

F2HEAL



PRELIMINARY
TO BE VERIFIED

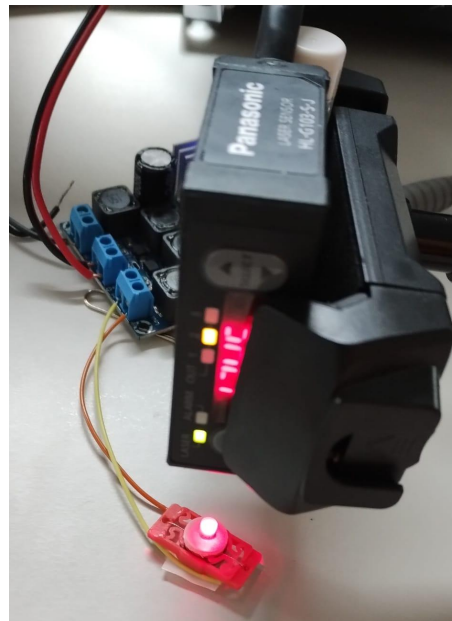
C-MF versus TEAX9 Frequency Displacement Response
20231216

Setup



Tactors :

C-MF



TEAX9

Displacement Sensor

Panasonic Compact Laser Displacement Sensor HL-G1



Driver | Amplifier

TPA3116 Class-D Amplifier



Datasheet Tactors



C-MF Tactor[†]

Product Data Sheet EAI Tactor



[†] US patent 7,798,982

Specifications

Physical Description:	0.92" (23.4 mm) by 1.09" (27.6 mm) by 0.45" (11.4 mm) high
Weight:	8 grams (excluding lead)
Exposed Material:	Polycarbonate, Aluminum, PVC
Electrical Wiring:	Flexible, insulated, #26 AWG tinsel
Body Contactor:	0.2" (5.1 mm) diameter, pre-loaded on skin
Tactile Pulse Characteristics:	180-280 Hz, <2 ms rise time
Electrical Characteristics:	10 ohms nominal with 18" wire
Recommended Drive:	Sine wave tone bursts 250Hz at 0.25A rms nominal, 0.5A max for very short durations. Duty cycle < 10%.
Recommended Controller:	EAI Universal Controller, C15-8 Controller

Product Description

The C-MF tactor is a miniature vibrotactile transducer optimized for use on the fingertip. The housing is shaped to locate the fingertip over a small vibrating contactor. EAI's C-MF series Tactors are state-of-the-art, wearable vibrotactile transducers, suitable for a wide variety of biomedical and research applications.

Applications

- Tactile Research
- Tactor gloves
- Wearable tactile feedback
- Haptic feedback
- Virtual reality
- Medical
- Entertainment
- Gaming

Operation

The C-MF series tactors incorporate a moving "contactor" that is lightly preloaded against the fingertip. The C-MF housing is shaped with a convex curve to center the finger and the fingertip. The C-MF is intended to be pressed against the finger using a stretchable glove, finger cot or tape strap wound around the fingertip.



TEAX09C005-8
Data Sheet

TEAX09C005-8 Miniature Audio Exciter

✓RoHS
COMPLIANT



Features

- Wide bandwidth and wide directivity
- Impedance: 8 ohm nominal
- Dimensions: 26mm x 13mm
- Thickness: 6.5mm
- Mass: 3.2g
- Self-adhesive fixing (3M VHB 9473PC)

Description

The TEAX09C005-8 is a miniature, highly optimised electrodynamic transducer.

This exciter is ideal for any near field applications where space is extremely limited.

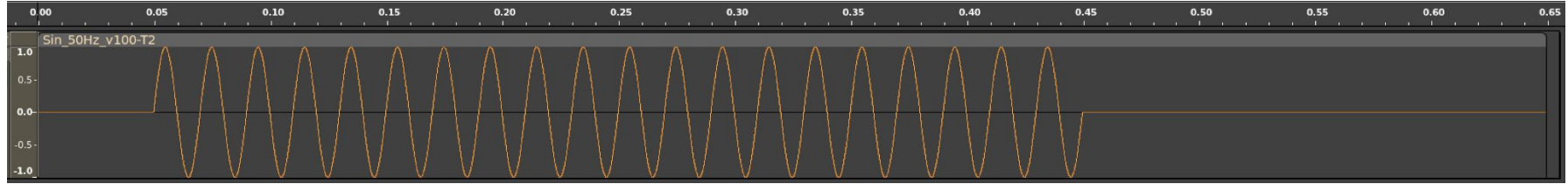
Applications

- Ultra slim and compact loudspeakers
- Portable, hand held audio devices
- GPS

Parameters

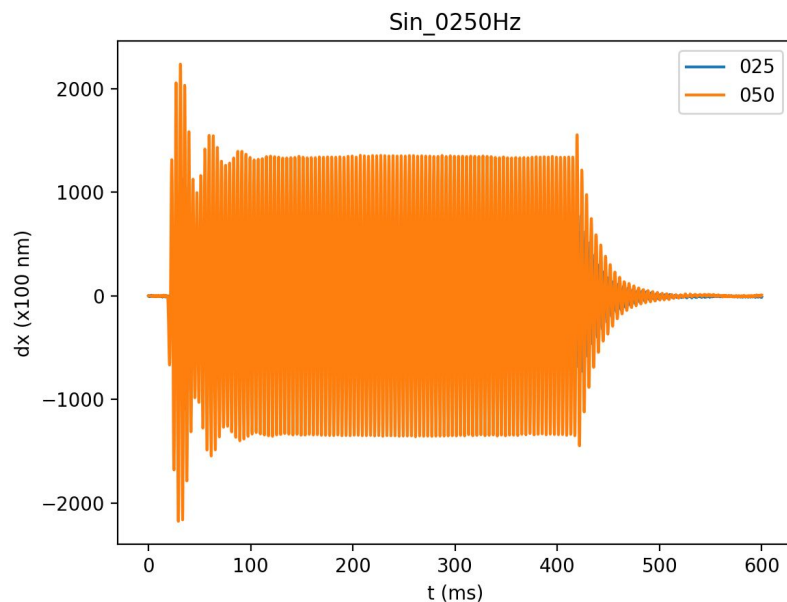
Parameter	Description	min	typ	max	Units
R_e	DC resistance	-10%	8.1	+10%	Ohms
L_e	Inductance (@ 10kHz)	-10%	0.07	+10%	mH
BL	Force factor		1.1		Tm
f_s	Resonance frequency	-15%	635	+15%	Hz
f_{dr}	Magnet resonance	-15%	200	+15%	Hz
dDrv	Voice coil diameter		8.7		mm
M _{ms}	Moving mass		0.13		g
C _{ms}	Compliance		0.48		mmN ⁻¹
R _{ms}	Suspension loss		0.028		Nsm ⁻¹
X _{reach max}	Maximum coil excursion (p-p)		1.2		mm

Method

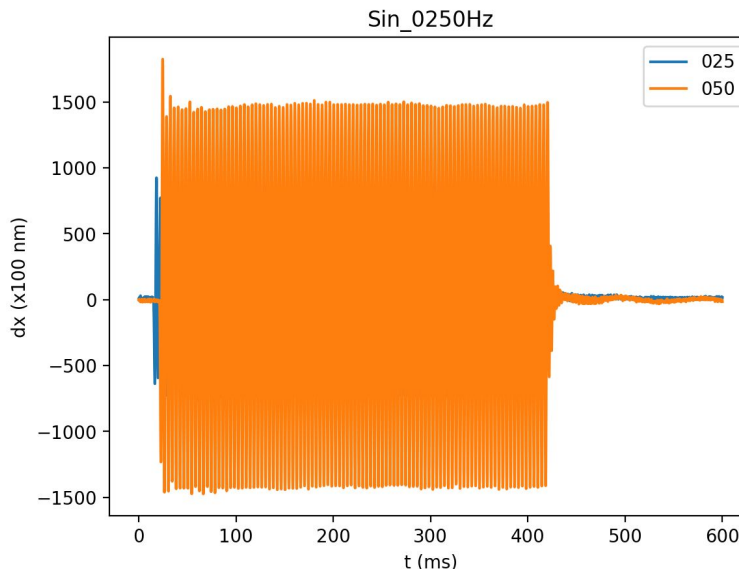


- Excitation Bursts of 400 ms Sinus wave at a fixed Frequency
- In range 20 to 300 Hz
- In steps of 1 Hz
- Repeated with inverted sinus (SinI)
- Repeated at 3 different volume levels
- Laser measures linear displacement @ 5 kHz | 0.2 ms
 - X-axis : TIME [ms] | 600 ms @ 5 kHz | 0.2 ms ~ 3000 samples
 - Y-axis : DISPLACEMENT | $\times 10^{-1} \mu\text{m}$ (micrometer) or $\times 100 \text{ nm}$ (nanometer)
 - Value Increases ~ coil moving inwards, towards magnet
 - Value Decreases ~ coil moves outwards, away from magnet

Sin 0250Hz



Target amplitude
 $\leq 0,03$ mm peak-to-peak



C-MF | TPA3116

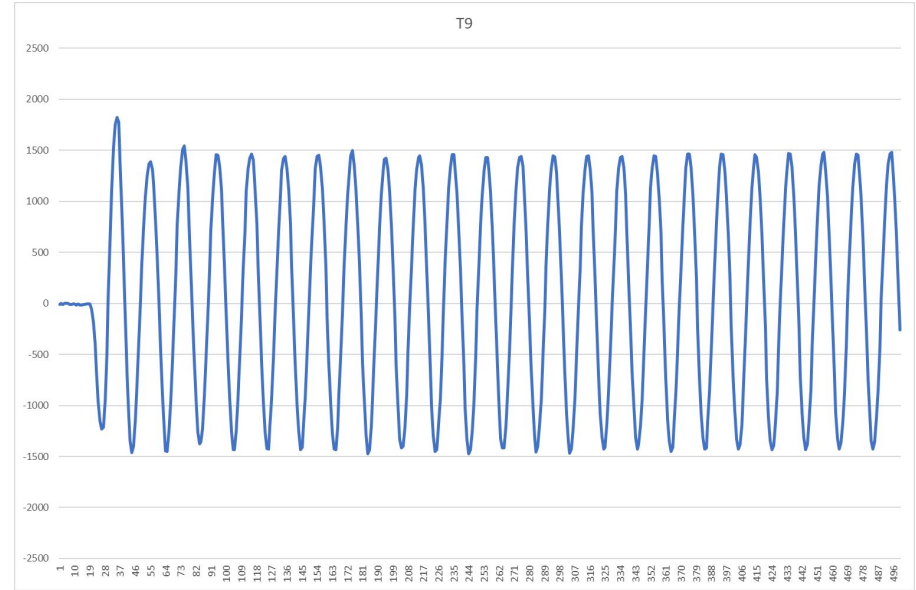
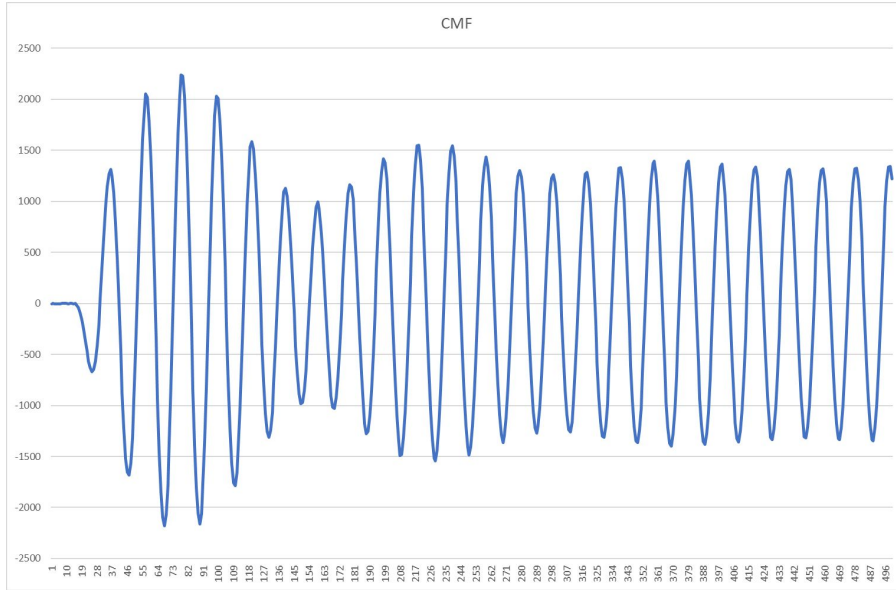
More transients at start and stop

Peak amplitude : 0,130 mm @ volume 50%

TEAX9 | TPA3116

Peak amplitude : 0,145 mm @ volume 50%

Sin 0250Hz Rise time



C-MF

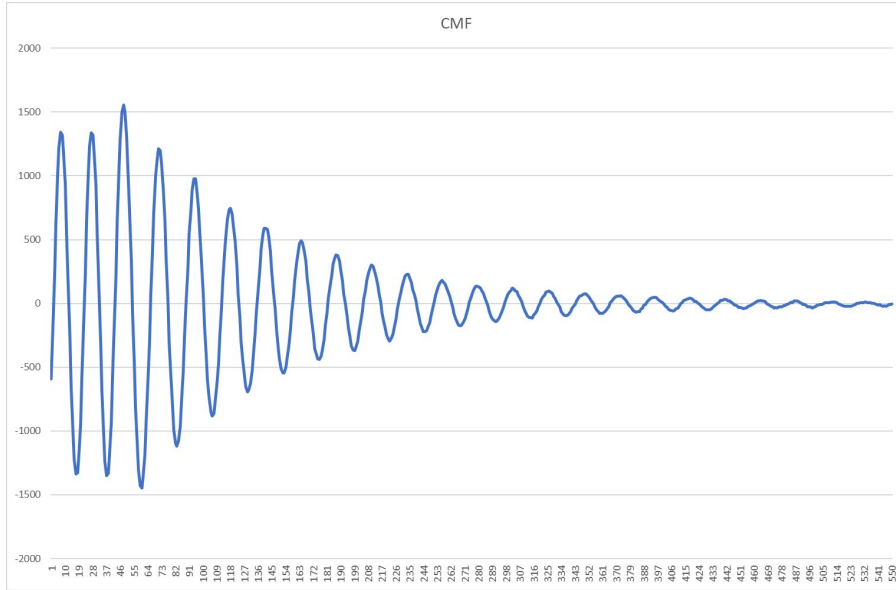
More transients at start and stop

Displacement starts Outwards

TEAX9

Displacement starts Outwards

Sin 0250Hz Fall time

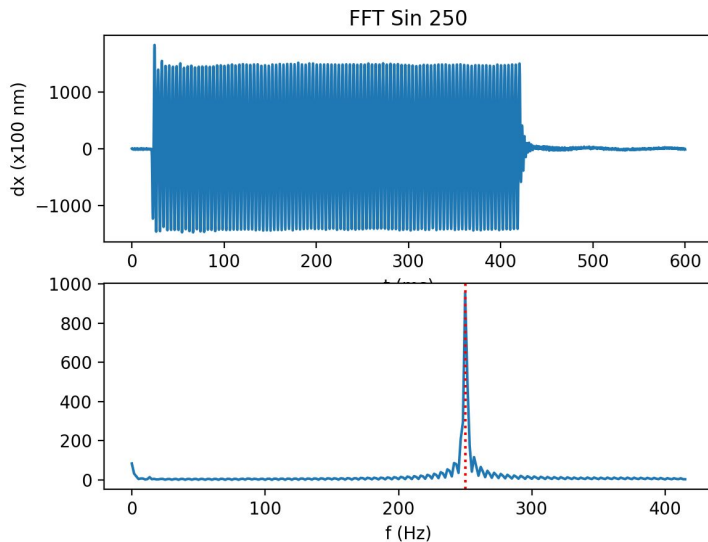
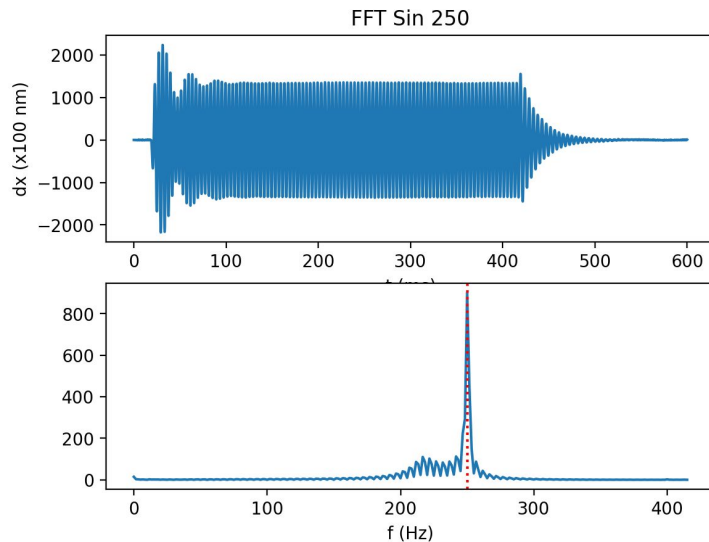


C-MF

More transients at start and stop

TEAX9

Sin 0250Hz - FFT

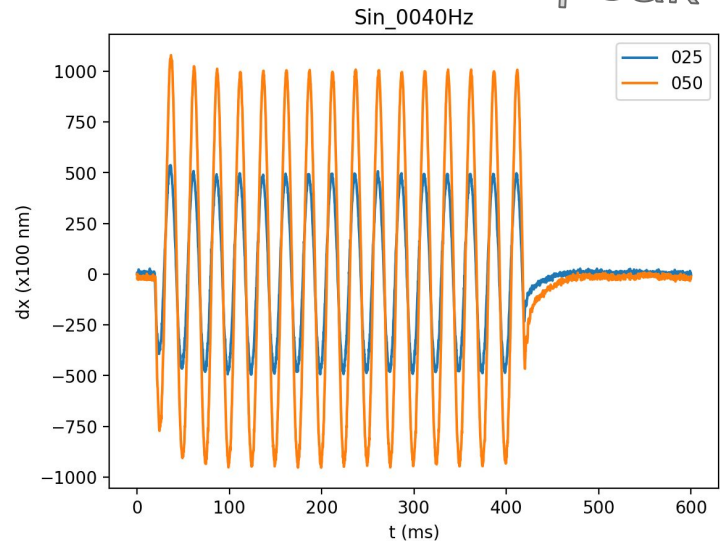
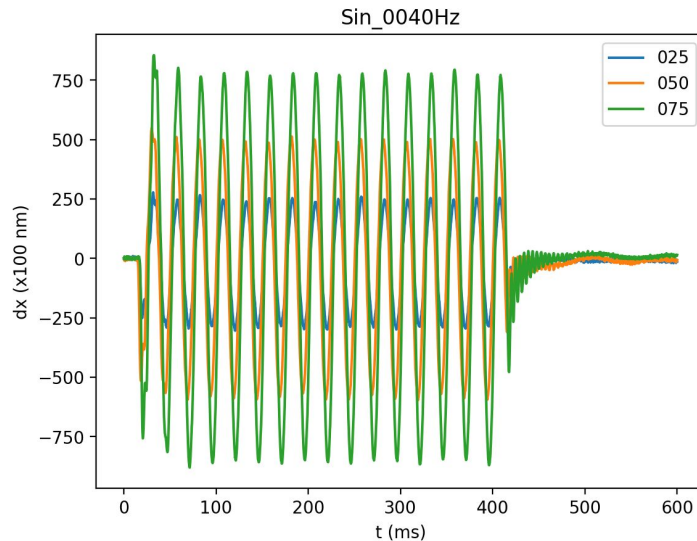


Red dash line : main frequency | Static DC component @ 0 Hz

C-MF	TEAX9
	Very small Static offset of 0,006 mm inwards

Sin 0040Hz @ different volume levels

Target amplitude
 $\leq 0,25$ mm peak-to-peak



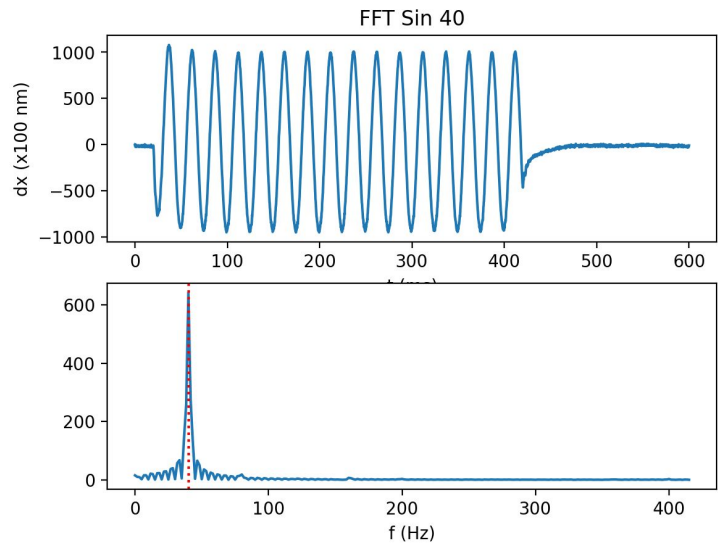
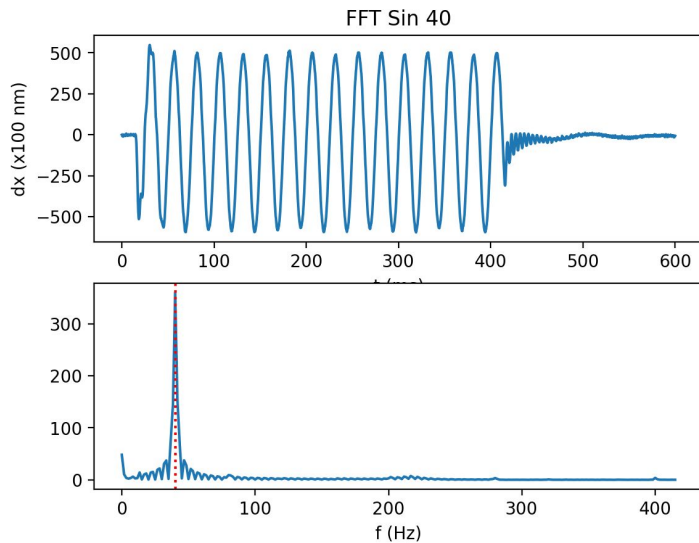
C-MF

Peak amplitude : 0,05 mm @ volume 50%

TEAX9

Peak amplitude : 0,10 mm @ volume 50%

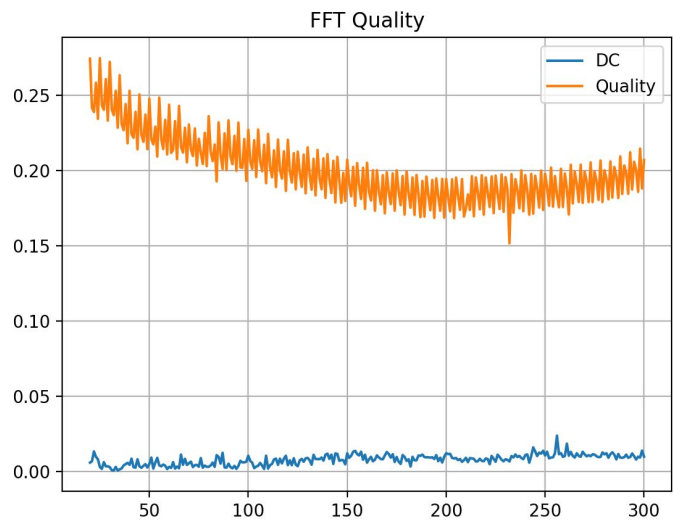
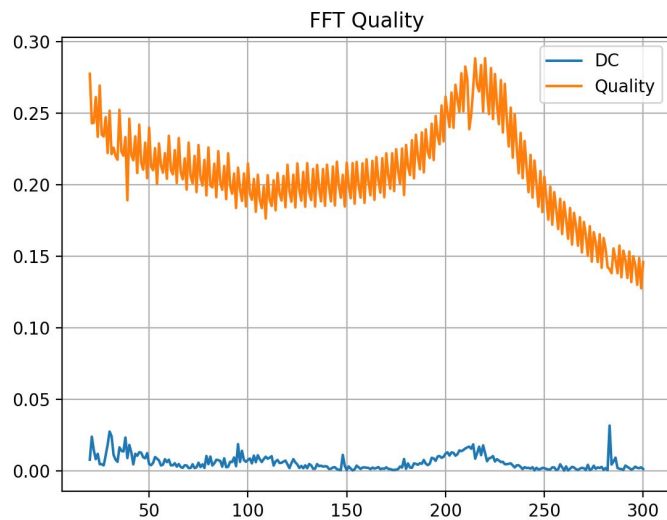
Sin 0040Hz - FFT



C-MF

TEAX9

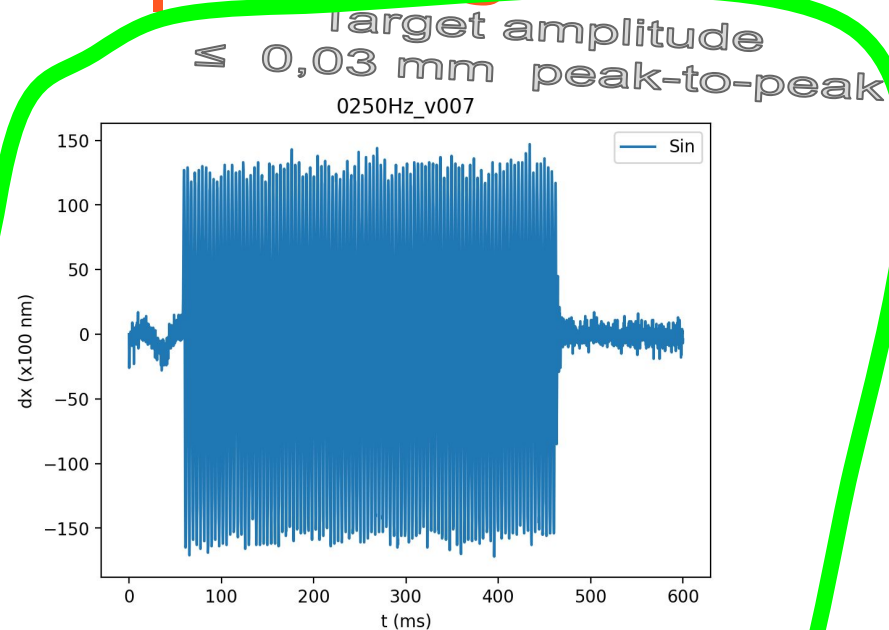
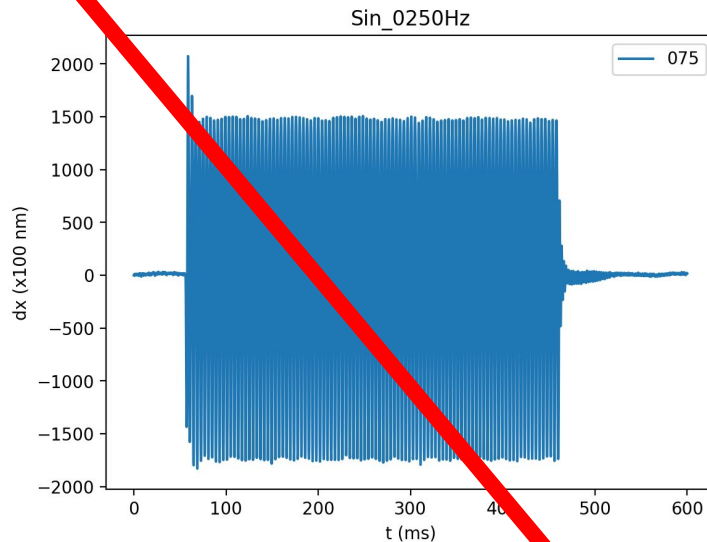
Fullband overview



C-MF

TEAX9

Sin 0250Hz | TEAX9 | VHP | uncharged



TEAX9 | VHP @ V 075%

Peak amplitude : 0,150 mm @ VHP volume 75%

P2P amplitude : 0,300 mm @ VHP volume 75%

Very small Static offset of 0,005 mm outwards

TEAX9 | VHP @ V 007%

Peak amplitude : 0,015 mm @ VHP volume 7%

P2P amplitude : 0,030 mm @ VHP volume 7%

Very small Static offset of 0,005 mm outwards

New presets

Preset #	001	002
	8 Channels	
	40 Hz	250 Hz
8 channels	TRUE	TRUE
Samplerate [Hz]	46875	46875
stimulation frequency [Hz]	40	250
stimulation duration [ms]	200	100
Cycle period (duration) [ms]	2240	1332
Number of cycles in pauze cycle	5	5
Number of cycles in pauze cycle to pauze	2	2
Jitter on timing %	23,50%	23,50%
Volume %	75,00%	7,00%
p2p displacement amplitude [mm]	0,25	0,03
Targetted mechanoreceptive units	FA I	FA II

Mechanoreceptive units FA I & II

FA I mechanoreceptive units :

React to vibration amplitudes -12 dB relative to 1 mm peak to peak skin displacement
~ 0.25 mm = 250 μ m @ vibration frequencies between 32 Hz to 64Hz
FA I units are predominantly located in the fingertips ~ 141 units/cm²

FA II mechanoreceptive units :

React to vibration amplitudes -30 dB relative to 1 mm peak to peak skin displacement
~ 0.03 mm = 30 μ m @ vibration frequencies between 128 Hz and 400 Hz.
FA II units covering an entire finger or more [17-18].
FA II units are in the fingertips ~ 18 units/cm²
The nearly homogenous density of FA II units might allow sparing the fingertips by targeting FA II mechanoreceptive units on the dorsal part of the middle phalanx.