

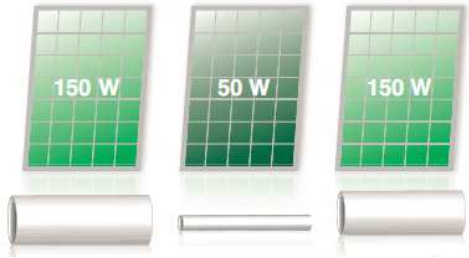
# Tigo Energy's Patented Impedance Matching

Today's PV systems are typically comprised of panels serially connected to one another in strings, and several of these strings are connected in parallel to form an array. Because of the serial and parallel interconnection, power output of each module in an array will be affected by the weakest modules.

Tigo Energy solves that problem with its patented "Impedance Matching" technology. This technology is implemented using an intelligent buck converter, and a central control unit.

## How Does it Work?

The best way of understanding Impedance Matching technology is by making an analogy of two sections of water pipe. A solar panel with higher generating capacity (150 watts) can be equated to a pipe of larger diameter, while one of lower capacity (50 watts) is represented by the thinner pipe.

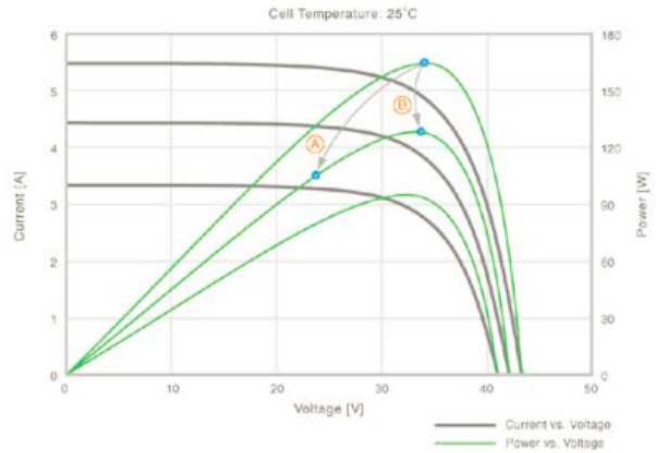


Connecting the panels in a string is analogous to connecting these pipes and allowing water to flow through them. As the pipe on the right is thinner than the left pipe the flow of water will be impaired:

- The weaker panel (thinner pipe) will have to handle higher current than it can, resulting in heat dissipation.
- Additionally, the thinner pipe will start leaking and will even further decrease the overall water output of the array (overall power output of the string). The reason can be found in the figure showing panel's I-V curves.

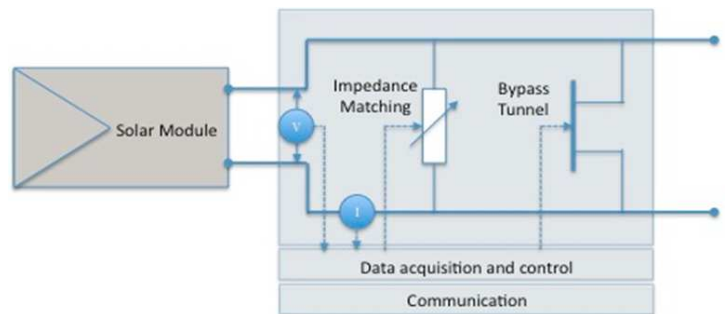
## System components

The Optimizer itself measures constantly panel parameters and sends them to the central control unit (MMU) using wireless Zigbee communication through antennas (Gateways). The MMU applies sophisticated analysis algorithm that results a command to the Optimizers: what is the Impedance Matching Factor (IMF) that Optimizer needs to apply for smooth power flow in the array.



If the array control is working to maximize current, the voltage output of the weaker panels will drop. The optimal path for the weaker panels is described by (B) but the actual path the panel is forced to take (A) which is resulting even lower power output for that panel and the whole array (analogous to the leaking).

Tigo Energy's "Impedance Matching" creates a parallel path for the water to flow using an additional pipe that goes around the weak panel, to bring to an optimal flow of water. In the power electronics equivalent, the bypass tunnel will maintain the optimal flow of energy for the string and will be modulated so that the system can independently reflect to the panel equivalent impedance to the one of the panel itself.



The central view of the entire system enables the algorithm to take the IMF decision that will mitigate the mismatch both inside a specific string, as well as between one string and another.

All the data that MMU gets from Optimizers is stored and used by Tigo Energy to constantly improve the algorithm and increase performance.