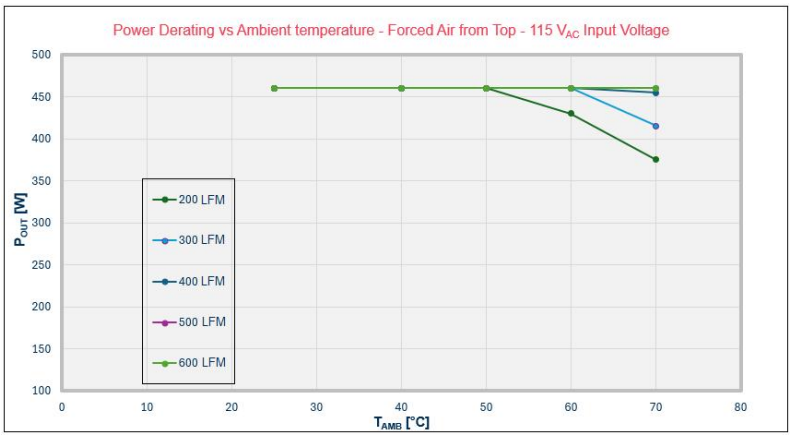


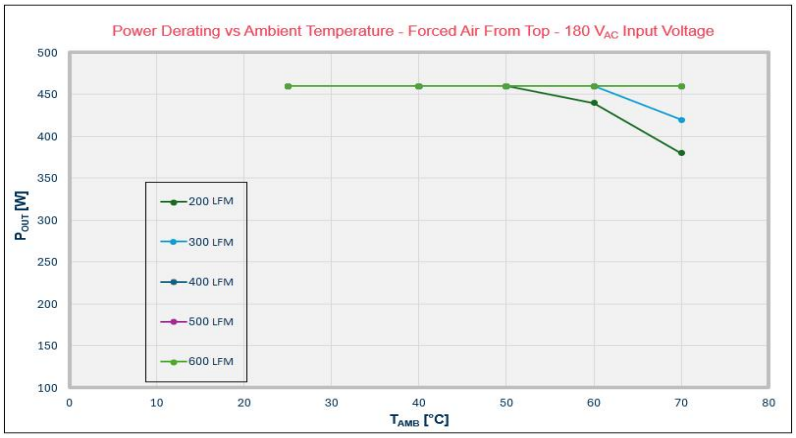


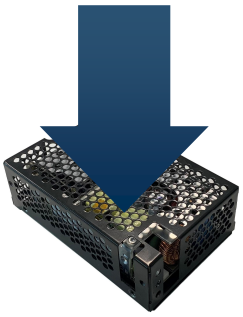
V_{OUT}: 24, 48, 56 V_{DC}











V_{OUT}: 24, 48, 56 V_{DC}

The above curves come from a climatic static chamber and a specific set up therefore they represent a thermal performance approximation of a MDP520 installed into a system where not all the variables can be controlled. Although they are a reasonable reference, it is always a recommended practice to monitor the power supply critical components temperature when operating into a system (see below hot-spots thermal map).

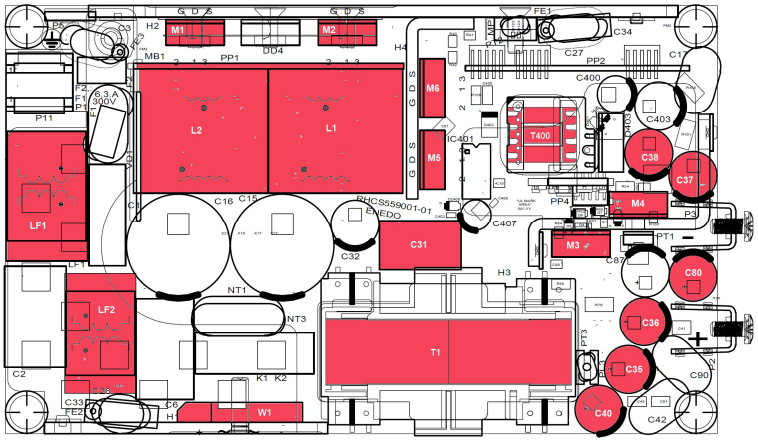
INPUT SPECIFICATIONS

Specification	Test Conditions / Notes		Min.	Nominal	Max.	Units
AC Input Voltage	PS starts and operates at 85 V_{AC} at all load conditions		90	100 ÷ 277	305	V_{RMS}
DC Input Voltage			170	-	300	V_{DC}
Input Frequency	440 Hz with reduced PFC and output power rating - Consult factory for details.		47	50/60	440	Hz
Input Current	RMS at 180 V_{AC}, maximum load, 50 / 60 Hz RMS at 85 V_{AC}, maximum load, 50 / 60 Hz		-	-	3.5 7.0	A
Inrush Current (peak)	Cold start, 25 °C ambient, full load					
		115 V_{AC}	-	-	10	A
		230 V_{AC}	-	-	20	
		277 V_{AC}	-	-	24	
Fusing	Slow blow, 8A, 250V on each AC lines.		-	-	8	A
Efficiency	At 115 V_{AC}, 20% rated load		-	89	-	%
	50% rated load		-	93	-	
	100% rated load		-	92	-	
	At 230 / 277 V_{AC}, 20% rated load		-	90	-	
	50% rated load		-	94	-	
	100% rated load		-	94.5	-	
Input Power Consumption	Power on, 115 V_{AC}, no load		-	-	4	W
	Power on, 230 V_{AC}, no load		-	-	4	
	Stand by, 115, 230 V_{AC}, no load		-	-	0.35	
Power Factor	From 50 to 100% of rated load, 277, 230, 115 V_{AC}, 50 / 60 Hz input voltages.		0.90	-	-	-
THDi	From 50 to 100% rated load, 115, 230, 277 V_{AC} 50 / 60 Hz.		-	-	20	%
Harmonic Current Fluctuations and Flicker	Complies with EN 61000-3-2 at 230 V_{AC}, 50/60 Hz, Class A. Complies with EN 61000-3-2 Class C at 230 V_{AC}, 50/60 Hz, >150 W load. Complies with EN 61000-3-2 Class D at 230 V_{AC}, 50/60 Hz, >35 W load. Complies with EN 61000-3-3 at nominal voltages and full load.					
Earth Leakage Current	Normal conditions					
	115 V_{RMS}, 60 Hz		-	100	-	µA
	230 V_{RMS}, 50 Hz		-	180	-	
	264 V_{RMS}, 60 Hz (worst case)		-	200	-	
	277 V_{RMS}, 60 Hz		-	250	290	
Touch Leakage Current	264 V_{RMS}, 60 Hz					
	Normal Condition (NC)		-	-	100	µA
	Single Fault Condition (SFC)		-	-	500	
Patient Leakage Current	264 V_{RMS}, 60 Hz					
	Normal Condition (NC)		-	-	100	µA
	Single Fault Condition (SFC)		-	-	500	

OUTPUT SPECIFICATIONS

Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
V1 Output Voltages	±0.5% set point accuracy, 20% load	-	12 24 36 48 56	-	V
V1 Output Power Rating	Natural Convection (see graph above) Forced air cooling (see graph above) Peak power	- - -	- - -	460 460 520	W
$5V_{SB}$ Output Voltage	±3% set point accuracy, 20% load	-	5	-	V
$5V_{SB}$ Output Current		-	-	1.0	A
V1 Voltage Adjustment Range	Manually by potentiometer	-	-	±5	%V1
V1 Load-Line-Cross Regulation	V_{AC}: 85 – 305 V_{RMS} ; I1: 0 – 100%	-	-	±2	%V1
$5V_{SB}$ Load-Line-Cross regulation	V_{AC}: 85 – 305 V_{RMS} ; I_{5SB}: 0 – 100%	-	-	±5	%$5V_{SB}$
V1 Line Regulation	V_{AC}: 85 – 305 V_{RMS}	-	-	±0.1	%V1
Transient Response: V1, $5V_{SB}$ Voltage Deviation	50% load changes at 1 A/µs 0.5 A load minimum load applied	-	-	±5	%V1 %$5V_{SB}$
V1 Ripple and Noise	Rated load, Peak-to-peak, 20 MHz BW. (100 nF ceramic, 10 µF tantalum at load)	-	-	1	%V1
V1 Start-up Rise Time	85<V_{IN}<305, any load conditions.	10	-	100	ms
Start-up Delay	V1 in regulation after de-asserting PS_ON V1 in regulation after AC is applied (worst case: 85 V_{AC}) $5V_{SB}$ in regulation after AC is applied (worst case: 85 V_{AC})	- - -	- - -	200 750 500	ms
Turn-on Overshoot		- -	- -	5 5	%V1 %V_{SB}
V1 Hold-up Time	At nominal V_{IN}, full load	16	-	-	ms
Minimum Load	V1and $5V_{SB}$	0	-	-	A
Maximum Load Capacitance	V1: 12 V_{DC} V1: 24 V_{DC} V1: 36 V_{DC} V1: 48 V_{DC} V1: 54 V_{DC}	- - - - -	- - - - -	28000 14000 12000 10000 8000	µF

To ensure the power supply proper operation when installed in a system or device, the hot-spots components operating temperature should not exceed the corresponding maximum limits shown in the table alongside.

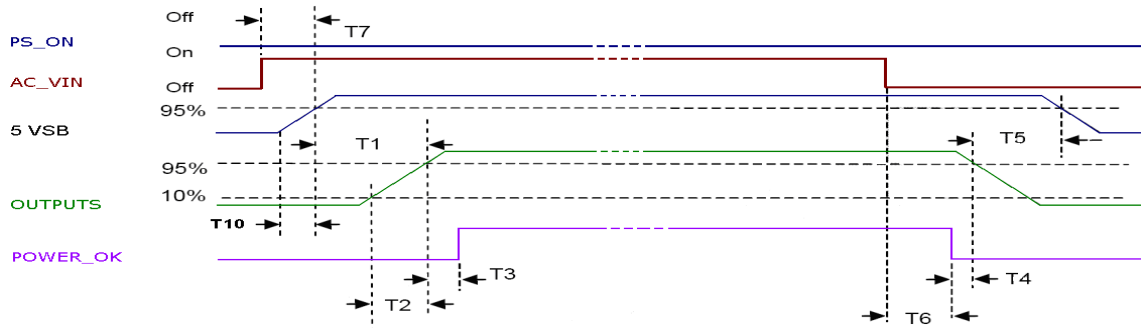


Hot Components PCB Reference	Maximum Operating Temperature [°C]
T1	130
T400	110
W1	125
LF1, LF2	120
L1, L2	120
M1, M2	120
M3, M4	120
M5, M6	120
C31	105
C35, C36, C40, C80	105
C37, C38	105

SIGNALS / CONTROLS

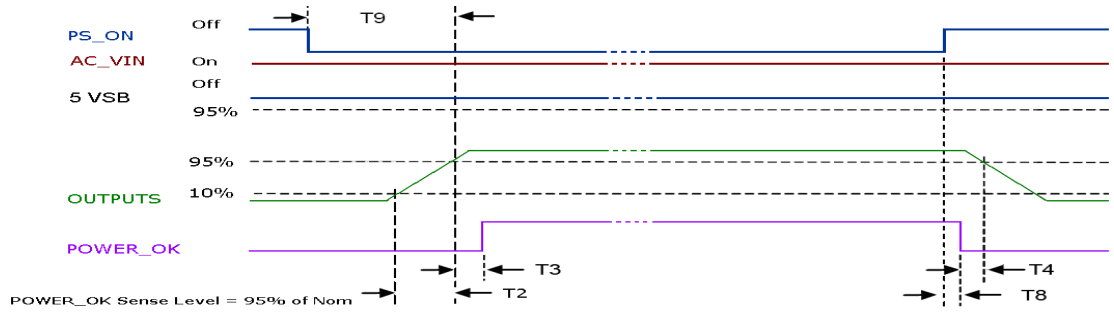
Signal	Notes	Min	Typ	Max	Unit
PS_ON	Active low, +5 V TTL signal compatible. Input low voltage	0	-	2.0	V
	Input high voltage (I_{IN}= 200 µA)	3.0	-	-	V
	V1 and V2 disabled when PS_ON is open				
	$5V_{SB}$ not affected by PS_ON				
	V1 and V2 enabled with PS_ON connected to RTN				
P_OK	+5 V TTL compatible				
	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				

SIGNALS TIMING



Above waveforms are expected with AC Input ON/OFF:

5 V_{SB} On – V1 On	50 ms ≤ T1 ≤ 250 ms
V1 Rise Time	5 ms ≤ T2 ≤ 85 ms
5 V_{SB} Rise Time	1 ms ≤ T10 ≤ 10 ms
V1 On – P_OK delay	30 ms ≤ T3 ≤ 100 ms
Power down warning[1]	T4 ≥ 5 ms
V1 Off – $5V_{SB}$ Off[2]	T5 ≥ 1.2 s
AC Off – P_OK Low	T6 ≥ 10 ms (115/ 230 V_{AC})
AC_ON – $5V_{SB}$ turn On time	T7 ≤ 1000 ms



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

V1 Rise Time	5 ms ≤ T2 ≤ 85 ms
V1 On – P_OK delay	30 ms ≤ T3 ≤ 100 ms
Power down warning1	1 ms ≤ T4 ≤ 5 ms
-PS_ON – P_OK down	T8 ≤ 1 ms
-PS_ON – V1 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 at least 50% of the maximum load on main output.

PROTECTION FEATURES

Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
Input Under Voltage	Auto-recovering, hiccup mode.	58	65	75	V_{AC}
Input Fuse	8 A 300 V_{AC} Time Lag Radial Fuse T/H	-	-	8	A
Over Current	At nominal input voltages V1: Hiccup mode, auto-recovering $5V_{SB}$: Hiccup mode, auto-recovering:	 115 -	 - -	 160 -	$\%I1_{Rated}$
Short Circuit	At nominal input voltages V1: Hiccup mode, auto-recovering. $5V_{SB}$: Hiccup mode, auto-recovering.	 -	 -	 -	
Over Voltage	V1, Power shut down, latch off. $5V_{SB}$, Hiccup mode, auto-recovering.	110 -	- -	145 150	$\%V_{NOM}$
Over Temperature (on secondary and primary side)	Hiccup mode, auto-recovering.	-	-	-	°C
Isolation: Input-to-Output	Reinforced (2x MoPP)	6000 4250	- -	- -	V_{DC} V_{AC}
Isolation: Input-to-Earth	Basic (1x MoPP) Production tested at 2545 V_{DC}	2545 1800	- -	- -	V_{DC} V_{AC}
Isolation: Output-to-Earth	Basic (1x MoPP)	2121 1500	- -	- -	V_{DC} V_{AC}
Means Of Protection: Primary to secondary	2x MoPP (IEC 60601-1 3rd edition) at 100 – 250 V_{AC}, 50/60 Hz up to 4000 m 2x MoPP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 50/60 Hz up to 3000 m 2x MoOP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 440 Hz (50/60 Hz)				
Means Of Protection: Primary to Protection Earth	1x MoPP (IEC 60601-1 3rd edition) at 100 – 250 V_{AC}, 50/60 Hz up to 4000 m 1x MoPP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 50/60 Hz up to 3000 m 1x MoOP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 440 Hz (50/60 Hz)				
Means Of Protection: Secondary to Protection Earth	1x MoPP (IEC 60601-1 3rd edition) at 100 – 250 V_{AC}, 50/60 Hz up to 4000 m 1x MoPP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 50/60 Hz up to 3000 m (U-chassis variant only) 1x MoOP (IEC 60601-1 3rd edition) at 100 – 277 V_{AC}, 440 Hz (U-chassis variant only)				
Equipment Protection Class	Class I, compatible with BF (Body Floating) ME				

ENVIRONMENTAL SPECIFICATIONS

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
Operating Temperature Range	Start up at -40 °C at <20% load. No de-rating up to 50°C at >600LFM	-40	-	50	°C
Operating Temperature Range with De-rating	See de-rating curves and conditions in the Output Specifications section	-	-	70	°C
Storage Temperature		-40	-	85	°C
Humidity	RH, Non-condensing Operating. Non-operating	-	-	90 95	% %
Operating Altitude	MoPP (100 – 250 V_{AC}, 50/60 Hz) MoPP (100 – 277 V_{AC}, 50/60 Hz) MoOP, ITE grade Power de-rating above 1800 m	- - -	- - -	4000 3000 5000	 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, 40 °C ambient 80% Duty cycle, Telcordia SR-332 Issue 2	400.000	-	-	Hours
Useful Life	Worst nominal V_{IN}, 80% load, 40 °C ambient.	-	5	-	Years

ELECTROMAGNETIC COMPATIBILITY (EMC) – EMISSIONS

Phenomenon	Conditions / Notes	Standard	Equipment/Performance Class
Conducted	115, 230, 277 V_{RMS}. Maximum load.	EN 55011 (ISM) EN 60601-1-2 (Medical)	B
Radiated	At 10 m distance	EN 55011 (ISM) EN 60601-1-2 (Medical)	A[3]
Line Voltage Fluctuation and Flicker	At 20%, 50% and 100% maximum load. Nominal input voltages	EN 61000-3-3	
Harmonic Current Emission	230 V_{AC} input voltage, 50 / 60 Hz	EN 61000-3-2	A
	230 V_{AC} 50 / 60 Hz, >150 W load	EN 61000-3-2	C
	230 V_{AC} 50 / 60 Hz, >40 W load	EN 61000-3-2	D

[3] Radiated emissions should be assessed at system level.

ELECTROMAGNETIC COMPATIBILITY (EMC) – IMMUNITY

Phenomenon	Conditions / Notes	Standard	Test Level	Criteria
	Reference standard for the medical version	EN 60601-1		
	Reference standard for Industrial/IMS equipment	EN 61000-6-2		
ESD	15 kV air discharge, 8 kV contact, at any point of the system.	EN 61000-4-2	4	A
Radiated Field	10 V/m, 80-1000 MHz, 1 KHz, 80% AM.	EN 61000-4-3	3	A
Electric Fast Transient	±2 kV on AC power port for 1 minute	EN 61000-4-4	3	A
Surge	±2 kV line to line; ± 4 kV line to earth on AC power port	EN 61000-4-5	4	A
Conducted RF Immunity	10 V_{RMS}, 0,15-80 MHz, 1 kHz/2 Hz 80% AM	EN 61000-4-6	3	A
Dips and Interruptions	200 – 277 V_{AC}:			
	Drop-out to 0% for 10 ms	EN61000-4-11		A
	Dip to 40% for 5 cycles (100 ms)	EN61000-4-11		A
	Dip to 70% for 25 cycles (500 ms)	EN61000-4-11		A
	Drop-out to 0% for 5 s	EN61000-4-11		B
	100 – 127 V_{AC}:			
	Drop-out to 0% for 10 ms	EN 61000-4-11		A
	Dip to 40% for 5 cycles (100 ms)	EN 61000-4-11		B (derating TBD)
	Dip to 70% for 25 cycles (500 ms)	EN 61000-4-11		A (derating TBD)
	Drop-out to 0% for 5 s	EN 61000-4-11		B

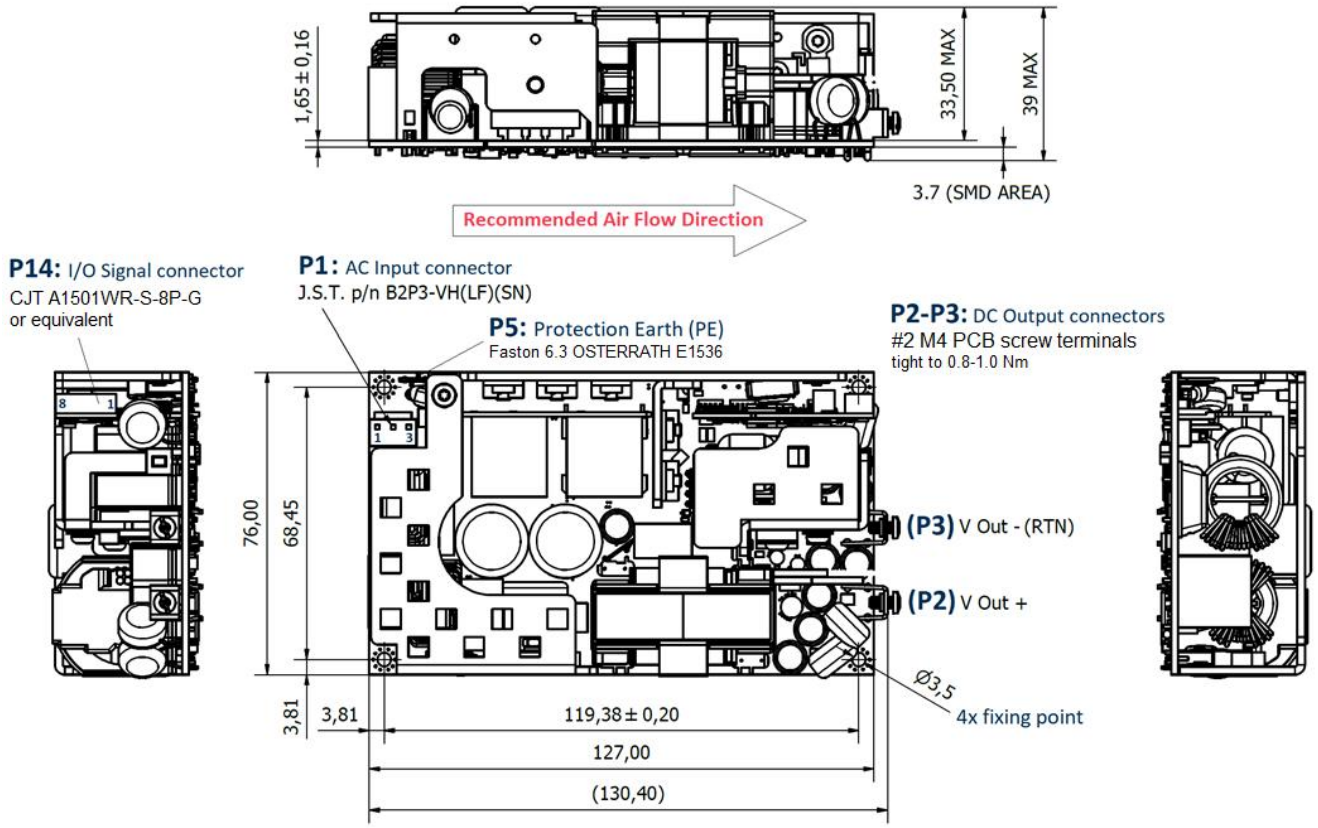
SAFETY AGENCIES APPROVALS

Certification Body	Safety Standards and file numbers	Category
	CSA C22.2 No.60601-1, ANSI/AAMI ES60601-1 3rd edition + A1	Medical
IEC IECEE CB Certification	IEC/EN 60601-1 3rd edition+A1	Medical
CE	Directive 2014/35/EU: Electrical Safety: Low Voltage electrical equipment (LVD)	Information Technology Equipment
	Directive 93/42/CEE: Safety Requirement of the Medical Device	Medical
	Directive 2014/30/EU: Electromagnetic Compatibility (EMC)	
	Directive EU 2015/863: RoHS 3	
Designed to meet IEC/EN/UL/CSA 61010-1 2nd edition and IEC/EN 60335-1 or IEC/EN 61558-1		

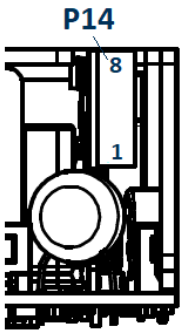
OUTLINE DRAWING AND CONNECTIONS – OPEN FRAME CHASSIS (-OF)

Overall dimensions: 76.2 x 127.0 x 38.5 mm (3.00 x 5.00 x 1.51 in)

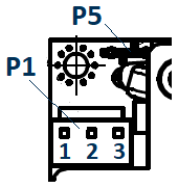
Weight: 400 g (0.88 lb)



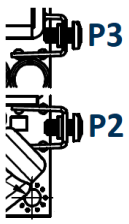
Signals Connector – P14		
CJT A1501WR-S-8P-G (or equivalent), mates with: CJT A1501H-8P *(housing)* CJT A1501-GP *(terminals)* or equivalent.	Pin Ref.	Function
	8	RS^-
	7	RS^+
	6	P_OK
	5	-PS_On
	4	RTN
	3	RTN
	2	$+5V_{SB}$
	1	$+5V_{SB}$



AC Input Connector – P1		
JST B2P3-VH(LF)(SN) Mates with JST NVAR-02VS *(housing)* JST SVT-41T-P1.1 *(terminal)* Use 16 AWG minimum wires	P1 Pin Ref.	Function
	1	L1
	2	NP
	3	L2
	P5: Protection Earth (PE)	



DC Output Connector – P2, P3		
2x M4 screw terminals KEYSTONE 7792 (tight to 0.8-1.0 Nm) Max deep screws 7 mm	Pin Ref.	Function
	P2	+V1
	P3	RTN



OUTLINE DRAWING AND CONNECTIONS – PROTECTIVE CAGE (-PC)