XP Power

XPerts in Power - Module 10
Regulation

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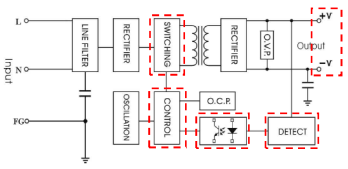
Module Contents

- Principal regulation function of a PSU
- Line Regulation
- Load Regulation
- Temperature Regulation
- Dynamic Load Regulation / Transient Response
- Switch on overshoot
- Remote Sense
- Linear regulation
- Cross regulation
- Current regulation
- Practical demonstration of the above regulations

Principal Regulation of a PSU

Ø The output regulation circuit detects the value of the actual voltage and the control circuit on the primary side controls the switching transistor.



Line regulation

- The value of the line regulation describes the change of the output voltage as the input voltage is varied over its range or specified range

  This measurement must be done with constant output load

  Measurement at the output of a PSU following at different inputs.

  90VAC – 12,002V

  264VAC- 12,009V

  Vmax - Vmin / Vmin x 100 =

  12,009V - 12,002V / 12,002V x 100 = 0,058%

  The value of the line regulation is specified in %.

XP Power 4

Load Regulation

- Load regulation describes the change of the output voltage over a defined load change. The load change is not defined and it depends on manufacturer in which range he specify it. There are different versions as 10-100%, 20-80% or 10 to 90% etc. of the maximum output current.

  The value is specified in %.

  It is calculated by the

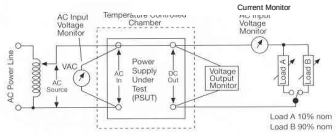
  voltage at min. load

  - voltage at max. load

  / voltage at max load x 100=

  12,016V-12,0006V

  /12,006Vx100=0,083%



  This measurement must be done with constant input voltage.

XP Power 5

Temperature Regulation

- The temperature coefficient describes the average percent change in output voltage per degree centigrade change in ambient temperature over a specified temperature range.

  The value of the temperature coefficient is specified in x% /°C. The values are typically in the range 0,03%/°C to 0.06%/°C.

  This means at a 12VDC output unit and 0,05%/°C (value on datasheet) the output voltage could change at a temperature change of 20°C in a range of 120mV. This is 6mV per °C temperature change.

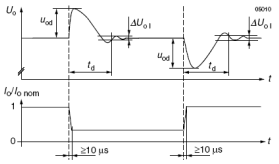
  Calculation: 12V x 0,05/100 x 20 = 120mV

XP Power 6

Dynamic Load Regulation / Transient Response

Ø The value of the transient response describe the maximum output voltage change in % of Vnom and the maximum time until the voltage will return within specified value for a defined load change.

The value of the load changes is typical 25%.
(e.g. 25% to 50% and back)
The measurement must not done from zero load, because the regulation will not work properly in this case.

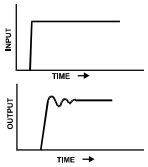


Dynamic load regulation $u_{o\,d}$ versus load change.

Switch on Overshoot

Ø The overshoot describe a transient change in the output voltage in excess of the specified output accuracy limits which can occur when a power supply is turned on.

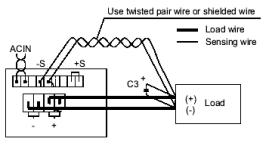
The height of the switch on overshoot depends on the speed of the regulation loop.



Remote Sense

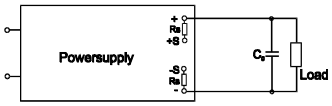
Ø Remote sense is a technique of regulating the output voltage of a power supply at the load by means of sensing leads which connect from the load back to the regulation circuit. This compensates for the voltage drops in the load leads.

To reduce HF impedance and eliminate ringing a low ESR capacitor should be connected directly on the load.



- If sense leads are not used, they have only to be connected direct at the unit when in the unit are no sense resistors built in.

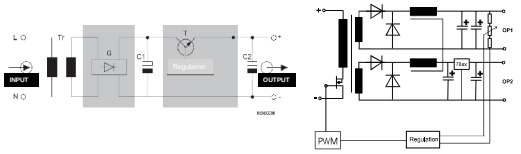
  In our product range only at the Schäfer units the sense lead must connected if they are not used.



XP Power 10

Linear Regulation

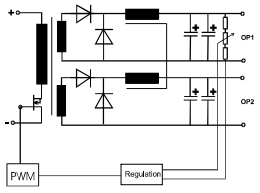
- Pure linear regulation still provides the lowest output noise and best transient response. The disadvantage is greater physical size and weight for a given power, together with higher heat dissipation. Mostly linear outputs will be used today as auxiliary outputs which are realised with linear regulators e.g. of the 78xx series.



XP Power 11

Cross Regulation

- Cross regulation defines a change in output voltage on an output for a given change in load for an other output. Cross regulation describe the regulation of auxiliary outputs which are regulated by magnetic coupling with the main regulated output in the transformer and / or the output choke. These are used at the auxiliary output at e. g. ECM40/60 series and SDS60/120 series.

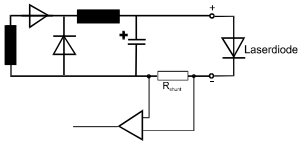


XP Power 12

Current Regulation

- The current regulation at power supplies is only interesting at units with an constant voltage / constant current function at the output. The constant current function will be used in special applications as Laser diode supplies or Metal-hydride batteries chargers.

  In this applications it is important to get a regulated current and not the output voltage.



Practical demonstrations

- Line regulation
- Load regulation
- Sense regulation
- Cross regulation

Line regulation:

Measurement of the output voltage by changing the input voltage in defined range.
Output current have to be constant during the measurement

Unit in test: RLM70PS05
Technical data:
IP: 90 - 264VAC
OP: 5VDC / 14A

	Output 5V/7A	Output 5V/14A
	output voltage (V)	output voltage (V)
Input voltage: 90VAC	5,022	5,019
Input voltage: 264VAC	5,021	5,018

Vmax - Vmin / Vmin x 100= 5,019V - 5,018V / 5,018V x 100 = 0,02%

Line regulation from 90 VAC to 264 VAC : 0,02%

Load regulation:		
Measurement of the output voltage by changing the output current in defined range.		
Input voltage have to be constant during the measurement		
Unit in test: RLM70PS05		
Technical data:		
IP: 90 - 264VAC		
OP: 5VDC / 14A		
	Input voltage 115VAC	Input voltage 230VAC
	output voltage (V)	output voltage (V)
Output current 0A (0%)	5,028	5,028
Output current 1,4A (10%)	5,027	5,027
Output current 7A (50%)	5,022	5,022
Output current 14A (100%)	5,018	5,018
Vmax. - Vmin / Vmin. X 100 =	5,028 - 5,018 / 5,018 x 100 = 0,2%	
Load regulation from 0%to 100%load: 0,2%		

Measurement of the output voltage at the load **without** connecting the **sense** leads to the load.

Input voltage have to be constant during the measurement

Unit in test: RLM70PS05
Technical data:
IP: 90 - 264VAC
OP: 5VDC / 14A

	Input voltage 115VAC	Input voltage 230VAC
	output voltage (V)	output voltage (V)
Output current 0A (0%)	5,02	5,029
Output current 7A (50%)	4,970	4,970
Output current 14A (100%)	4,910	4,910

Voltage losses at load leads is at maximum current of 14A: 119mV
(at approx. 20cm load leads with 4 x 0,5mm²)

Measurement of the output voltage at the load **with** connecting the **sense** leads to the load.

Input voltage have to be constant during the measurement

Unit in test: RLM70PS05
Technical data:
IP: 90 - 264VAC
OP: 5VDC / 14A

	Input voltage 115VAC	Input voltage 230VAC
	output voltage (V)	output voltage (V)
Output current 0A (0%)	5,027	5,027
Output current 7A (50%)	5,022	5,022
Output current 14A (100%)	5,018	5,018

With sense leads connected to the load we get no voltage losses.

Cross Regulation:

Measurement of the different output voltages at the changes f the out put currents at the different outputs
Input voltage have to be constant during the measurement

Unit in test: SDS60UT06
Technical data:
IP: 90 - 264VAC
OP1: 5VDC / 6A
OP2: 12VDC / 3A
OP3: -5VDC / 0,8A

All measurements at 230VAC input

		12V / 0,3A	12V / 3A	
5V / 0,6A	5,164V	11,64V	5,165V	11,42V
5V / 6A	4,984V	12,25V	5,059V	11,65V

At a load change from 10 to 100% the 12V output is within the specified range of +-5%.
The voltage change of the 5VDC depends on the internal circuit of the SDS Multi output units.
At this units the 12V also feed to the regulation lood.
This give a more stable 12V rail and a little less stable 5V rail.

XP Power 19

Linear regulation:

Measurement of the linear reugulated output (-5V) at changes of the other outputs

All measurements at 230VAC input

	5V / 0A	5V / 0,8A
5V/0A and 12V/0A	4,973V	4,535V
5V/0A and 12V/0,3A	4,976V	4,938V
5V/0,6A and 12V/0A	4,977V	4,939V
5V/0,6A and 12V/0,3A	4,977V	4,941V
5V/6A and 12V/3A	5,024V	4,985V

This measurement show that it is necesssary to have a minimum load on the main output, to get enough energy to the linear regulated rail.
In this case the linear reail con be loaded with full load and the output voltage is nearly stable.

XP Power 20