

Can haptics be measured?

Published online: <http://www.hbm.com/en/menu/applications/industrial-process-control/technical-articles/ipc-technical-articles-detail-view/datum/2008/09/01/can-haptics-be-measured/>

Actively sensing the size, contours, surface texture, weight, etc. of an object by using all skin senses and depth sensitivity is referred to as **haptic perception**. The sum of a person's haptic perceptions makes it possible for the brain to pinpoint and evaluate mechanical stimuli, temperature stimuli, and pain. **Haptics** is the study of haptic perception.



Where is haptics used in industry?

It must be subjectively pleasant for an operator to use operator controls that are manufactured in series production. These control elements should be designed so that sensory feedback (for example pressure points on buttons) is perceived as pleasant.

To do this, however, it must be possible to achieve sufficiently reproducible conditions in production. A manual 100% test would tie up expensive employee resources and would only allow for documentation of results as OK/not OK. It also entails the risk of subjective evaluations. The solution: systems that automate the test process and meet these requirements:



- Automated final test of operating units with actuators
- Objective and documentable haptic test
- User-friendly process for generating a test sequence – even without computer knowledge
- Individual evaluation and visualization tools
- Economical 100% series test
- Force-/torque-dependent control of actuator

Measurability of haptics

The EASYswitch process monitoring system is based on a standardized core, which incorporates the technological evaluation algorithms of the haptics test and offers maximum flexibility for adjusting customer requirements. This makes it possible to equip EASYswitch with a different number of axes of motion and with one or multi-dimensional application-related sensors according to specific needs.

Sensors in the measurement system:

- Robust piezoelectric force sensor or torque sensor
- Highly dynamic, rapidly changing pressure/torque forces
- Small measurement range for low activation forces
- Miniature charge amplifier for converting the charge signal from the sensor into a voltage signal



Figure: HBM piezosensor with charge amplifier

The EASYswitch test controller provides exact measurement curves at 20-bit resolution. Defining several test curves at the beginning of the test ensures a systematic approach. It is important to minimize the mechanical effects of the test rig.

EASYswitch produces measurement curves in real time, determining up to 9 local maxima and minima for each switching or closing action. The haptics and switching functions of the control element can be precisely determined from the position and magnitude of these characteristic values. Two amplifiers working in parallel make it possible to operate standard force/displacement and torque/angle of rotation sensors.



Figure: EASYswitch process controller

CANbus, Profibus, and digital I/Os on the device allow for a connection to PLC or control systems. Device parameters and evaluation conditions can be adjusted with

FASTpressSuite setup software. The standard EASYswitch Ethernet interface can also be used to save measured curves and results on a system computer.

To determine and adjust the evaluation criteria for the haptics measurement, a special haptics window containing the extreme values of the closing process is inserted into each switching or closing range. The position and magnitude of the values make it possible to draw detailed conclusions about the haptics of the closing element. By comparing the five parameters assigned in EASYswitch and the measured values, the quality of the component can be determined with a definitive rating of OK / not OK.

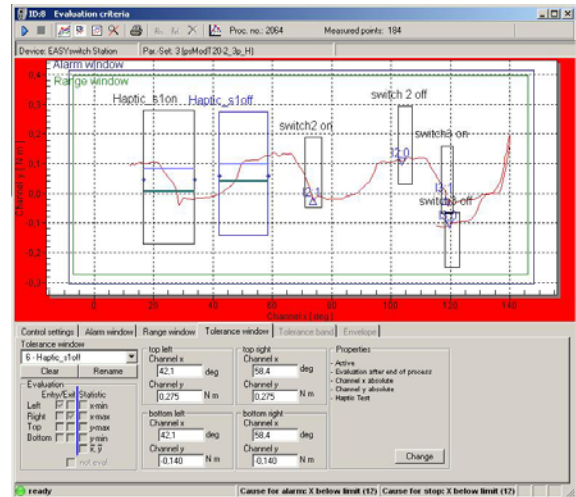


Figure: Haptics curve

Evaluation criteria:

1. Force at mechanical switching peak F_a
2. Drop in force after mechanical switching peak $F_a - F_r$

Then: Click ratio $((F_a - F_r) / F_a) 100\%$

3. Displacement differential $S_r - S_a$
4. Ratio of force/displacement $(F_a - F_r) / (S_r - S_a)$

To test electrical switches and switching systems, a switch check window is placed in EASYswitch at the position of the expected switching event. The window checks the function and position of the switching point by directing the electrical signal of the switch to the digital input of EASYswitch. Up to five switches can be checked at a time, which considerably reduces test overhead.

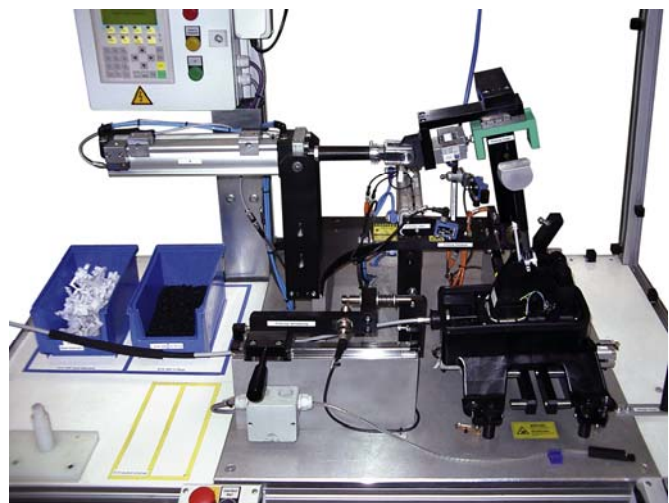


Figure: Test bench

To test the haptics and switching function of a switch, the evaluation windows are simply superimposed. Switching events can be visualized and saved with FASTpress software. The open software concept of FASTpressSuite also makes it possible to integrate final and functional electrical tests into modern test bench concepts.

No special knowledge of device programming is required. The results of the haptics measurement can be displayed after each test process on a service PC or system monitor. All measurement curves and results can be saved on a test stand PC for documentation purposes and to fulfill verification and tracking requirements.

This provides documentation of installed parts, even after years.

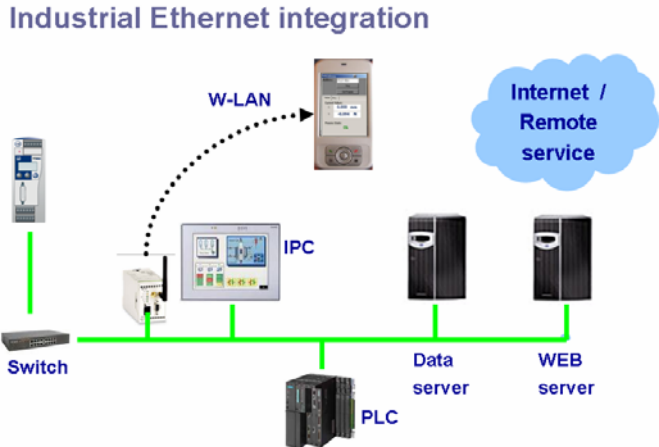


Figure: System configuration