Maximum power point tracking mppt

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Maximum power point tracking (MPPT) or sometimes just power point tracking (PPT)) is a technique used commonly with wind turbines and <u>photovoltaic</u> (PV) solar systems to maximize power extraction under all conditions.

Indeed, some power sources, like solar panels, present power characteristics that strongly depend on the operating conditions. For instance, the cloud coverage significantly impacts the capability of a panel to deliver electricity. As such, maximizing the extracted power requires identifying – and tracking – the operating point that provides the highest power level as a function of the operating conditions.

Therefore, Maximum Power Point Tracking (MPPT) is often applied in renewable energy systems – e.g. photovoltaic plants or wind turbines – as their power delivery capability varies significantly and in an unpredictable manner. Other special operating points may be interesting to track, such as the maximum efficiency point tracking (MEPT), or other optimum, e.g. related to operating costs.

For practically all real power sources, the power that can be extracted varies with the operating point. While electrical sources are related to the voltage/current pair, the same principle also applies to force/speed, flux/surface, etc.

In all cases, the inevitable internal resistance (or equivalent quantity) limits the maximum possible output power. Non-linear or more complex characteristics also exist, but with the same result: the maximum power point is not located at the [max. voltage ? max. current] point (or equivalent quantity). Therefore, the operating point that delivers the maximum power must be constantly tracked by searching for the best voltage ? current combination.

This results in a bump-shaped power-voltage characteristic, whose top is typically located between 60-80% of the open-circuit voltage. This point is however not fixed but varies with the output current, which depends itself on the temperature and irradiance, i.e. the operating conditions of the PV cells themselves.

In some cases (such as, to some extent, photovoltaic systems), the output characteristics (here I-V) are relatively well-known and precise, such that they can be used to locate the maximum power point using look-up tables. This is however not the case for all systems, motivating the use of more empirical approaches.

To date, numerous maximum power point tracking algorithms have been proposed, with various trade-offs between performance (tracking speed, accuracy) and complexity (need for sensors, mathematical modeling, computation burden, etc.).

Among other possible algorithms, the Perturb and Observe (P& O)tracking algorithm actively varies the current set-point – i.e. adds a small perturbation – and observes the corresponding impact on the output power. Depending on whether that perturbation tends to increase or decrease the output power, the current setpoint is respectively increased or decreased accordingly.

In other words, if adding a small DI to the current setpoint increases the resulting output power, then the subsequent current setpoint is further increased. Reciprocally, if a positive DI tends to reduce the output power, then the subsequent current reference is reduced by DI.

As such, this maximum power point tracking algorithm is designed for use as part of a discretized process that isslowerthan the current control dynamics. This can typically be implemented using a multi-rate technique, where the current control is executed within the main control interrupt (fast control loop) and the MPPT algorithm executed within a secondary control interrupt (slow control loop).

The proposed maximum power point tracking algorithm can be implemented as shown below. It requires the introduction of a slower control rate for the MPPT itself. The management of multiple control rates within Simulink is further explained inMulti-rate control with Simulink (PN145).