

DESCRIPTION

The DDP400 and MDP400 series of industrial and medical grade AC-DC power supplies are distinguished by their extremely compact form factor and high conversion efficiency.

The series provide a steady 400 W of regulated DC power through the full 90 to 264 V_{AC} input voltage range. Based on an open frame, 3.00" x 6.50" x 1.46" form factor, the series is available in four different packages to 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 series generate less heat facilitating thermal management in space constrained system and offering high reliability.

Both the DDP and MDP series are available in four standard output voltages: 12, 24, 36, 48 V_{DC}, offer an auxiliary 12 V_{DC} and 5 V_{DC} stand-by outputs. Available control signals include Power Good (P_OK) and Remote On/Off (PS_ON).

Open frame and boxed units can deliver full output power up to 50 °C, can operate up to 70 °C with derating and are capable to start up from -30 °C.

A built in fan speed control circuit assure proper forced air cooling minimizing operation noise and enhancing useful life.

The MDP400 range comply with the 2nd and 3rd edition of the IEC 60601-1 safety standards for medical equipments and, the DDP400 range, comply with the 2nd edition of the IEC 60950-1 safety standards for IT equipments. Both the series meets the EN 55022 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.

3 YEAR WARRANTY



KEY FEATURES

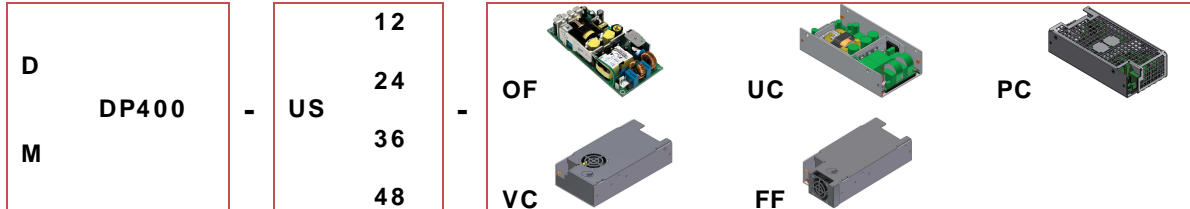
- Universal input voltage range
- 400 W rated power (440 W peak)
- Extremely high efficiency (94% typical)
- Low stand-by consumption (<0.5 W)
- 12, 24, 36 and 48V standard output variants
- Active PFC, EN61000-3-2 compliant (Class C)
- Low earth leakage current
- Fan speed control circuit (off at < 50 W load)
- Over temperature protection
- OV, OC, and short circuit protections
- +5 V Stand-by, 2 A Output
- 12 V Auxiliary, 1 A output
- Remote On/off and power good signals
- U-chassis and boxed packages fit 1U applications.
- ANSI/AAMI ES60601-1 3rd ed. compliant
- IEC/EN/UL 60601-1 2nd/3rd ed. compliant.
- RoHS-6 compliant (EU directive 2011/65/EU)
- 4000 m altitude operation.

MARKET SEGMENT AND APPLICATIONS

- Video Wall Display & 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: DDP400-	12 V _{DC} : US12-	Open Frame: OF
Medical: MDP400-	24 V _{DC} : US24-	U-Chassis: UC
	36 V _{DC} : US36-	Punched Cover: PC
	48 V _{DC} : US48-	Vented Cover: VC
		Front Fan: FF



Model Number	V1 (V)	I1 ¹ Convection (A)	I1 ² Forced air (A)	V1 ³ Ripple (mV)	V2 (V)	I2 ¹ Rated (A)	V2 ³ Ripple (mV)	5V _{SB} (V)	I5V _{SB} ¹ Convection (A)	I5V _{SB} ² Forced air (A)	5V _{SB} ³ Ripple (mV)
DDP/ MDP400-US12-OF/ UC	12	20.8	33.3	120	12	1	240	5	1.5	2	50
DDP/ MDP400-US24-OF/ UC	24	10.4	16.7	240	12	1	240	5	1.5	2	50
DDP/ MDP400-US36-OF/ UC	36	6.9	13.9	360	12	1	240	5	1.5	2	50
DDP/ MDP400-US48-OF/ UC	48	5.2	8.3	480	12	1	240	5	1.5	2	50
DDP/ MDP400-US12-VC/ FF	12	-	33.3	120	12	1	240	5	-	2	50
DDP/ MDP400-US24-VC/ FF	24	-	16.7	240	12	1	240	5	-	2	50
DDP/ MDP400-US36-VC/ FF	36	-	13.9	360	12	1	240	5	-	2	50
DDP/ MDP400-US48-VC/ FF	48	-	8.3	480	12	1	240	5	-	2	50

¹ The combined output power of V1, V2 and 5V_{SB} for "-OF" and "-UC" packages, must not exceed 400 W when cooled by 400 LFM air flow, and 250 W when convection cooled, up to 50 °C. Above 50 °C output de-rating applies. See de-rating curves below. In any case, the heat sink maximum temperature should not exceed +110 °C at 50 °C ambient temperature.

² The combined output power of V1, V2 and 5V_{SB} for "-VC" and "-FF" packages, must not exceed 400 W up to 50 °C, and 280 W at 70 °C ambient temperature. See de-rating curves below.

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

INPUT SPECIFICATIONS

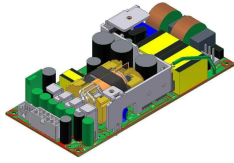
Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
AC Input Voltage	PS starts and operates at 90 V _{AC} at all load conditions	90	100-240	264	V _{AC}
DC Input Voltage		170	-	270	V _{DC}
Input Frequency		47	50/60	440	Hz
Input Current	RMS at 180 V _{AC} , maximum load RMS at 90 V _{AC} , maximum load	-	-	2.5 5	A
Inrush Current	265 V _{AC} , 25 °C ambient, cold start. 24, 36, 48 V, no damage	-	-	- 20	A
Fusing	2X Time Lag 6.3 A, 250 V on both L and N	-	-	6.3	A
Efficiency	At 230 V _{AC} , 20% rated load 50 – 100 % rated load	-	90 94	-	%
Input Power Consumption	At 115 V _{AC} , 20% rated load 50 – 100 % rated load	-	90 92	-	%
Power Factor	Power on, 115-230 V _{RMS} , no load Stand by, 115-230 V _{RMS} , no load	-	1 0.5	1.5	W
Harmonic Current Fluctuations and Flicker	At full rated load, 115 V _{AC} , 60 Hz and 230 V _{AC} , 50 Hz input voltages	0.95	-	-	-
Leakage Current	Complies with EN-61000-3-2 Class C at 230 V _{AC} 50 Hz, load > 50 W. Complies with EN-61000-3-3 at nominal voltages and full load.	-	-	300	µA

OUTPUT SPECIFICATIONS

Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
V1 Output Voltage	12V	-	12	-	V
	24V (0.5% set point accuracy)	-	24	-	
	36V (0.5% set point accuracy)	-	36	-	
	48V (0.5% set point accuracy)	-	48	-	
V1 Output Power Rating	All voltages, OF/UC, convection cooling	-	-	250	W
	All voltages, VC/FF, and OF/UC forced air cooling (> 400 LFM)	-	-	400	
	All models, peak power (≤ 10 s)	-	-	440	
V2 Output Voltage	All models.				
	Load on V2: from 5 to 1000 mA Load on V1: from 0.1 to I1 rated	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 voltages, OF/UC, convection cooling	-	-	1.5	A
	All voltages, VC/FF, and OF/UC forced air cooling (> 400 LFM)	-	-	2	
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 – 13.9 A (36V)				
	0 – 8.3 A (48V)				
	V2 Load: 0 – 1 A				
	5V _{SB} Load: 0 – 2 A				
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 – 13.9 A (36V)				
	0 – 8.3 A (48V)				
	V2 Load: 0 – 1 A				
	5V _{SB} Load: 0 – 2 A				
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/ μ s				
	12V at 2200 μ F Load / I _{OUT} > 0.5 A				
	24 V at 1000 μ F Load / I _{OUT} > 0.5 A				
	36 V at 820 μ F Load / I _{OUT} > 0.5 A				
	48V at 560 μ F Load / I _{OUT} > 0.5 A				
	5V _{SB} at 560 μ F Load / I _{OUT} > 0.1 A				
V1 Ripple and Noise	All models, Peak-to-peak, 20 MHz BW.				
	100 nF ceramic and 10 μ F 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			200	
	V1 in regulation after AC is applied	-	-	750	ms
	5V _{SB} in regulation after AC is applied			500	
Turn-on Overshoot	At 500 mA output current, V1 in regulation within 50 ms.	-	10	-	% V1
			10		% V2
			10		% V _{SB}
Hold-up Time	At nominal V _{IN} , 400 W, for all outputs	-	16	-	
	At nominal V _{IN} , 365 W, for all outputs	-	20	-	ms
	At nominal V _{IN} , 200 W, for all outputs	-	35	-	
Minimum Load *	All models; V1, V2 and 5V _{SB}	0	-	-	A
Maximum Load Capacitance	At nominal V _{IN} , 25 °C ambient				
	12 V	-	-	33000	μ F
	24 V	-	-	16000	
	36 V	-	-	10000	
48 V	-	-	7000		
Temperature Drift		-1.2	-	+1.2	mV/°C

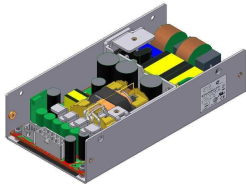
* - When the load on the main output is less than 100 mA, V2 output voltage might regulate below its minimum value. Contact ROAL Electronics for details.

Package Model Number Output Power De-rating Curves



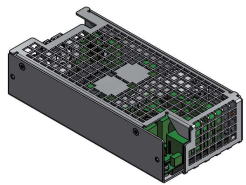
Open Frame

DDP/ MDP400 - US12/ 24/ 36/ 48-OF



U-Chassis

DDP/ MDP400 - US12/ 24/ 36/ 48-UC



Punched Cover

DDP/ MDP400-US12/ 24/ 36/ 48-PC



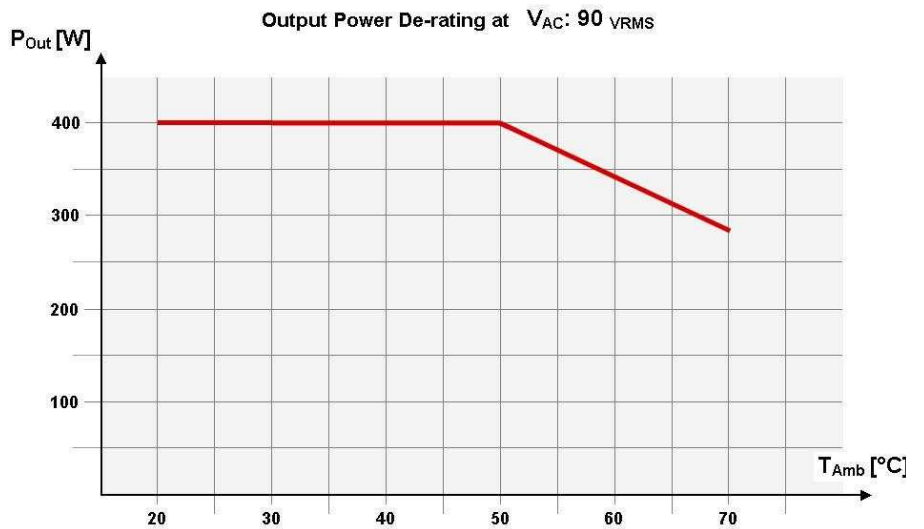
Front Fan

DDP/ MDP400 - US12/ 24/ 36/ 48-FF



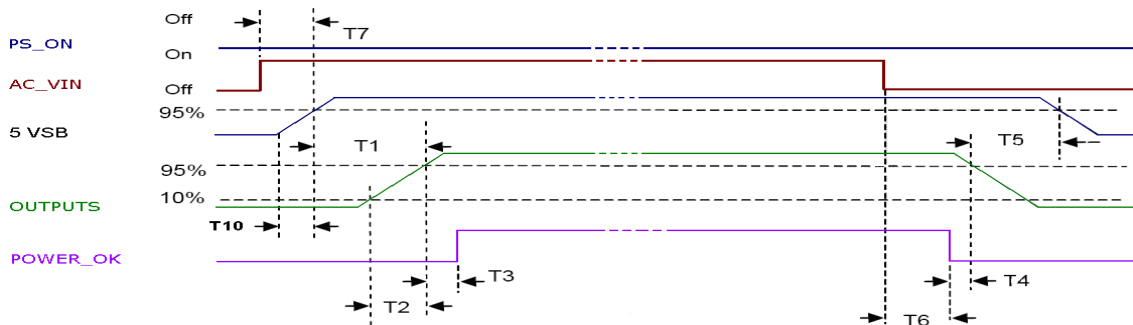
Vented Cover

DDP/ MDP400 - US12/ 24/ 36/ 48-VC



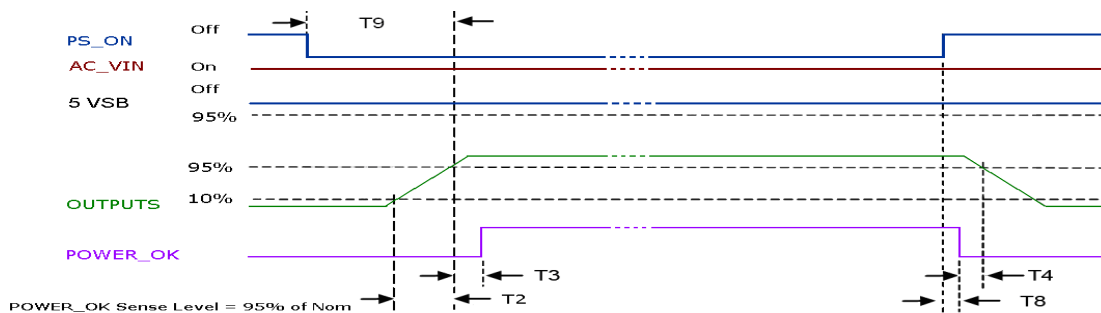
Signal	Notes	Min	Typ	Max	Unit
PS_ON	Active low, +5 V TTL signal compatible. Input low voltage	0	-	2.0	V
	Input high voltage ($I_{IN} = 200 \mu A$)	3.0	-	-	V
	V1 and V2 disabled when PS_ON is open				
	5V _{SB} not affected by PS_ON				
P_OK	V1 and V2 enabled with PS_ON connected to RTN				
	+5 V TTL compatible				
	Logic level low (< 10 mA sinking)	-	-	0.7	V
	Logic level high (100 μA 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	$50 \text{ ms} \leq T1 \leq 250 \text{ ms}$
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 ¹	$T4 \geq 1 \text{ ms}$
Main Output off - Standby off ²	$T5 \geq 1.2 \text{ s}$
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 ¹	$1 \text{ ms} \leq T4 \leq 5 \text{ ms}$
PS_ON - Main Output (off) Timing	$T8 \leq 1 \text{ ms}$
PS_ON - Main Output (on) Timing	$T9 \leq 200 \text{ ms}$

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 Lockout	Auto Recovery, 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-recovery V2: PTC limiting, auto-recovering 5 VSB: Hiccup mode, auto-recovering.	110	-	150	% I _{1 MAX}
Short Circuit	At nominal input voltages. V1: Hiccup mode, auto-recovery V2: PTC limiting, auto-recovering 5 VSB: Hiccup mode, auto-recovering.	-	-	-	
Over Voltage	12 V 24 V 36 V 48 V 5 V _{SB} Unit shut down and latch off	110	-	136	% V _{NOM}
Over Temperature (on primary stage)	Shut down, latch off.	-	-	-	
Over Temperature (on secondary side)	Hiccup mode with auto recovery	-	-	-	
Isolation Primary to Secondary	Reinforced	4000	-	-	V _{AC}
Isolation Input to Earth	Basic	1500	-	-	V _{AC}
Isolation V1/ V2		100	-	-	V _{DC}
Isolation Output to Earth		500	-	-	V _{DC}

ENVIRONMENTAL SPECIFICATIONS

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
Operating Temperature Range	No de-rating up to 50°C PS starts up at -30 °C	-20	-	50	°C
De-rated Operating Temperature Range	Convection cooling: Linearly de-rate from 250 W at 50 °C, to 100 W at 70 °C Forced air cooling: Linearly de-rate from 400 W at 50 °C, to 280 W at 70 °C. See graphs above for fan boxed versions.	-	-	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 convection.	-	4	-	Years
Thermal Considerations	The output power de-rating curves are herein provided. These curves can be used as a guideline to assess the limit in performance of a power supply once installed in a system providing controlled air flow at a certain input voltage and ambient temperature.				

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. All load conditions > 50 W.	EN 61000-3-2	C

ELECTROMAGNETIC COMPATIBILITY (EMC) - IMMUNITY

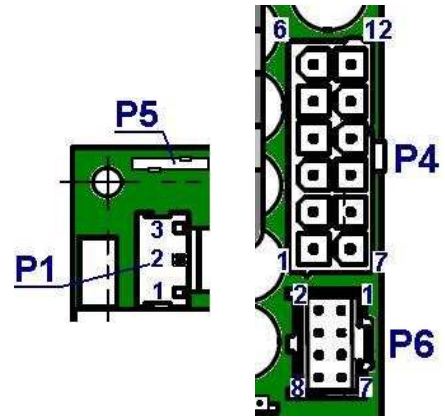
Phenomenon	Conditions / Notes	Standard	Test Level	Performance criteria
	Reference standard for the medical version	EN 60601-1-2		
ESD	15 kV air discharge, 8 kV contact, at any point of the system.	EN 61000-4-2	4	A
Radiated Field	3 V/m, 80-1000 MHz, 1 KHz/2 Hz 80% AM. Dwell time is 3 sec for 2 Hz modulation Dwell time is 1 sec for 1KHz modulation	EN 61000-4-3	3	A
Electric Fast Transient Surge	± 2 kV on AC power port for 1 minute; ± 1 kV on signal/control lines	EN 61000-4-4	3	A
	± 2kV line to line; ± 4 KV line to earth; on AC power port; ± 0.5 kV for outdoor cables	EN 61000-4-5	3	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)	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

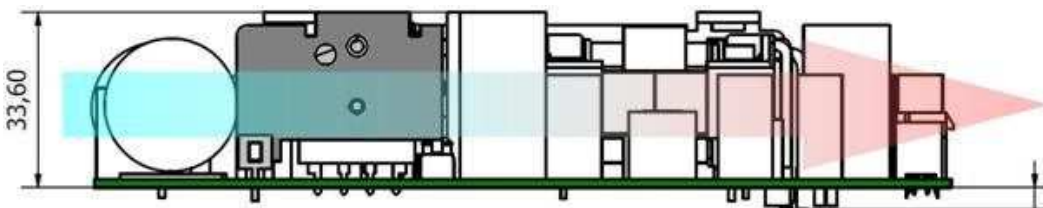
Certification Body	Safety Standards and file numbers	Category
CSA/ UL	CSA C22.2 No. 60950-1, UL 60950-1; 2007, 2 nd edition	Information Technology Eq.
	CSA C22.2 No.601.1, ANSI/AAMI ES60601-1 3 rd edition	Medical
IEC IECCE CB Certification	IEC/EN 60950-1 2 nd edition	Information Technology Eq.
	IEC/EN 60601-1 3 rd edition	Medical
	IEC/EN 61558-2-16 (24 V _{DC} Open Frame version only)	SMPS
CE	Low Voltage Directive (LDV) 2006/95/EC	Information Technology Eq.
	Low Voltage Directive (LDV) 2007/47/EC MDD	Medical

OUTLINE DRAWING AND CONNECTIONS – OPEN FRAME

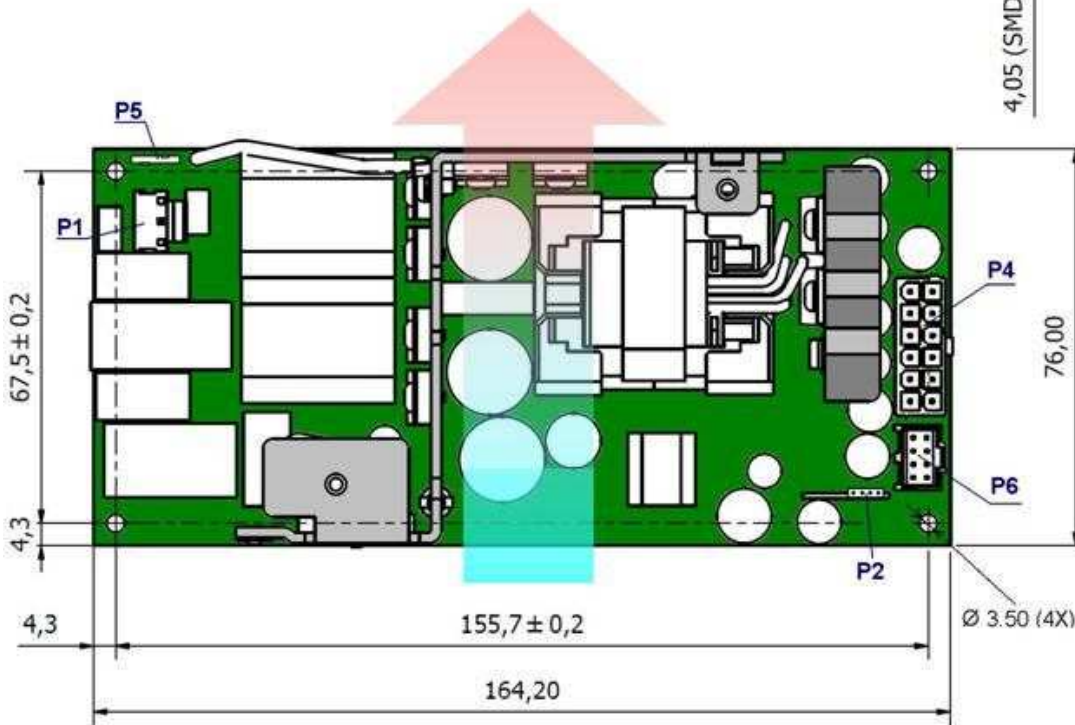
Connector	Manufacturer and Part Number
AC Input Connector P1	Molex 26-60-4030 or equivalent
P1 Mating Connector	Molex 09-93-0300 (Crimp Terminal Housing) Molex 08-50-0105 (Crimp Terminal, 18-24 AWG)
Protection Earth Connector P5	Tyco 63849-1 equivalent
P5 Mating Connector	Any tin finished 6.35x0.81 mm receptacle
Output Connector P4	Molex 39-28-8120 or equivalent
P4 Mating Connector	Molex 39-01-2120 (Crimp Terminal Housing) Molex 39-00-0039 (Crimp Terminal, 18-24 AWG)
Signals Connector P6	Molex 90130-1108 or equivalent
P6 Mating Connector	Molex 90142-0008 (Crimp Terminal Housing) Molex 90119-0109 (Crimp Terminal, 22-24 AWG)



Note: PCB head connectors and their mating are the same for all the package options.



Recommended Air Flow Directions



AC Input P1	
Pin	Function
1	AC Neutral
2	Not Present
3	AC Live

Protection Earth P5	
GND	AC Ground

Output Connector P4	
Pin	Function
1	V1
2	V1
3	V1
4	V1
5	V1
6	V1
7	DC Return
8	DC Return
9	DC Return
10	DC Return
11	DC Return
12	DC Return

Signal Connector P6	
Pin	Function
1	+5V _{SB}
2	P_OK
3	-V2
4	PS_ON
5	RS+
6	RTN
7	+V2
8	RTN

Overall dimensions: (76.0 X 164.2 X 37.7) mm; (2.99 X 6.46 X 1.48) in

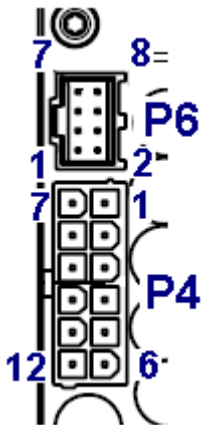
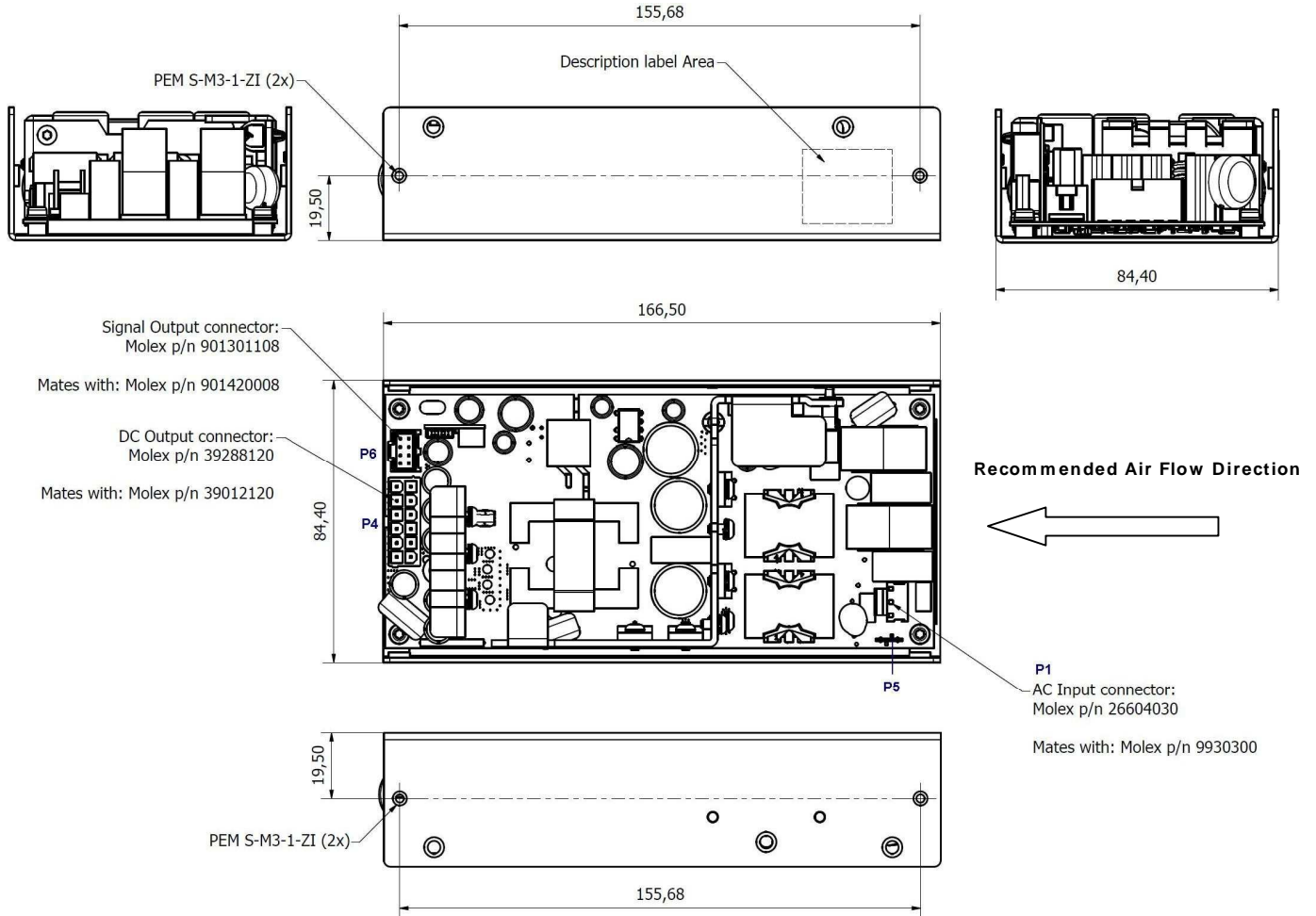
Weight: 410 g; 0.90 lb



OUTLINE DRAWING AND CONNECTIONS _ U-CHASSIS

Overall dimensions: (84.4 X 166.5 X 40) mm; (3.32 X 6.55 X 1.57) in

Weight: 525 g; 1.16 lb

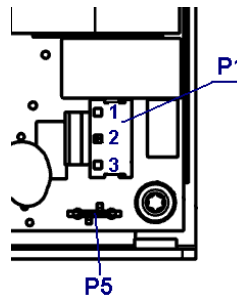


Signals Connector P6

Pin Ref.	Function
1	+5V _{SB}
2	P_OK
3	-V2
4	PS_ON
5	RS+
6	RTN
7	+V2
8	RTN

Output Connector P4

Pin Ref.	Function
1 - 6	+V1
7 - 12	V1 RTN



AC Input Connector P1

Pin Ref.	Function
1	Neutral
2	Not Present
3	Live

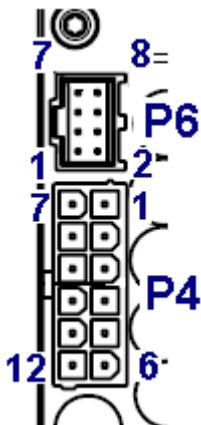
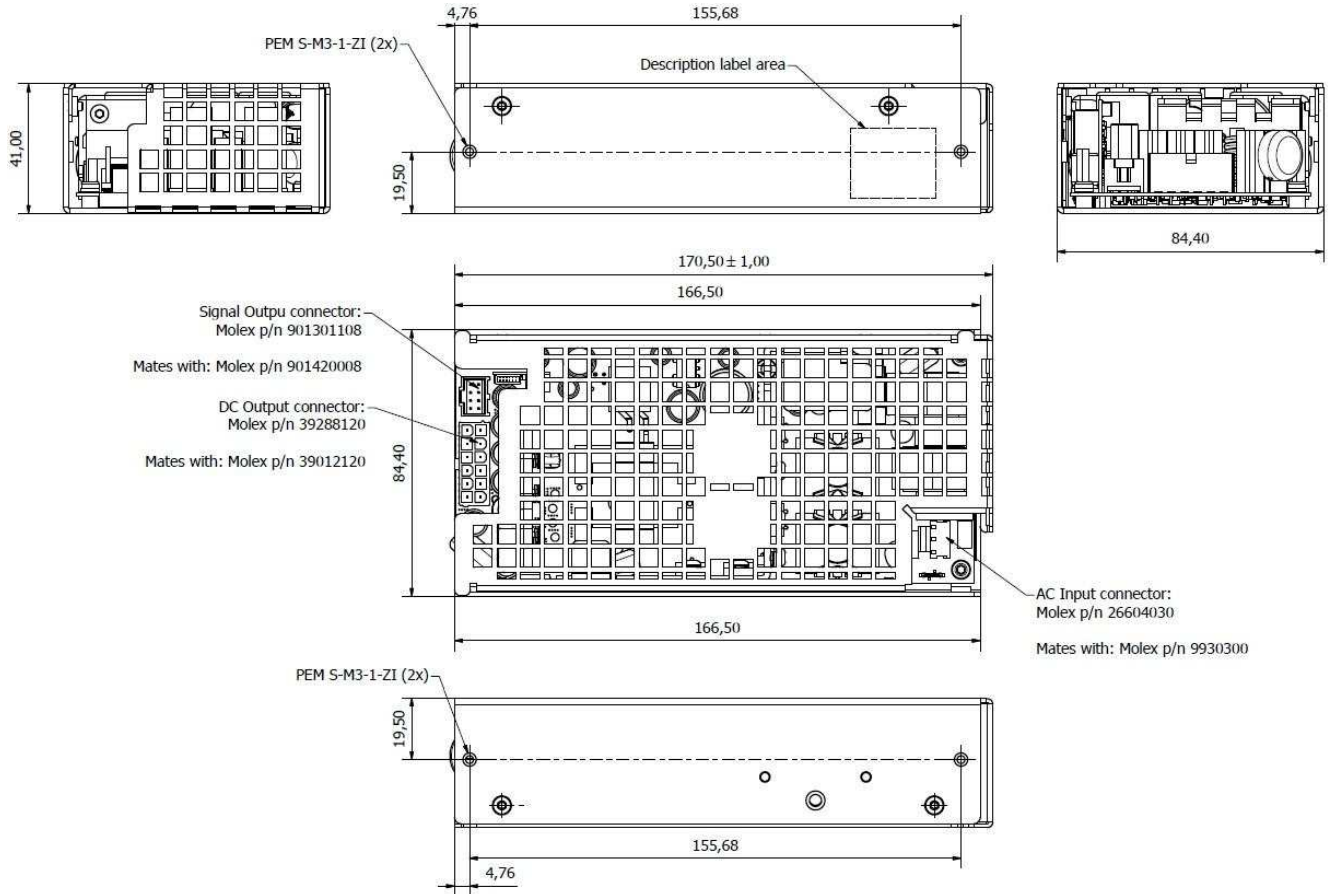
Protection earth P5

Protection Earth

OUTLINE DRAWING AND CONNECTIONS _ PUNCHED COVER

Overall dimensions: (84.4 X 170.5 X 41.0) mm; (3.32 X 6.71 X 1.61) in

Weight: 575 g; 1.43 lb

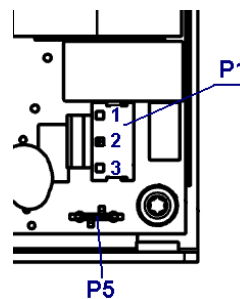


Signals Connector P6

Pin Ref.	Function
1	+5V _{SB}
2	P_OK
3	-V2
4	PS_ON
5	RS+
6	RTN
7	+V2
8	RTN

Output Connector P4

Pin Ref.	Function
1 - 6	+V1
7 - 12	V1 RTN



AC Input Connector P1

Pin Ref.	Function
1	Neutral
2	Not Present
3	Live

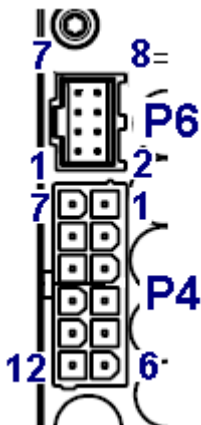
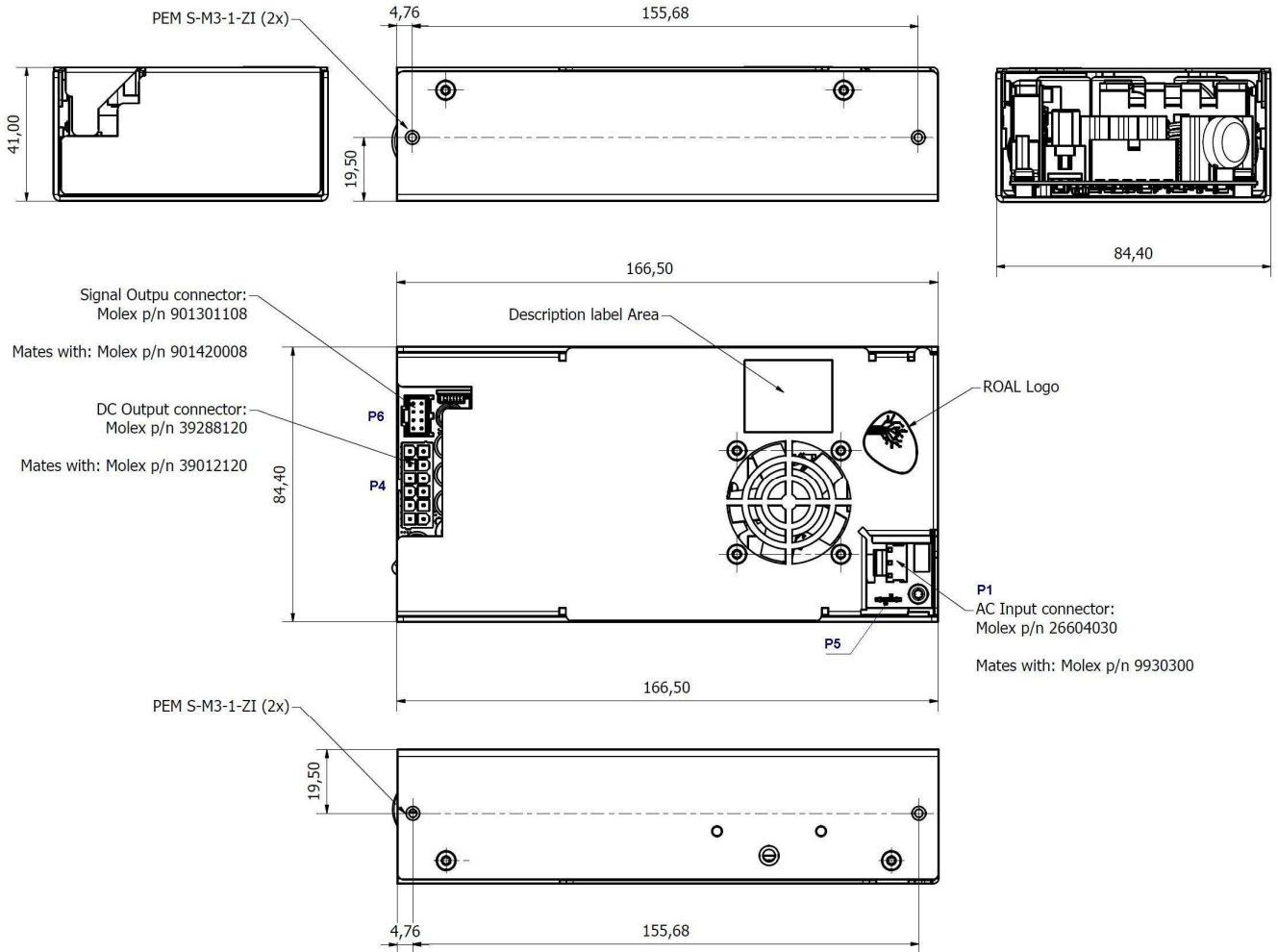
Protection earth P5

Protection Earth

OUTLINE DRAWING AND CONNECTIONS _ VENTED COVER

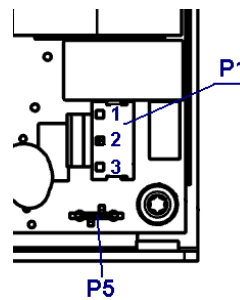
Overall dimensions: (84.4 X 166.5 X 41.0) mm; (3.32 X 6.55 X 1.61) in

Weight: 670 g; 1.48 lb



Signals Connector P6		
Pin Ref.	Function	
1	+5V _{SB}	
2	P_OK	
3	-V2	
4	PS_ON	
5	RS+	
6	RTN	
7	+V2	
8	RTN	

Output Connector P4		
Pin Ref.	Function	
1 - 6	+V1	
7 - 12	V1 RTN	



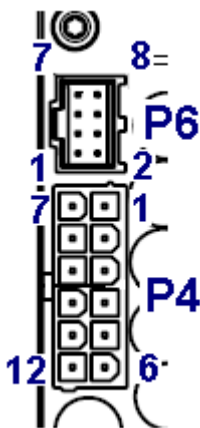
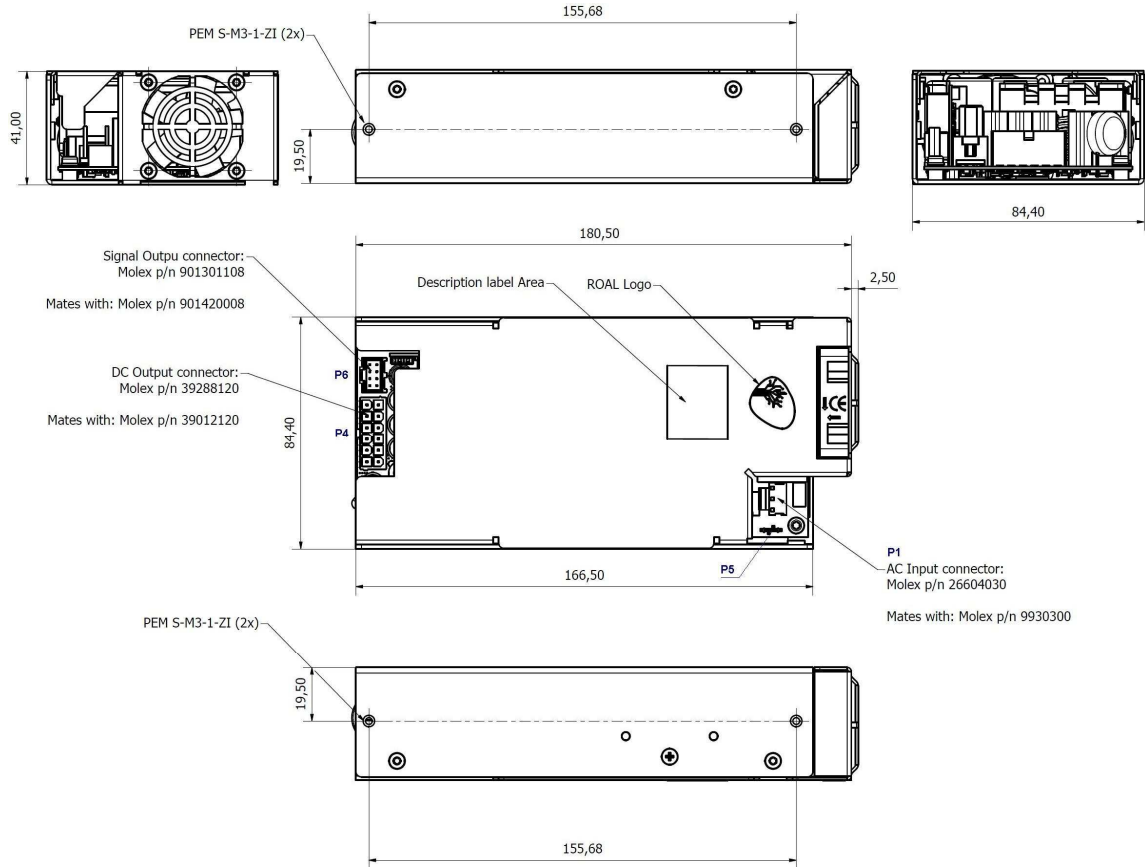
AC Input Connector P1		
Pin Ref.	Function	
1	Neutral	
2	Not Present	
3	Live	

Protection earth P5		
Protection Earth		

OUTLINE DRAWING AND CONNECTIONS _ FRONT FAN

Overall dimensions: (84.4 X 183.0 X 41.0) mm; (3.32 X 7.20 X 1.61) in

Weight: 685 g; 1.51 lb

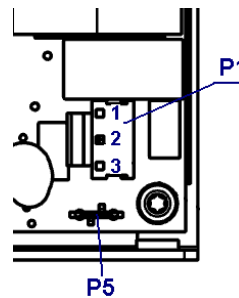


Signals Connector P6

Pin Ref.	Function
1	+5V _{SB}
2	P_OK
3	-V2
4	PS_ON
5	RS+
6	RTN
7	+V2
8	RTN

Output Connector P4

Pin Ref.	Function
1 - 6	+V1
7 - 12	V1 RTN



AC Input Connector P1

Pin Ref.	Function
1	Neutral
2	Not Present
3	Live

Protection earth P5

Protection Earth

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