Modular power supply units are common power supply units for the new generation of PRIMERGY mono and dual socket servers, which in accordance with requirements enable individual configuration with maximum efficiency and simplified storage.

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1 Introduction: Modular power supply unit

The modular power supply unit (abbreviation: modular PSU) is a common power supply concept for the vast majority of Fujitsu PRIMERGY tower and rack servers. The space-saving 1U power supply unit (185 mm x 73.5 mm x 40 mm) is available in three versions:

- 450 W (80 PLUS certification & CSCI platinum level)
- 800 W (80 PLUS certification & CSCI platinum level)
- 800 W (80 PLUS certification & CSCI titanium level)
- 48DC 800 W (80 PLUS gold level & CSCI gold level)

Modular PSU is available to a range of PRIMERGY servers:

<table>
<thead>
<tr>
<th>PRIMERGY</th>
<th>450 W PSU</th>
<th>800 W PSU</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX100 S8</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>RX2520 M1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RX200 S8</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RX300 S8</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RX350 S8</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>RX500 S7</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>TX140 S2</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>TX150 S8</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>TX2540 M1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>TX300 S8</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

PRIMERGY dual socket servers generally support both the 450 W power supply unit and the 800 W power supply unit. In contrast, the mono socket servers have lower power consumption and therefore only require the 450 W power supply unit. Modular PSU also support the proven security function called “PowerSafeguard”, which even safeguards further operation of the server if a power supply unit fails during redundant operation and the power consumption exceeds the capacity of the remaining power supply unit. Depending on the server configuration, this protection is available up to an excess capacity of 30 %. (See chapter S.3).

2 Advantages of the modular PSU

Modular PSU offer a range of advantages, in particular in the areas of energy efficiency and easier maintenance and stocking.

2.1 Improved energy efficiency

High energy efficiency depends on the utilization level of the power supply units. The best possible degree of efficiency is only achieved with a utilization level of approx. 50 %. The server configurations are often very different. The energy consumption spectrum ranges from 60 Watt up to more than 1000 Watt. To obtain the best possible energy efficiency with every configuration, the modular PSU offers on the one hand power supply units in different sizes so as to enable the individual configuration of the PRIMERGY servers with an adequate power supply, and on the other hand provides the option of installing up to four power supply units (e.g. with the RX350 S8). The latter enables an individual configuration for phase and PSU redundancy with an optimum degree of efficiency of the power supply units.

Modular power supply units rely on technology with the highest energy efficiency standard, which enable an efficiency degree of up to 96 % and thus meet the CSCI certification standard "80 PLUS titanium". This high degree of efficiency ensures that merely 4 % of the energy consumption is lost in the form of waste heat and is not available to the server. Furthermore, PRIMERGY Power Management - with its easy and automated energy management - helps achieve significant savings in energy requirements. For example, innovative functions, such as the automatic deactivation of unused PCIe ports, help to further reduce power requirements.

The combination of efficient, modular power supply units with intelligent power management contributes to making the new
generation of PRIMERGY dual socket servers the most efficient in their class. This for example has enabled the Fujitsu PRIMERGY RX300 S8 to achieve world records in the SPECpower benchmark at the launch time, which measures the energy efficiency of servers.\(^1\)

### 2.2 Easier maintenance and stocking

Ten Fujitsu PRIMERGY racks and tower servers are currently based on the modular PSU. The standardized concept permits easier stocking and maintenance of the servers. This means that only three power supply units (450 W and 800 W platinum and titanium) have to be held in stock in order to equip the different server configurations with an adequate power supply unit, regardless of whether it is a new configuration or a maintenance case.

### 3 Functions of the modular PSU

#### 3.1 Titanium and Platinum efficiency

Modular 450 W and 800 W power supply units fulfill the state-of-the-art ‘80 PLUS platinum’ efficiency class. With the 800 W 80 PLUS titanium power supply units Fujitsu offers the industry leading highest efficiency. The degree of efficiency here depends on the utilization level of the power supply unit. The best possible degree of efficiency is therefore only achieved with an approx. 50 % utilization level, as illustrated in the table below. Unnecessary oversizing of power supply units thus reduces the possible energy efficiency.

<table>
<thead>
<tr>
<th>Levels</th>
<th>10% Load</th>
<th>20% Load</th>
<th>50% Load</th>
<th>100% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Efficiency</td>
<td>PF</td>
<td>Efficiency</td>
<td>PF</td>
</tr>
<tr>
<td>Silver</td>
<td>75</td>
<td>0.65</td>
<td>85</td>
<td>0.8</td>
</tr>
<tr>
<td>Gold</td>
<td>80</td>
<td>0.65</td>
<td>88</td>
<td>0.8</td>
</tr>
<tr>
<td>Platinum</td>
<td>82</td>
<td>0.65</td>
<td>90</td>
<td>0.8</td>
</tr>
<tr>
<td>Titanium</td>
<td>90</td>
<td>0.65</td>
<td>94</td>
<td>0.95</td>
</tr>
</tbody>
</table>

(230 V Internal Redundant, PF = Power Factor)

#### 3.2 Customer benefit of the 80 PLUS titanium PSU

While the 80 PLUS titanium PSU costs a little more than the platinum PSU, this additional costs will be over-compensated within the regular lifetime of a server. Like the calculation below shows, over a lifetime of 5 years a titanium PSU can save up to 275 € in energy costs.

**Example**

- PRIMERGY RX300 S8, redundant 800 W PSU, PSU load 25 % equals 200 W net power consumption
- 80 PLUS Titanium PSU: 12,7 W loss (94 % efficiency @ 25 % load)
- 80 PLUS Platinum PSU: 22,2 W loss (90 % efficiency @ 25 % load)
- Average power saving: 19 W for 2x PSU
- Server runtime: 24 hours / 365 days
- Productive lifetime: 5 years
- Energy costs: 0,15 € / kWh
- Power usage effectiveness (PUE): 2.2

\[
\text{Possible energy savings: } 275 \text{ € for 5 years}
\]

The 80 PLUS titanium power supply unit underlines Fujitsu’s overall strategy to provide energy efficient solutions for IT infrastructures.

\(^1\) Competitive benchmark results stated above reflect results published on www.spec.org as of September 10, 2013. Score of 8,097 overall ssj_ops/watt published by Fujitsu on the PRIMERGY RX300 S8, see:
3.3 PowerSafeguard

PowerSafeguard also protects further operation of the server if a power supply unit in a redundant configuration fails and the energy requirements of the remaining power supply units exceed a maximum of 30%. This protection mechanism is permitted through automatic reduction of energy consumption within a few milliseconds.

To do this PowerSafeguard sets the P states of the processor to a minimum and then successively increases them again until the maximum performance of the power supply unit is reached. However, the resulting impact on the entire performance in a high configuration is limited in most cases, as only short-term peak utilization is no longer supported, as the diagram above shows. The servers frequently only work with a server utilization of approx. 30%, and in virtualization environments with approx. 50 - 70%.

3.4 Redundant modes

Modular PSU supports a range of power supply unit redundancy modes:

- Non-Redundant Mode
  In this mode, the PSU output is sufficient to support the installed system configuration. If one power supply unit failed, the system may shutdown immediately.
  Possible configurations: 1+0, 2+0

- PSU-Redundant Mode
  In this mode one spare PSU is available, so if one PSU fails, system continues to operate
  Possible configurations: 1+1, 2+1, 3+1

If one PSU fails, peak system performance can be reduced by PowerSafeguard, if the smaller PSU were chosen to enable more efficient operation. For applications, where full system performance is needed, even during exchange of the failing PSU, the larger 800W PSU shall be selected.

- AC Redundant (Dual Phase) Mode
  In this mode the power supplies will be connected to two different power lines, so that the system can continue to work even if a power line or a single PSU fails.
  Possible configurations: 1+1, 2+2
Redundancy modes of PRIMERGY servers with 2 power supply units:

<table>
<thead>
<tr>
<th>Config</th>
<th>PSU 1</th>
<th>PSU 2</th>
<th>Up to Power (Medium, Standard, Max)</th>
<th>Redundancy level (no, PSU, Phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>450W</td>
<td>-</td>
<td>450W</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>450W</td>
<td>450W</td>
<td>450W</td>
<td>1+1</td>
</tr>
<tr>
<td>3</td>
<td>800W</td>
<td>-</td>
<td>800W</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>800W</td>
<td>800W</td>
<td>800W</td>
<td>1+1</td>
</tr>
</tbody>
</table>

Redundancy modes of the PRIMERGY RX350/TX300 S8

<table>
<thead>
<tr>
<th>Config</th>
<th>PSU 1</th>
<th>PSU 2</th>
<th>PSU 3</th>
<th>PSU 4</th>
<th>Up to Power (Medium, Standard, Max)</th>
<th>Redundancy level (no, PSU, Phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>450W</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>450W</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>450W</td>
<td>450W</td>
<td>-</td>
<td>-</td>
<td>450W</td>
<td>1+1</td>
</tr>
<tr>
<td>3</td>
<td>450W</td>
<td>450W</td>
<td>450W</td>
<td>-</td>
<td>802W</td>
<td>2+1</td>
</tr>
<tr>
<td>4</td>
<td>450W</td>
<td>450W</td>
<td>450W</td>
<td>450W</td>
<td>1191W</td>
<td>3+1</td>
</tr>
<tr>
<td>5</td>
<td>800W</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>800W</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>800W</td>
<td>800W</td>
<td>-</td>
<td>-</td>
<td>800W</td>
<td>1+1</td>
</tr>
<tr>
<td>7</td>
<td>800W</td>
<td>800W</td>
<td>800W</td>
<td>-</td>
<td>1428W</td>
<td>2+1</td>
</tr>
<tr>
<td>8</td>
<td>800W</td>
<td>800W</td>
<td>800W</td>
<td>800W</td>
<td>1428W</td>
<td>2+2</td>
</tr>
</tbody>
</table>

A mixed-mode of 450 W and 800 W platinum or 800 W platinum and titanium for standard operations is not allowed. However, it is technical supported and a continuous operation is guaranteed. A mixed-mixed should only be used in the event of upgrades and for a short period of time.

3.5 Power Management in iRMC / ServerView™

Power Management in iRMC/ServerView™ permits with its various energy profiles the energy requirements of the PRIMERGY server to be adapted according to individual requirements.

Several pre-defined energy modes are available for this purpose:

- O/S controlled:
  The iRMC S4 leaves the control of the energy consumption to the operating system.

- Minimum Power:
  The iRMC S4 controls the server with regard keeping energy consumption as low as possible. In this case, performance is not always at an optimum. This mode is especially interesting for times of low performance requirements (weekends/night), thus enabling significant savings to be made in energy requirements.

- Power Limit:
  A pre-defined energy consumption will not be exceeded. This mode is required, if specific energy values in the rack or in the data center compulsory must not be exceeded.

- Scheduled:
  The individual energy modes can also be assigned to a time schedule, which determines the time and day on which an energy mode is activated (see figure below).
The individual energy modes can also be assigned to a time schedule, which determines the time and day on which an energy mode is activated (see figure below).

Please note: Above settings are CPU specific and are not available for all CPU types and Fujitsu PRIMERGY servers

More information about power management and its options is available here:
- German: http://manuals.ts.fujitsu.com/file/11472/irmc-s4-uq-de.pdf

4 Selection criteria for the modular PSU 450 W or 800 W

When selecting a suitable power supply unit, you should first determine on which value focus should be placed. Two possible options are:
- Maximum performance and expandability
- Optimal efficiency

4.1 Focus on maximum performance and expandability

If emphasis is placed on maximum performance (at all times) and/or on the maximum expandability of the server for future requirements, then the PRIMERGY dual socket server should be equipped with the modular PSU 800 W. This ensures full system performance with each configuration, even if a power supply unit in a 1+1 configuration should fail.

PowerSafeguard does not intervene here.

4.2 Focus on best efficiency

If focus is placed on the achievement of best possible efficiency in the data center, then two essential aspects should be taken into account when selecting the power supply unit:
- Configuration of the PRIMERGY server and
- Future upgrades

The specific configuration of the PRIMERGY server is decisive for the selection of the suitable power supply unit. The following components thus have a considerable influence on overall power consumption:
- Number and class of Intel processors
- Number and type of hard disks (2.5"/3.5", SSD/SATA/SAS, 7,2K/10K/15K)
- Number and type of connected I/O cards
- Number and type of connected RAM modules
- Configuration of GPGPU cards
The following overview mirrors the energy consumption of an RX300 S7 with 100% CPU utilization in the respective configurations.

### RX300 S7: est. power consumption

(For illustration only – use PowerCalculator to check your PRIMERGY configuration)

<table>
<thead>
<tr>
<th>1 CPU</th>
<th>2 CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x E5-2609 80W</td>
<td>2 x E5-2609 80W</td>
</tr>
<tr>
<td>1 x E5-2630 95W</td>
<td>2 x E5-2630 95W</td>
</tr>
<tr>
<td>1 x E5-2670 115W</td>
<td>2 x E5-2670 115W</td>
</tr>
<tr>
<td>1 x E5-2690 135W</td>
<td>2 x E5-2690 135W</td>
</tr>
</tbody>
</table>

#### Memory configuration

<table>
<thead>
<tr>
<th>1 x 8GB</th>
<th>4 x 8GB</th>
<th>1 x 8GB</th>
<th>4 x 8GB</th>
<th>4 x 16GB</th>
<th>12 x 16GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x 8GB</td>
<td>8 x 8GB</td>
<td>2 x 8GB</td>
<td>8 x 8GB</td>
<td>8 x 16GB</td>
<td>24 x 16GB</td>
</tr>
</tbody>
</table>

#### HDD and PCIe configuration

- 2 x 450W recommended - no impact if 1 PSU failed
- 2 x 450W PSU possible, system performance will be throttled down by PowerSafeguard if 1 PSU failed
- 2 x 800W PSU is recommended

Even if there is no simple formula for selecting a 450 W or 800 W power supply unit, it can however be said that - if the following two sample configurations are exceeded - an 800W power supply should be chosen:

#### Configuration 1:
- 2x Intel Xeon E5-2660
- 8x Memory DIMMs
- 8x HDDs
- 4x PCIe cards

#### Configuration 2:
- 2x Intel Xeon E5-2650
- 24x Memory DIMMs
- 2x HDDs
- 4x PCIe cards

As a matter of principle, the respective PRIMERGY configuration should be configured in SystemArchitect and the power consumption checked using the PRIMERGY PowerCalculator (see section 5) in order to obtain a sound basis for selecting a suitable power supply unit. And in the event of a pending server upgrade, the configuration should first be checked in the PowerCalculator to determine whether a larger power supply unit is required.

### 5 PowerCalculator in SystemArchitect: Aids for choosing the suitable power supply unit

The PowerCalculator in SystemArchitect provides excellent help when it comes to calculating the performance values and thus with the selection of the suitable power supply unit.

A detailed description of how to calculate the performance values and which points should be taken into account are available under:
White paper PRIMERGY Modular Power Supply Unit


Contact
FUJITSU Technology Solutions GmbH
Address: Florian Frimmel, Bürgermeister-Ulrich-Str 100, 86199 Augsburg, Germany
Phone: +49(0)821-804-3659
E-mail: florian.frimmel@ts.fujitsu.com
Website: www.fujitsu.com/fts
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