IMA PLUS 2000 Watts Power Supply Series
for medical and industrial applications

Application Note

⚠ **NOTE**

This product is only for installation by professional electricians within other equipment and must not be operated as a standalone product.

Table of Contents

1. Features

- Safety rated for Medical, Industrial and IT
- Wide operating input voltage range: 80 Vac to 275 Vac or 120 Vdc to 300 Vdc
- Wide adjustable output voltage range (+/- 20%)
- 5 Vdc standby output
- High efficiency: up to 94%
- Size: 309.6 x 127 x 40.6 mm
- Variable speed fan control
- 3000W peak power (up to 5s)
- Standby power < 2Watt
- Low acoustic noise level of less than 39 dB(A)
- Active current sharing
- 2 × MOPP
- PMBus™ compatible for control, programming and monitoring
- 500,000 hour MTBF
- Optional conformal coating
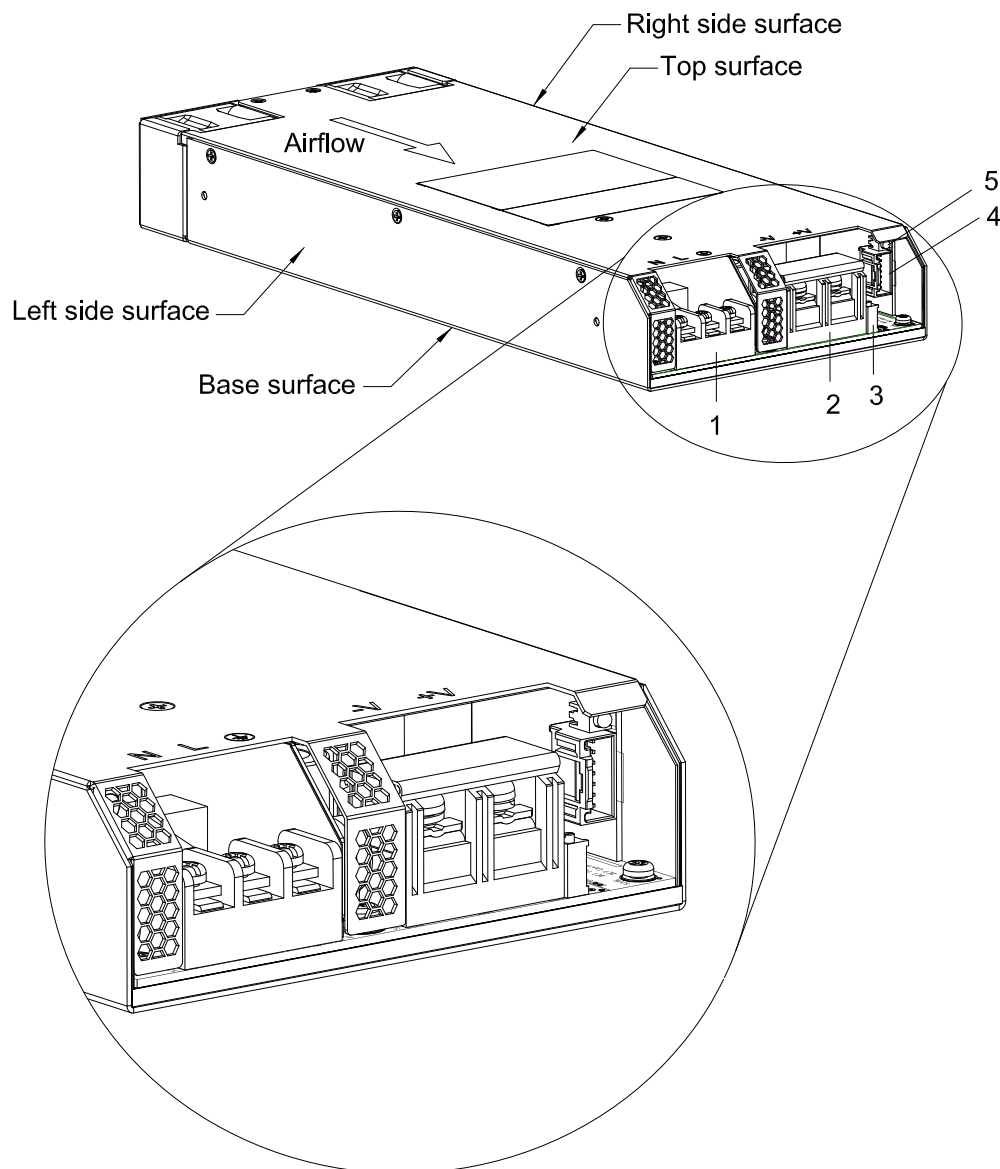- 3 years warranty

2. Overview

Fig. 1: Components of the IMA-S2000

1. AC/DC input terminal block (J1)
2. DC output terminal block (J2)
3. Output voltage adjustment potentiometer
4. Signal connector and Auxiliary DC Output (J3)
5. Green status LED
6. Fans

2.1 AC/DC Input terminal block (J1)

J1 is the input connector, a standard screw type 3-pin connector with clamp washer and a terminal centres pitch distance of 11 mm.
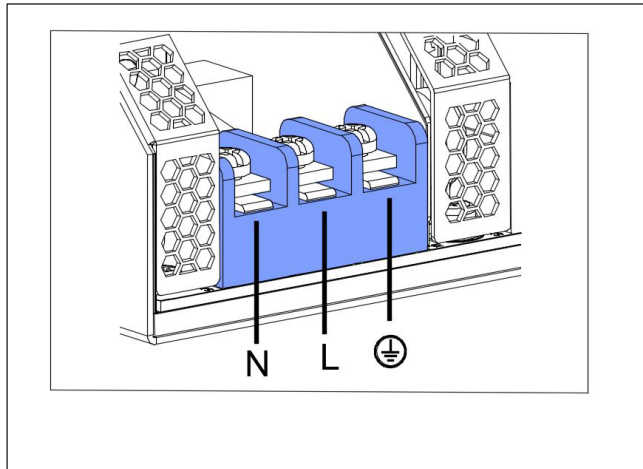

Fig. 2: AC/DC Input terminal block (J1) - pin assignment

Pin	Assignment
N	Neutral
L	Line (Phase)
⏚	Ground/Earth

Table 1: AC/DC input terminal block (J1) - pin assignment

Wire range: 12-14 AWG

Screw torque: 1.8 Nm (16 lb-in)

Screws are suitable for slotted and Phillips head screwdrivers.

2.2 Main DC Output terminal block (J2)

J2 is the output connector, a standard screw type 2-pin connector with clamp washer and a terminal centres pitch distance of 19 mm.
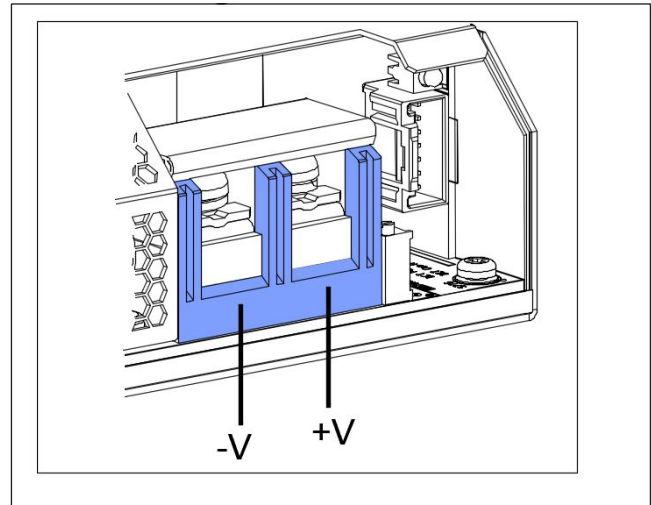
Fig. 3: Main DC Output terminal block (J2) - pin assignment

Pin	Assignment
-V	Main DC Return
+V	Main Output +

Table 2: DC output port (J2) - pin assignment

Wire range: 4-10 AWG

Screw torque: 2.4 Nm (21.24 lb-in)

2.3 Output voltage adjustment potentiometer

The **Output voltage adjustment potentiometer** is for output voltage adjustment within the range of specifications.

Fig. 4: Output voltage adjustment potentiometer

Model	Output voltage	
	Nominal	**Adjustment Range**
IMA-S2000-24	24 V	19.2 V to 28.8 V
IMA-S2000-48	48 V	38.4 V to 57.6 V

Table 3:   Output voltage adjustment range

2.4   Signal port and Auxiliary DC Output (J3)

Fig. 5:   Signal port and Auxiliary DC Output (J3)
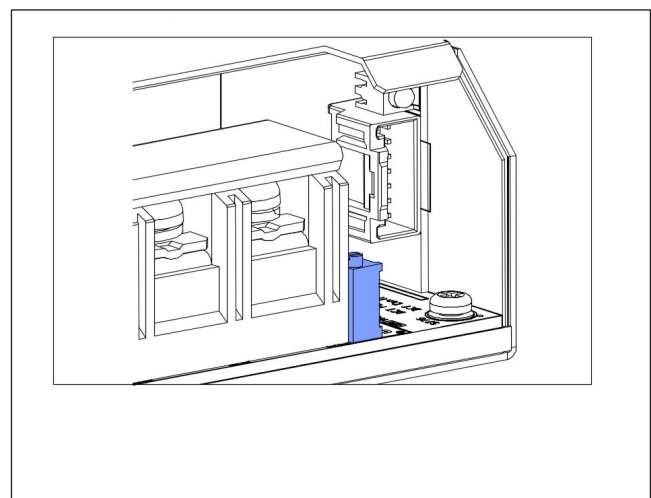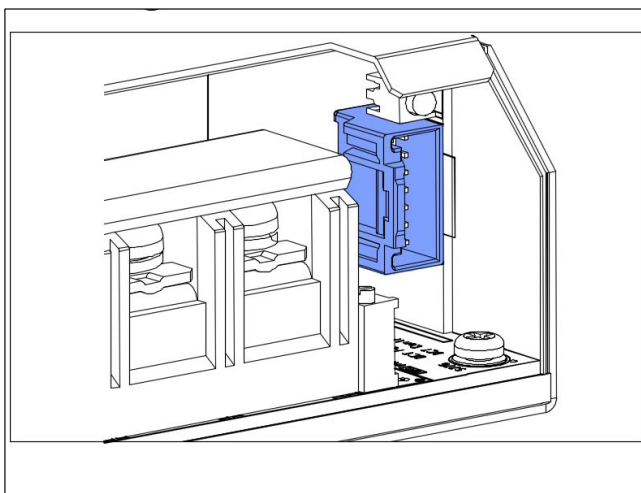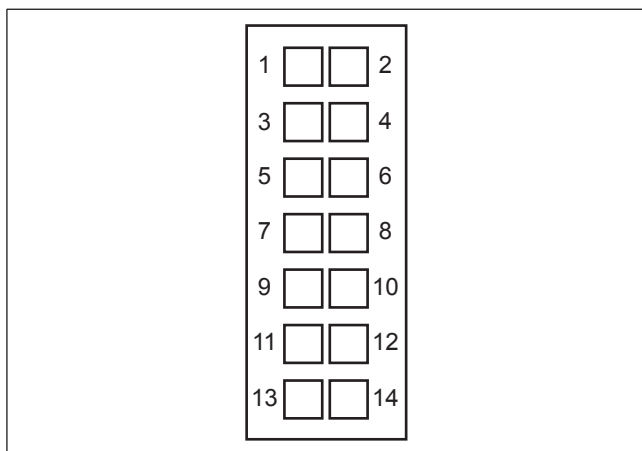

Fig. 6:   Signal port and Auxiliary DC Output (J3) - Pin assignment

Pin	Assignment	Usage
1	+5VSB	+5 V standby
2	+5VSB	+5 V standby
3	5VSB_RTN	5 V standby return
4	5VSB_RTN	5 V standby return
5	SCL	Serial Clock Line
6	SDA	Serial Data Line
7	AC_GOOD	
8	REMOTE +	Remote On/Off pin
9	PWR_GOOD	See *"Power Good", p. 8*
10	REMOTE -	Remote On/Off pin
11	Current_Share_V	I2C Slave address p.10
12	Address	
13	+V_SENSE	See *"Remote +V_SENSE, -V_SENSE", p. 8*
14	-V_SENSE	

Table 4:   Signal port and Auxiliary DC Output (J3) - Pin assignment

On the end product, it is recommended to connect all 3 pins **+5VSB** together and all 3 pins **5VSB_Return** together.

2.5   Green status LED

The **Green status LED** indicates the status of the **Power Supply Unit**.
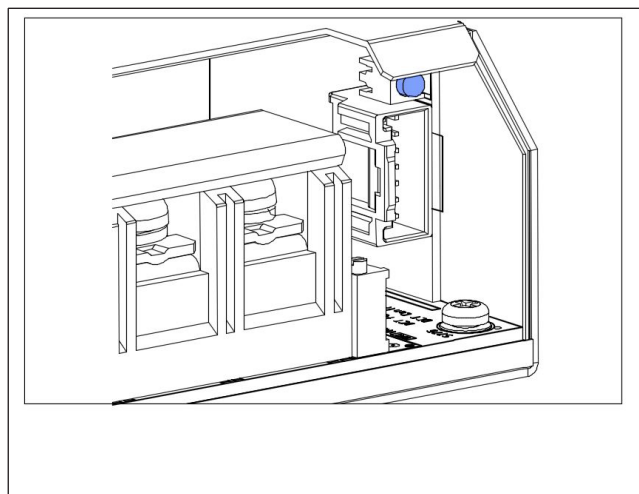

Fig. 7:   Green Status LED

LED status	Assignment
OFF	No AC power available
Blinking	AC Present / +5VSB on (Main DC Output OFF)
ON	Power Supply ON and OK

Table 5:   Status LED

3. Electrical functions

3.1 Input requirements

The AC input voltage and the DC input voltage must be in the defined voltage ranges (*see data sheet*). Otherwise, the power supply may not work properly or even fail. The maximum investigated branch circuit rating is 25 A. Therefore, a 25 A breaker should be used for medical applications.

3.2 Output requirements

Main DC Output

Output current and power of the end product must not exceed the rated/specified values at any value of output voltage. The output current must not exceed the maximum output current.

Auxiliary DC Output

The **Auxiliary DC Output** supports a maximum current of 2 A.
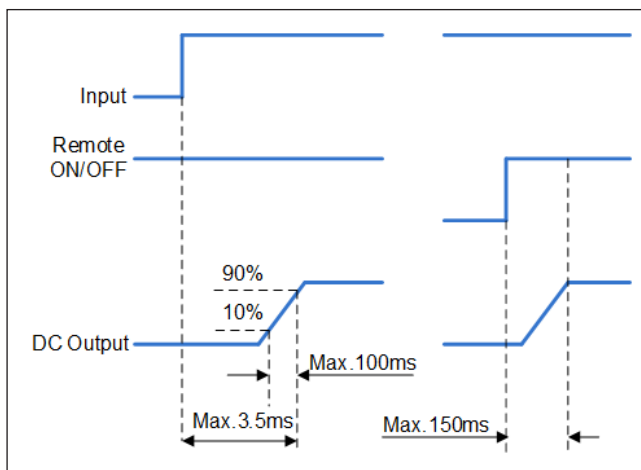
3.3 Start-up timing

Fig. 8:   Start-up timing YYPLI-Model

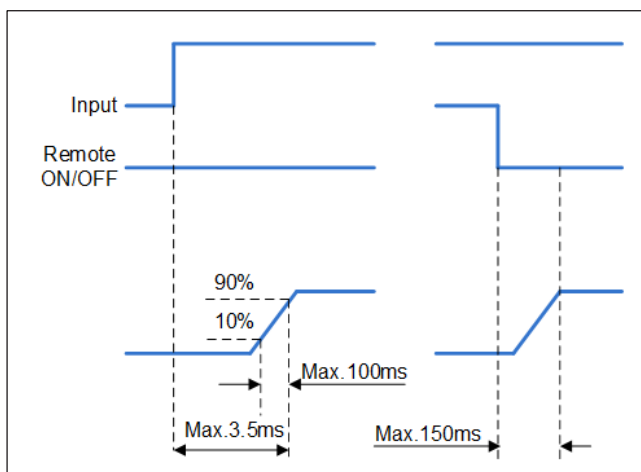*Fig. 9:   Start-up timing YYPLY-Model*

3.4 No-load operation

A no-load condition causes no damage, hazardous condition or reduction in performance.

3.5 Fan Speed Control

The maximum fan speed is limited to make sure the acoustical noise is less than 39 dB(A) at the condition of 100 VAC, 100 % load and 30 °C ambient temperature. Fan speed varies linearly with the temperature.

To keep the noise low the fan will be turned in standby mode.

3.6 Output over voltage protection (OVP)

Main DC Output

The *Output Over Voltage Protection (OVP)* function shuts down **Main DC Output** when the output voltage reaches the protected voltage.

The settings for the *OVP* function cannot be changed.

Resetting the OVP function for the Main DC Output

Disconnect the power supply from the supply voltage for a few seconds, then re-connect.

or

Set the *Remote ON/OFF* function from *OFF* to *ON*.

Auxiliary DC Output

The **Auxiliary DC Output** is shut off when the output voltage exceeds 6 Vdc (typical). To reset OVP, turn the input voltage off and on.

3.7 Output over current protection (OCP)

When the output current exceeds 115% (typical) of the maximum output current, the **Main DC Output** is switched off.

The characteristic of the *OCP* function is a hiccup mode. The **Main DC Output** automatically recovers when the overload condition disappears.
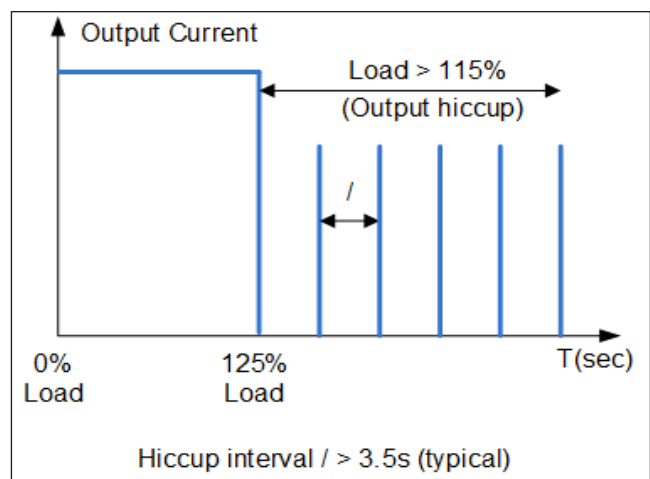

Fig. 10: Hiccup mode

The settings for the *OCP* function cannot be changed by the user.

If you need to adjust the settings for the *OCP* function, please contact Delta.

3.8   Short circuit protection (SCP)

The *Short Circuit Protection (SCP)* function will shut down the **Power Supply Unit** when a short circuit is applied to the **Main DC Output** or to the standby power.

The characteristic of the *SCP* function is a hiccup mode.

After removing the short circuit, the **Power Supply Unit** returns to normal operation.

3.9   Over temperature protection (OTP)

The *Over Temperature Protection (OTP)* function shuts down **Main DC Output** and **Auxiliary DC Output** when the temperature of components inside the **Power Supply Unit** is too high.

The OTP function will also occur, and the **Main DC Output** be shutdown, when a fan fails or the air flow of the fans is blocked.

Restarting after OTP shutdown

In case of an output power reduction by the *OTP* function, perform the following steps:

1. Turn off the input voltage.
2. Eliminate all conditions causing overheating.
3. Let the **Power Supply Unit** cool down.
4. Turn on the input voltage.

3.10   Output power derating versus ambient temperature

When output voltage is > 48 Vdc, the output current is reduced by 0.75 A per 1 V.

When output voltage is > 24 Vdc, the output current is reduced by 3.3 A per 1 V.

3.11   Remote ON/OFF

The power supply can be turned on/off by setting up a defined voltage level to pin Remote +, 8 and Remote -, 10 on Connector J3. SW1 and SW2 are used for this. please see Fig 11.

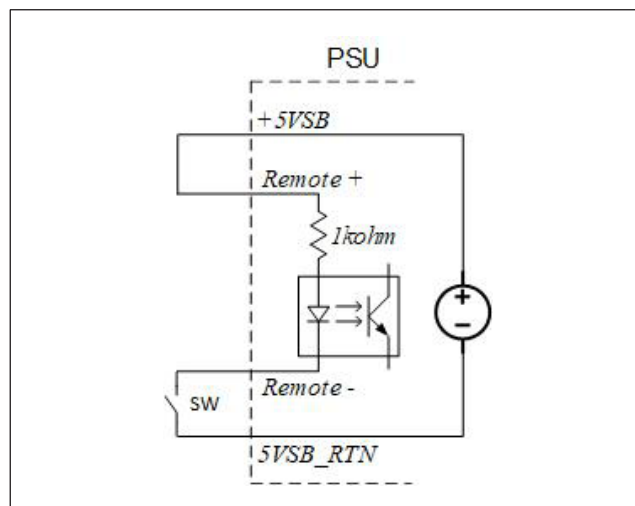An external pull up resistor with 220 Ω is connected to +5V power.

Fig. 11: Remote ON/OFF Pin 1a
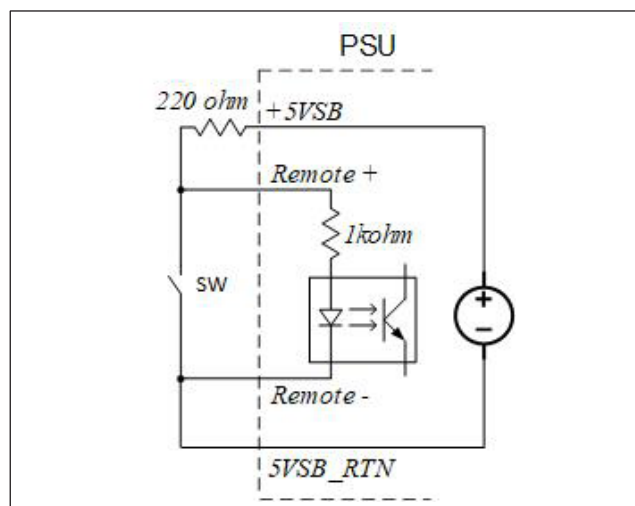
Fig. 12: Remote ON/OFF Pin 1b

The **Auxiliary DC Output** is not affected by the *Remote ON/OFF* function. The **Auxiliary DC Output** will always be on if the AC input voltage is applied, regardless of the status of the *Remote ON/OFF* signal.

3.12   AC Good

AC Good (AC_GOOD) is used to indicate presence of the AC input. The logic "High", shall indicate the AC input is present. The logic "Low" shall indicate the loss of the AC input.

Fig. 13: PWR_GOOD/AC_GOOD - function Timing

3.13 Power Good

This signal must be connected to 5Vsb through a resistor on the system side. The maximum voltage for AC_Good is 30 V. The maximum sink current is 1 mA.
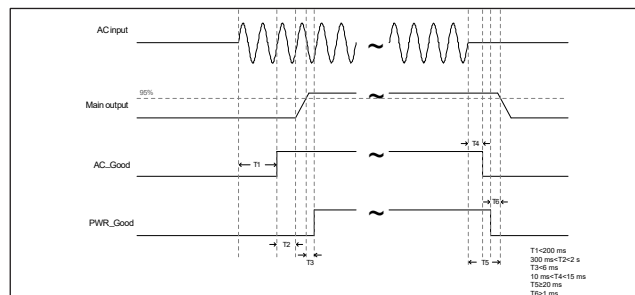
When the input voltage fails, the *Power Good* function provides a time delay before the **Main DC Output** is switched off. This time delay can be used to monitor the *PWR_GOOD* signal for a warning or to save key data.

The *PWR_GOOD* signal is provided on **J3 Pin 9 (PWR_ GOOD)**.

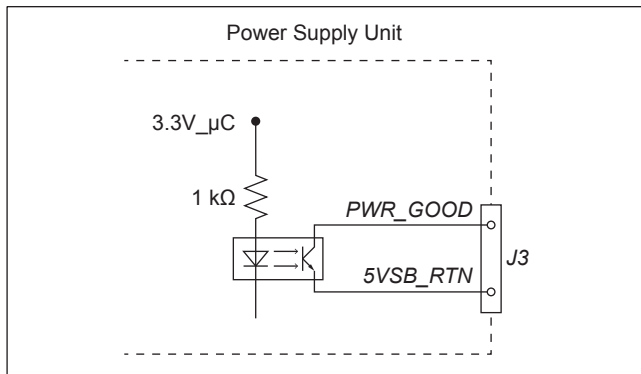The function uses the open collector circuit as shown in *Fig. 12, p. 8*.

Fig. 14: PWR_GOOD (Power Good) - Circuit diagram

As soon as AC input voltage and DC output voltage are in the predefined range, the *PWR_GOOD* signal is set to *HIGH*.
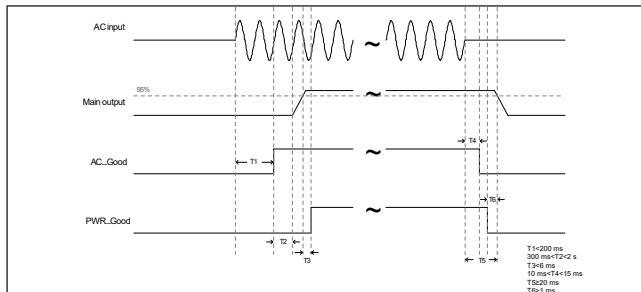

Fig. 15: PWR_GOOD/AC_GOOD - function Timing

Pull the *PWR_GOOD* signal to **+5VSB (J3 Pin 1, J3 Pin 2)** (or another voltage in the customer system) by a resistor. The resistor is needed to limit the collector current.

The maximum voltage for *PWR_GOOD* is 30 V, the maximum sink current is 1 mA.

3.14 Output voltage ripple and noise

Ripple and noise are measured at 20 MHz by using a twisted pair of load wires terminated with a 0.1 µF film capacitor and a 10 µF tantalum capacitor.

NOTE: The output ripple cannot be measured accurately if the probe ground lead from the oscilloscope is too long.
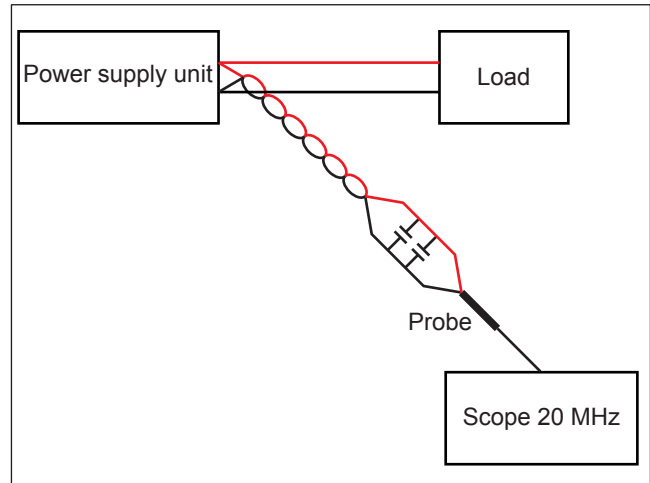
Fig. 16: Ripple measurement setup

3.15 Remote +V_SENSE, -V_SENSE

⚠ **NOTICE**

Do not short or reversely connect +V_SENSE and -V_SENSE. Doing this can cause damage to the power supply.

J3 Pin 13 (+V_SENSE) and **J3 Pin 14 (-V_SENSE)** can be used to compensate voltage drop on output cable.

There is a voltage drop on the output cable that connects the **Power Supply Unit** with the load. The voltage drop is particularly high with heavy loads.

The *Remote SENSE* circuit can compensate a voltage drop of maximum 200 mV on the output cable. The 200 mV drop is the total combined voltage drop across both DC return and DC Output+.

To use this function, the twisted pair of the *V_SENSE* signals and the input of the load have to be connected.

3.16 Redundant operation

3.16.1 Parallel operation

2 **Power Supply Units** can be used in parallel operation. If you need more than 2 units operating in parallel, please contact Delta.

An Or-ing circuit is built-in to prevent that the redundant system fails when a single unit fails.

The maximum start-up load of the redundant system may not exceed the maximum output current of a single power supply, otherwise the redundant system may not power-up.

3.16.2 Current sharing

The **Power Supply Unit** has an *Active Current Sharing* circuit for the **Main DC Output**, in order to ensure output current balance during parallel operation.

An *One-wire Current Share* bus (*CS* bus) is used to achieve current sharing between the **Power Supply Units**. For parallel operation, the *CS* buses of all **Power Supply Units** of the redundant system have to be connected. The CS Bus is connected to the signal connector *J3 Pin 11 (CURRENT -SHARE)*.

The voltage at the *CS* pin will vary linearly with load current on **Main Output**; and will be 6 V at rated load current, when the output voltage is at its rated value.

The difference in output voltage can impact the current sharing accuracy. All outputs fo the **Power Supply Unit** are factory-set within rated voltage ±50 mV. If you need to adjust the output voltage in the end user application, adjust the output voltage of each power supply to the same voltage level which will be used in parallel. It is recommended to set the output voltage within ±50 mV of the target voltage.

Parallel units share load current within ±10% of each other. The maximum error has to be calculated as follows:

$$\text{Maximum error} = \frac{I_{PSUmax} - I_{PSUmin}}{I_{PSUmax}}$$

I_{PSUmax} The current of the **Power Supply Unit** with the highest current

I_{PSUmin} The current of the **Power Supply Unit** with the lowest current

This applies for all loads greater than 25% rated output of each **Power Supply Unit**.
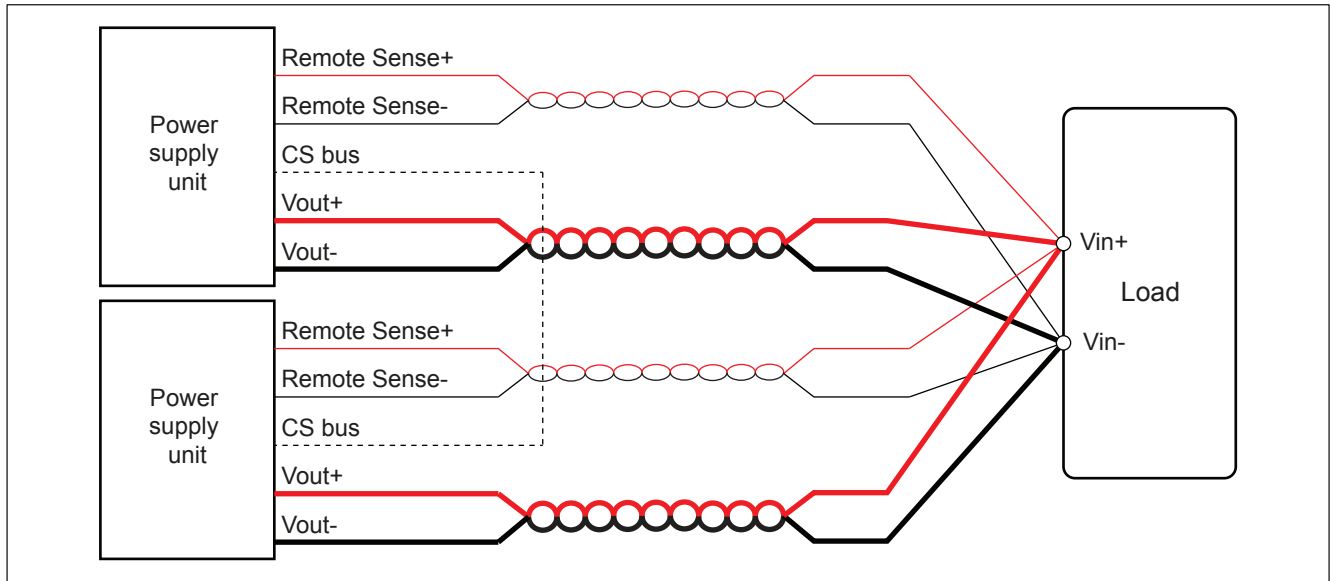
See *Fig. 15, p. 10.*

Fig. 17: Active Current Sharing (CS) bus - functional diagram

3.16.3 I²C slave address

To identify the **Power Supply Unit** in a redundant system, an I²C slave address can be applied to each **Power Supply Unit**.

The address can be set as a voltage on **J3 Pin 12 (ADDRESS)**. 8 voltages (addresses) are available which are referenced to **5VSB_RTN (J3 Pin 3, J3 Pin 4)**. See *Table 7, p. 10*.

Address	Voltage [V]	Resistor [kΩ]	PSU address*
ADD0	0.4125 ± 0.1	5.62	*0x22*
ADD1	0.825 ± 0.1	13	*0x24*
ADD2	1.2375 ± 0.1	24.3	*0x26*
ADD3	1.65 ± 0.1	39.2	*0x28*
ADD4	2.0625 ± 0.1	66.5	*0x2A*
ADD5	2.475 ± 0.1	121	*0x2C*
ADD6	2.8875 ± 0.1	247	*0x2E*
ADD7	3.3 ± 0.1	No resistor, pin open	*0x30*

* Include R/W bit

Table 6:   Voltage levels for I²C slave addresses

To set the voltage, an external resistor should be connected between **J3 Pin 12 (ADDRESS)** and **5VSB_RTN (J3 Pin 3, J3 Pin 4)**, see *Fig. 16, p. 11*.
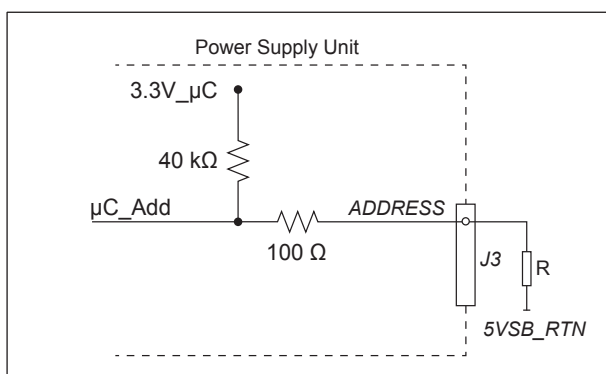
Fig. 18: Connecting resistor for I²C slave address

4. Installing the IMA-S2000

4.1 General safety instructions

⚠ **WARNING**

Risk of electric shock
During operation high voltages
- ► Always disconnect the **Power Supply Unit** from any AC and DC supply voltages, and wait minimum 1 minute before you start working on it.
- ► When connecting the **Power Supply Unit** to an AC input voltage, first connect the earth ground wire to the terminal block, then connect N and L.
- ► When disconnecting the **Power Supply Unit** from the AC input voltage, first disconnect the wires N and L, then disconnect the earth ground wire from the terminal block.
- ► Take care that no objects can fall into the **Power Supply Unit**.
- ► Perform the installation in a dry environment so that no moisture can get into the **Power Supply Unit**.

⚠ **CAUTION**

High temperatures
During operation the Power Supply Unit gets very hot.
- ► Let the **Power Supply Unit** cool down before you start working on it.

This product is only for installation by professional installers within other equipment and must not be operated as a standalone product.

4.2 General installation requirements

The Power Supply Unit is a built-in component. For the installation the following relevant standards have to be considered:

- EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013
- IEC 60950-1:2005 + A1:2009 + A2:2013
- CSA C22.2 No. 60950-1-07, 2nd Edition, 2011-12
- UL 601-1:08
- ANSI/AAMI ES60601-1:2005
- IEC 62368, 2nd edition

For creepage distances, clearances, thickness of insulation between primary circuit and PE as well as thickness of insulation between primary and secondary circuits the following standards have to be considered:

- EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013
- IEC 60950-1:2005 + A1:2009 + A2:2013
- CSA C22.2 No. 60950-1-07, 2nd Edition, 2011-12
- UL 601-1:08
- ANSI/AAMI ES60601-1:2005
- IEC 62368, 2nd edition

The output power shall not exceed the maximum allowed output power. The value is printed on the unit label of the **Power Supply Unit**.

4.3 Cooling requirements

To ensure sufficient fan cooling while the device is in operation, the clearance should be as large as possible on both the fan side and the terminal block side surface. In Delta qualification, simulation wall was placed and kept minimum 20 mm from fan side surface, see *Fig. 20, p. 16*.

The **Power Supply Unit** should not be placed on a low thermal conductive surface, for example, plastics.

Refer to the data sheet for the maximum continuous rating of the **Power Supply Unit** under consideration of its environmental temperature.

4.4 Connecting wires to the PSU

AC/DC Input terminal block (J1)

Use flexible cable

Wire range: 12-14 AWG

Maximum screw torque: 1.8 Nm (16 lb-in)

For insulation stripping and terminal lug, see *Fig. 17, p. 13*.

Main DC Output terminal block (J2)

Use flexible cable

Wire range: 4-10 AWG

Maximum screw torque: 2.4 Nm (21.24 lb-in)

For insulation stripping and terminal lug, see *Fig. 17, p. 13*.

Diameter of lug for input should be suitable for M4 screws.

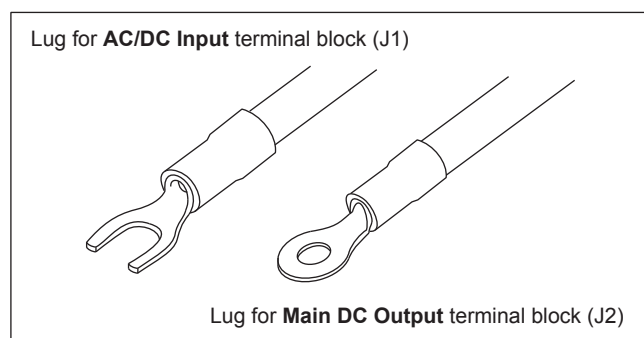Diameter of lug for output should be suitable for M5 screws.

Fig. 19: Preparing cables for connecting

4.5 Electromagnetic compatibility

The **Power Supply Unit** has to be installed inside an grounded metal box.

The AC input cable should be twisted and laid as far away as possible from the output cable.

All cables should be routed as close as possible to the grounded metal box.

Add a shielding to the input cable or the output cable (or ideally to both) if they are close to each other.
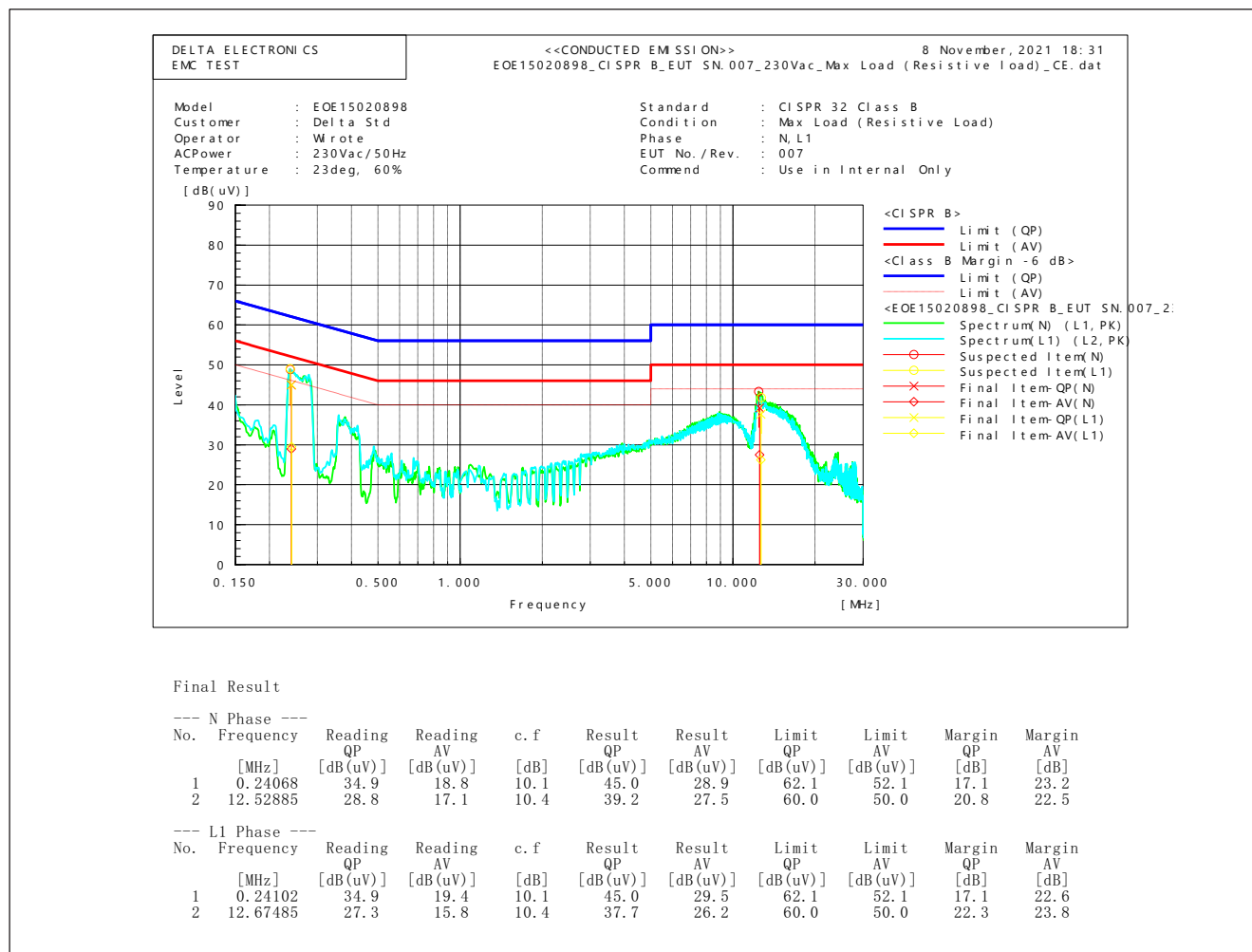
Ensure the input FG terminal is connected to ground.

Fig. 20: Electromagnetic compatibility

4.6   Mounting the Power Supply Unit

Use M3 screws with the appropriate length (see *Fig. 19, p. 15)* through the base mounting holes. This is necessary to ensure a safety distance between the screw and internal components.

Recommended mounting tightening torque is 0.6 Nm (5.3 lb-in).
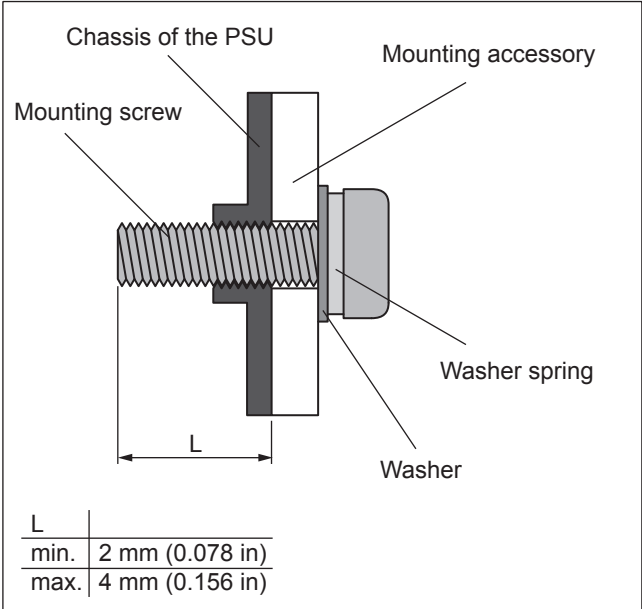

L	
min.	2 mm (0.078 in)
max.	4 mm (0.156 in)

Fig. 21: Mounting the Power Supply Unit

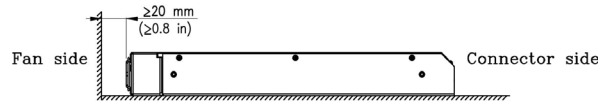**Mounting orientations**

Fig. 22: Standard mounting orientation
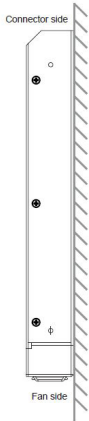

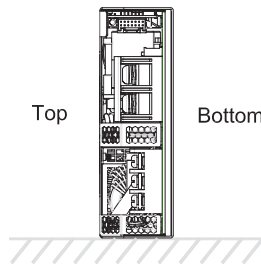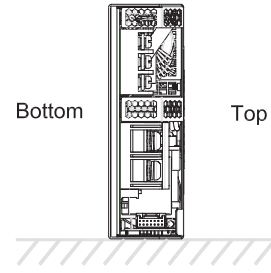*Fig. 23: Vertical mounting*   *Fig. 24: Mounting on the left side*   *Fig. 25: Mounting on the right side*
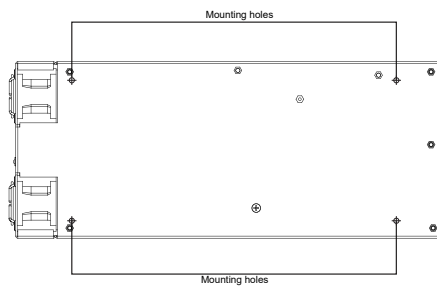

Fig. 26: Position of mounting holes

Note: Always keep ≥20 mm (0.79 in) space on the fan side and on the connector side to ensure proper airflow. Other mounting orientations are not allowed. When you do not use the standard mounting orientation, the maximum ambient temperature decreases by 5 K.
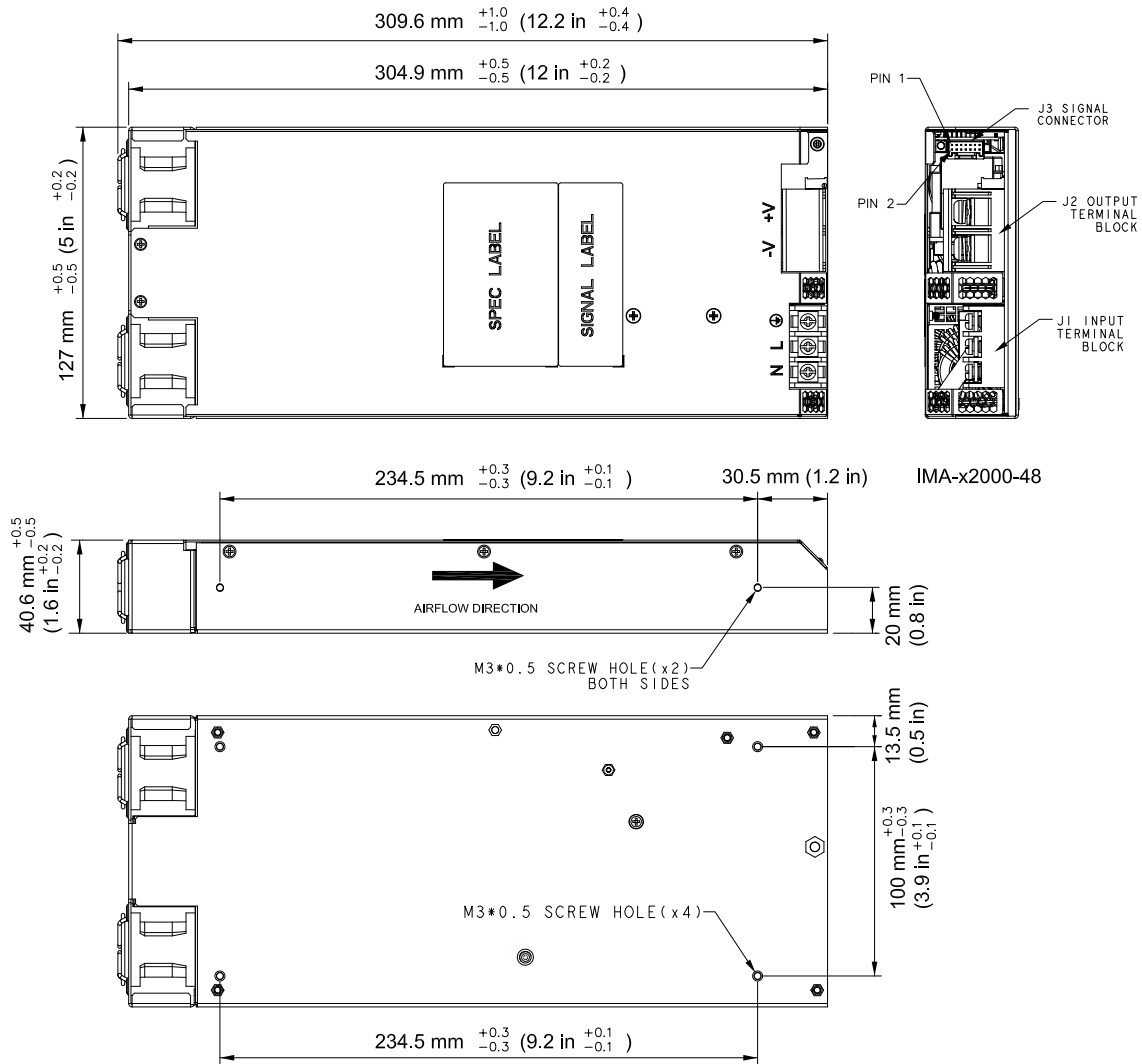
Dimensional drawings

Fig. 27: Dimensional drawing IMA-S2000

Notes:

- Base plate mounting, M3 thread holes, maximum penetration 6.0 mm from bottom face of chassis, torque 0.6 Nm (5.31 lb-in).
- (J1) Input terminal block: Switchlab T36-BM1103, M4 screw in 3 positions, torque 1.8 Nm (16 lb-in).
- (J2) Output terminal block: Dinkle 0166-8002C, M5 screw in 2 positions, torque 2.4 Nm (21.24 lb-in).
- (J3) Mating connector for J3 is Molex, part number 501646-1400 (with positive lock). The connector is not shipped with the power supply unit.

5.   Disposal

Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities instead . Contact your local authorities for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. when replacing old appliances with new once, the retailer is legally obligated to take back your old appliance for disposal at least for free of charge.
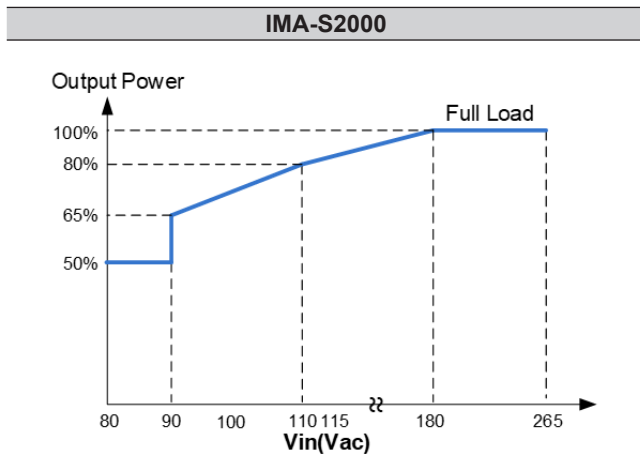
6.   Appendix

6.1   Curves

IMA-S2000

Fig. 28: Output power versus input voltage

IMA-S2000
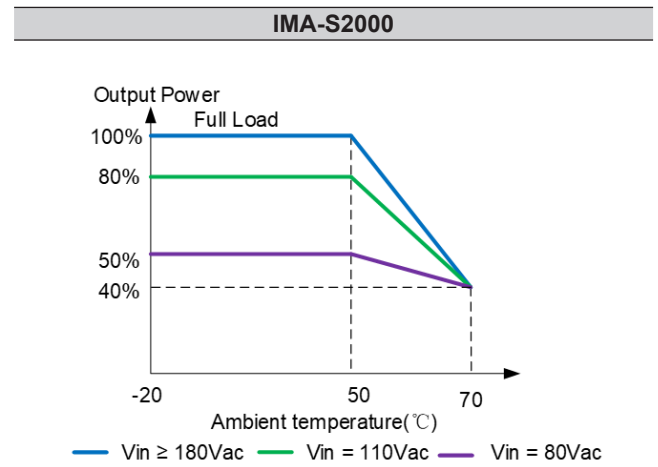
Fig. 29: Output power versus ambient temperature

IMA-S2000-24
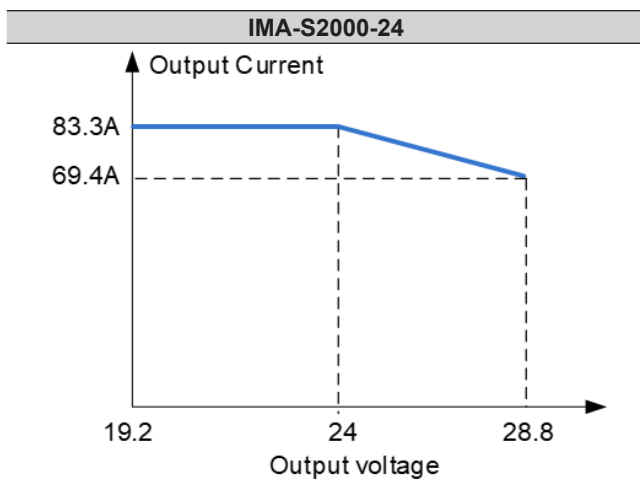
Fig. 30: Output current versus output voltage 24 V

IMA-S2000-48
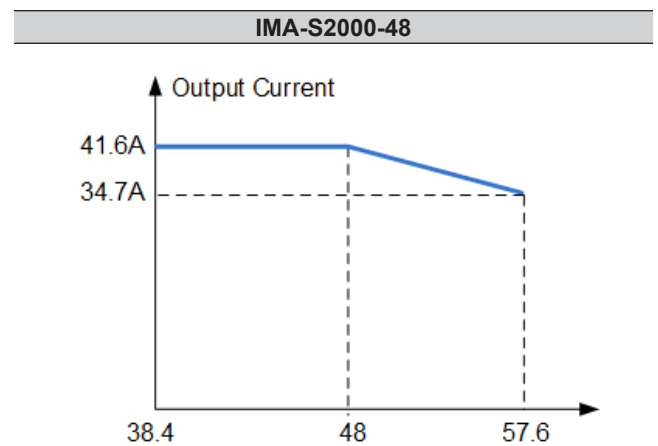
Fig. 31: Output current versus output voltage 48 V

IMA-S2000-24

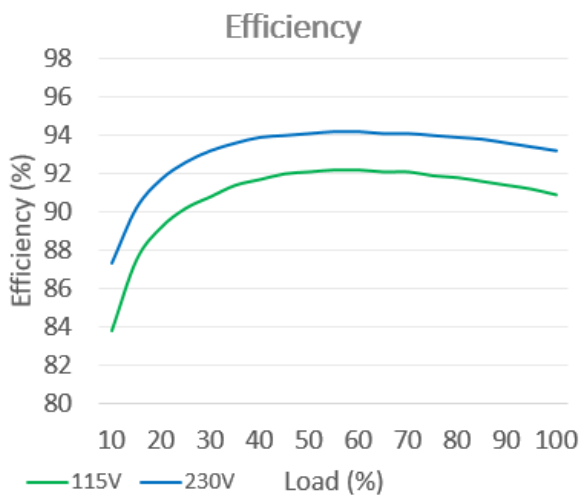| IMA-S2000-48 |
|---|

Fig. 32: *Typical efficiency curves 24 V*
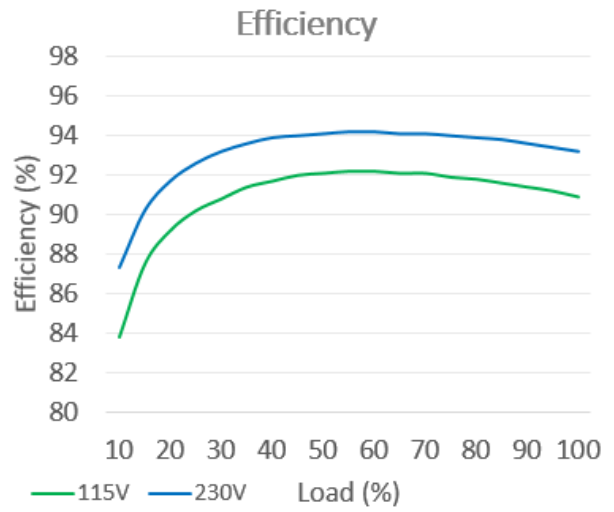
Fig. 33: *Typical efficiency curves 48 V*

7. PMBus™

7.1 PMBus™ Communication

IMA-x2000 series power supplies provide an intelligent, digital solution for optimum system flexibility. PMBus™ standard is supported, thus user can monitor and control the **Power Supply Unit** via I2C communication digitally.

Please contact your Delta sales partner for details.

Fig. 34: Graphical User Interface of the PMBus™

7.2 PMBus™ Command Map

The following sets of standard commands are supported as per the standard PMBus™ protocol specification. While reading data using any of the standard PMBus™ commands, the power supply should always send the LSB first followed by MSB with bit order of the bytes from 7 to 0. More information on "PMBus specification" can be found at https://pmbus.org

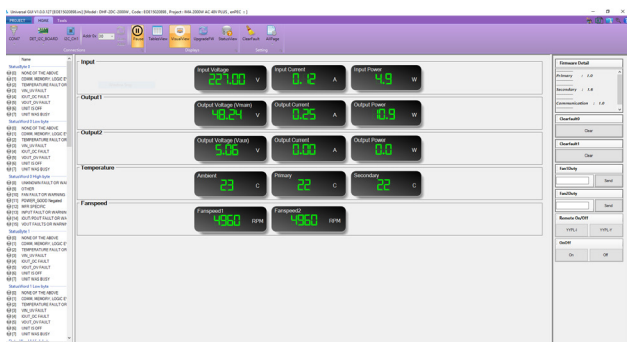| Command Code	Command Name	Page		Transaction Type		Data Format	Number of data bytes	Instruction
		0 (12V)	1 (5VSB)	Writing data	Reading data			
00h	PAGE	√	√	Write Byte	Read Byte	Unsigned Integer	1	provide the ability to configure, control and monitor multiple phases on one PMBus unit
01h	OPERATION	√		Write Byte	Read Byte	N/A	1	turn unit on or off in conjunction with the input from the control pin
02h	ON_OFF_CONFIG	√		N/A	Read Byte	N/A	1	configure the combination of CONTROL pin input and serial bus commands needed to turn the unit on and off
03h	CLEAR_FAULTS	√	√	Send Byte	N/A	N/A	0	clear any fault bits that have been set
19h	CAPABILITY	√		N/A	Read Byte	N/A	1	determine some key capabilities of a PMBus device
20h	VOUT_MODE	√	√	N/A	Read Byte	N/A	1	whether the device uses the Linear, VID or Direct modes for output voltage related commands
3Ah	FAN_CONFIG_1_2	√		N/A	Read Byte	N/A	1	configure up to two fans associated with one PMBus device
3Bh	FAN_COMMAND_1	√		Write Word	Read Word	Unsigned Integer	2	adjust the operation of up to four fans contained in the PMBus device or in the host system
3Ch	FAN_COMMAND_2	√		Write Word	Read Word	Unsigned Integer	2	adjust the operation of up to four fans contained in the PMBus device or in the host system
40h	VOUT_OV_FAULT_LIMIT	√	√	N/A	Read Word	Linear	2	set the value of the output voltage at the sense or output pins that causes an output voltage high warning
4ah	IOUT_OCFAULT_LIMIT	√	√	N/A	Read Word	Linear	2	set the value of the output current at the sense or output pins that causes an output current high warning
46h	IOUT_OC_FAULT_LIMIT	√	√	N/A	Read Word	Linear	2	set the value of the output current, in amperes, that causes the overcurrent detector to indicate an overcurrent fault condition
4Fh	OT_FAULT_LIMIT	√		N/A	Read Word	Linear	2	set the temperature, in degrees Celsius, of the unit at which it should indicate an Overtemperature Fault
51h	OT_WARN_LIMIT	√		N/A	Read Word	Linear	2	set the temperature, in degrees Celsius, of the unit at which it should indicate an Undertemperature Warning alarm
55h	VIN_OV_FAULT_LIMIT	√		N/A	Read Word	Linear	2	set the value of the vin at the sense or VIN pins that causes an input vin high warning
59h	VIN_UV_FAULT_LIMIT	√		N/A	Read Word	Linear	2	set the value of the vin at the sense or VIN pins that causes an input vin low warning
78h	STATUS_BYTE	√	√	N/A	Read Byte	N/A	1	return one byte of information with a summary of the unit's fault condition

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