

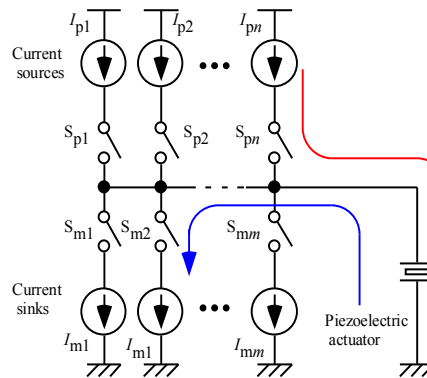
電流パルスを用いた圧電アクチュエータの駆動法

Driving Method of Piezoelectric Actuator by Series of Current Pulse

豊田工業大学 古谷克司 Toyota Technological Institute Katsushi Furutani

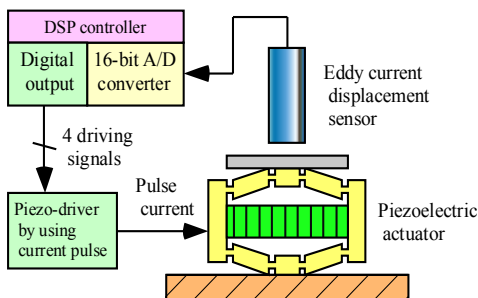
Outline: Sub-nanometer resolution in full-stroke of the displacement range is obtained.
The hysteresis is very small because this method is equivalent to a charge control.

- 変位制御
 - 印加電圧
 - 電荷制御
- デジタル制御
 - D/A変換器からの出力
 - D/A, A/D変換器の分解能によりダイナミックレンジに制限
- 解決法:
 - パルス密度変調 (PDM)

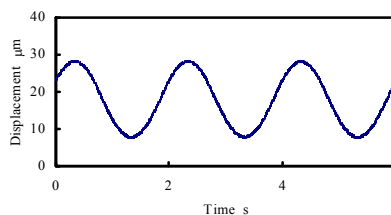


- 複数の電流源(ソースとシンク)を並列接続
 - 大変位 → 大電流
 - 微小変位 → 微小電流
- 電流パルスの出力
- PDMによる高速変位と微細な分解能

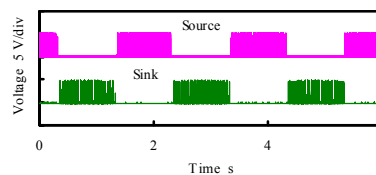
Principle of driving method by using current pulse



Configuration of control system



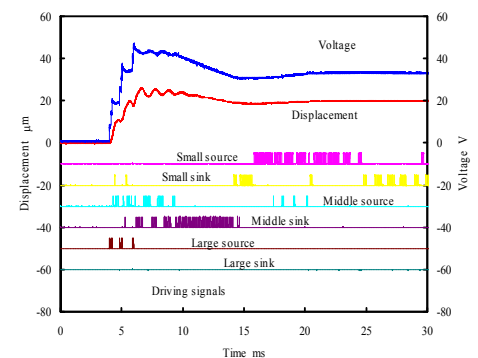
(a) Displacement



(b) Driving signals

Displacement control by feed-forward control

Stacked piezoelectric actuator:
AE0505D16 (capacitance: 1.4 μ F) by NEC/Tokin
Displacement with magnification
70 μ m at 100 V
Hysteresis: 14%
Natural frequency: 770 Hz



Example of feedback control with PID controller

Peak and duration of current pulse

Coarse/ Fine	Source/ Sink	Current mA	Pulse duration μ s
Coarse	Source	220	8.6
	Sink	164	17.0
Fine	Source	3.2	9.7
	Sink	0.8	40.8

Comparison of current-pulse drive with linear-amplifier drive

Drive	Hysteresis %	Distortion rate %
Current pulse	0.3	0.04
Linear amplifier	7.3	0.01

Displacement with fine-motion circuit: 7.1 nm/pulse
(equivalent to 13 bits)

Linearity of displacement: source 2%, sink 3%