Abstract

Anesthesia machines are used by anesthesiologists in medical care to release a patient from pain, reflexes and consciousness during an operation. This is done by introducing a known amount of anesthetic agent like Halothane, Desflurane, Isoflurane (...) into the patient's body in addition to carrier gas and a proper ventilation. In order to do this, the agents need to be vaporized and precisely injected into the freshgas flow of the ventilator inside the anaesthesia machine.

In most of all cases, so called vaporizers are used to transport, vaporize and introduce different anesthetic agents into the anesthesia machine's circular system. They contain only one specific type of anesthetic agent and are safely connected to the anesthesia machine onto the so called vaporbar. This connection needs to be interchangeable in case of the need for an other agent.
Current state of the art vaporizers from Dräger use a manual control dial on top in combination with a complex pneumatic-mechanical control loop system to precisely adjust the amount of anesthetic agent in the fresh gas flow. The vaporizer represent itself as an independent system on its own - there is currently no electrical information exchange between the vaporizer and the anesthesia machine.

Nowadays, anaesthesia machines allow more control over the overall system and display more and more useful information on their screen. Buttons are replaced by touchscreens in modern devices. Nonetheless, the vaporizer and its control dial must be controlled in addition to the machine. In order to bring several beneficial functions into the new vaporizer, an easier handling and additional information to machine-side, both the manual control dial and the pneumatic-mechanical control loop shall be replaced by an electrical system. A motor will replace the control dial. The mechanical temperature compensation will be replaced by a system of temperature/pressure sensors and valves. A two-microcontroller system - one for controlling and one for superveillance - making this health critical system redundant and safe.

The indicators for actual agent percentage, alarm warnings and indicator LEDs will be removed from the vaporizers surface and only displayed on the touchscreen of the anesthesia machine. Therefore a UART based powerline communication is realised between vaporbar and vapor as one serial communication channel. This half-duplex communication line is used to exchange information, such as motor position, temperature, (...) and send control commands only to one vaporizer at a time (Drägers auto exclusion function).

Within the scope of this work, a system of several actuator control circuits, microcontrollers and a powerline communication will be designed and built-up. This is implemented in a vaporizer/vaporbar and tested to conform the IEC 60601 3^{rd} Edition EMI-standard.