A Generalized Power-Based Modelica Library with Application to an Industrial Hydraulic Plant

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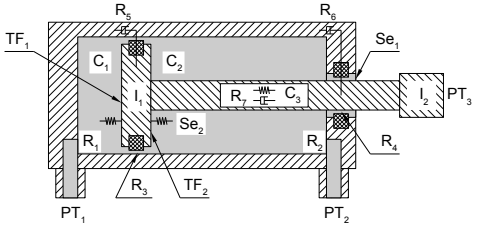
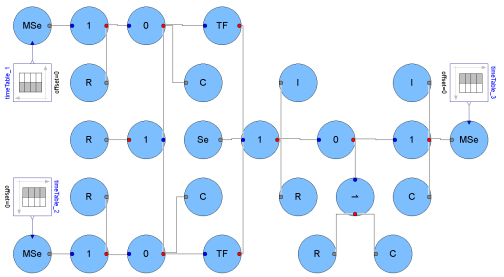
The generalized power-based approach is an efficient modeling formalism based on the idea that in each technically relevant discipline, power is represented by the product of an effort value and a flow value. By the generalized power definition, unified modeling elements are conceptualized applicable to the direct multidisciplinary modeling of complex systems. Consequently, the modeling procedure consists of the characterization of domain specific processes corresponding to their unified complements and interconnecting these complements to the model of complete system according to its structure.

The Bond Graph (BG) formalism provides a multidisciplinary, generalized power-based approach to the modeling and also graphical model representation of dynamic systems. By the object-oriented nature, BG possess the according advantages. The Modelica language and the BG formalism are partly closely related modeling methodologies. Hence, an implementation of the BG formalism in Modelica is considered in this contribution. The proposed implementation attempts to take advantages of both modeling concepts.

The corresponding developed library BondGraph available online at the official Modelica web page [1] is discussed in detail. It allows graphical modeling according to the bond graph formalism, and contains common bond graph elements, as well as specific nonlinear elements, especially related to hydraulic effects. For these, attention has been paid to their numerically stable computation. Furthermore, several composed models are provided, such as switching valves, pipes, cylinders, etc. A combination with blocks of the Modelica Standard Library is possible. The application of BondGraph to an industrial plant is described to demonstrate its capabilities.



(a) Iconic model of a hydraulic cylinder.



(b) According Bond Graph representation of the cylinder using the BondGraph library in Dymola.

References

[1] I. Alkov and R. Diekmann. (2013) BondGraph library. [Online]. Available: https://www.modelica.org/libraries