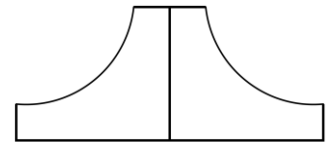




## SM15K - Series 15kW DC POWER SUPPLIES

### Bi-Directional - Constant Power

| Models       | Voltage range | Current range |
|--------------|---------------|---------------|
| SM70-CP-450  | 0 – 70 V      | - 450 – 450 A |
| SM210-CP-150 | 0 – 210 V     | -150 – 150 A  |
| SM500-CP-90  | 0 – 500 V     | -90 – 90 A    |
| SM1000-CP-45 | 0 – 1000V     | -45 – 45 A    |
| SM1500-CP-30 | 0 – 1500 V    | -30 – 30 A    |



### Features

- Bi-directional power supply, standard 15kW Source & Sink
- Flexible output with constant power characteristic
- Power regeneration technology: sink power is not dissipated but fed back into the grid
- Designed for long life at continuous full power
- Excellent dynamic response to load changes, digital controlled with the possibility to adapt to the type of load
- Very low heat dissipation, efficiency 95% or more
- Protected against all overload and short circuit conditions

### Functionalities

- Operation on a wide range of three phase AC input voltages
- Standard ethernet & web interface
- EMC surpasses CE requirements: low emission & high immunity
- Low audible noise: temperature controlled cooling fans
- Durable digital encoders for voltage & current adjustment and menu operation
- Large user display, menu driven operations

|   | SM70-CP-450    | SM210-CP-150   | SM500-CP-90   | SM1000-CP-45   | SM1500-CP-30   |
|---|----------------|----------------|---------------|----------------|----------------|
| <b>Output rating</b>  |                |                |               |                |                |
| Voltage range   | 0 - 70 V       | 0 - 210 V      | 0 - 500 V     | 0 - 1000 V     | 0 - 1500 V     |
| Current range   | -450 - 450 A   | -150 - 150 A   | -90 - 90 A    | -45 - 45 A     | -30 - 30 A     |
| <b>Regenerative mode</b>  |                |                |               |                |                |
| Minimum sink voltage  | 1.2 V @ -450 A | 3.0 V @ -150 A | 7.0 V @ -90 A | 12.0 V @ -45 A | 19.5 V @ -30 A |
| <i>Note: Unit switches automatically between source ↔ sink.</i> | 0.8 V @ -215 A | 1.5 V @ -75 A  | 4.0 V @ -30 A | 8.5 V @ -15 A  | 14 V @ -10 A   |
| Absolute maximum sink voltage                                   | 0.8 V @ -45 A  | 1.5 V @ -15 A  | 1.8 V @ -10 A | 2.5 V @ -5 A   | 4.5 V @ -3 A   |
| Minimum sink current  | 74 V           | 220 V          | 525 V         | 1050 V         | 1575 V         |
| Minimum sink power  | 0.4%           | 0.4%           | 0.4%          | 0.4%           | 0.4%           |
|   | 0.8%           | 0.8%           | 1.2%          | 1.2%           | 1.2%           |
| <b>AC Input</b>   |                |                |               |                |                |
| Rated voltage range   | 380 - 480 V    |                |               |                |                |
| Rated frequency   | 50 / 60 Hz     |                |               |                |                |
| Rated current   | Maximum 27 A   |                |               |                |                |
| Current, 15kW   | 23 A           |                |               |                |                |
| Power factor, 15kW / 7.5kW                                      | 0.996 / 0.988  |                |               |                |                |
| Internal fuses  | 30 AT          |                |               |                |                |
| Standby input power ( $V_o=I_o=0$ ) <sup>1</sup>                | 100 W          |                |               |                |                |
| Standby input power ( $V_o=V_{max}$ ) <sup>1</sup>              | 180 W          |                |               |                |                |
| <b>Efficiency (Sink &amp; Source mode):</b>                     |                |                |               |                |                |
| 15 kW, $I_{out}=100\%$  | 95 %           |                |               |                |                |
| 15 kW, $U_{out}=100\%$  | 96 %           |                |               |                |                |
| <b>Regulation</b>   |                |                |               |                |                |
| Load 0 - 100% <b>CV</b>   | 6 mV           | 5 mV           | 4 mV          | 10mV           | 10 mV          |
| Line 342 - 528 $V_{AC}$ <sup>2</sup> <b>CV</b>                  | < 1 mV         | < 1 mV         | < 1 mV        | <1mV           | < 1 mV         |
| Load 0 - 100% <b>CC</b>   | 35 mA          | 12 mA          | 8 mA          | 2mA            | 2 mA           |
| Line 342 - 528 $V_{AC}$ <sup>1,3</sup> <b>CC</b>                | 4 mA           | 3 mA           | 1 mA          | 1mA            | 1 mA           |
| <b>Ripple + noise</b> <sup>5</sup>                              |                |                |               |                |                |
| Source mode:  | 33 V / 450 A   | 100 V / 150 A  | 167 V / 90 A  | 333V / 45A     | 500 V / 30 A   |
| rms (BW=300 kHz) <b>CV</b>                                      | 10 mV          | 30 mV          | 10 mV         | 25mV           | 25 mV          |
| p-p (BW=20 MHz) <b>CV</b>                                       | 60 mV          | 150 mV         | 55 mV         | 150mV          | 150 mV         |
| rms (BW=300 kHz) <b>CC</b>                                      | 100 mA         | -              | 45 mA         | 45mA           | 12 mA          |
| p-p (BW=20 MHz) <b>CC</b>                                       | -              | -              | 200 mA        | 200mA          | 70 mA          |
| rms (BW=300 kHz) <b>CV</b>                                      | 70 V / 215 A   | 210 V / 71.5 A | 500 V / 30 A  | 1000V / 15A    | 1500 V / 10 A  |
| p-p (BW=20 MHz) <b>CV</b>                                       | 10 mV          | 20 mV          | 25mV          | 35mV           | 35mV           |
| p-p (BW=20 MHz) <b>CV</b>                                       | 60 mV          | 125 mV         | 115mV         | 250mV          | 250mV          |
| rms (BW=300 kHz) <b>CC</b>                                      | 100 mA         | -              | 45 mA         | 45mA           | 5 mA           |
| p-p (BW=20 MHz) <b>CC</b>                                       | -              | -              | 200 mA        | 200mA          | 25 mA          |
| Sink mode:  | 33 V / 450 A   | 100 V / 150 A  | 167 V / 90 A  | 333V / 45A     | 500 V / 30 A   |
| rms (BW=300 kHz) <b>CV</b>                                      | 8 mV           | 30 mV          | 7 mV          | 15mV           | 15 mV          |
| p-p (BW=20 MHz) <b>CV</b>                                       | 50 mV          | 150 mV         | 35 mV         | 75mV           | 130 mV         |
| rms (BW=300 kHz) <b>CC</b>                                      | 100 mA         | -              | 45 mA         | 60mA           | 10 mA          |
| p-p (BW=20 MHz) <b>CC</b>                                       | -              | -              | 200 mA        | -              | 60 mA          |
| rms (BW=300 kHz) <b>CV</b>                                      | 70 V / 215 A   | 210 V / 71.5 A | 500 V / 30 A  | 1000V / 15A    | 1500 V / 10 A  |
| p-p (BW=20 MHz) <b>CV</b>                                       | 8 mV           | 20 mV          | 10 mV         | 25mV           | 25 mV          |
| p-p (BW=20 MHz) <b>CV</b>                                       | 50 mV          | 125 mV         | 50 mV         | 125mV          | 200 mV         |
| rms (BW=300 kHz) <b>CC</b>                                      | 100 mA         | -              | 90 mA         | 60mA           | 3 mA           |
| p-p (BW=20 MHz) <b>CC</b>                                       | -              | -              | 320 mA        | -              | 12 mA          |
| <b>Programming &amp; monitoring accuracy</b> <sup>4</sup>       |                |                |               |                |                |
| Voltage   | ± 0.08%        |                |               |                |                |
| Current   | ± 0.15%        |                |               |                |                |
| <b>Temperature coefficient, per °C</b> <sup>1,5</sup>           |                |                |               |                |                |
| <b>CV</b>   | 20 ppm         |                |               |                |                |
| <b>CC</b>   | 50 ppm         |                |               |                |                |
| <b>Stability over 8 hours</b> <sup>1,5</sup>                    |                |                |               |                |                |
| <b>CV</b>   | 50 ppm         |                |               |                |                |
| <b>CC</b> <sup>3</sup>  | 80 ppm         |                |               |                |                |

<sup>1</sup> After 1 hour warm up<sup>2</sup> Remote voltage sense<sup>3</sup> Local voltage sense<sup>4</sup> Excluding INT MOD ANA<sup>5</sup> Measured at full load

|  | SM70-CP-450  | SM210-CP-150        | SM500-CP-90         | SM1000-CP-45       | SM1500-CP-30                       |
|--|--|---------------------|---------------------|--------------------|------------------------------------|
| <b>Programming speed</b> <sup>6, 7</sup>           |  |                     |                     |                    |                                    |
| <b>Rise time (10 - 90%)</b>                        |  |                     |                     |                    |                                    |
| Output voltage step                                | 0 → 33 V   | 0 → 100 V           | 0 → 167 V           | 0 → 333 V          | 0 → 500 V                          |
| Load = 15 kW                                       | 2.2 ms   | 1.6 ms              | 1.5 ms              | 1.5 ms             | 1.5 ms                             |
| Load = 1500 W                                      | 1.5 ms   | 1.3 ms              | 1 ms                | 1 ms               | 1 ms                               |
| Output voltage step                                | 0 → 70 V   | 0 → 210 V           | 0 → 500 V           | 0 → 1000 V         | 0 → 1500 V                         |
| Load = 15 kW                                       | 5.5 ms   | 3 ms                | 4.5 ms              | 4.5 ms             | 4.5 ms                             |
| Load = 1500 W                                      | 3.5 ms   | 2.7 ms              | 3.5 ms              | 3.5 ms             | 3.5 ms                             |
| <b>Fall time (90 - 10%)</b>                        |  |                     |                     |                    |                                    |
| Output voltage step                                | 33 → 0 V   | 100 → 0 V           | 167 → 0 V           | 0 → 333 V          | 500 → 0 V                          |
| Load = 15 kW                                       | 1.5 ms   | 1.3 ms              | 0.8 ms              | 0.9 ms             | 0.8 ms                             |
| Load = 1500 W                                      | 1.5 ms   | 1.3 ms              | 0.9 ms              | 1.0 ms             | 0.9 ms                             |
| Output voltage step                                | 70 → 0 V   | 210 → 0 V           | 500 → 0 V           | 0 → 1000 V         | 1500 → 0 V                         |
| Load = 15 kW                                       | 2.6 ms   | 2.5 ms              | 2.5 ms              | 2.8 ms             | 2.8 ms                             |
| Load = 1500 W                                      | 3.5 ms   | 2.5 ms              | 3.5 ms              | 3.5 ms             | 3.5 ms                             |
| <b>Recovery time</b> <sup>8, 9</sup>               |  |                     |                     |                    |                                    |
| Condition  | 33V, 225 → 450A  | 100V, 75 → 150A     | 167V, 45 → 90A      | 333V, 22.5 → 45A   | 500V, 15 → 30A                     |
| Recovery within                                    | 100 mV   | 500 mV              | 750 mV              | 2.5 V              | 2.8 V                              |
| di/dt of load step                                 | 5 A/μs   | 2.4 A/μs            | 0.8 A/μs            | 0.4 A/μs           | 0.25 A/μs                          |
| Time   | 100 μs   | 100 μs              | 100 μs              | 100 μs             | 100 μs                             |
| Maximum deviation                                  | 0.8 V  | 1.4 V               | 2.8 V               | 9.0 V              | 9.0 V                              |
| Condition  | 70V, 112 → 215A  | 210V, 36 → 72A      | 500V, 15 → 30A      | 1000V, 7.5 → 15A   | 1500V, 5 → 10A                     |
| Recovery within                                    | 100 mV   | 250 mV              | 500 mV              | 1 V                | 1.2 V                              |
| di/dt of load step                                 | 2 A/μs   | 1.15 A/μs           | 0.25 A/μs           | 0.15 A/μs          | 0.085 A/μs                         |
| Time   | 100 μs   | 100 μs              | 150 μs              | 150 μs             | 150 μs                             |
| Maximum deviation                                  | 0.3 V  | 0.75 V              | 1.2 V               | 3.0 V              | 3.5 V                              |
| <b>DC output capacitance</b>                       |  |                     |                     |                    |                                    |
| X-capacitors (typical)                             | 22000 μF   | 1170 μF             | 560 μF              | 141 μF             | 58 μF                              |
| Y-capacitors (typical)                             | 950 nF   | 950 nF              | 145 nF              | 145 nF             | 145 nF                             |
| <b>Output impedance</b> <sup>10</sup>              |  |                     |                     |                    |                                    |
| 0-1 kHz  | < 0.75 mΩ  | < 5 mΩ              | < 16 mΩ             | < 150 mΩ           | < 250 mΩ                           |
| 1-100 kHz  | < 40 mΩ  | < 40 mΩ             | < 160 mΩ            | < 800 mΩ           | < 2 Ω                              |
| <b>Pulsating load</b>                              |  |                     |                     |                    |                                    |
| Max. tolerable AC component of load current        |  |                     |                     |                    |                                    |
| f > 1 kHz  | 60 A <sub>RMS</sub>  | 15 A <sub>RMS</sub> | 15 A <sub>RMS</sub> | 3 A <sub>RMS</sub> | 2.5 A <sub>RMS</sub>               |
| f < 1 kHz  | 450 A <sub>pk</sub>  | 150 A <sub>pk</sub> | 90 A <sub>pk</sub>  | 45 A <sub>pk</sub> | 30 A <sub>pk</sub>                 |
| <b>Hold-up time</b>                                |  |                     |                     |                    |                                    |
| V <sub>out</sub> = 100%, P <sub>out</sub> = 15 kW  | 10 ms  | 10 ms               | 15 ms               | 15 ms              | 15 ms                              |
| I <sub>out</sub> = 100%, P <sub>out</sub> = 15 kW  | 10 ms  | 10 ms               | 15 ms               | 15 ms              | 15 ms                              |
| V <sub>out</sub> = 100%, P <sub>out</sub> = 7.5 kW | 25 ms  | 20 ms               | 35 ms               | 35 ms              | 35 ms                              |
| <b>Turn on delay</b> <sup>11</sup>                 | 2.5 s after mains switch is turned on, the rated output voltage is reached                 |                     |                     |                    |                                    |
| <b>Inrush current</b> <sup>10</sup>                | 23 A   |                     |                     |                    |                                    |
| <b>Safety standards</b>                            | EN 60950 / EN 61010  |                     |                     |                    |                                    |
| <b>Insulation</b>                                  |  |                     |                     |                    |                                    |
| AC / DC terminals                                  | 3750V <sub>RMS</sub> (1 min.)  |                     |                     |                    | 3750 V <sub>RMS</sub> (1 min.)     |
| Creepage / clearance                               | 8 mm   |                     |                     |                    | 8 mm                               |
| AC power terminals / case                          | 2500 V <sub>RMS</sub>  |                     |                     |                    | 2500 V <sub>RMS</sub>              |
| DC power terminals / case                          | 1000 V <sub>DC</sub> <sup>12</sup>   |                     |                     |                    | 1500 V <sub>DC</sub> <sup>12</sup> |
| <b>EMC</b>   |  |                     |                     |                    |                                    |
| Emission   | EN 61326-1, class B equipment(for use in domestic establishments)                          |                     |                     |                    |                                    |
| Immunity   | EN 61326-1, equipment for use in industrial and domestic establishments                    |                     |                     |                    |                                    |
| <b>Environmental conditions</b>                    |  |                     |                     |                    |                                    |
| Storage temperature                                | - 40 to + 85 °C  |                     |                     |                    |                                    |
| Operating temperature                              | - 20 to + 50 °C, Derate output to 75% at 60 °C   |                     |                     |                    |                                    |
| Output automatically disabled at overtemperature   |  |                     |                     |                    |                                    |
| Humidity   | Maximum 95% RH, non condensing, up to 40 °C<br>Maximum 75% RH, non condensing, up to 50 °C |                     |                     |                    |                                    |
| IP Rating  | IP20   |                     |                     |                    |                                    |
| Pollution degree                                   | 2  |                     |                     |                    |                                    |
| <b>MTBF</b>  | 500 000 hrs  |                     |                     |                    |                                    |

<sup>6</sup> Measured on resistive load with power supply in CV mode, different conditions may influence the specified speed

<sup>7</sup> Signal latency depends on the interface used & data traffic

<sup>8</sup> Local voltage sense

<sup>9</sup> Remote sensing and long wiring may influence the values

<sup>10</sup> Typical

<sup>11</sup> Unit should be configured to switch on the output at startup

<sup>12</sup> See "Safety Instructions"

|  | SM70-CP-450   | SM210-CP-150  | SM500-CP-90   | SM1000-CP-45   | SM1500-CP-30   |
|--|---|---|---|--|--|
| <b>Series operation</b><br>Maximum total voltage<br>Master / slave operation   | Series operation not allowed  |   | 750V <sup>13</sup><br>1000V <sup>14</sup><br>Maximum 6 units <sup>15</sup>    | Series operation not allowed   |  |
| <b>Parallel operation</b><br>Master / slave operation  | Maximum 60 units  |   |   |  |  |
| <b>Remote sensing</b><br>Maximum voltage drop per load lead  | Default 1 V, can be set to 10 V   |   |   |  |  |
| <b>Limits</b><br>Adjustable<br>Voltage<br>Current<br>Power<br>Fixed<br>Voltage OverLoad level<br>Voltage Self-Protection level | 0 - 101 %<br>0 - 101 %<br>0 - 101 %<br>102.5 % - unit will continue to operate (OL-indication in display)<br>105 % - output is automatically disabled (PROT-indication in display)  |   |   |  |  |
| <b>Potentiometers</b><br>Front panel control knob resolution   | 15 bits   |   |   |  |  |
| <b>Meter scale</b><br>Voltage<br>Current<br>Power<br>Accuracy read output  | 4 digit<br>0.00 - 70.00V<br>-450.0 - 450.0A<br>-15000 - 15000W<br>0.2% + 2 digit  | 4 digit<br>0.0 - 210.0V<br>-150.0 - 150.0A<br>-15000 - 15000W<br>0.2% + 2 digit | 4 digit<br>0.0 - 500.0V<br>-90.0 - 90.0A<br>-15000 - 15000W<br>0.2% + 2 digit | 4 digit<br>0 - 1000V<br>-45.00 - 45.00A<br>-15000 - 15000W<br>0.2% + 2 digit | 4 digit<br>0 - 1500V<br>-30.00 - 30.00A<br>-15000 - 15000W<br>0.2% + 2 digit |
| <b>Mounting</b>  | Stacking of units allowed   |   |   |  |  |
| <b>AC terminals (CON A)</b>  | Screw terminals for wire 4 mm <sup>2</sup> , 3 phase + earth (no neutral)   |   |   |  |  |
| <b>DC terminals (CON B1 &amp; B2)</b>  | M12 bolts   | M8 bolts  |   |  |  |
| <b>Programming connectors (LAN)</b>  | Standard with RJ45-connector for Ethernet at rear panel, 100 Mb/s, full-duplex  |   |   |  |  |
| <b>Interlock (CON F)</b>   | Input for contact at rear panel   |   |   |  |  |
| <b>Cooling</b><br>Audio noise level<br>Airflow direction<br>Thermal protection   | Low noise, fan speed adapts to temperature of internal system<br>ca. 50 dBA at full load, 25 °C ambient temperature, 1 m distance<br>ca. 65 dBA at full load, 50 °C ambient temperature, 1 m distance<br>From left to right<br>Output shuts down in case of insufficient cooling (over temperature indication in display) |   |   |  |  |
| <b>Dimensions</b><br>Front panel: h x w<br>behind front panel: h x w x d   | 132 x 483 mm (19", 3 U)<br>128 x 448 x 591 mm (excluding feet)<br>No additional depth is required with optional interfaces assembled  |   |   |  |  |
| <b>Weight</b>  | 27 kg   |   |   |  |  |

CV = Constant Voltage

CC = Constant Current

CP = Constant Power

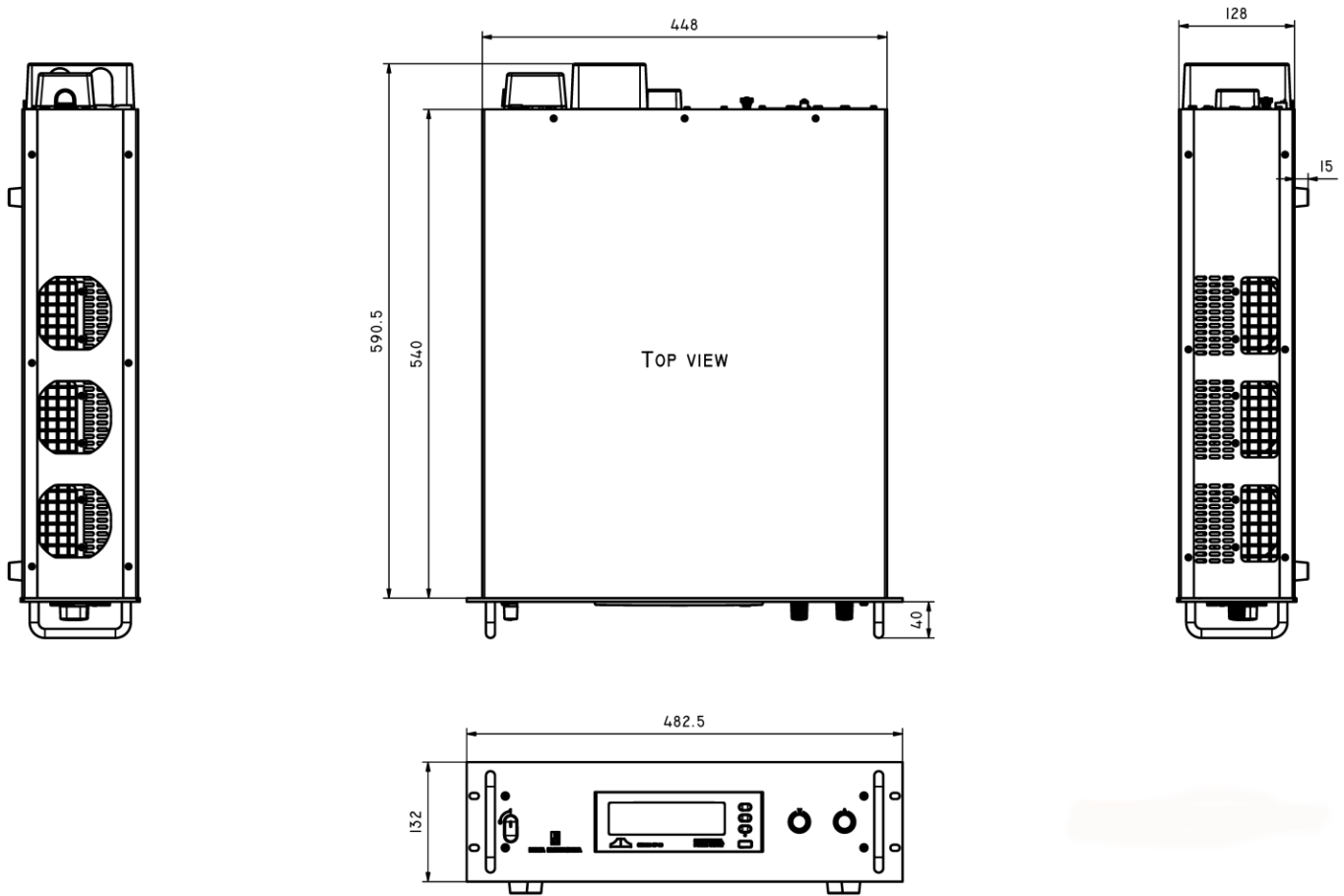
Specifications measured at  $T_{amb} = 25 \pm 5 \text{ }^{\circ}\text{C}$  and  $V_{in} = 400 \text{ V}_{AC}$ , 3 phase, 50 Hz unless otherwise noted. The information in this document is subject to change without notice.

<sup>13</sup> Units delivered before Q4 / 2018. Contact factory for upgrading to enable 1000V series operation for older units.

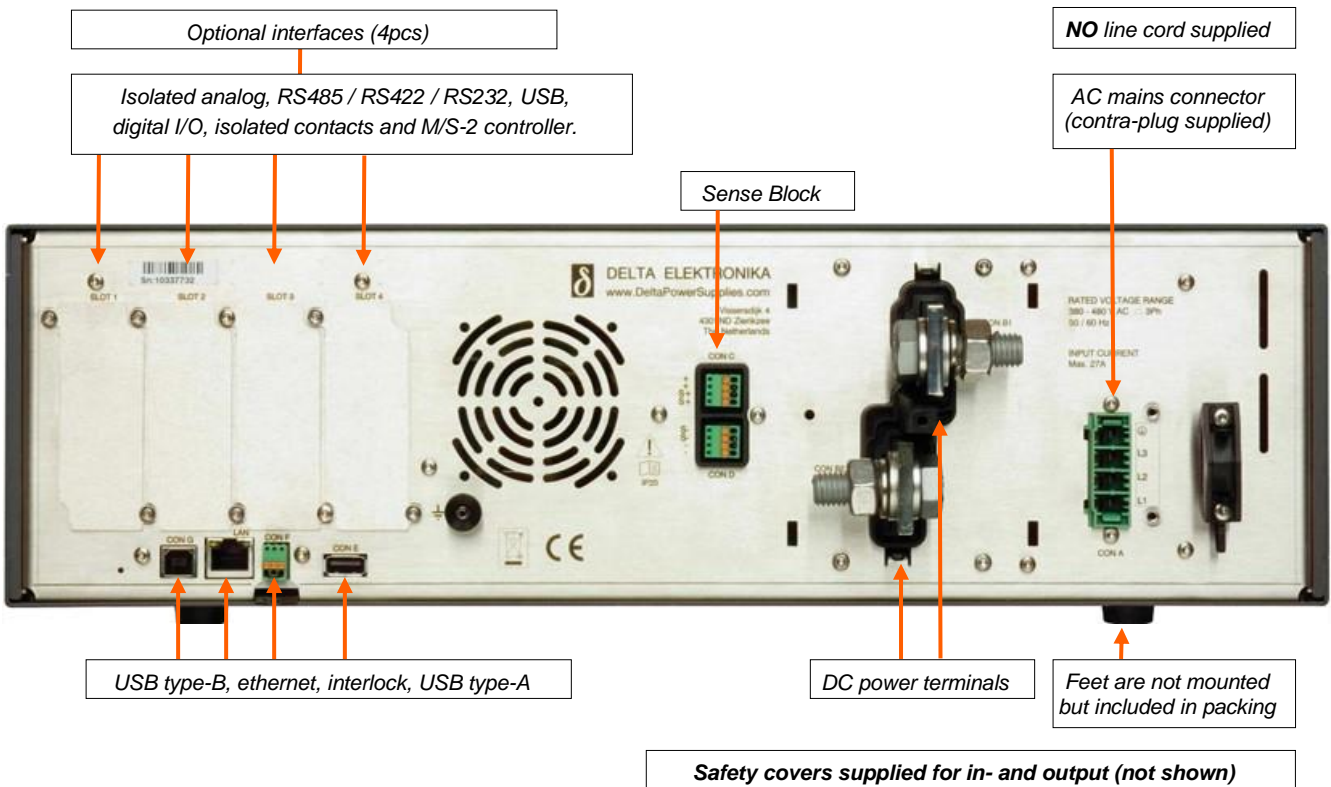
<sup>14</sup> Units delivered in Q4 / 2018 or later.

<sup>15</sup> See "Safety Instructions"

**Dimensions**



**Rear view**



## Typical Applications

- Solar inverter testing, PV-Simulation
- Car testing systems
- ATE in industrial production lines
- Plasma chambers
- Automotive battery simulations
- Controlled battery (dis)charging
- Lasers
- Sustainable energy
- Driving PWM-Controlled DC motors
- Accurate current sources
- Aerospace and military equipment

## Standard Features



### Bi-Directional Two-Quadrant Output

Full power Bi-Directional two quadrant operation maintains the DC output voltage constant whether the output power is positive or negative. Ideal for PWM-speed controlled DC-Motors and ATE systems.



### Digital CV-, CC- and CP-Settings

Reliable, long-life digital encoders are mounted at the front panel. Includes total front panel lock (also for CV- / CC-knobs) and a coarse or fine pitch adjustment depending on the turning speed.



### High Voltage Isolation

A high DC output isolation allows floating operation up to 1000 V for SM70-CP-450, SM210-CP-150, SM500-CP-90 and SM1000-CP-45 and up to 1500 V for SM1500-CP-30.



### Sequencer

Arbitrary Waveform generator or standalone automation.



### Ethernet Interface

Ethernet interface for programming and monitoring



### USB-Input

Not yet available: USB-Input for exchange of settings or for controlling the unit.

## Options



### Software control and Interfaces

Field installable interfaces:

- Master / Slave controller
- Isolated Contacts
- Serial controller with multiple protocols: RS 232, RS 485, RS 422 and USB (Device)
- Digital I/O
- Isolated Analog Programming

Order Codes:

- INT MOD M/S-2
- INT MOD CON
- INT MOD SER
- INT MOD DIG
- INT MOD ANA