IMA 400 Watts Power Supply Series
for medical and industrial applications

Application note

Smarter. Greener. Together.

⚠ **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 approval for Medical (IEC 60601-1-2), Industrial (IEC 62368) 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: 4 x 6.96 x 1.6 in (1U design)
- Low acoustic noise level of less than 30 dB(A)
- Active current sharing
- 2 × MOPP
- PMBus™ compatible for control, programming and monitoring
- 500,000 hour MTBF
- Optional conformal coating
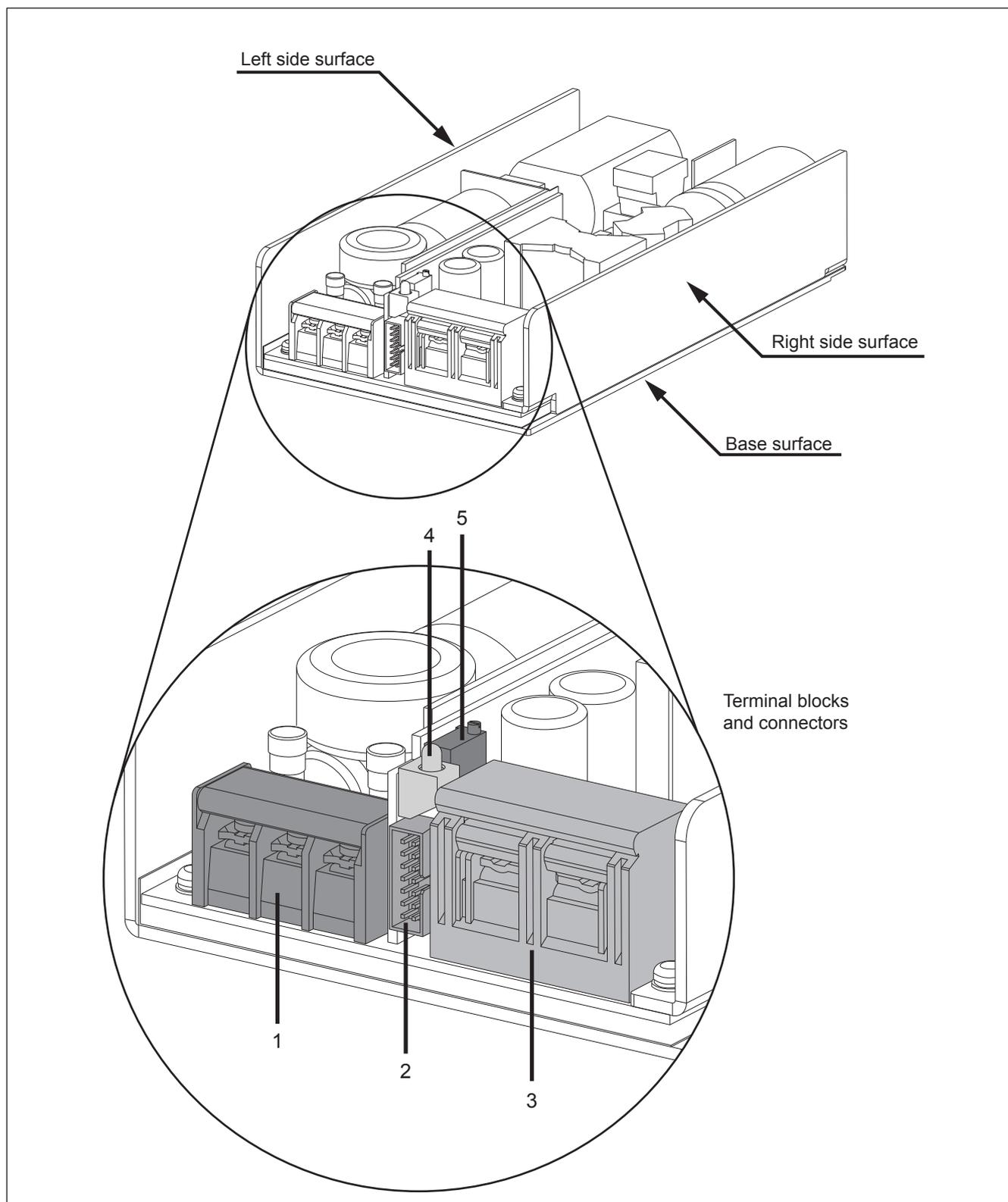- 3 years warranty

2. Overview

Fig. 1:   Components of the IMA-x400

1. AC/DC Input terminal block (J1)
2. Signal port and Auxiliary DC Output (J3)
3. DC Output terminal block (J2)
4. Green status LED
5. Output voltage adjustment potentiometer

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 9.5 mm (0.37 in).
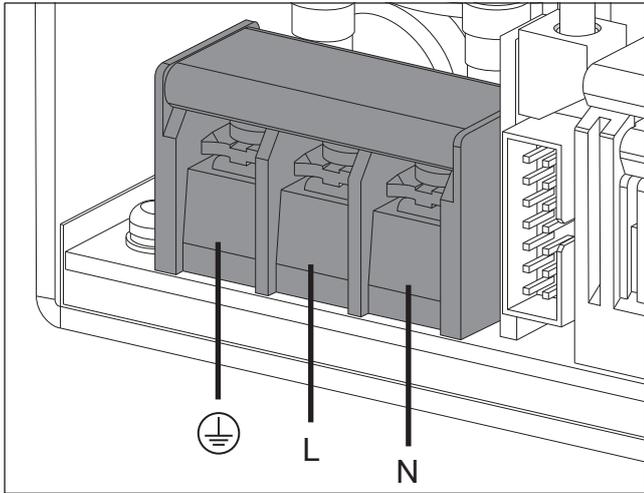

Fig. 2: AC/DC Input terminal block (J1) - pin assignment

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

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

Wire range: 12-18 AWG

Screw torque: 1.3 Nm (11.5 lb-in)

Screws are suitable for slotted and Phillips head screwdrivers.

2.2 Signal port and Auxiliary DC Output (J3)
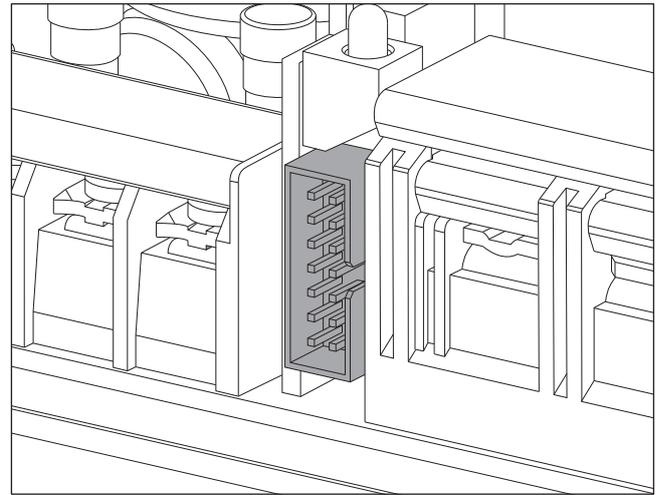
Fig. 3: Signal port and Auxiliary DC Output (J3)
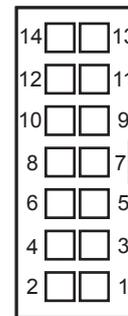
Fig. 4: Signal port and Auxiliary DC Output (J3) - Pin assignment

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, Serial Data Line, see *"3.15.4 I2C slave address", p. 12*
6	SDA	
7	5VSB_RTN	5 V standby return
8	+5VSB	+5 V standby
9	PWR_GOOD	See *"3.12 Power Good", p. 10*
10	Remote ON/OFF	See *"3.11 Remote ON/ OFF", p. 9*
11	Current_Share_V	See *"3.15.1 Redundant operation", p. 11*
12	Address	
13	+V_SENSE	See *"3.14 Remote +V_SENSE, -V_SENSE", p. 10*
14	-V_SENSE	

Table 2: 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.

There is no galvanic isolation between *5VSB GND* and **Main DC Output GND**.

2.3   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 16 mm (0.63 in).
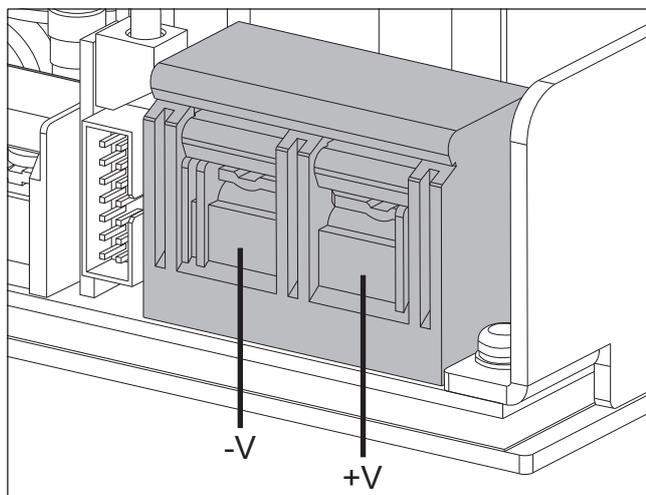
Fig. 5:   Main DC Output terminal block (J2) - pin assignment

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

Table 3:   DC output port (J2) - pin assignment

Wire range: 4 - 12 AWG

Screw torque: 1.3 Nm (11.5 lb-in)

Screws are suitable for slotted and Phillips head screwdrivers.

2.4   Output voltage adjustment potentiometer

The **Output voltage adjustment potentiometer** is for output voltage adjustment within the range of specifications.
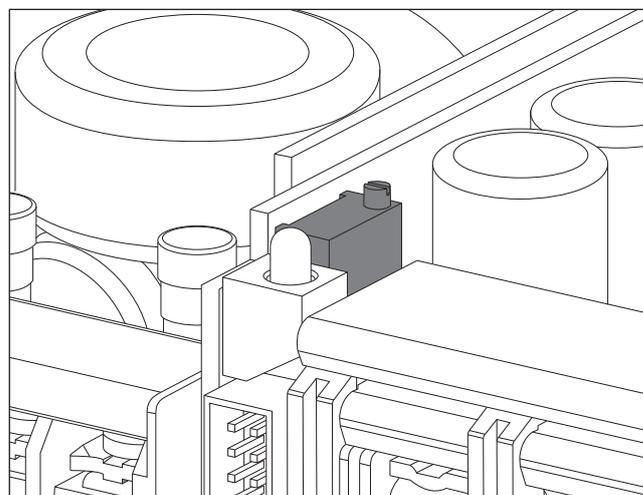
Fig. 6:   Output voltage adjustment potentiometer

Model	Output voltage	
	Nominal	**Adjustment Range**
IMA-x400-12	12 V	9.6 ... 14.4 V
IMA-x400-24	24 V	19.2 ... 28.8 V
IMA-x400-48	48 V	38.4 ... 56 V

Table 4:   Output voltage adjustment range

2.5   Green status LED

The **Green status LED** indicates the status of the **Power Supply Unit**.
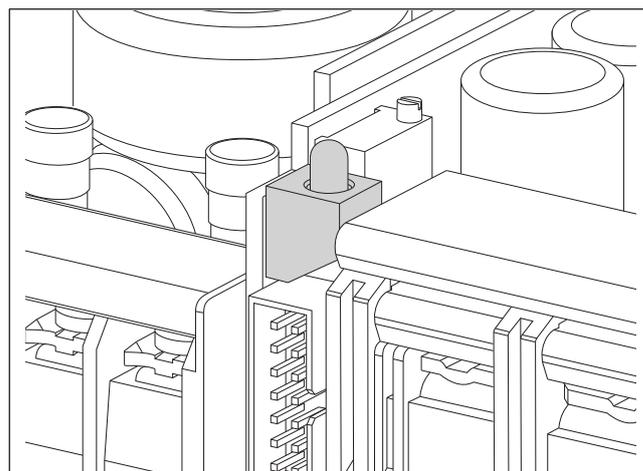
Fig. 7:   Green Status LED

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 20 A. Therefore, a 20 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 0.5 A.

3.3 Start-up timing
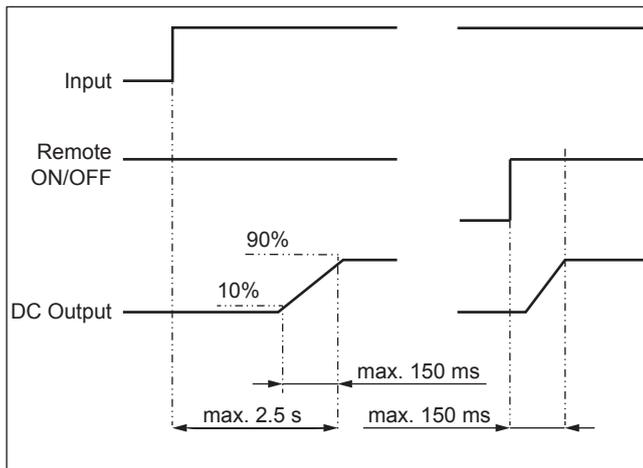
Fig. 8:   Start-up timing ZYPLI-Model
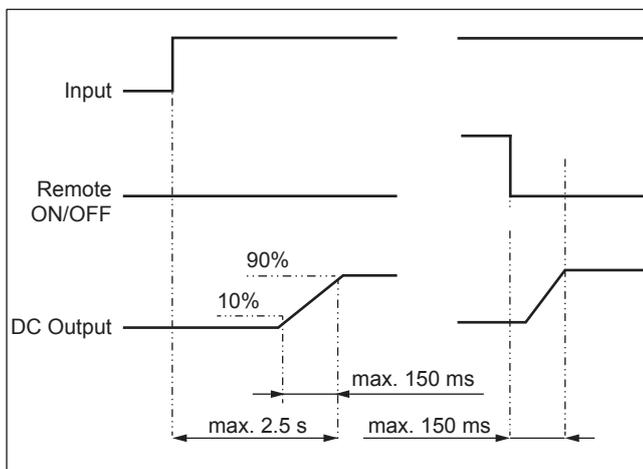
Fig. 9:   Start-up timing ZYPLY-Model

3.4 No-load operation

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

3.5 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.

3.6 Output over current protection (OCP)

When the output current exceeds 125% (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.

Output current

Load > 125%
(Output hiccup)

I

0%
Load

125%
Load

t (sec)

Hiccup interval I = 3.5 s (typical)

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.

3.7 Short circuit protection (SCP)

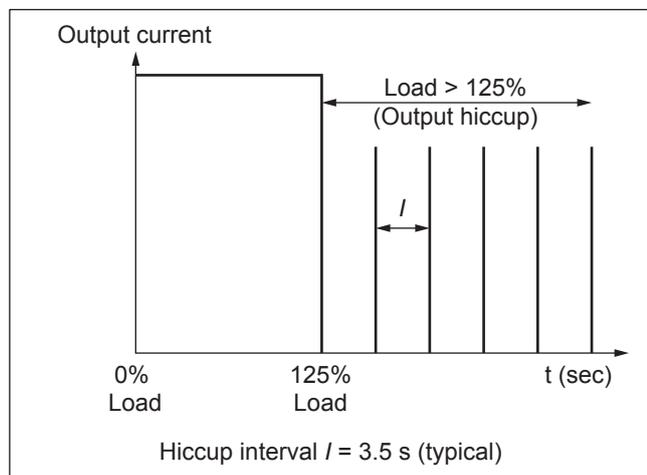The *Short Circuit Protection (SCP)* function will shut down the **Power Supply Unit** when a short circuit is applied to the **Main DC Output** or to the standby power.

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

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

3.8 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.

3.9 Output power derating versus ambient temperature

The maximum output power rate depends on on the ambient temperature. For derating curves see *"6. Appendix", p. 19*.

Standard mounting orientation

12 V **Power Supply Unit**: With airflow > 0.8 m/s, the **Power Supply Unit** can be operated with full load at ambient temperatures of up to 55 °C (131 °F). At ambient temperatures above 55 °C (131 °F), the output power at the **Main DC Output** is linearly derated from 100% at 55 °C (131 °F) to 75% at 70 °C (158 °F).

24/48 V **Power Supply Unit**: There is no derating of output power with airflow > 0.8 m/s.

With convection cooling, the **Power Supply Unit** can be operated at 300 W (290 W for 12 V) at ambient temperatures of up to 40 °C (104 °F). And at ambient temperatures above 40 °C (104 °F), the output power at the **Main DC Output** is linearly derated from 300 W (290 W for 12 V) at 40 °C (104 °F) to 100 W at 70 °C (158 °F).

3.10 Capacitors Life

The expected capacitors life is 10 years (86400 hours) at nominal input, 45 °C (113 °F) ambient temperature and 80% load. Temperature of below capacitors should not be over the below table to achieve 10 years (86400 hours) life.

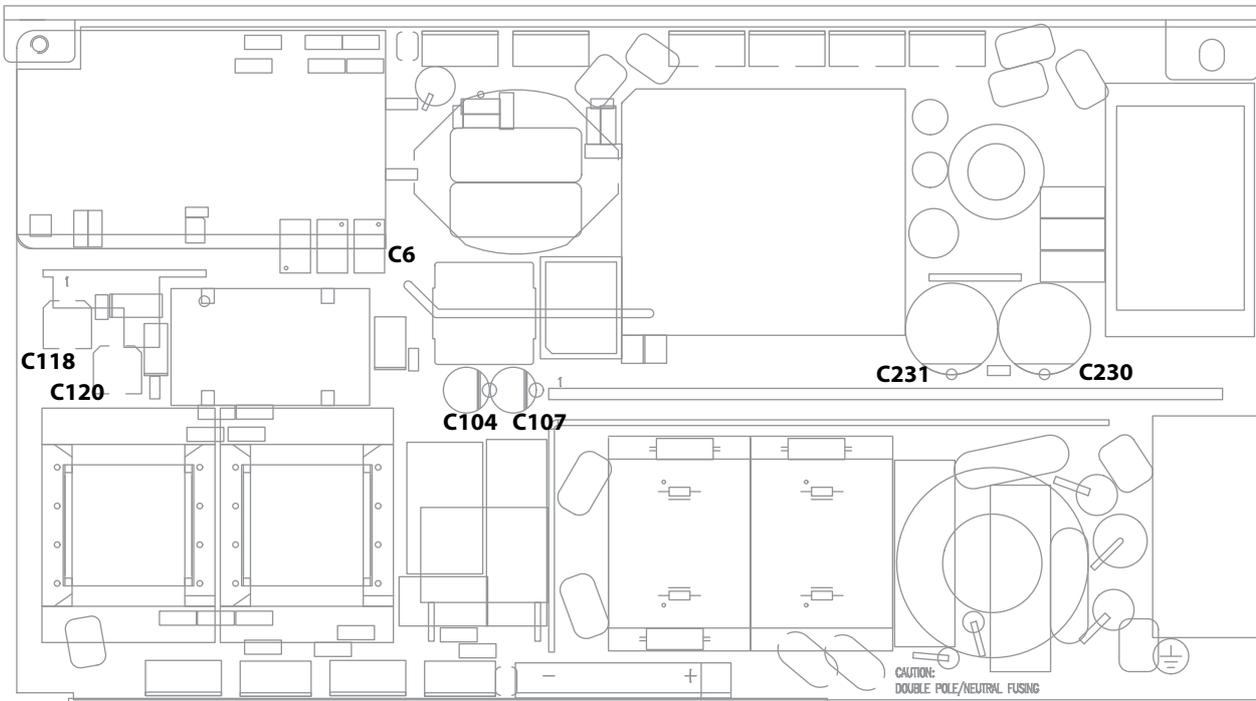| Capacitors	Temperature °C (°F)
C6	65 °C (149 °F)
C104	66 °C (150.8 °F)
C107	53 °C (127.4 °F)
C118	46 °C (114.8 °F)
C120	47 °C (116.6 °F)
C230	70 °C (158 °F)
C231	70 °C (158 °F)
C414	67 °C (152.6 °F)

Table 6:   Cap Life

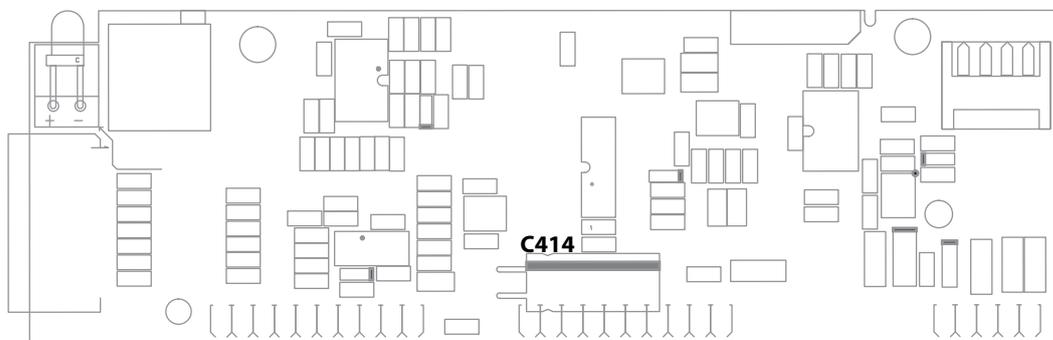*Fig. 11: Main conductor board; position of capacitors*

Fig. 12: Vertical conductor board; position of capacitors

3.11 Remote ON/OFF

If an input voltage has been connected to the Power Supply Unit, the *Remote ON/OFF* function is used to turn the **DC Main Output** on and off.

The *Remote ON/OFF* function works independently from the input voltages.

The *Remote ON/OFF* control logic is selectable via PMBus™:

Write `0x0000` to address `0xDF` for low level active
Write `0x0001` to address `0xDF` for high level active

IMA-x400-xx-ZNPLI (High level active)

If there is no connection to *J3 Pin 10 (Remote ON/OFF)*, the power supply will turn on.

The **Main DC Output** is switched on when *J3 Pin 10 (Remote On/OFF)* and *5VSB_RTN (J3 Pin 3, J3 Pin 4 or J3 Pin 7)* are opened.

The **Main DC Output** is switched off when *J3 Pin 10 (Remote On/OFF)* and *5VSB_RTN (J3 Pin 3, J3 Pin 4 or J3 Pin 7)* are shorted.

IMA-x400-xx-ZNPLY (Low level active)

If there is no connection to *J3 Pin 10 (Remote ON/OFF)*, the power supply will not turn on.

The **Main DC Output** is switched on when *J3 Pin 10 (Remote ON/OFF)* and *5VSB_RTN (J3 Pin 3, J3 Pin 4 or J3 Pin 7)* are shorted.

The **Main DC Output** is switched off when *3 Pin 10 (Remote ON/OFF)* and *5VSB_RTN (J3 Pin 3, J3 Pin 4 or J3 Pin 7)* are opened.

Remote On/Off and 5VSB_RTN	Main DC Output	
shorted	OFF	IMA-x400-xx-ZNPLI
open	ON	
shorted	ON	IMA-x400-xx-ZNPLY
open	OFF	

Table 7:   Remote ON/OFF switching logic for ZNPLI & ZNPLY

An internal pull up resistor with 1 kΩ is connected to +5VSB standby power, see *Fig. 13, p. 9*.
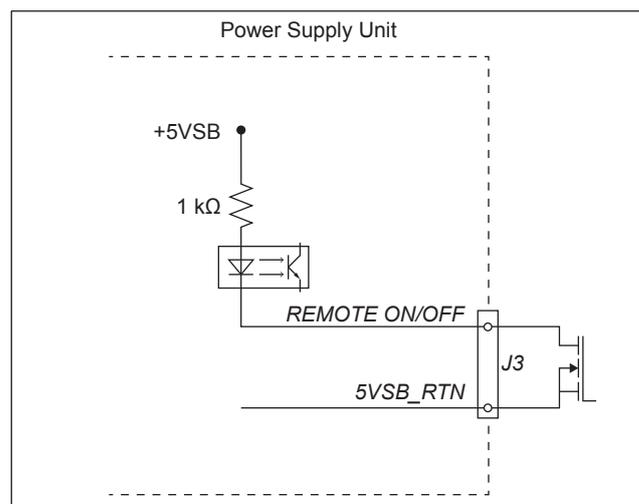

Fig. 13: Remote ON/OFF circuit diagram

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 Power Good

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)*.

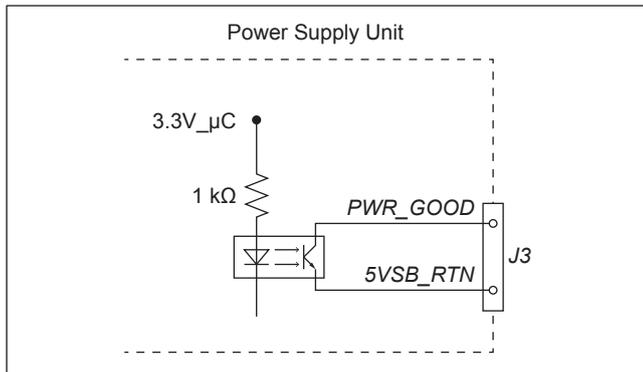The function uses the open collector circuit as shown in *Fig. 14, p. 10*.

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*.

When the input voltage is removed and remains absent for at least 10 ms, the *PWR_GOOD* signal is set to *LOW*. Another 10 ms later (minimum interval), the **Main DC Output** is switched off. See *Fig. 15, p. 10*.
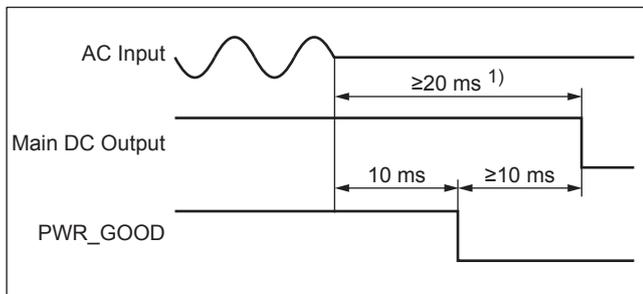
[1] For DC output voltage ≤ Nominal output voltage;
  will reduce at DC output voltages > Nominal output voltage.

Fig. 15: PWR_GOOD (Power Good) - Signal sequence

Pull the *PWR_GOOD* signal to **+5VSB (J3 Pin 1, J3 Pin 2 or J3 Pin 8)** (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.

3.13 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.
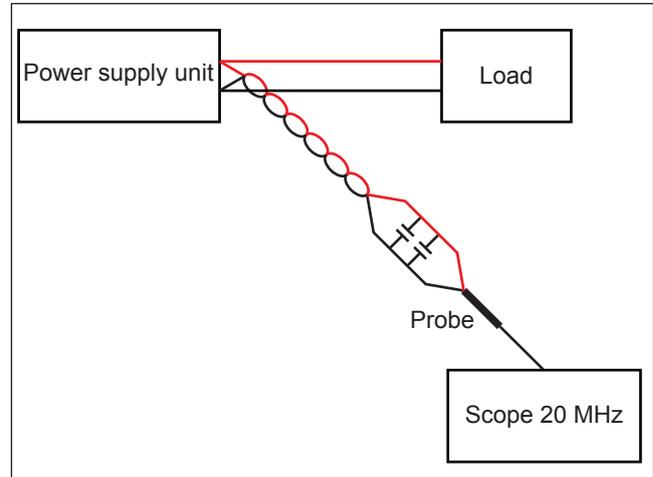
Fig. 16: Ripple measurement setup

3.14 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.

3.15 Parallel operation

3.15.1 Redundant operation

Up to 2 **Power Supply Units** can be used in redundant operation. If you need more than 2 units operating redundantly, 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.

3.15.2 Special requirements for parallel operation

Up to 8 Power Supply Units of the same **Maximum DC output power** can be used in parallel operation.

When you need to exceed the maximum output current of one of the **Power Supply Units** during start-up, you have to ensure that one of the following conditions is fulfilled:

1. When you can ensure that the input voltages come in simultaneously on both PSU: Set "*Remote ON/OFF*" to ON (Y-Model: shorted, I-Model: open) before you apply the input voltages.

2. If you cannot ensure that the input voltages come in simultaneously: Set "*Remote ON/OFF*" to OFF (Y-Model: open, I-Model: shorted) before you apply the input voltages. After the input voltages are available, set „*REMOTE ON/OFF*" simultaneously to ON for both **Power Supply Units**.

For more information about the *REMOTE ON/OFF* function, see *"3.11 Remote ON/OFF", p. 9.*

3.15.3 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_V)*.

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. 17, p. 11.*
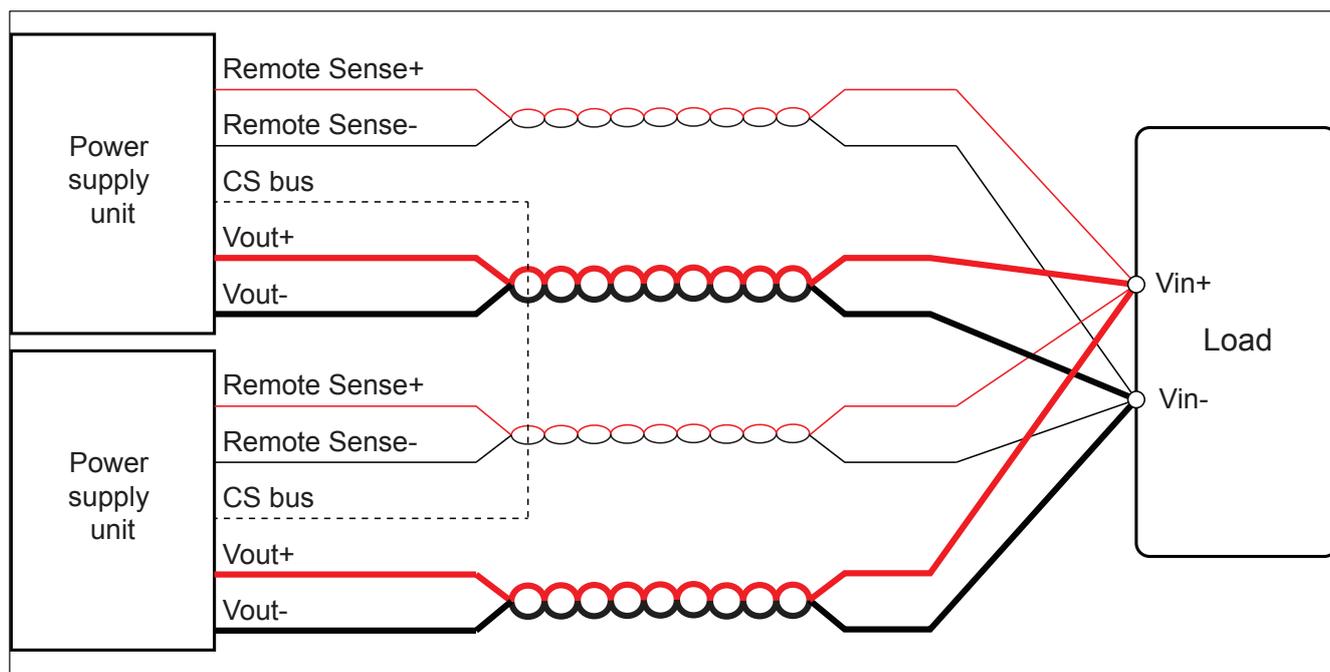
Fig. 17: Active Current Sharing (CS) bus - functional diagram

3.15.4 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 or J3 Pin 7)*. See *Table 8, p. 12*.

Address	Voltage [V]	Resistor [kΩ]	PSU address
ADD0	0.4125 ± 0.1	5.62	22h
ADD1	0.825 ± 0.1	13	24h
ADD2	1.2375 ± 0.1	24.3	26h
ADD3	1.65 ± 0.1	39.2	28h
ADD4	2.0625 ± 0.1	66.5	2Ah
ADD5	2.475 ± 0.1	121	2Ch
ADD6	2.8875 ± 0.1	247	2Eh
ADD7	3.3 ± 0.1	no resistor, pin open	30h

Table 8:   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 or J3 Pin 7)*, see *Fig. 18, p. 12*.
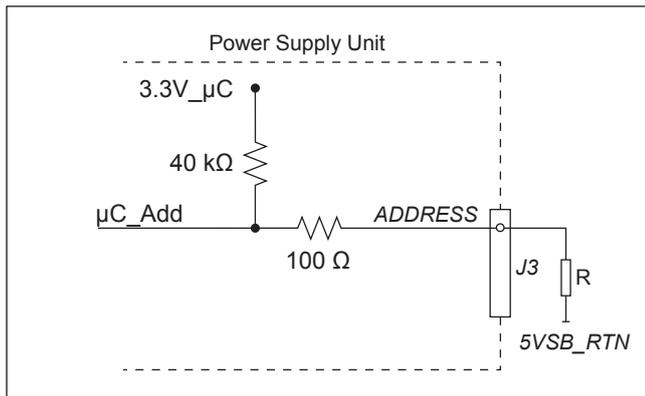
Fig. 18: Connecting resistor for I²C slave address

4. Installing the IMA-x400

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 ES 60601-1:2005
● 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

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: 12-18 AWG

Maximum screw torque: 1.3 Nm (11.5 lb-in)

For insulation stripping and terminal lug, see *Fig. 19, p. 13*.

Main DC Output terminal block (J2)

Use flexible cable

Wire range: 4-12 AWG

Maximum screw torque: 1.3 Nm (11.5 lb-in)

For insulation stripping and terminal lug, see *Fig. 19, p. 13*.

Diameter of lug for input should be suitable for M3.5 screws.

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

Lug for **AC/DC Input** terminal block (J1)

Lug for **Main DC Output** terminal block (J2)
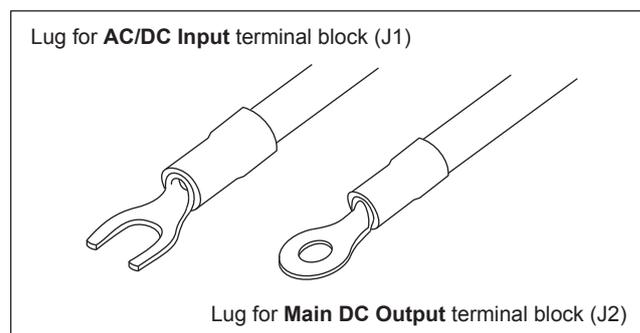
Fig. 19: Preparing cables for connecting

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.

```
DELTA ELECTRONICS              <<CONDUCTED EMISSION>>              14 January,2015 14:44
EMC TEST               EOE13020472_CISPR B_No 001_230Vac_Max Load (Resistive Load)_PR_CE.dat

Model        : EOE13020472              Standard     : ITE: CISPR 22 Class B
Customer     : Delta-std                Condition    : Max Load (Resistive Load)
Operator     : Wirote                   Phase        : N, L1
ACPower      : 230 Vac/50Hz             EUT No./Rev. : 001
Temperature  : 23deg, 60%               Commend      : Use for QE Report
```


Final Result

```
--- N Phase ---
No.   Frequency   Reading   Reading   c.f    Result    Result    Limit     Limit     Margin   Margin
                  QP        AV               QP        AV        QP        AV
      [MHz]       [dB(?V)]  [dB(?V)]  [dB]   [dB(?V)]  [dB(?V)]  [dB(?V)]  [dB(?V)]  [dB]     [dB]
  1   0.21786     31.2      23.8      10.1   41.3      33.9      62.9      52.9      21.6     19.0
  2   0.33312     30.2       8.5      10.1   40.3      18.6      59.4      49.4      19.1     30.8
  3   0.63379     24.2      14.4      10.1   34.3      24.5      56.0      46.0      21.7     21.5
  4   0.72907     25.9      17.6      10.1   36.0      27.7      56.0      46.0      20.0     18.3
  5   0.80311     23.2      15.3      10.1   33.3      25.4      56.0      46.0      22.7     20.6
  6   0.98602     25.1      14.7      10.0   35.1      24.7      56.0      46.0      20.9     21.3
  7   1.90697     27.9      13.7      10.1   38.0      23.8      56.0      46.0      18.0     22.2
  8   2.19232     28.7      16.1      10.1   38.8      26.2      56.0      46.0      17.2     19.8

--- L1 Phase ---
No.   Frequency   Reading   Reading   c.f    Result    Result    Limit     Limit     Margin   Margin
                  QP        AV               QP        AV        QP        AV
      [MHz]       [dB(?V)]  [dB(?V)]  [dB]   [dB(?V)]  [dB(?V)]  [dB(?V)]  [dB(?V)]  [dB]     [dB]
  1   0.208       29.4      12.9      10.1   39.5      23.0      63.3      53.3      23.8     30.3
  2   0.33377     29.2       7.8      10.1   39.3      17.9      59.4      49.4      20.1     31.5
  3   0.64132     27.6      17.7      10.1   37.7      27.8      56.0      46.0      18.3     18.2
  4   0.7273      25.7      18.2      10.1   35.8      28.3      56.0      46.0      20.2     17.7
  5   0.8022      28.4      19.3      10.1   38.5      29.4      56.0      46.0      17.5     16.6
  6   0.94951     28.2      18.3      10.0   38.2      28.3      56.0      46.0      17.8     17.7
  7   1.09567     27.2      16.7      10.0   37.2      26.7      56.0      46.0      18.8     19.3
  8   1.89442     28.2      17.7      10.1   38.3      27.8      56.0      46.0      17.7     18.2
  9   2.19106     28.4      16.6      10.1   38.5      26.7      56.0      46.0      17.5     19.3
```
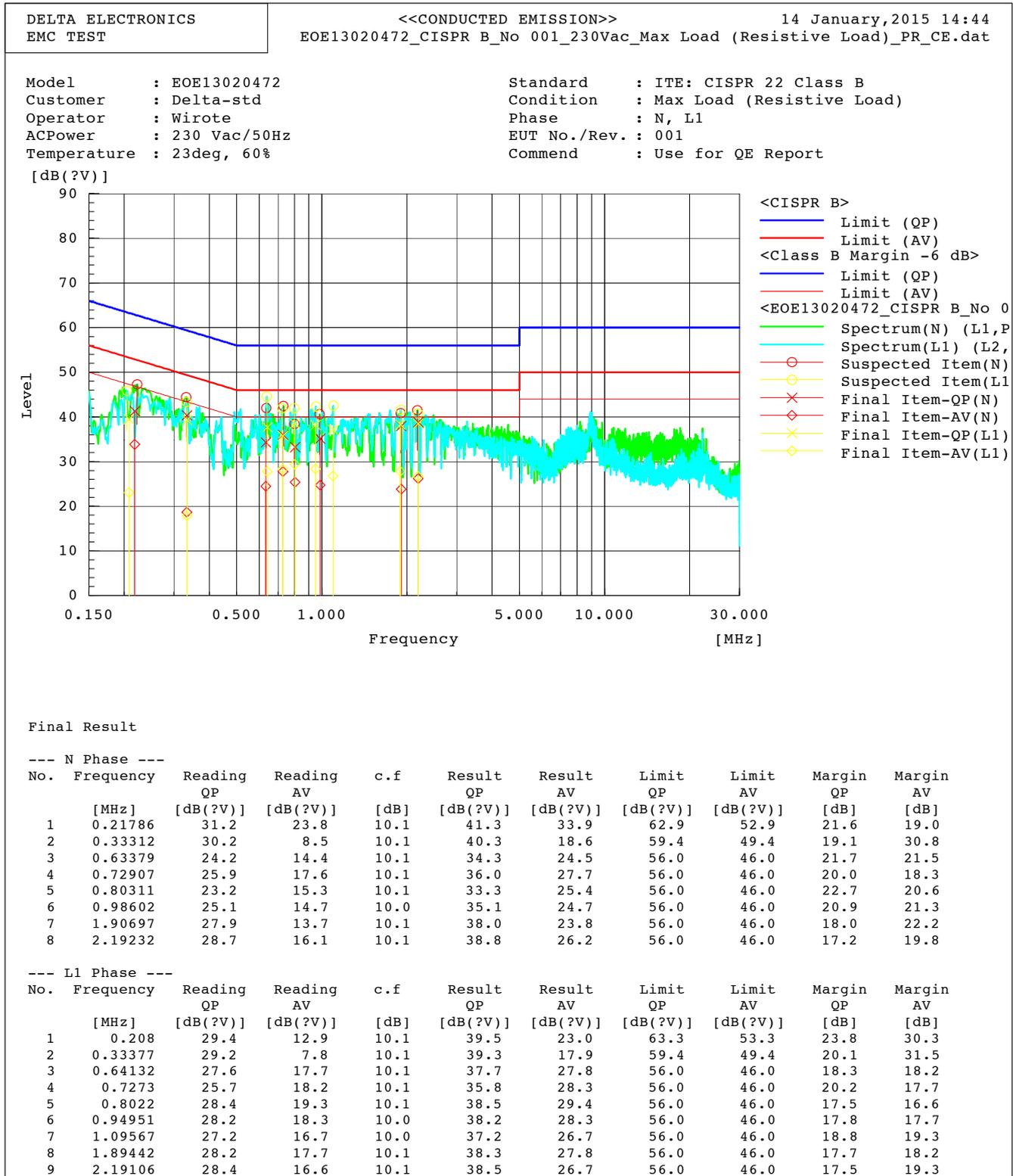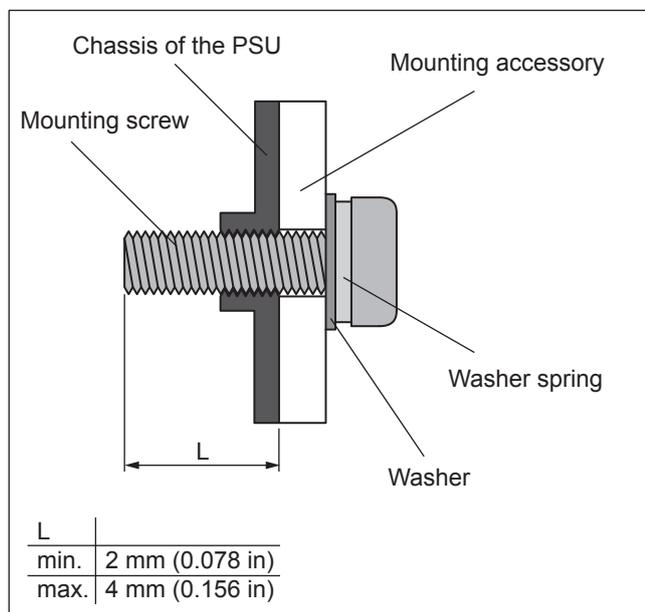
Fig. 20: Electromagnetic compatibility

4.6   Mounting the Power Supply Unit

Use M3 screws with the appropriate length (see *Fig. 21, 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

Connector side

Bottom	Top	Top	Bottom
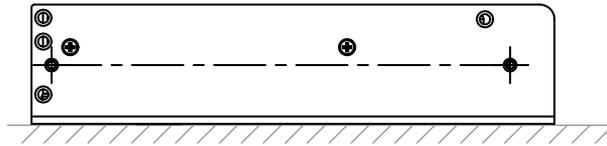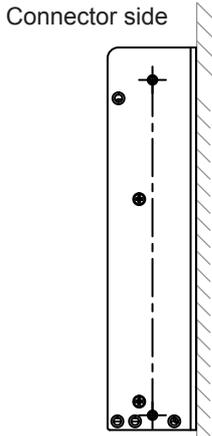
Fig. 23: Vertical mounting   *Fig. 24: Mounting on the left side*   *Fig. 25: Mounting on the right side*
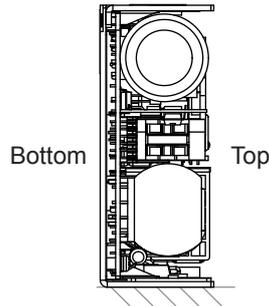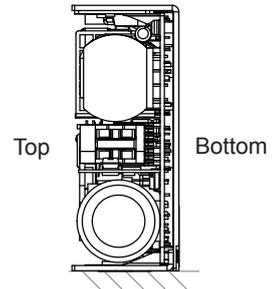
Bottom view   **Side view**
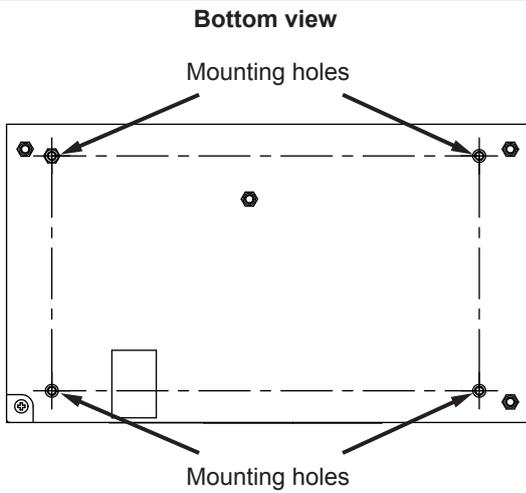

Mounting holes

Mounting holes

Mounting holes

Connector side
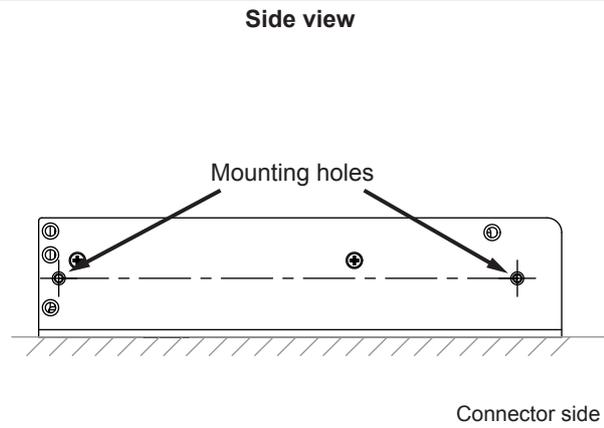
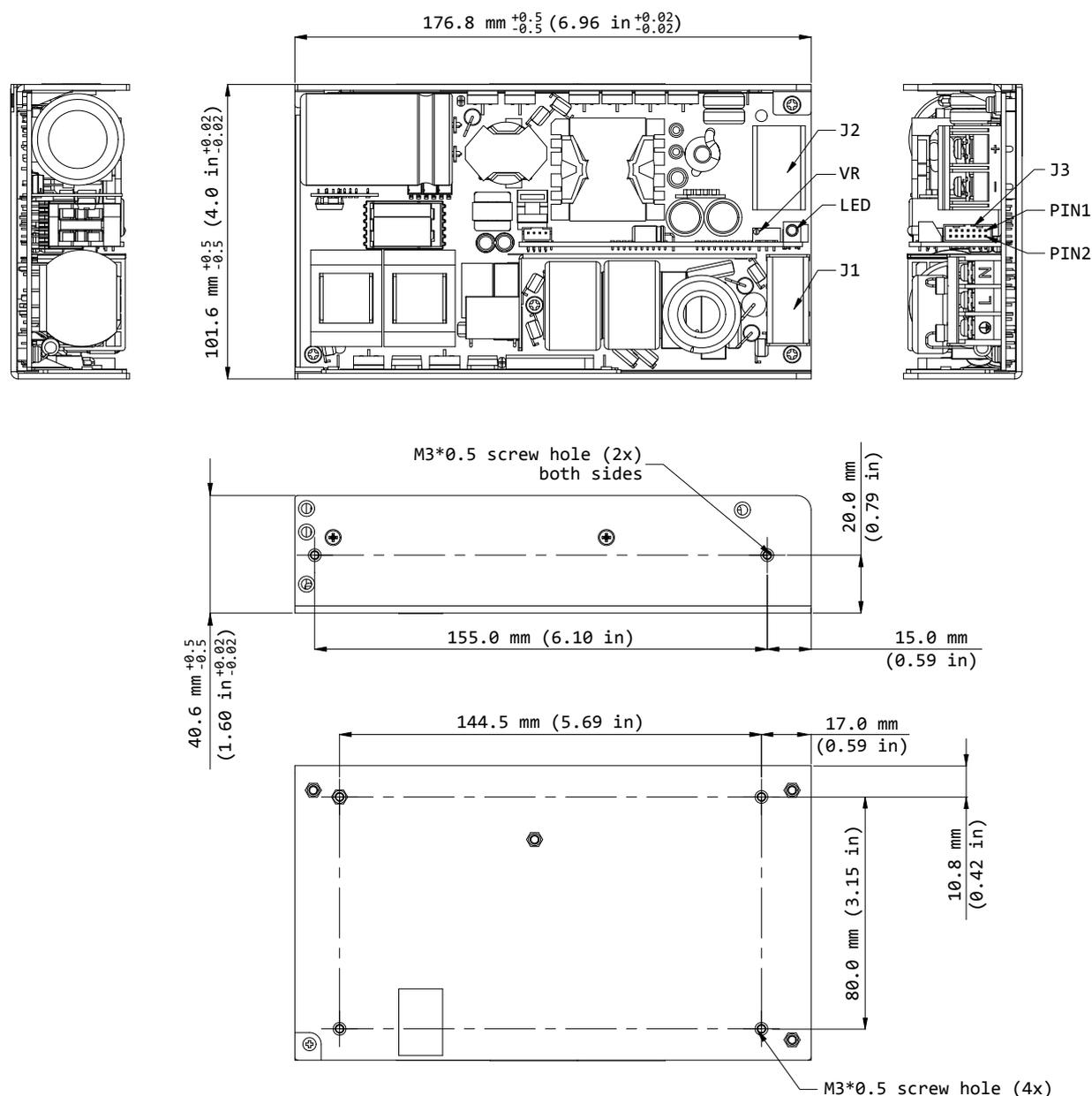*Fig. 26: Position of the mounting holes*

Dimensional drawings

Fig. 27: Dimensional drawing IMA-x400-xx

Notes:

- Base plate mounting, M3 thread holes, maximum penetration 4.0 mm (0.16 in) (from outside face of chassis), maximum torque 0.6 Nm (5.31 lb-in)
- (J1) Input terminal block, Switchlab T14-EMII03, M3.5 screw in 3 positions, maximum torque1.3 Nm (11.5 lb-in)
- (J2) Output terminal block, Dinkle DT-7C-B01W-3943-02, M4 screw in 2 positions, maximum torque 1.5 Nm (13.28 lb-in)
- (J3) Mating connector is either Molex, part number 51110-1450 (without locking ramp), or Molex part number 51110-1451 (with locking ramp). The connector is not shipped with the power supply unit.
- General tolerance: ±0.3 mm (0.012 in)

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.
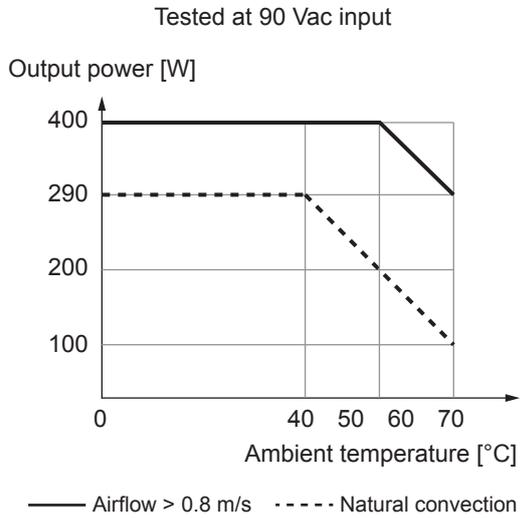
6. Appendix

6.1 Curves

IMA-x400-12

Tested at 90 Vac input

Fig. 28: Output power versus ambient temperature 12 V

IMA-x400-24/48

Tested at 90 Vac input

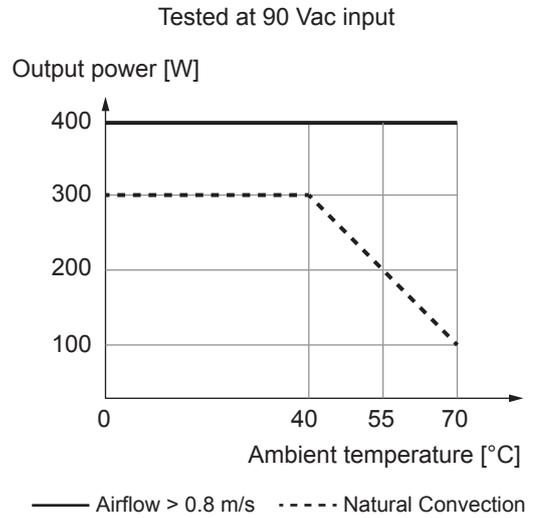*Fig. 29: Output power versus ambient temperature 24/48 V*

IMA-x400-xx
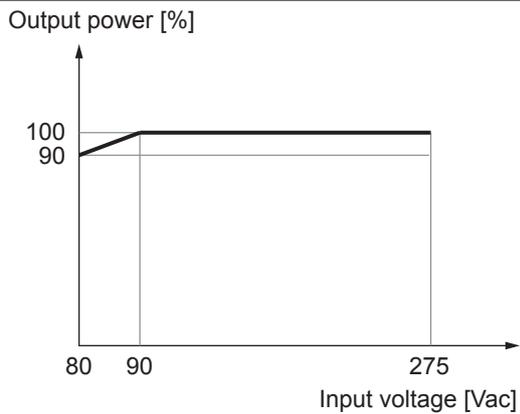
Fig. 30: Output power versus input voltage

IMA-x400-12

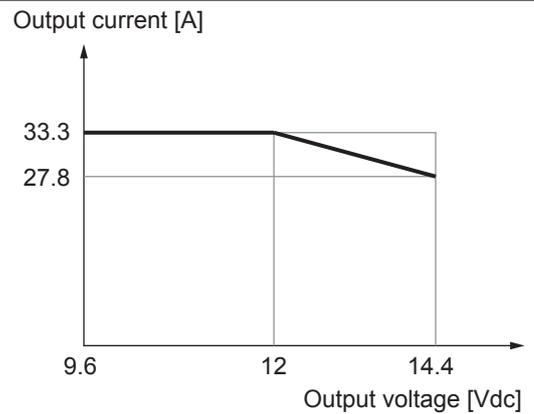*Fig. 31: Output current versus output voltage 12 V*

IMA-x400-24

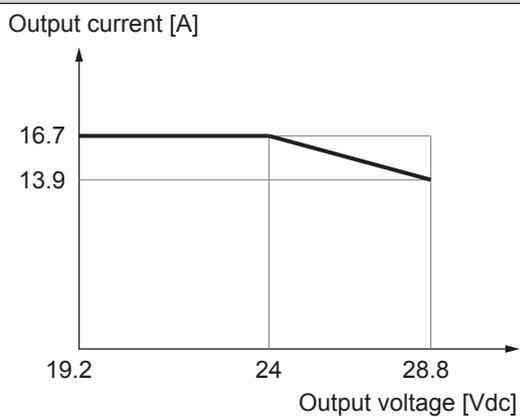*Fig. 32: Output current versus output voltage 24 V*

IMA-x400-48

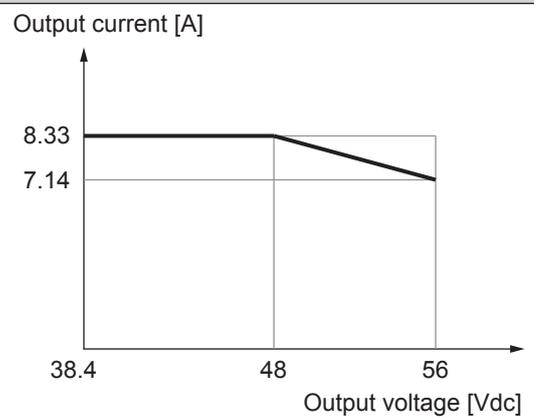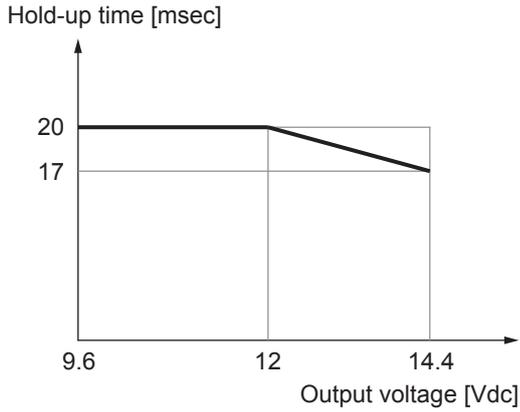*Fig. 33: Output current versus output voltage 48 V*

Fig. 34: Hold-up time versus output voltage 12 V
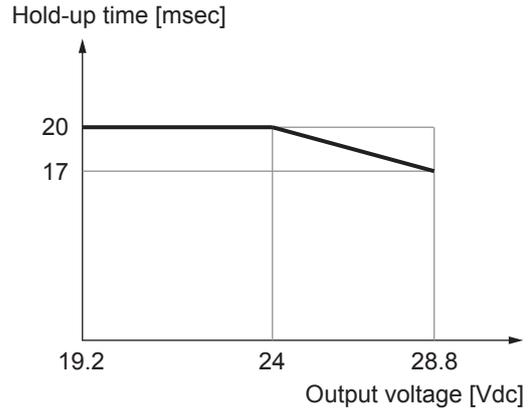
Fig. 35: Hold-up time versus output voltage 24 V
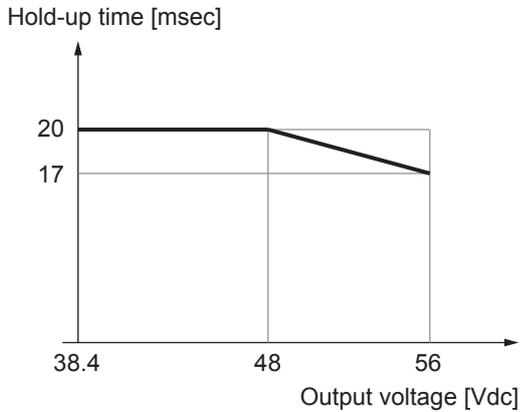
Fig. 36: Hold-up time versus output voltage 48 V
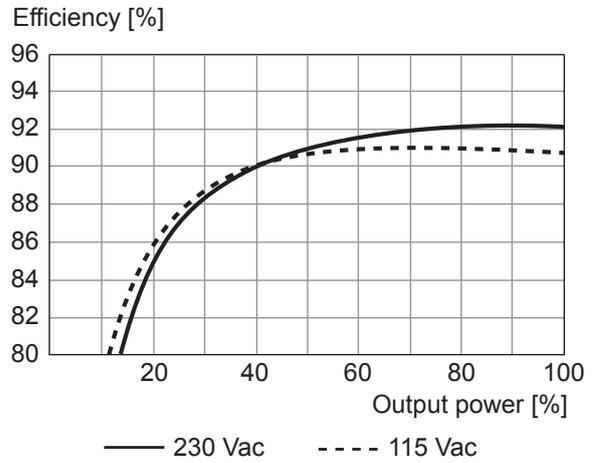
Fig. 37: Typical efficiency curves 12 V
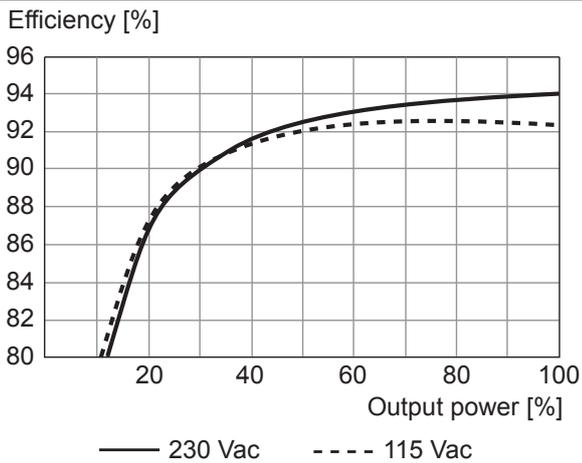
Fig. 38: Typical efficiency curves 24 V
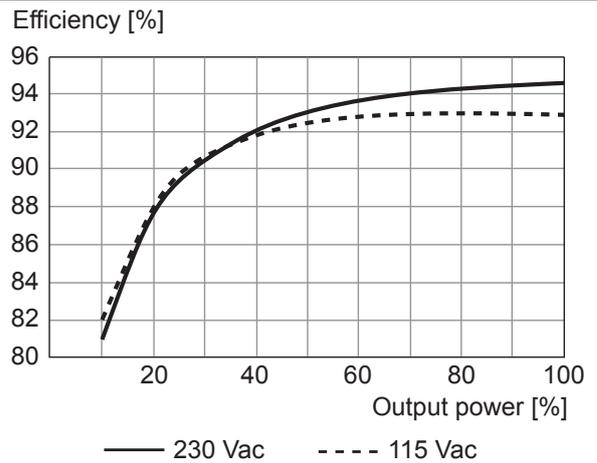
Fig. 39: Typical efficiency curves 48 V

7.   PMBus™

7.1   PMBus™ Communication

IMA-x400 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. 40: 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 (big-ending).

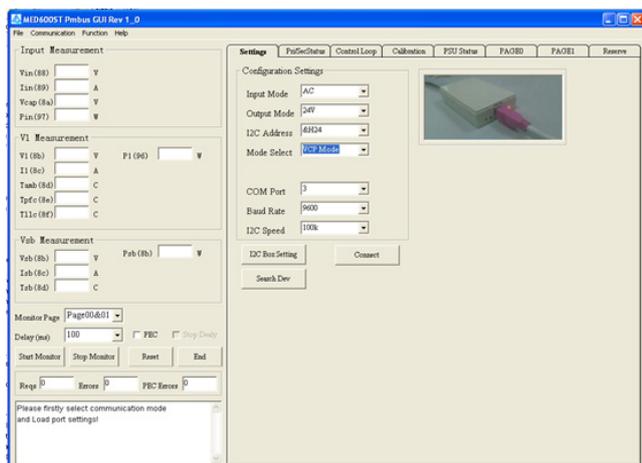| Command Code	Command Name	Page		Transaction Type		Number of data bytes	Instruction
		0 (V1)	1 (5VSB)	Writing data	Reading data		
00h	PAGE	√	√	Write Byte	Read Byte	1	provides the ability to configure, control, and monitor multiple phases on one PMBus unit
01h	OPERATION	√	√	Write Byte	Read Byte	1	turn unit on or off in conjunction with the input from the control pin
03h	CLEAR_FAULTS	√	√	Send Byte	N/A	0	clear any fault bits that have been set
19h	CAPABILITY	√	√	N/A	Read Byte	1	determine some key capabilities of a PMBus device
1Ah	QUERY	□	□	N/A	Block Write – Block Read Process Call	Variable	ask a PMBus device if it supports a given command
20h	VOUT_MODE	√	√	N/A	Read Byte	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	1	configure up to fan associated with one PMBus device(Default:No Fan)
3Bh	FAN_COMMAND_1	√	√	Write Word	Read Word	2	□
40h	VOUT_OV_FAULT_LIMIT	√	√	N/A	Read Word	2	set the value of the output voltage at the sense or output pins that causes an output voltage high warning
46h	IOUT_OC_FAULT_LIMIT	√	√	Write Word (V1 only)	Read Word	2	set the value of the output current, in amperes, that causes the overcurrent detector to indicate an overcurrent fault condition
4Ah	IOUT_OC_WARN_LIMIT	√	√	Write Word (V1 only)	Read Word	2	set the value of the output current that causes an output overcurrent warning
4Fh	OT_FAULT_LIMIT	√	√	N/A	Read Word	2	set the temperature, in degrees Celsius, of the unit at which it should indicate an Overtemperature
51h	OT_WARN_LIMIT	√	√	N/A	Read Word	2	set the temperature, in degrees Celsius, of the unit at which it should indicate an Undertemperature Warning alarm
78h	STATUS_BYTE	√	√	N/A	Read Byte	1	returns one bytes of information with a summary of the unit's fault condition
79h	STATUS_WORD	√	√	N/A	Read Word	2	returns two bytes of information with a summary of the unit's fault condition

Command Code	Command Name	Page		Transaction Type		Number of data bytes	Instruction
		0 (V1)	1 (5VSB)	Writing data	Reading data		
7Ah	STATUS_VOUT	√	√	N/A	Read Byte	1	return one data byte with contents:Output Overvoltage Fault,Warning,Undervoltage Warning,Fault TON_MAX_FAULT'TOFF_MAX_WARNING,VOUT Tracking Error
7Bh	STATUS_IOUT	√	√	N/A	Read Byte	1	return one data byte with contents as follows:Output Overcurrent Fault,Output Overcurrent And Low Voltage Fault,Output Overcurrent Warning,Output Undercurrent Fault,Current Share Fault,In Power Limiting Mode,Output Overpower Fault,Output Overpower Warning
7Ch	STATUS_INPUT	√	√	N/A	Read Byte	1	returns one data byte with contents as follows:Input Overvoltage Fault,Input Overvoltage Warning,Input Undervoltage Warning,Input Undervoltage Fault,Unit Off For Insufficient Input Voltage,(Input Overcurrent Fault,Input Overcurrent Warning,Input Overpower Warning
7Dh	STATUS_TEMPERATURE	√	√	N/A	Read Byte	1	return one data byte with contents as follows:Overtemperature Fault,Overtemperature Warning,Undertemperature Warning,Undertemperature Fault
7Eh	STATUS_CML	√	√	N/A	Read Byte	1	returns one data byte with contents as follows:Invalid Or Unsupported Command Received,Invalid Or Unsupported Data Received,Packet Error Check Failed,Memory Fault Detected,Processor Fault Detected,A communication fault other than the ones listed in this table has occurred,Other Memory Or Logic Fault has occurred
7Fh	STATUS_OTHER	√	√	N/A	Read Byte	1	return one data byte with contents as follows:Input Fuse Or Circuit Breaker Fault,Input OR-ing Device Fault,Output OR-ing Device Fault
80h	STATUS_MFR_SPECIFIC	√	√	N/A	Read Byte	1	return one data byte with contents Manufacturer Defined
81h	STATUS_FANS_1_2	√	√	N/A	Read Byte	1	report on the status of any fans installed in position 1 or position 2
88h	READ_VIN(Note 2	√	√	N/A	Read Word	2	return the input voltage in volts.
8Ah	READ_VCAP	√	√	N/A	Read Word	2	return voltage on the energy storage capacitor in volts

PMBus™

Command Code	Command Name	Page		Transaction Type		Num-ber of data bytes	Instruction
		0 (V1)	1 (5VSB)	Writing data	Reading data		
8Bh	READ_VOUT	√	√	N/A	Read Word	2	return the actual, measured (not commanded) output voltage in the same format as set by the VOUT_MODE command
8Ch	READ_IOUT	√	□	N/A	Read Word	2	return the measured output current in amperes
8Dh	READ_TEMPERATURE_1 (Ambient)	√	√	N/A	Read Word	2	return the temperature in degree Celsius
8Eh	READ_TEMPERATURE_2 (PFC)	√	√	N/A	Read Word	2	return the temperature in degree Celsius
8Fh	READ_TEMPERATURE_3 (LLC for Page0 or VSB for Page1)	√	√	N/A	Read Word	2	return the temperature in degree Celsius
90h	READ_FAN_SPEED_1	√	√	N/A	Read Word	2	fan speed(Defaul:0)
96h	READ_POUT(Note 2)	√	□	N/A	Read Word	2	return the output power, in watts, of the PMBus device
98h	PMBUS_REVISION	√	√	N/A	Read Byte	1	store or read the revision of the PMBus to which the device is compliant
A0h	MFR_VIN_MIN	√	√	N/A	Read Word	2	set or retrieve the minimum rated value, in volts, of the input voltage
A1h	MFR_VIN_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated value, in volts, of the input voltage
A2h	MFR_IIN_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated value, in amperes, of the input current
A3h	MFR_PIN_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated Input power, in watts, that the unit is rated to supply
A4h	MFR_VOUT_MIN	√	√	N/A	Read Word	2	set or retrieve the minimum rated value, in volts, to which the output voltage may be set
A5h	MFR_VOUT_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated value, in volts, to which the output voltage may be set
A6h	MFR_IOUT_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated value, in amperes, to which the output may be loaded
A7h	MFR_POUT_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated output power, in watts, that the unit is rated to supply
A8h	MFR_TAMBIENT_MAX	√	√	N/A	Read Word	2	set or retrieve the maximum rated ambient temperature, in degrees Celsius, in which the unit may be operated
A9h	MFR_TAMBIENT_MIN	√	√	N/A	Read Word	2	set or retrieve the minimum rated ambient temperature, in degrees Celsius, in which the unit may be operated
D8h	UNLOCK COMMAND	√	□	Write Word	N/A	2	Write 0x00AA to unlock command for remote level select
DFh	REMOTE ON LEVEL SELECT	√	□	Write Word	N/A	2	After unlock, write 0x0000 for low level effective, write 0x0001 for high level effective, Default: low level effective

Table 9:   PMBus™ command map

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