

**2X MOPP MEDICAL, FAN-LESS SEALED PACKAGE, 600W AC-DC, POWER SUPPLY**

# MDP600 SC Series



**UV RESISTANT  
I/O CABLING**

**IP66  
IP67  
IP68**

## Certifications



## Applications



## FEATURES

- » Sealed enclosure, IP66/67/68 Ingress Protection grade
- » High efficiency (94% from 50% to 100% load)
- » Low stand-by power consumption (< 0.35 W)
- » Universal input voltage range (85 – 264 V<sub>AC</sub>)
- » Input inrush current limiting (<30 A)
- » 800 W peak power (up to 10 s)
- » Single 24 or 48 VDC output voltages
- » Active PFC, EN61000-3-2 compliant (Class C, >25% load)
- » Low earth / touch leakage current
- » Over temperature, OV, OC and SC protections.
- » Stand by +5 V, 1.5 A output.
- » Remote On / Off signal
- » Medical safety approval to IEC 60601-1 3rd edition,
- » 2xMoPP protection grade BF appliances compatible.
- » IEC 60601-1-2 4th edition EMC compliant.
- » RoHS 3 compliant (Directive 2015/863/EU)

## MARKET SEGMENTS AND APPLICATIONS

- » Clinical Analysers
- » Dental units / chairs
- » MRI / Full Body TC Systems
- » Medical Diagnostic & Imaging Systems

## PRODUCT DESCRIPTION

The MDP600 SC Series of medical grade AC-DC power supplies provide the compact form factor, ingress protection index and high efficiency that the marketplace demands.

It provides a steady 600 W of regulated DC power through the full 85 to 264 V<sub>AC</sub> input range, all in a 4.92 x 9.86 x 2.36" form factor.

The MDP600 SC series is available in an aluminium extruded chassis

having fins for an optimal heat dispersion via natural convection. Being its PWA assembling full potted within the enclosure, it offers a base plate that, once installed in contact with a system metallic frame, can be an effective path to dispel heat also through conduction helping thermal management.

The input / output connections are by flying wires fixed to the chassis through water tight glands which combined with the sealed enclosure give the power supply an IP66/67/68 ingress protection grade (IP68 characterized as 1 m depth for 40 days).

By converting energy at up to 94% efficiency, the MDP600 SC series generates less heat, facilitating optimal thermal management in space constrained environments, resulting in very high reliability.

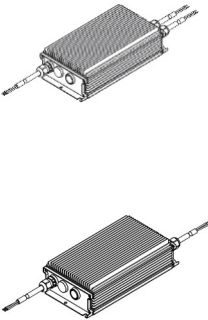
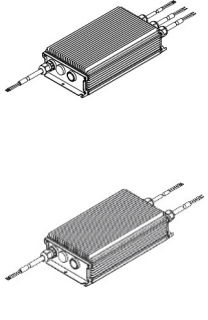
The MDP600 SC standard variant comes in 24 or 48 V<sub>DC</sub> single output voltages (28, 36 and 52 V<sub>DC</sub> can be developed upon project assessment).

The option variant (S) offers in addition, a +5 V<sub>DC</sub> stand-by output and the following control signals: +/- remote sense, remote On/Off (-PS\_Inhibit), power good (PS\_Ok), I-share (ISHARE1+V\_SLOGIC). The power unit can be operated in a -30 to 70 °C ambient temperature being the output power de-rated above certain limits depending on the input AC. It provides UV resistant Input / Output cabling.

Protection features include High Breaking capacity 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).

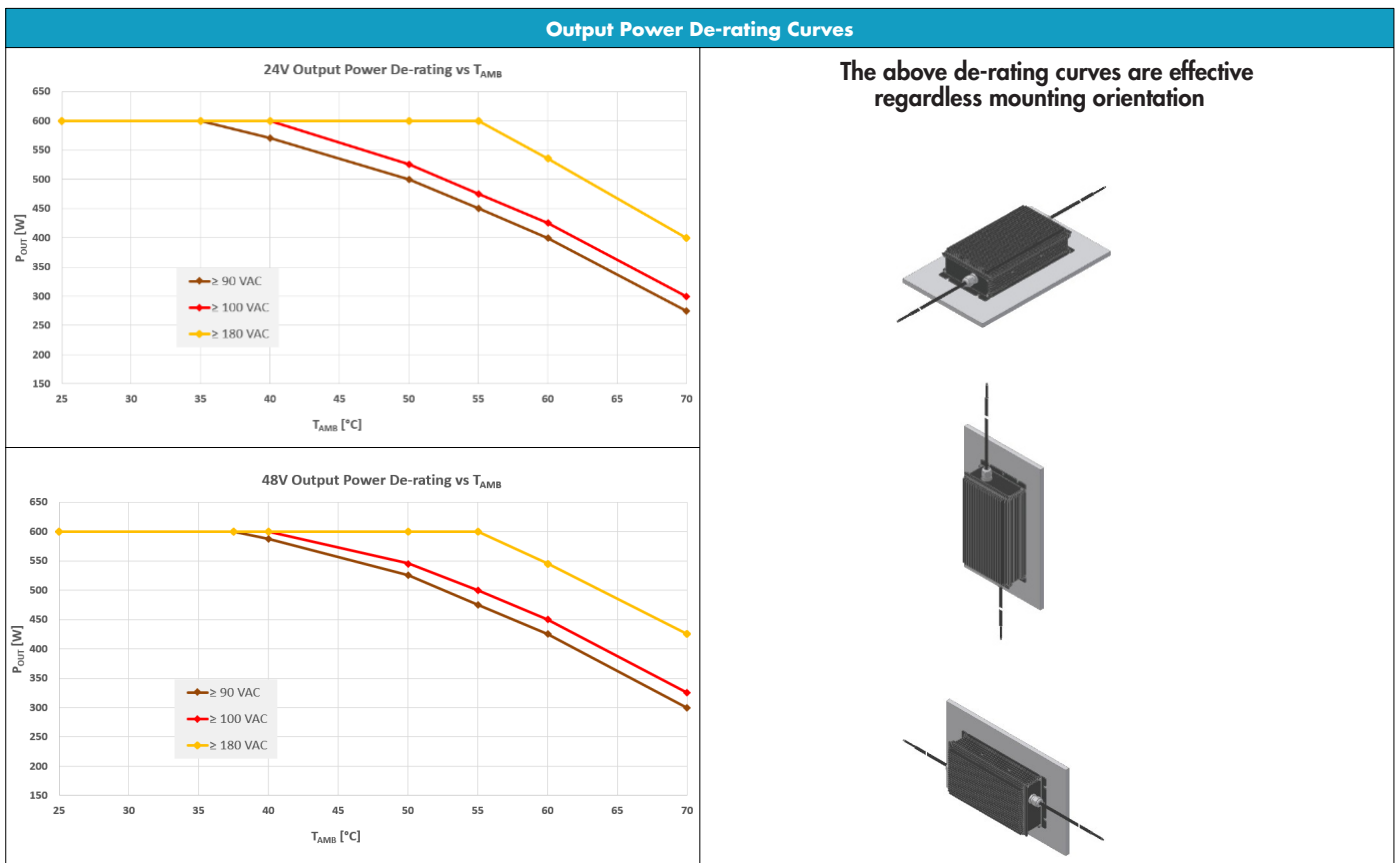
The MDP600 SC series complies with the 3rd edition of the IEC60601-1 safety standard for medical equipment, offers 2x MoPP means of patient protection and is suitable for BF rated applied parts. The MDP600 SC series meets the EN 55011 and EN 60601-1-2 EMC limits of Class B for conducted and radiated emissions as well as the IEC/EN61000-3, for harmonic and flicker, and IEC/EN 60601-1-2 4th edition for EMC immunity standards.

# Model Coding and Output Ratings

Model Grade and Output Power	Output Voltages		Packages	
ME: <b>MDP600-</b>	24 V <sub>DC</sub> : <b>US24-</b>  24 V <sub>DC</sub> : <b>US48-</b>	Sealed Chassis: <b>SC</b>	 Standard	 Signals: -S

Model Code	V1 Nominal [V <sub>DC</sub> ]	I1 Rated <sup>(1)</sup> [A]		I <sub>STBY</sub> Rated <sup>(1)</sup> [A]		Cooling [LFM]	Max Combined Output Power <sup>(1)</sup> [W]	
		55 °C	70 °C	55 °C	70 °C		55 °C	70 °C
<b>MDP600-US24-SC (-S)</b>	24	25	16.6	1.5	1.5	Natural Convection	600	400
<b>MDP600-US48-SC (-S)</b>	48	12.5	8.8	1.5	1.5	Natural Convection	600	425

<sup>1</sup> Rated currents and combined power are referred to 55 °C ambient and V<sub>AC</sub> ≥ 180 V<sub>RMS</sub>.



## Input Specifications

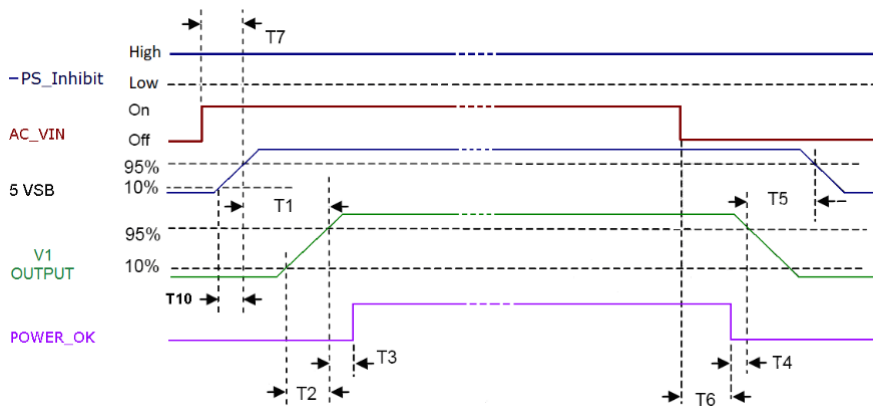
Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
AC Input Voltage	MoPP grade	85	100-240	264	$V_{RMS}$
	MoOP grade	85	100-277	305	
	PS starts and operates at 85 $V_{AC}$ at all load conditions				
DC Input Voltage	Built in fuses has been safety certified up to 250 $V_{DC}$ . Operating the MDP600 above that limit up to 300 $V_{DC}$ does require an external fuse protection.	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	-	-	4.0	A
	RMS at 85 $V_{AC}$ , maximum load, 50 / 60 Hz			8.5	
Inrush Current (peak)	Cold start, 25 °C ambient, full load				A
	115 $V_{AC}$	-	-	20	
	230 $V_{AC}$	-	-	30	
Fusing	High breaking, 10A, 250V on each AC lines.	-	-	10	A
Efficiency	<b>At 115 <math>V_{AC}</math>,</b>				%
	20% rated load	-	89	-	
	50% rated load	-	93	-	
	100% rated load	-	92	-	
	<b>At 230 / 264 <math>V_{AC}</math>,</b>				
	20% rated load	-	90	-	
50% rated load	-	94	-		
100% rated load	-	94	-		
Input Power Consumption	Power on, 115 $V_{AC}$ , no load	-	-	5	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, 230, 115 $V_{AC}$ , 50 / 60 Hz input voltages.	1.12	-	-	-
THDi	From 50 to 100% rated load, 115, 230, 264 $V_{AC}$ 50 / 60 Hz.	-	-	20	%
Harmonic Current Fluctuations and Flicker	Complies with EN 61000-3-2 at 230 $V_{AC}$ , 50/60 Hz, Class A, D. Complies with EN 61000-3-2 Class C at 230 VAC, 50/60 Hz, >150 W load. Complies with EN 61000-3-3 at nominal voltages and full load.				
Earth Leakage Current	Normal conditions				$\mu A$
	115 $V_{RMS}$ , 60 Hz	-	170	-	
	230 $V_{RMS}$ , 50 Hz	-	290	-	
	264 $V_{RMS}$ , 60 Hz (worst case)	-	-	460	

## Output Specifications

Specification	Test Conditions / Notes	Min.	Nom.	Max.	Units
<b>V1 Output Voltages</b>	±0.5% set point accuracy RS+ closed on +V1, RS- closed on V1 RTN, at 20% load on option variant (S).	- -	24 48	- -	V
<b>V1 Output Power Rating</b>	Convection cooling (Refer to the de-rating curves above) Peak (less than 10 s, after P_OK high)	- -	- -	600 800	W
<b>5V<sub>SB</sub> Output Voltage</b>	±3% set point accuracy, 20% load.	-	5	-	V
<b>5V<sub>SB</sub> Output Current</b>		-	-	1.5	A
<b>V1 Voltage Adjustment Range</b>	Factory calibration upon customer request	-	-	±5	%V1
<b>V1 Load-Line-Cross Regulation</b>	$V_{AC}: 85 - 264 V_{RMS}; I_{OUT}: 0 - 100\%$	-	-	±2	%V1
<b>5V<sub>SB</sub> Load-Line-Cross regulation</b>	$V_{AC}: 85 - 264 V_{RMS}; I_{5SB}: 0 - 100\%$	-	-	±5	%5V <sub>SB</sub>
<b>V1 Line Regulation</b>	$V_{AC}: 85 - 264 V_{RMS}$	-	-	±0.1	%V1
<b>Transient Response: V1, 5V<sub>SB</sub> Voltage Deviation</b>	25% load changes at 1 A/μs 24V at 1000 μF load / $I_{OUT} > 2.5 A$ 48V at 560 μF load / $I_{OUT} > 1.25 A$ 5V <sub>SB</sub> at 560 μF load / $I_{OUT} > 0.1 A$	-	-	±5	%V1 %5V <sub>SB</sub>
<b>V1 Ripple and Noise</b>	Rated load, Peak-to-peak, 20 MHz BW. (100 nF ceramic, 10 μF tantalum at load)	-	-	1	%V1
<b>V1 Start-up Rise Time</b>	$85 < V_{IN} < 264$ , any load conditions.	10	-	100	ms
<b>Start-up Delay</b>	V1 in regulation after de-asserting PS_Inhibit V1 in regulation after AC is applied (worst case: 85 V <sub>AC</sub> ) 5V <sub>SB</sub> in regulation after AC is applied (worst case: 85 V <sub>AC</sub> )	- - -	- - -	450 2050 1500	ms
<b>Turn-on Overshoot</b>		- -	- -	10 10	%V1 %V <sub>SB</sub>
<b>V1 Hold-up Time</b>	At nominal V <sub>IN</sub> , full load	16	-	-	ms
<b>Minimum Load</b>	V1 and 5V <sub>SB</sub>	0	-	-	A
<b>Maximum Load Capacitance</b>	V1: 24 V <sub>DC</sub> V1: 48 V <sub>DC</sub>	- -	- -	16000 8000	μF
<b>V1 Current Sharing Accuracy</b>	Two units in parallel at I1 rated load. VS-Logic and I-Share signals connected together. RS+, RS- signals connected together and to the load.	45.5	-	54.5	%I1

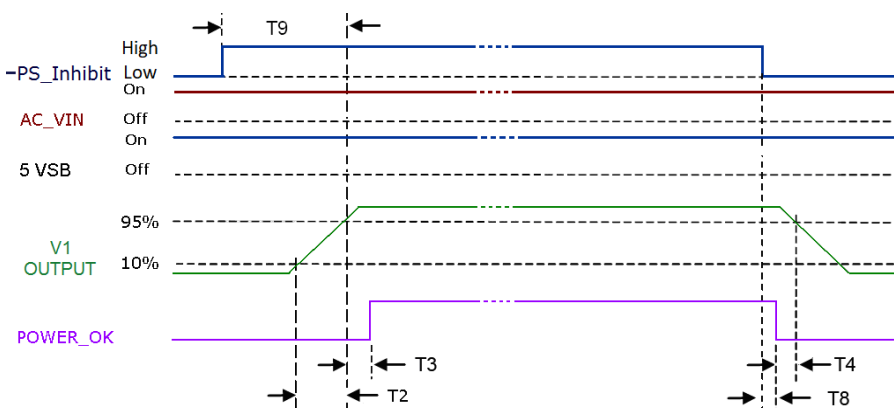
## Signals / Controls and Timing

Signal	Notes	Min	Typ.	Max	Unit
<b>-PS_Inhibit</b>	Active low. Input low voltage	0	-	1.5	V
	Input high voltage (IIN= 300 $\mu$ A)	3.5	-	5.5	V
	V1 disabled when -PS_Inhibit is pulled low				
	5V <sub>SB</sub> not affected by -PS_Inhibit				
<b>P_OK2</b>	V1 enabled when -PS_Inhibit is floating or high				
	Logic level low (<10 mA sinking)	-	-	0.7	V
	Logic level high (100 $\mu$ A sourcing)	2.4	-	5.5	V
	Low to high time after V1 in regulation	40	-	350	ms
<b>5V<sub>SB</sub> Output</b>	Power down warning time	1	-	-	ms
	Active and in regulation after a $85 < V_{AC} < 264$ is applied	-	-	1500	ms
	5V <sub>SB</sub> not affected by PS_Inhibit				



Above waveforms are expected with AC Input ON/OFF:

5V <sub>SB</sub> On – V1 On	250 ms ≤ T1 ≤ 550 ms
V1 rise time	10 ms ≤ T2 ≤ 100 ms
5 V <sub>SB</sub> Rise Time	3 ms ≤ T10 ≤ 40 ms
V1 On – POWER_OK delay	200 ms ≤ T3 ≤ 350 ms
Power down warning	T4 ≥ 1 ms
V1 Off – 5V <sub>SB</sub> Off	T5 ≥ 0.5 s (V1 load > 25 W)
AC Off – POWER_OK low	T6 ≥ 15 ms
AC_On – 5V <sub>SB</sub> turn on time	T7 ≤ 1.5 s



Above waveforms are expected with PS\_Inhibit Signal On/Off state change:

V1 rise time	10 ms ≤ T2 ≤ 100 ms
V1 On – POWER_OK delay	200 ms ≤ T3 ≤ 350 ms
Power down warning	T4 ≥ 1 ms
PS_Inhibit – POWER_OK low timing	T8 ≤ 2 ms
PS_Inhibit – V1 On delay	T9 ≤ 450 ms

## Protection Features

Specification	Test Conditions / Notes	Min.	Nominal	Max.	Units
Input Under Voltage	Auto-recovering	58	65	75	V <sub>AC</sub>
Input Fuse	High breaking, 10A, 250V on L and L1.	-	-	10	A
Over Current	At nominal input voltages				
	V1: Hiccup mode, auto-recovering (>10 s)	108	-	132	%I <sub>Rated</sub>
	V1: Hiccup mode, auto-recovering (<10 s)	135	-	163	%I <sub>Rated</sub>
	5V <sub>SB</sub> : Hiccup mode, auto-recovering:	1.6	-	3.6	A
Short Circuit	At nominal input voltages				
	V1: Hiccup mode, auto-recovering.	-	-	-	
	5V <sub>SB</sub> : Hiccup mode, auto-recovering.				
Over Voltage	V1, Power shut down, latch off.	120	-	145	%V <sub>NOM</sub>
	5V <sub>SB</sub> : Hiccup mode, auto-recovering.	-	-	150	
Over Temperature (on primary stage)	Shut down, latch off.	-	-	-	°C
Over Temperature (on secondary side)	Hiccup mode, auto-recovering.	-	-	-	°C
Isolation: Primary-to-Secondary	Reinforced (2xMoPP)	5660	-	-	V <sub>DC</sub>
		4000	-	-	V <sub>AC</sub>
Isolation: Input-to-Earth	Basic (1xMoPP) Production tested at 2121 V <sub>DC</sub>	2121	-	-	V <sub>DC</sub>
		1500	-	-	V <sub>AC</sub>
Isolation: V1-to-5V <sub>SB</sub>	Basic	100	-	-	V <sub>AC</sub>
Isolation: Output-to-Earth	Basic (1xMoPP)	1500	-	-	V <sub>AC</sub>
Equipment Protection Class	Class I				

## Environmental Specifications

Specification	Test Conditions / Notes	Min	Nominal	Max	Units
Operating Temperature Range	No de-rating up to 55°C, at ≥ 180 V <sub>AC</sub>	-30	-	55	°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	Medical grade MoPP (100-240 V <sub>AC</sub> , 50/60 Hz)	-	-	4000	m
	Medical grade MoOP (100-277 V <sub>AC</sub> , 50/60 Hz)			5000	
Shock	<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).				
Vibration	<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 gRMS, 3 axes, 30 min. Non-Operating: 5 – 500 Hz, 2.46 gRMS (0.0122 g <sup>2</sup> /Hz), 3 axes, 30 min.				
MTBF	Full Load, 40 °C ambient 80% Duty cycle, Telcordia SR-332 Issue 2	200.00.00	-	-	Hours
Useful Life	Worst nominal V <sub>IN</sub> , 80% load, 40 °C ambient	-	10	-	Years

## Electromagnetic Compatibility (EMC) – Emissions

Phenomenon	Conditions / Notes	Standard	Equipment/Performance Class
Conducted	115, 230, 277 V <sub>RMS</sub> . Maximum load.	EN 55011 (ISM) EN 60601-1-2 (Medical) FCC Part 15	B
Radiated	The "S" variant compliance to the Class B is conditioned by the use of a common ground plane between the power supply and its load	EN 55011 (ISM) EN 60601-1-2 (Medical) FCC Part 15	B
Line Voltage Fluctuation and Flicker	At 20%, 50% and 100% maximum load. Nominal input voltages	EN 61000-3-3	
Harmonic Current Emission	230 V <sub>AC</sub> input voltage, 50 / 60 Hz 230 V <sub>AC</sub> 50 / 60 Hz, >150 W load	EN 61000-3-2 EN 61000-3-2	A, D C

## Electromagnetic Compatibility (EMC) – Immunity

Phenomenon	Conditions / Notes	Standard	Test Level	Criteria
	<b>Reference standard for the medical version</b>	<b>EN 60601-1-2 4<sup>th</sup> edition</b>		
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	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 <sub>RMS</sub> , 0,15-80 MHz, 1 kHz, 80% AM	EN 61000-4-6	3	A
Dips and Interruptions	<b>200 – 277 V<sub>AC</sub>:</b> Drop-out to 0% for 10 ms Dip to 40% for 5 cycles (100 ms) Dip to 70% for 25 cycles (500 ms) Drop-out to 0% for 5 s	EN61000-4-11 EN61000-4-11 EN61000-4-11 EN61000-4-11		A A A B
	<b>100 – 127 V<sub>AC</sub>:</b> Drop-out to 0% for 10 ms Dip to 40% for 5 cycles (100 ms) Dip to 70% for 25 cycles (500 ms) Drop-out to 0% for 5 s	EN 61000-4-11 EN 61000-4-11 EN 61000-4-11 EN 61000-4-11		A A (de-rate to 150 W) A (de-rate to 400 W) B

## Safety Agencies Approvals

Certification Body	Safety Standards and file numbers	Category
CSA/UL	CSA C22.2 No.60601-1, ANSI/AAMI ES60601-1 3rd edition + A1 Including Risk Management Assessment	Medical
IEC IECCE CB Certification	IEC/EN 60601-1 3rd edition+A1 Including Risk Management Assessment	Medical
CE	Directive 93/42/CEE: Safety Requirement of the Medical Device	Medical
	Directive 2014/30/EU: Electromagnetic Compatibility (EMC)	
	Directive 2015/863/EU: RoHS 3	
Designed to meet IEC/EN/UL/CSA 61010-1 2 <sup>nd</sup> edition		

# Outline Drawing and Connections

**OVERALL DIMENSIONS:** 125.0 x 250.5 x 60.0 mm (4.92 x 9.86 x 2.36 in)  
**WEIGHT:** Standard 2770 g (6.11 lb); Signals (-S) 2850 g (6.28 lb)

**SC Series**

**Standard Series**

**Signals Series (-S)**

**Input cable**

WIRE COLOR	FUNCTION
BLACK	Line
GREEN	PG
WHITE	Neutral

**OutputCable**

WIRE COLOR	FUNCTION
RED	+ V1
BLUE	V1 RTN

**24 V**

**48V**

**OutputCable**

WIRE COLOR	SIGNAL NAME
BLACK	RTN
RED	+5V <sub>SB</sub>
BROWN	RS-
GREEN	P OK
YELLOW	-PSINHIBIT
GREY	VS LOGIC
BLUE	I SHARE 1
WHITE	RS+

**24 V**

**48V**

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