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Small power plant excitation system development combined with several upgrades for improved voltage output achievements

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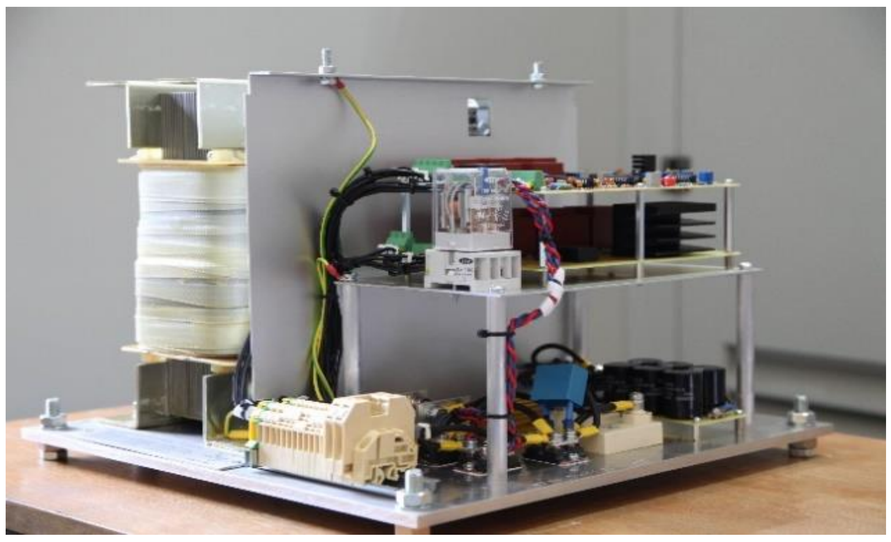
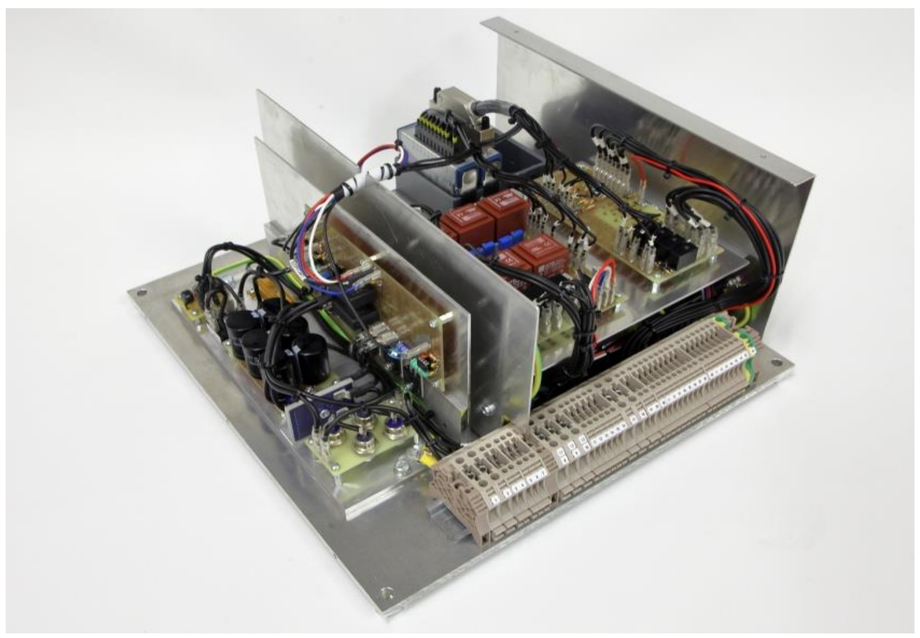
Despite their size small hydroelectric power plants can have a major role in grid voltage and frequency regulation. Many of these units are positioned in areas with low grid short-circuit power so their reactive power contribution can be quite noticeable. Some power plants are also capable of small island operation due to unpredicted grid failures.

Due to the markets supply and demand gap in the small excitation system domain (excitation current up to 100 A), a new model was developed in 2013 at our Power electronic laboratory. Since the first analogue and digital units, there has been a lot of improvement in the past few years, mainly in the voltage and output stability domain. Despite the improvements the regulator still holds on to its primary key features such as high reliability, stability and robustness. With its built-in functions the power plants are capable of parallel and small island operation and therefore meet the conditions required by the system operator (SODO).

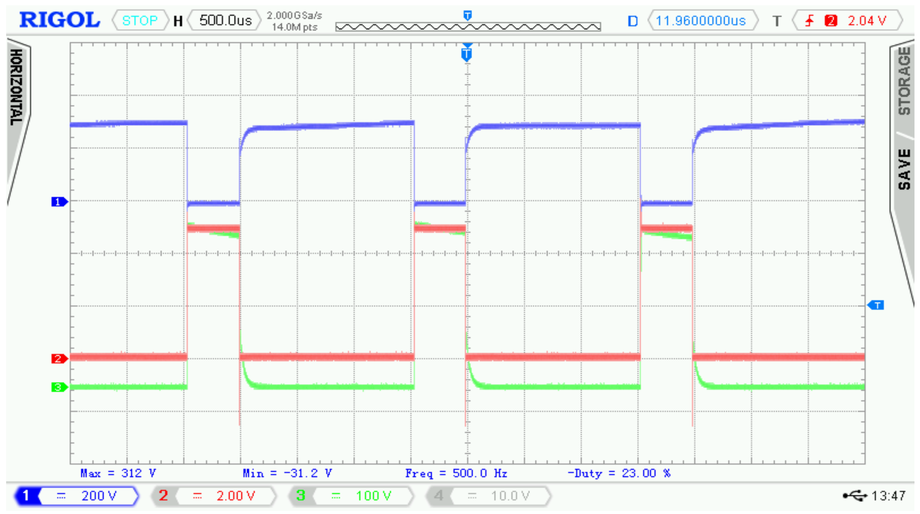


The MHE Belica analogue excitation system

Circuit thermal testing



MHE Činžat 1 digital excitation system



IGBT driver input signals during test procedures

Voltage regulation mode

$$0 = \frac{U_{REF} - U_{GEN}}{U_N} + \frac{Q_{GEN}}{S_N} \cdot u_{Q-DROOP} + \frac{P_{GEN}}{S_N} \cdot u_{P-DROOP},$$

Reactive power regulation mode

$$Q_{REF} - Q_{GEN} = 0$$

Power factor regulation mode

$$tan(\rho)_{REF} - \frac{Q_{GEN}}{|P_{GEN}|} = 0$$

$$tan(\rho) = \frac{Q_{GEN}}{P_{GEN}}$$

SODO regulation mode

$$Q_{GEN-setpoint} = 0{,}75 \cdot P_{NG} \cdot \left[\frac{P_{GEN}}{psodo \cdot P_{NG}} + \frac{U_{CG} - U_D}{STAT \cdot U_N}\right]$$