ing profiles, either upon user/host request or by request from a self-adapting haptic hardware/software system. In addition, in one or more embodiments, haptics customizing engine **604** is configured to load new profiles to the haptics engine **612** or save new profiles to the EEPROM **606** as defined by a user or hardware/software developer. EEPROM **606** is configured to store haptic profile information for use in the haptic engine **612**. This information can be predefined at production time, as well as updated or supplemented at runtime by users, host system, developers, or an adaptive module of the haptic system.

[0054] HID keyboard components **608** is configured to provide Human Interface Device functionality to the host system (if necessary) in order to allow the haptic system to act in the same manner as a keypad, keyboard, touchpad, mouse, and also to provide haptic information to the host for display, modification, or other use.

[0055] Key scanning component **610** is configured to provide a mechanism for the haptic system to know when it should trigger playback of a haptic profile. The haptic system does not need to directly scan keys itself. Rather, the haptic system can alternatively take key/switch/input state information from another device, such as a keyboard controller, touch screen controller, or other user input device.

[0056] Haptics engine **612** is configured to control the input signals to the haptic actuator based on profile data supplied by the EEPROM **606**, haptics customization engine **604**, and/or whatever other sources of data exist.

[0057] The adjustable DC/DC converter is configured to supply the actuator operating voltage. The output voltage may or may not be regulated, may or may not be adjustable on the fly, or may or may not be adjustable at all. The DC/DC converter may or may not have any common or uncommon features of typical power supplies, such as over current protection, under voltage protection, sleep mode, off mode, voltage feedback, etc. On the fly adjustment allows the output voltage to be adjustable such that the host or haptics customization engine **604** can modify the output voltage.

[0058] In operation, in one or more embodiments, the high side and low side switches are configured to drive the voltage of an actuator phase to the actuator's maximum positive operating voltage, maximum negative operating voltage, or any voltage in between, including ground or a high impedance (floating) potential.

[0059] Having described an example electronic device, consider now a discussion of example circuitry that can be utilized to implement the embodiments described above.

[0060] FIG. **4***b* illustrates an example voltage regulator in accordance with one or more embodiments. In this example, the adjustable, low voltage regulator feeds a high voltage DC/DC converter, such as converter **614** in FIG. **4***a*, to allow a real-time adjustable high voltage level. In this example, a linear regulator with resistor-adjusted output voltage is used to drive a DC/DC converter whose output voltage is proportional to its input voltage. Additionally, the resistor path that controls the output voltage of the linear regulator contains an electrically-controlled potentiometer with a serial interface. This allows a microcontroller to serially set the resistance of the feedback branch and control the output of the linear regulator which in turn drives the DC/DC converter and controls the actuator drive voltage. It is to be appreciated there are many other ways to use regulated and unregulated supplies to provide the necessary operating voltage, and also that an adjustable high voltage rail is not necessary for every implementation, although if adjustability is required there are additionally many ways of providing adjustability.

[0061] FIG. **4***c* along with FIG. **4***e* illustrate a USB device that can allow real-time changes of haptic profiles and can act as an HID compliant keyboard. This circuit is an example implementation of one way to provide the system user with a means to interact with the haptic device. A USB device is provided which defines two interfaces. One is a standard HID keyboard, the other is a generic HID device functioning as a haptic customization engine. The standard keyboard interface allows the key presses on the haptic device to register on the host as keypresses of a keyboard. In a similar fashion, the device could register the inputs as mouse commands, touch screen or touch pad input, or switch closures. The haptic customization engine interface allows host software to send a variety of commands to define, redefine, modify, select or read haptic profile information that is stored/used in the haptic device.

[0062] FIG. **4***d* illustrates an example schematic, combined with FIG. **4***f*, of the high-side and low-side switches used to drive the actuator. The components, including the optoisolators, constitute but one implementation. Accordingly, other implementations can be utilized without departing from the spirit and scope of the claimed subject matter.

[0063] FIG. **4***e* illustrates an example schematic of a microcontroller and supporting hardware used to implement the haptic customization engine, the haptic engine, the USB interface, the key scan circuitry, and the EEPROM. Other circuitry can be used without departing from the spirit and scope of the claimed subject matter.

[0064] FIG. **4***f* illustrates the details of FIG. **4***d*. This schematic is an example implementation of a solid state switch stacking scheme that allows inexpensive, low voltage parts to be used together in order to switch high voltage. This particular stacking scheme utilizes capacitor coupled MOSFET gates and is uniquely designed for this switching application to be very power efficient during idle and active state due to the elimination of resistors while providing reliable switching function to capacitive loads which include many electrically-deformable devices such as, by way of example and not limitation, electroactive polymers, piezo materials, and electrostatic actuators. It is to be appreciated and understood that capacitive coupling is not the only way to stack switches for increased voltage handling, nor are stacked switches the only way to handle switching of high voltage.

[0065] Embodiment with User Input Mechanism

[0066] In other embodiments, a device includes an actuator mechanism that is configured to provide tactile feedback to a user. In at least some embodiments, the actuator mechanism comprises a pair of spaced-apart substrates each of which supports a conductive layer of material. At least one of the substrates supports or otherwise is in operative contact with a user input mechanism by which a user can provide input to the device. In at least some embodiments, a dielectric material and an adjacent air gap are interposed between the substrates. In some instances, the dielectric material can comprise air itself. The device also includes drive circuitry operably connected to the spaced-apart substrates. The drive circuitry is configured to drive the conductive layers of material with an electrical signal responsive to the device receiving input via the user input mechanism. Driving the conductive layers causes movement of one or both of the substrates. In some embodiments, the drive circuitry can use different drive pro-