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A system test platform for the CERN power converter control electronics

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The power converters at CERN deliver a broad range of complex functionalities to assure the correct magnetic field throughout the beam acceleration cycle. The power converter controls are composed of remotely programmable electronics, however such flexibility is also vulnerable to regression that requires thorough testing. Further, testing requires a significant investment in infrastructure to allow systems capable of supplying up to 10MW, 100kV and 100kA to be validated. This paper describes a system test platform using continuous integration techniques and hardware-in-the-loop modelling to validate the controls before deployment.

Summary (500 words)

The power converters at CERN deliver a broad range of complex functionalities to assure the correct magnetic field throughout the beam acceleration cycle. These complex functionalities are diverse, for example to assure a precision of the regulated current is better than 100 parts per million, or to minimise the consumed power when delivering up to 31 different current functions on a pulse to pulse modulation basis.
To be capable of delivering such functionality, by design the power converter controls must be remotely programmable electronics. The controls platform is composed of both microprocessors and DSPs running software, and FPGAs running firmware. In total there are more than 100 different compiled codes that must be deployed in different combinations to the accelerator power converter control systems. Such flexibility is vulnerable to regression that requires thorough testing, however this is in itself a challenge, as the target systems vary in size and can be rated up to 10MW, 100kV and 100kA. Traditionally thorough lab testing has been made before final installation and commissioning, however this model is no longer adequate for platforms that can now change even after operation has begun.
To meet the challenge of validating the electronics controls, a platform that can test the electronics controls using continuous integration techniques has been developed. The python code to control the tests is running in a gitlab repository from which the continuous integration and continuous deployment (CI/CD) environment is configured. In particular, to meet the challenge of testing large power systems, models of the systems have been deployed in a hardware-in-the-loop (HIL) platform. These models replicate the behaviour of the power plant when interfaced to the controls platform, thus allowing the controls behaviour to be explored and validated.

This paper describes a system test platform using continuous integration techniques and hardware-in-the-loop modelling to validate the controls before deployment. The hardware and software technologies required for such a platform will be described, and early results of the testing will be presented.
By using continuous integration techniques, and hardware in the loop technology, the ability to validate code for regression can be made whenever a new code compilation is made, or before code deployment. Further, this is possible without the cost of maintaining a high power test platform for a wide range of equipment.

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