Höcherl & Hackl
The electronic load

Application Note #10

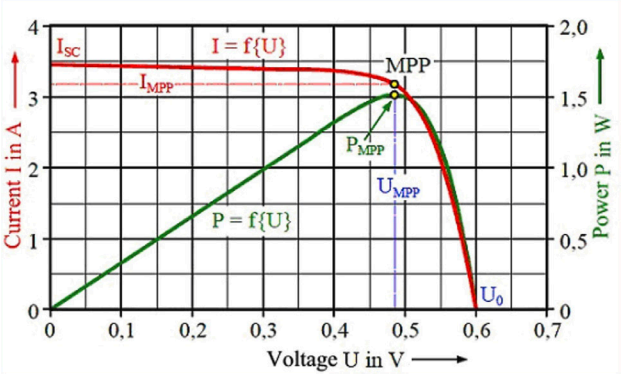
MPP Tracking with ZS Series electronic loads

Electronic ZS loads can be equipped with Option ZS13 for MPP (Maximum Power Point) Tracking.
MPP Tracking is used for operating solar panels to get the maximum possible power from the panel. The MPP results from the diagram of a solar panel. The MPP function of the load seeks the MPP and holds it also at variable solar radiation.

Functional principle

To use the MPP function of the load it is necessary to understand how MPP Tracking works.
In MPPT mode the electronic Load works in constant voltage mode. When MPPT is activated the load begins with setting a higher voltage than the output voltage of the panel and reduces the voltage stepwise downwards.
When the voltage setting is lower than the voltage of the solar panel current flow will begin.
The electronic load continuously measures current and voltage and calculates the resulting power. As long as the power increases the direction of the voltage change is retained. When the power begins to decrease (the settings have passed the MPP) the direction of the voltage run is reversed to cause power to increase again. In this way the electronic Load will continuously regulate the MPP.

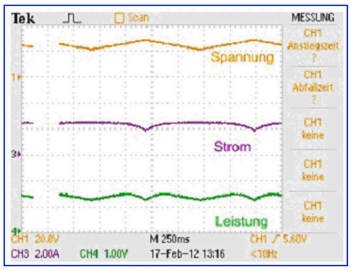
How far the electronic load deviates from the MPP can be set by system parameter No. 53 "Delta_P_Min".
In addition the ZS load needs information about:



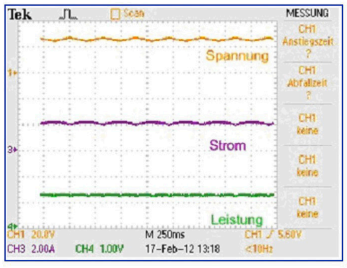
			System Parameter
Nennleistung des Panels	nominal panel power	"Pmax"	48
Leerlaufspannung des Panels	unloaded panel voltage	"VOC"	49
Max. Kurzschlussstrom	max. short circuit current	"ISC"	50
Spannung im MPP Punkt	expected voltage at MPP	"VPM"	51
auftretender Strom bei MPP	expected current at MPP	"IPM"	52
Leistungsbereich	power regulation range	"Delta_P_min"	53

The parameters are required that the load can select the suitable current range and that it can find the MPP as fast as possible. Theses parameters are stored in non-volatile memory of the electronic load and are available after power cycling.

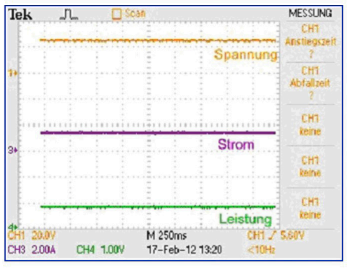
The diagram shows voltage (upper curve), current (in the middle) and power (lower curve).
The electronic load varies the voltage continuously up or down till the power deviates from the set "delta_P_min" value. Then the voltage changes the direction until the same deviation is achieved in the opposite direction. At high numbers for "delta_P_min" the triangle-shaped voltage is recognizable. The upper peak of the power diagram is the MPP.can occur because of the leakage inductance. In this case a capacitor of a few µF can be connected to the load input to stabilize the system.



When "delta_P_min" is reduced (here by factor 10 referred to the diagram before), the amplitude of the triangle-shaped voltage will be reduced and the power curve will also get smoother. Now the electronic Load is working very close to the MPP.

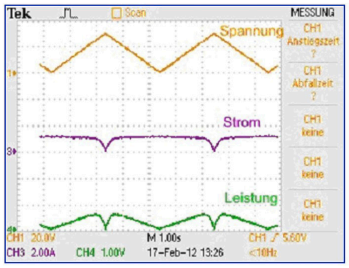


At further reduction of "delta_P_min" there is nearly nothing to see of the regulation process and the power is kept exactly at the MPP.



Limits of the MPPT Mode

When "delta_P_min" is set too high so that the panel can not supply sufficient power MPP regulation will permanently change between open circuit and short circuit.
This can happen when the panel is shadowed or when there is only a low radiation.
The MPP Mode can also not be kept when the load is working at its limits (max. voltage, max. current of the selected range, or max. power)



Data Acquisition During Running MPPT Mode

When voltage, current and power are measured during MPP Mode, consider that resulting from the running regulation process the numbers are not constant but change depending on the setting of "delta_P_min" (see waveform diagrams for different settings of "delta_P_min").
When "delta_P_min" is very high (referred to the actual power of the panel) the measured numbers for power will become worse.

Determination of the Suitable Current Range for the Device Under Test

The ZS electronic loads have up to 4 setting ranges.
At MPPT mode that setting range has to be chosen which will cover the maximum short circuit current at highest radiation.
This is done by programming parameter 50 "ISC" (short circuit current of the panel).
When starting MPPT mode the electronic Load will set the appropriate current range and keep it while MPPT is running.
At low radiation it can happen that the current is much less and that the selection of a smaller current range would be useful.
In this case the value for "IPM" has to be reprogrammed to select a smaller current range. Please check what current ranges the electronic load provides.
When suddenly a full radiation appears then a higher current is required to keep the MPP than that of the selected current range. Then the electronic load will signalize "OCP" (overcurrent protection).
OCP should therefore be continuously checked by the control software to response by changing the current range.

Evaluation of the Delta_P_min Parameter of a Panel

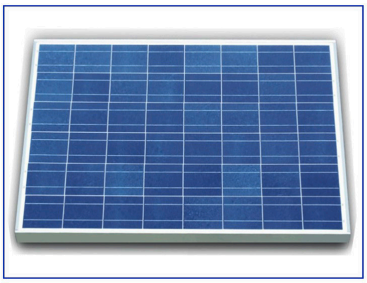
The „Delta_P_min" parameter defines the permitted deviation to the MPP being determined at least to calculate the present MPP. For a new device „Delta_P_min" is at works set to:

Delta_P_min = 0.0002 · max. Voltage · max. current range

Example: ZS530-3:
Delta_P_min = 0.0002 · 300 V · 12 A = 0.72 W
This setting is well suited for a panel with about 50 W.
In MPP mode the regulation may deviate 0.72 W from the MPP.
For panels with lower power a smaller number for Delta_P_min should be chosen because the MPP Regulation would work too far from the real MPP and the mean value of the power would be below.
The number for Delta_P_min should also be changed when there is only low radiation.

When a panel supplies only a small part of its nominal power „delta_P_min" should be matched.
The current range should be also matched when possible.
When Delta_P_min is set to 0, the unit works at the smallest possible number for Delta_P_min.
The Delta_P_min setting is kept in non-volatile memory of the electronic Load.

Technical data of the panel:	
Nominal Power P	224 W
Voltage at nominal power	29.2 V
Current at nominal power	7.68A
Open circuit voltage	36.8 V
Short circuit current	8.09 A



MPP Tracking Programming Example

Commands:
SYSTem:PARameter 48,224
SYSTem:PARameter 49,36.8
SYSTem:PARameter 50,8.09
SYSTem:PARameter 51,29.2
SYSTem:PARameter 52,7.68
SYSTem:PARameter 53,0.5
MODE:VOLT
MODE:MPP
INP ON
AN