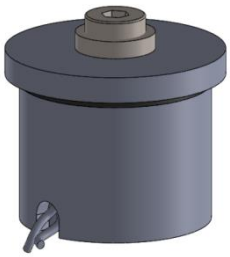
NC-C1012-12V

Haptic actuator with user action sensing capability



1-Overview----------

Features

1. **Actuator Features**
    a. Nominal supply voltage: 12Vdc
    b. Up to 9N of delivered force to haptic surface
    c. Wide temperature range: -40 °C to +125 °C

2. **Sensing capability**
    a. Position sensing via actuator feedback
    b. Internal elastic element to measure user action
    c. Small displacement: typical 0 to 300 µm

General description

The NC-C1012-12V is a linear actuator with integrated force sensor designed for moving a touch surface with a predefined vibration. The user touch action on the surface is detected and measured by the integrated force sensor giving to a control system the needed information to trigger a specific haptic sensation.
The typical use of NC-C1012-12V is to reproduce the haptic sensation of a standard tactile switch over a touch surface or a touch screen. A more general application is the use of the NC-C1012-12V for creating user specific haptic effects driven by a microcontroller.

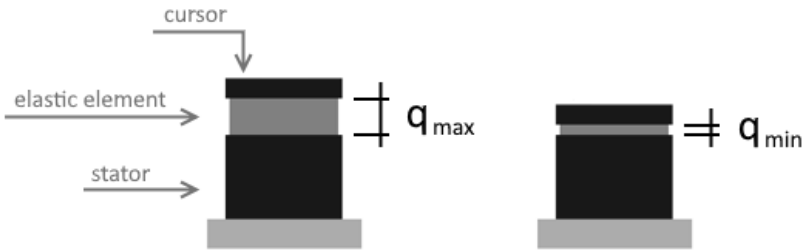
Applications

Automotive, industrial, consumer household appliances, general purpose.

2-Operating principles----------

A Niceclick haptic actuator is an electromechanical device composed of three coaxial main mechanical parts:

- the stator
- the elastic element
- the cursor



The Niceclick actuator is a small cylinder which can change its vertical dimension when electrically powered. When an electrical current flows in it, the stator will attract the cursor so compressing the elastic element: the vertical dimension will decrease. When the electrical current stops, the elastic element will pull the cursor up until the device will come back to the original dimension.

The standard installation of a Niceclick device is to attach one side (stator or cursor) to the haptic surface and the other side to the haptic device base or to a mass. When the device is powered, it will change its dimension so moving the haptic surface towards the base or the mass. The displacement of the surface, i.e. a vibration, will be recognized by a human finger as an haptic effect.

As the human fingers can recognize specific profiles of vibrations, modulating the electrical power inside the Niceclick will result in creating a controlled surface movement. If this movement is a replica of the movement of a physical tactile switch, the perceived haptic feedback will be the same of the tactile switch.

The distance q between the stator and the cursor is a very important parameter as it is needed to create a specific vibration profile. For quality reasons, especially for wide haptic surfaces, the displacement of the cursor has to be limited to a very low value.

3-Electromechanical specification----------

Absolute Maximum Ratings

(Note: Unless otherwise specified, Ta = 25°C)

Table 1- Absolute Maximum Rating

Symbol	Parameter	Value	Unit
V_{max}	Maximum driving voltage (pulse t=1ms)	30	V
I_{max}	Maximum not repetitive current peak (pulse t=1ms)	3.3	A
P_{max}	Maximum not repetitive power peak (pulse t=1ms)	100	W
P_{cnt}	Continuous power	1,2	W
F_{max}	Maximum compression force without damage	50	N
T_{max}	Maximum operating temperature	+125	°C
T_{min}	Minimum operating temperature	-40	°C

Mating connector

MOLEX 501568-0207

Electrical characteristics

(Note: Unless otherwise specified, Ta = 25°C)

Table 2 - Electrical Characteristics

Symbol	Description	Min	Typ	Max	Unit	Condition
V	Impulsive driving voltage		12		V	(Note1)
I	Impulsive driving current		1.5		A	(Note1)
V	Continuous driving voltage			3	V	(Note1)
I	Continuous driving current			0,4	A	(Note1)

Note1: Power dissipation of the Niceclick is limited. See power derating curves for maximum values.

Actuator equivalent circuit:

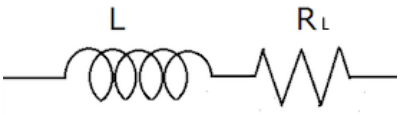


Table 3 - Equivalent circuit parameters

Symbol	Description	Min	Typ	Max	Unit	Condition
L_{long}	Inductance		1,3		mH	No cursor, f=16KHz
L_{short}	Inductance		1,7		mH	Cursor at q=0, f=16KHz
R_L	Coil resistance		7.8		Ω	At T = 25°C

Note: values depend on temperature and other environmental parameters.

Power dissipation

A Niceclick device is generally used to produce two different haptic effect categories:

- single pulses (max duration 30ms)
- vibrations

Both effects have very short electrical time constants if compared with the thermal constant of the Niceclick device. This means that when defining a haptic effect, i.e. a current profile to be injected in the Niceclick, the average power has to be considered.

While average power calculation for vibration effects is quite intuitive, when considering single pulses the average power calculation strategy is not so obvious. The calculation can be done by considering the maximum repetition time of the single pulse (typical values are 250ms, 500ms or 1sec) and calculate the average power of a sequence of pulses repeated forever.

As ambient temperature is a very important parameter for power dissipation, a derating curve has to be applied in accordance with it.

Figure 1 - Niceclick device in free air

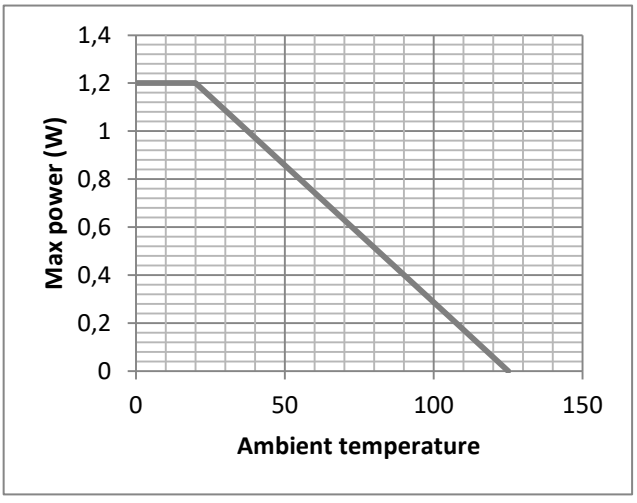
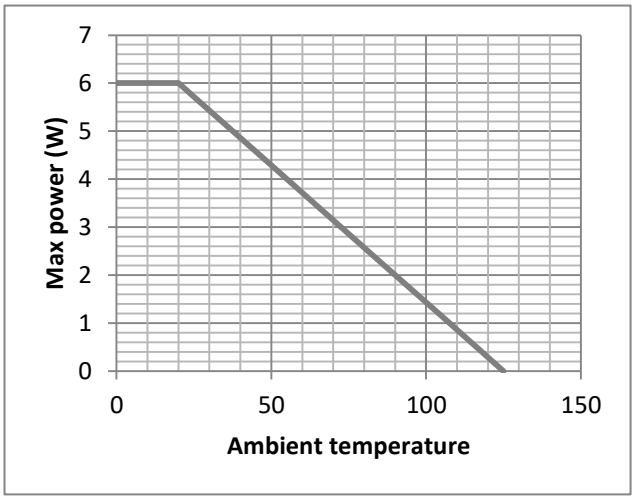
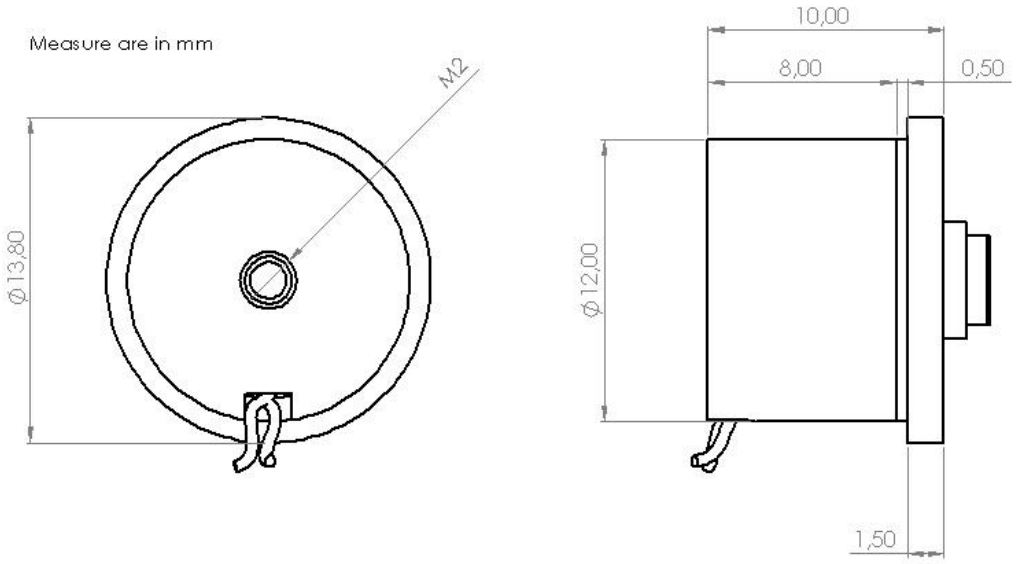


Figure 2 - Niceclick device stator attached to a 100x100x20 mm aluminum base



Mechanical dimensions



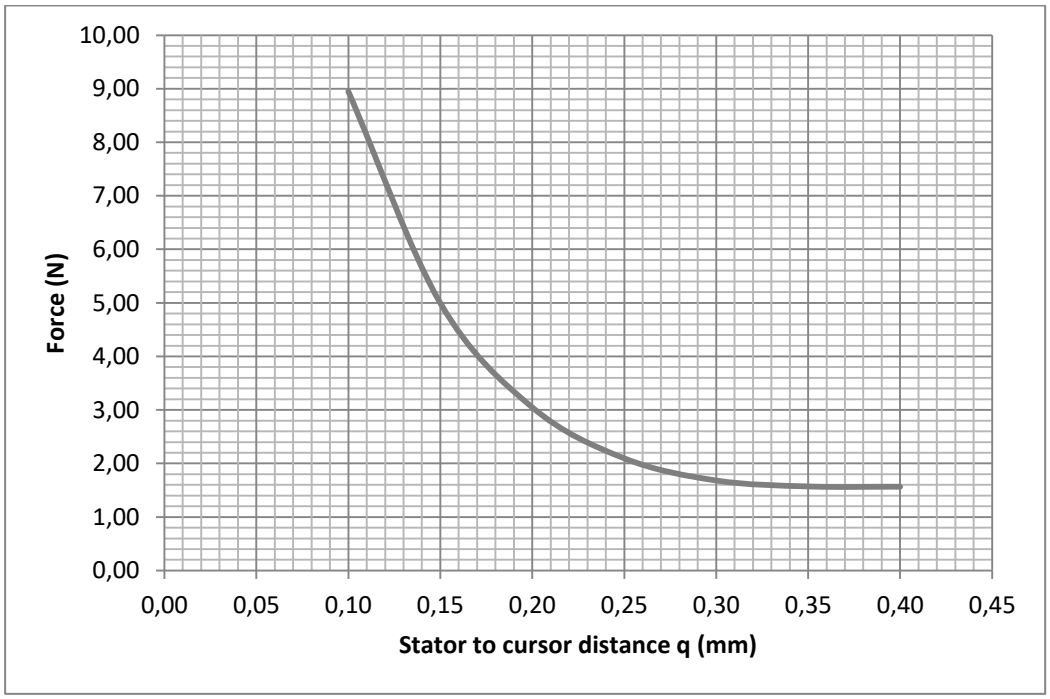
4-Haptic application hints----------

Haptic actuation

Generating a haptic effect means to move a haptic surface when touched by a user finger. To deliver a specific haptic sensation means to move the surface in a predefined way. The Niceclick actuator is able to deliver to the haptic surface a level of force depending on the current flowing in it and the distance between stator and cursor. Different haptic effects can be generated by modulating the current therefore modulating the force applied to the haptic surface.

A standard electronic circuit controlling the current flowing inside the Niceclick device can be used to create expected haptic effects.

Figure 1 - Typical force delivered to haptic surface vs displacement @ I=1.5A

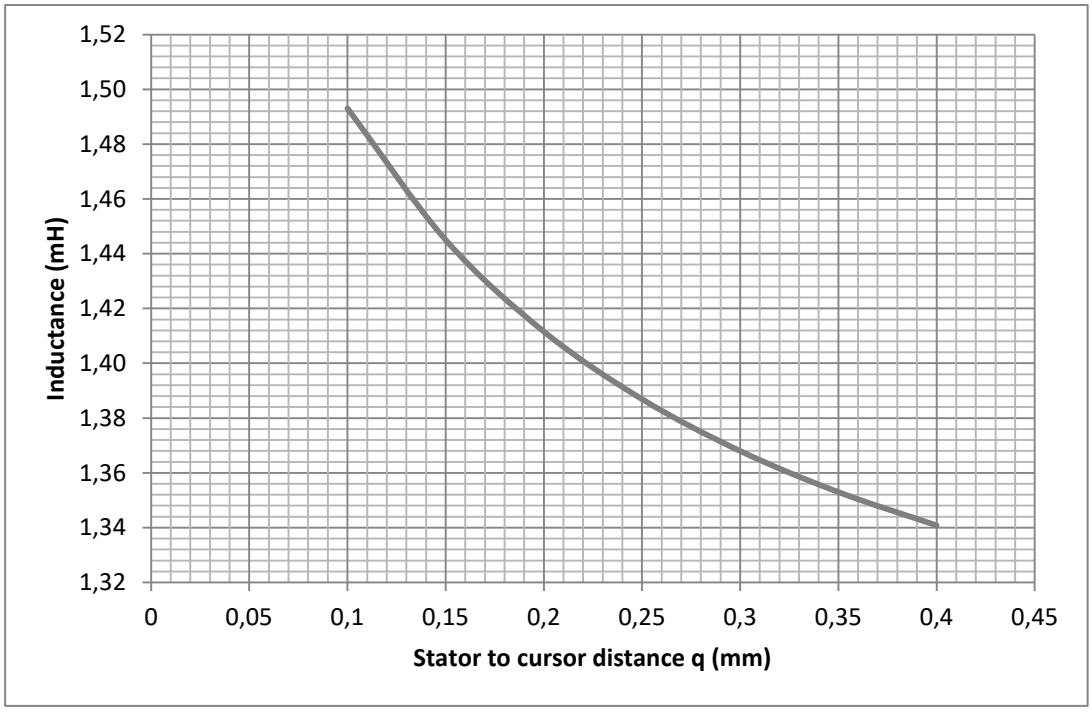


User action sensing

The value of the inductance L of the Niceclick is related to the gap q between the stator and the cursor. When a user touches a haptic surface connected to one or more Niceclick devices, the surface vertical position will change according to the user actions. The measure of L of each device together with some geometrical calculation gives the possibility to know the position of the surface and to deliver haptic effects relevant to that information.

A standard electronic circuit measuring the inductance value of a coil can be used, then the information can be acquired by a microcontroller in order to identify the action a user is performing on the surface.

Figure 4 - Typical inductance vs. displacement @16KHz



Mechanical installation hints

Both force sensing and haptic actuation functions available for a Niceclick device require that a suitable mechanical architecture for the haptic surface is used.

Refer to www.niceclick.eu and search for suitable App Notes.

Electronic reference circuits

Both user action sensing and haptic actuation require an electronic circuit to be properly managed.

Refer to www.niceclick.eu and search for suitable App Notes.

Software library support

A highly-efficient & extremely productive TRAMA ***NC-Lib*** software embedded library has been developed to simplify the development of real haptic applications with the following features:

- Available for the most used microcontroller families
- User action sensing and haptic actuation support
- Communication support for ***NC-tuner*** calibration tool

Refer to www.niceclick.eu for further information.

Disclaimer

All specifications subject to change without notice.

Trama has no responsibility for possible omissions and inaccuracies in the present datasheet. For the latest product specification refer to the Niceclick website (http://www.niceclick.eu).