

KEY FEATURES

- Universal input voltage range (90 – 264 V_{AC})
- 160 W rated power (100 W natural convection cooling)
- Compact standard form factor (2x4x1) in
- High efficiency (91% typical)
- 5, 12, and 24 V_{DC} standard output voltages
- Active PFC, EN61000-3-2 compliant (Class C, >50% load).
- Low earth / touch leakage current (<100 μA for Class II)
- Class I and Class II protection class variants
- Over temperature protection
- Over voltage protection
- Over Current and short circuit protection
- Auxiliary / fan 12 V_{DC}, 0.5 A output.
- Medical safety approval to IEC 60601-1 3rd edition
- IEC 60601-1-2 4th edition EMC compliant (Class II)
- RoHS 2 compliant (Directive 2011/65/EU)
- 4000 m altitude operation



DESCRIPTION

The MFA160 is a series of high efficiency, small form factor single output AC-DC medical approved power supplies. The 5V variant comes as IEC Class II and operator protection (MoOP), the 12V variant comes as IEC Class I and operator protection (MoOP), the 24V variant comes as both IEC Class I, MoOP and as IEC Class II, 2xMoPP patient protections. The series provide a steady 160 W of regulated DC power from an open-frame 2 x 4 x 1" standard form factor which makes easier its integration into space constrained systems. By converting energy at 91% typical efficiency, the series generate less heat which facilitating thermal management into a system. The series comes in 5, 12 and 24 V_{DC} standard output voltages and offers an auxiliary 12 V_{DC}, 0.5 A output. It can deliver full output power from -20 to 50 °C at 500 LFM airflow and can be operated up to 70 °C applying output power derating. When natural convection cooled, the 12, 24V variants can deliver a steady 100 W, and the 5V, 70 W up to 50 °C ambient. All MFA160 variants can be operated up to 4000 m without de-rating thanks to PCB Creepage and clearance greater than 8 mm. Protection features include fuses on both AC lines, output over-current, short-circuit, output over-voltage and over-temperature. The MFA160 series comply with the 3rd edition of the IEC/EN 60601-1 and ANSI/AAMI ES60601-1 safety standards for medical equipment. It meets the EN 60601-1-2 EMC limits of Class B for conducted emissions, the IEC/EN 61000-3 for harmonic content and EN 55011 / EN 60601-2 for EMC immunity.

MARKET SEGMENTS AND APPLICATIONS

- Class I / Class II medical equipment
- Laboratory / Analysis Equipment
- Portable / Home health care equipment
- Electromagnetic / Laser aesthetical appliances

MODEL CODING AND OUTPUT RATINGS

MFA	160	-USxx	-2 / -3	PP			
Medical grade	160 W Rated Power	Output voltages: 5, 12, 24 V	Class II IEC protection	2xMoPP Patient protection			
Available Model Numbers	V1 [V]	I1 ¹ Convection [A]	I1 ¹ Forced air [A]	V1 ² Ripple [mV]	V2 [V]	I2 ¹ Rated [A]	V2 ² Ripple [mV]
MFA160-US05-2	5	14	20	50	12	0.5	240
MFA160-US12	12	8.3	13.3	120	12	0.5	240
MFA160-US24	24	4.1	6.6	240	12	0.5	240
MFA160-US24-3 PP	24	4.1	6.6	240	12	0.5	240

¹ The combined output power of V1 and V2 must not exceed 70 W for the 5V and 100 W for the other variants, when natural convection cooled, up to 50 °C ambient. The combined output power of V1 and V2 must not exceed 100 W for the 5V and 160 W for other variants when forced air cooled at 500 LFM, up to 50 °C ambient. In both convection or forced air cooling de-rating applies above 50 °C ambient (see output power – ambient temperature graphs below).

² 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}
Input Frequency		47	50/60	63	Hz
DC Input Voltage		170	-	300	V _{DC}
Input Current	RMS at 90 V _{AC} , maximum load	-	-	2.3	A
Inrush Current	No damage at 230 V _{AC} , cold start/hot start.				
Fusing	2.5 A, Time Lag, 250 V on L and N	-	2.5	-	A
Efficiency	115 V _{AC} , full load (12, 24, 48 V)	-	90	-	%
	230 V _{AC} , full load (12, 24, 48 V)	-	91	-	%
No load Power Consumption	115 V _{AC}	-	2.5	-	W
	230 V _{AC}	-	2.3	-	W
Power Factor	At full rated load, 115 V _{AC} , 60 Hz	0.98	-	-	
	230 V _{AC} , 50 Hz	0.89	-	-	
Harmonic Current	Complies with EN-61000-3-2 Class D at 230 V _{AC} 50 Hz.				
Fluctuations and Flicker	Complies with EN-61000-3-3 at nominal voltages and full load.				
Earth Leakage Current	264 V _{AC} , 60 Hz, normal condition, Class II	-	-	100	μA
	264 V _{AC} , 60 Hz, normal condition, Class I	-	-	200	μA

OUTPUT SPECIFICATIONS

Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
V1 Set Point Accuracy			±1	-	%
V1 Output Power Rating	Natural convection	-	-	100	W
	500 LFM forced air	-	-	160	W
V2 Output Voltage	15% accuracy	10.2	12	13.8	V
V2 Output Current		-	-	0.5	A
V1 Voltage Adjustment Range		-	-	±5	%V1
Load Regulation	V _{AC} : nominal voltages V1 Load: 0 – 100% rated	-	-	±1	%V1
	V2 Load: 0 – 0.5 A	-	-	±5	%V2
Load-Line Cross Regulation	V _{AC} : 90 – 264 V _{RMS} V1: 0 – 100% load (V2 at 50% load)	-	-	±1	%V1
	V2: 0 – 0.5 A load (V1 at 50% load)	-	-	±15	%V2
V1 Line Regulation	V _{AC} : 90 – 264 V _{RMS}	-	-	±0.1	%V1
V1 Transient Response (Voltage Deviation)	50% load changes at 0.1 A/μs Recovery to regulation band within 1 ms	-	-	10	%V1
V1 Ripple and Noise	Peak-to-peak, 20 MHz BW.	-	-	1	%V1
Start-up Rise Time	90 < V _{IN} < 264, any load conditions.	0.2	-	5	ms
Start-up Delay	V1 in regulation after AC is applied	-	-	1000	ms
Turn-on Overshoot		-	10	-	%V1
Hold-up Time	At nominal V _{IN} , rated load, all models	16	-	-	ms
Minimum Load	V1, V2	0	-	-	A
Temperature Drift		-	±0.25	-	mV/°C

PROTECTION FEATURES

Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
Input Fuse	Time Lag 2.5 A, 250 V on L and N				
Over Current	Hiccup mode, auto-recovery	110	-	150	%I _{MAX}
Short Circuit	Hiccup mode, auto-recovery				
Over Voltage	Shut down, latch off mode	110	-	130	%V _{NOM}
Over Temperature	Shut-down, auto-recovery				
Isolation	I-to-O, Reinforced (-PP)	4000	-	-	V _{AC}
	V1-to-V2	100	-	-	V _{AC}
	I-to-PE (Class I), (-PP)	1500	-	-	V _{AC}
	O-to-PE (Class I), functional	500	-	-	V _{DC}
Creepage and Clearance		8	-	-	mm

 ENVIRONMENTAL SPECIFICATIONS

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
Operating Temperature (*)	No de-rating up to 50°C, 50% load at 70°C Linearly de-rate above 50 °C	-20	-	70	°C
Storage Temperature Range		-40	-	80	°C
Cooling (*)	5V: above 70 W output Other variants: above 100 W Output	200	-	500	LFM
Relative Humidity	Non-condensing	-	-	95	%
Operating Altitude		-	-	4000	m
Shock	Operating: 10 g, 11 ms, half sine, one shock input in each axes				
Vibration	Operating, sinusoidal: 0.5 g peak-to-peak, 10-300 Hz, 3 axes				
MTBF	>200000 hours (5V variant) at 75% Full Load, Nominal V _{AC} , 25 °C ambient MIL-HDBK-217-E-1				

(*) See de-rating curves below

 ELECTROMAGNETIC COMPATIBILITY (EMC) – EMISSIONS

Phenomenon	Conditions / Notes	Standard	Equipment/Performance Class
Conducted	115 V _{RMS} , 230 V _{RMS} . Maximum load.	EN 60601-1-2	B
Radiated	At 10 m distance	EN 60601-1-2	A
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.	EN 61000-3-2	D

 ELECTROMAGNETIC COMPATIBILITY (EMC) – IMMUNITY

Phenomenon	Conditions / Notes	Standard	Test Level	Performance criteria
	Reference standard for the medical version		EN 60601-1-2, 4 th Edition	
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, 80% AM, 3 m distance	EN 61000-4-3	3	A
Electric Fast Transient	±2 kV on AC power port ±1 kV on signal/control lines	EN 61000-4-4	3	A
Surge	±1 kV line-to-line ±2 kV line to earth ±0.5 kV for outdoor cables	EN 61000-4-5	3	A
Conducted RF Immunity	3 V _{RMS} , 0,15-80 MHz, 80% AM	EN 61000-4-6	3	A
Magnetic Field Immunity	50 and 60 Hz, 3 A/m			
Dips and Interruptions	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		B

 SAFETY AGENCIES APPROVALS

Certification Body	Safety standards and file numbers	Agency files references
UL / CSA	ANSI/AAMI ES60601-1 (2005 + C1:2009 + A2:2010); CAN/CSA C22.2 No.60601-1:2008	Ask EFORE for reference
CB Certification	IEC 60601-1 3rd edition + C1:2006 + C2:2007	Ask EFORE for reference
Nemko	EN 60601-1: 2006 + C1:2010 + A11:2011	Ask EFORE for reference
CE	Low Voltage Directive (LVD) 2014/35/EU RoHS2 Directive 2011/65/EU Electro-magnetic Compatibility (EMC) 2014/30/EU	Ask EFORE for reference

OUTLINE DRAWING, CONNECTIONS AND OUTPUT POWER DE-RATING

Overall dimensions:

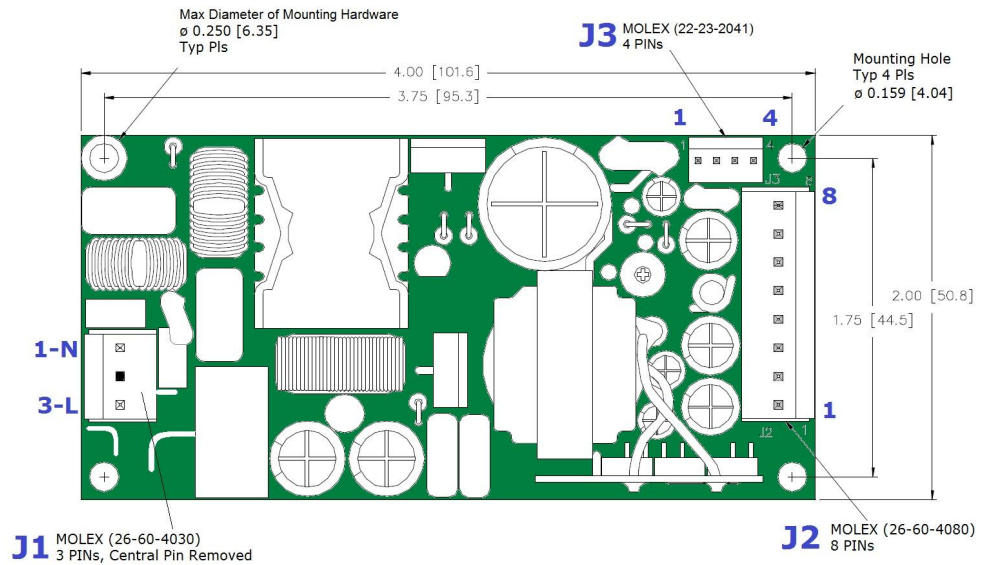
(50.8 X 101.6 X 27.5) mm

(2.00 X 4.00 X 1.08) in

Weight:

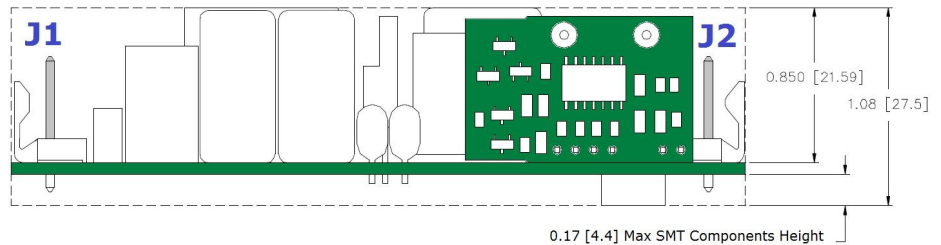
160 g

0.35 lb



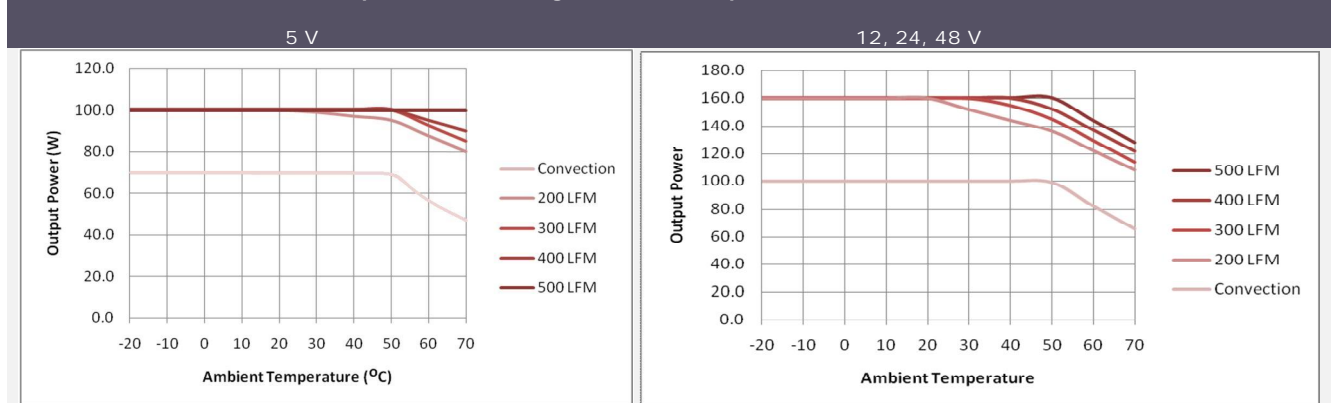
Forced air cooling:

Air flow direction, longitudinal or transverse, must be coplanar to the PCB no matter its orientation.



Connector	Manufacturer and Part Number	Pin Assignment
AC Input Connector J1	Molex 26-60-4030 or equivalent	1: AC Line 1; 2: Not present; 3: AC Line 2
J1 Mating Connector	Molex 09-93-0300 (Crimp Terminal Housing) Molex 08-50-0105 (Crimp Terminal, 18-24 AWG)	
Output Connector J2	Molex 26-60-4080 or equivalent	1 – 4: V1 RTN; 5 – 8: +V1
J2 Mating Connector	Molex 09-91-0800 (Crimp Terminal Housing) Molex 08-50-0105 (Crimp Terminal, 18-24 AWG)	
Auxiliary Connector J3	Molex 22-23-2041 or equivalent	1, 2: V2 RTN; 3, 4: +V2
J3 Mating Connector	Molex 22-01-2047 (Crimp Terminal Housing) Molex 08-50-0113 (Crimp Terminal, 22-24 AWG)	

Output Power De-rating vs Ambient temperature. $V_{IN}: 100 - 264 V_{RMS}$



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