## LV8712T

#### **Bi-CMOS LSI**

# **PWM Constant-Current Control Stepping Motor Driver**



http://onsemi.com

#### Overview

The LV8712T is a stepping motor driver of the micro-step drive corresponding to supports 2W 1-2 phase excitation. It is the best for the drive of the stepping motor for a scanner and a small printer.

#### **Features**

- Single-channel PWM constant-current control stepping motor driver incorporated.
- Excitation mode can be set to 2-phase, 1-2 phase, W1-2 phase, or 2W1-2 phase
- Microstep can control easily by the CLK-IN input.
  Power-supply voltage of motor
  Output current
  IO max = 18V
- Output ON resistance :  $R_{ON} = 1.1\Omega$  (upper and lower total, typical,  $T_a = 25^{\circ}C$ )
- A thermal shutdown circuit and a low voltage detecting circuit are built into.

#### **Specifications**

#### **Absolute Maximum Ratings** at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage	VM max		18	V
Logic supply voltage	V <sub>CC</sub> max		6	V
Output peak current	I <sub>O</sub> peak	Each 1ch, tw ≤ 10ms, duty 20%	1.0	Α
Output continuousness current	I <sub>O</sub> max	Each 1ch	800	mA
Logic input voltage	V <sub>IN</sub>		-0.3 to V <sub>CC</sub> + 0.3	V
Allowable power dissipation	Pd max	*	1.35	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

<sup>\*</sup> Specified circuit board: 57.0mm×57.0mm×1.7mm, glass epoxy 2-layer board.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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## Allowable Operating Ratings at Ta = 25°C

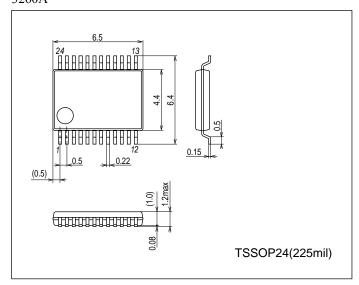
Parameter	Symbol	Conditions	Ratings	Unit
Motor supply voltage range	VM		4 to 16	V
Logic supply voltage range	VCC		2.7 to 5.5	V
Logic input voltage	V <sub>IN</sub>		-0.3 tp V <sub>CC</sub> +0.3	V
VREF input voltage range	VREF		0 to V <sub>CC</sub> -1.8	V

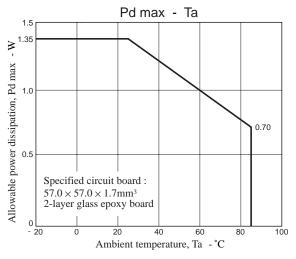
## **Electrical Characteristics** at Ta = 25°C, VM = 12V, $V_{CC} = 3.3VVREF = 1.0V$

Parameter		Symbol	Conditions		Ratings		
		Cymbol	35.14.115.115	min	typ	max	Unit
Standby mode current drain		IMstn	PS = "L", no load			1	μΑ
		I <sub>CC</sub> stn	PS = "L", no load			1	μΑ
Current drain		IM	PS = "H", no load	0.3	0.5	0.7	mA
		Icc	PS = "H", no load	0.9	1.3	1.7	mA
Thermal shutdov	vn temperature	TSD	Design guarantee		180		°C
Thermal hysteres	sis width	ΔTSD	Design guarantee		40		°C
V <sub>CC</sub> low voltage	cutting voltage	VthV <sub>CC</sub>		2.1	2.4	2.7	V
Low voltage hyst	eresis voltage	VthHIS		100	130	160	mV
REG5 output vol	tage	Vreg5	$I_O = -1 \text{mA}$	4.5	5	5.5	V
Output on resista	ance	RonU	I <sub>O</sub> = -800mA, Source-side on resistance		0.78	1.0	Ω
		RonD	I <sub>O</sub> = 800mA, Sink-side on resistance		0.32	0.43	Ω
Output leakage of	current	l <sub>O</sub> leak	V <sub>O</sub> = 15V			10	μΑ
Diode forward vo	oltage	VD	ID = -800mA		1.0	1.2	V
Logic pin input c	urrent	I <sub>IN</sub> L	V <sub>IN</sub> = 0.8V	4	8	12	μΑ
		I <sub>IN</sub> H	V <sub>IN</sub> = 3.3V	22	33	45	μΑ
Logic high-level	input voltage	V <sub>IN</sub> H		2.0			V
Logic low-level in	nput voltage	V <sub>IN</sub> L				0.8	V
VREF input curre	ent	IREF	VREF = 1.0V	-0.5			μΑ
Current setting comparator	2W1-2-phase drive	Vtdac0_2W	Step 0 (When initialized : channel 1 comparator level)	0.191	0.2	0.209	V
threshold	a	Vtdac1_2W	Step 1 (Initial state+1)	0.187	0.196	0.205	V
voltage		Vtdac2_2W	Step 2 (Initial state+2)	0.175	0.184	0.193	V
(current step		Vtdac3_2W	Step 3 (Initial state+3)	0.158	0.166	0.174	V
switching)		Vtdac4_2W	Step 4 (Initial state+4)	0.132	0.140	0.148	V
		Vtdac5_2W	Step 5 (Initial state+5)	0.102	0.110	0.118	V
		Vtdac6_2W	Step 6 (Initial state+6)	0.068	0.076	0.084	V
		Vtdac7_2W	Step 7 (Initial state+7)	0.032	0.040	0.048	V
	W1-2-phase drive	Vtdac0_W	Step 0 (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
		Vtdac2_W	Step 2 (Initial state+1)	0.175	0.184	0.193	V
		Vtdac4_W	Step 4 (Initial state+2)	0.132	0.140	0.148	V
		Vtdac6_W	Step 6 (Initial state+3)	0.068	0.076	0.084	V
	1-2 phase drive	Vtdac0_H	Step 0 (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
		Vtdac4_H	Step 4 (Initial state+1)	0.132	0.140	0.148	V
	2 phase drive	Vtdac4_F	Step 4' (When initialized : channel 1 comparator level)	0.191	0.200	0.209	V
Current setting comparator		Vtatt00	ATT1 = L, ATT2 = L	0.191	0.200	0.209	V
threshold voltage	)	Vtatt01	ATT1 = H, ATT2 = L	0.152	0.160	0.168	V
(current attenuation rate switching)		Vtatt10	ATT1 = L, ATT2 = H	0.112	0.120	0.128	V
		Vtatt11	ATT1 = H, ATT2 = H	0.072	0.080	0.088	V
		Fchop	Cchop = 220pF	36	45	54	kl
CHOP pin thresh		V <sub>CHOP</sub> H		0.6	0.7	0.8	
,	<b>0</b> -	VCHOPL		0.17	0.2	0.23	
CHOP pin charge	e/discharge current	Ichop		7	10	13	μ
		Vsatmon	Imoni = 1mA	<u> </u>	250	400	m
MONI pin saturation voltage					200	100	

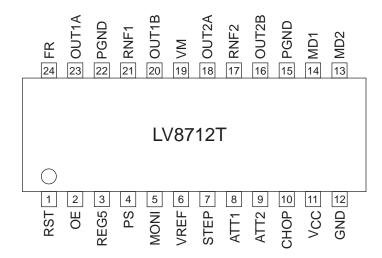
## **Package Dimensions**

unit: mm (typ) 3260A

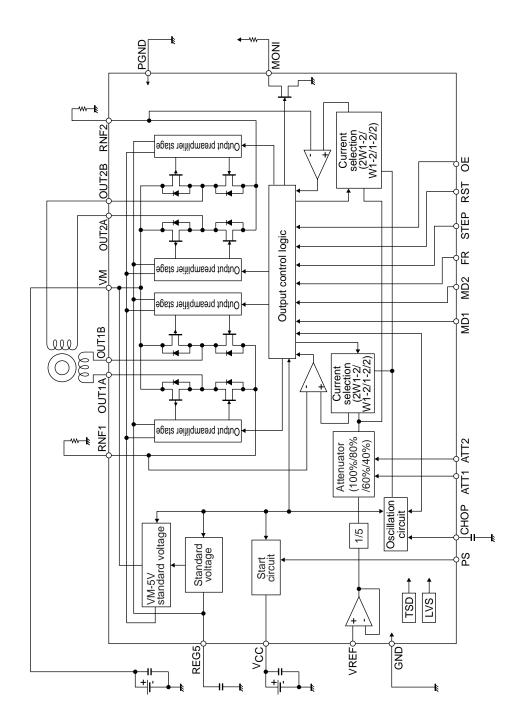




## **Pin Assignment**



### **Block Diagram**



## LV8712T

#### Pin Functions

Pin Fu	inctions		
Pin No.	Pin Name	Pin Functtion	Equivalent Circuit
1	RST	Excitation reset signal input pin.	V00 c
2	OE	Output enable signal input pin.	Vcc o •
7	STEP	STEP signal input pin.	
8	ATT1	Motor holding current switching pin.	"   "
9	ATT2	Motor holding current switching pin.	
13	MD2	Excitation mode switching pin 2.	
14	MD1	Excitation mode switching pin 1.	6kΩ " L
24	FR	CW / CCW switching signal input pin.	
			* \$100kΩ
			GND O-
4	PS	Power save signal input pin.	V <sub>CC</sub> 0 •
			.000
			_
			T
			4)—
			6kΩ
			<b>↓</b>
			T
			GND O +
16	OUT2B	Channel 2 OUTB output pin.	\/A
17	RNF2	Channel 2 current-sense resistor	VM ○
		connection pin.	
18	OUT2A	Channel 2 OUTA output pin.	
20	OUT1B	Channel 1 OUTB output pin.	
21	RNF1	Channel 1 current-sense resistor	23(8)
		connection pin.	
23	OUT1A	Channel 1 OUTA output pin.Power	
			5000
			560Ω 1kΩ
			560Ω 21 1kΩ "
			$\square$
			GNDO
6	VREF	Constant current control reference	
	71121	voltage input pin.	VCC O + +
			<b>↓</b> ♥↓ ♥↓
			T
			500Ω
			6
			GND O
			OND O

Continued on next page.

Pin No.	from preceding prints	Pin Functtion	Fauivalant Circuit
3 3	REG5	Internal power supply capacitor connection pin.	Equivalent Circuit $ \begin{array}{c} V_{\text{M}} \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ $
5	MONI	Position detection monitor pin.	VCC (5)
10	СНОР	Chopping frequency setting capacitor connection pin.	VCC 0 500Ω 500Ω GND 0 10

#### **Description of operation**

#### Stepping motor control

#### (1) Power save function

This IC is switched between standby and operating mode by setting the PS pin. In standby mode, the IC is set to power-save mode and all logic is reset. In addition, the internal regulator circuit do not operate in standby mode.

PS	Mode	Internal regulator
Low or Open	Standby mode	Standby
High	Operating mode	Operating

#### (2) The order of turning on recommended power supply

The order of turning on each power supply recommends the following.

VCC power supply order  $\rightarrow$  VM power supply order  $\rightarrow$  PS pin = High

It becomes the above-mentioned opposite for power supply OFF.

However, the above-mentioned is a recommendation, the overcurrent is not caused by not having defended this, and IC is destroyed.

#### (3) STEP pin function

Input		Operating mode
PS	STP	
Low	*	Standby mode
High		Excitation step proceeds
High		Excitation step is kept

#### (4) Excitation mode setting function(initial position)

MD1	MD2	Excitation mode	Initial position	
			Channel 1	Channel 2
Low	Low	2 phase excitation	100%	-100%
High	Low	1-2 phase excitation	100%	0%
Low	High	W1-2 phase excitation	100%	0%
High	High	2W1-2 phase excitation	100%	0%

This is the initial position of each excitation mode in the initial state after power-on and when the counter is reset.

#### (5) Position detection monitoring function

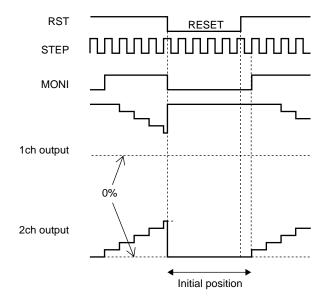
The MONI position detection monitoring pin is of an open drian type.

When the excitation position is in the initial position, the MONI output is placed in the ON state.

(Refer to "(12) Examples of current waveforms in each of the excitation modes.")

#### (6) Reset function

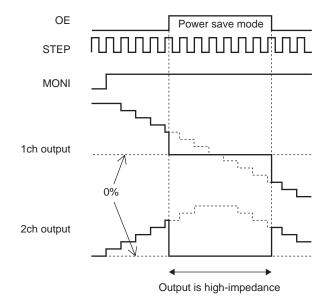
RST	Operating mode
High	Normal operation
Low	Reset state



When the RST pin is set to Low, the excitation position of the output is forcibly set to the initial position, and the MONI output is placed in the ON state. When RST is then set to High, the excitation position is advanced by the next STEP input.

#### (7) Output enable function

OE	Operating mode
Low	Output ON
High	Output OFF



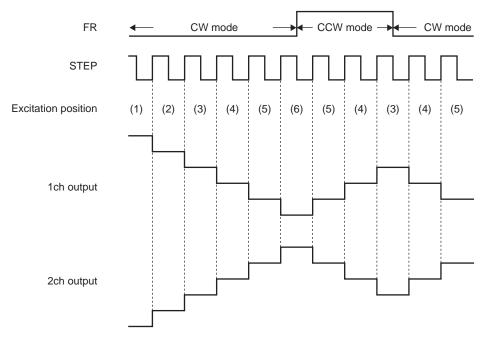
When the OE pin is set High, the output is forced OFF and goes to high impedance.

However, the internal logic circuits are operating, so the excitation position proceeds when the STEP signal is input.

Therefore, when OE is returned to Low, the output level conforms to the excitation position proceeded by the STEP input.

(8) Forward/reverse switching function

FR	Operating mode
Low	Clockwise (CW)
High	Counter-clockwise (CCW)



The internal D/A converter proceeds by one bit at the rising edge of the input STEP pulse.

In addition, CW and CCW mode are switched by setting the FR pin.

In CW mode, the channel 2 current phase is delayed by 90° relative to the channel 1 current.

In CCW mode, the channel 2 current phase is advanced by 90° relative to the channel 1 current.

#### (9) Setting constant-current control

The setting of STM driver's constant current control is decided the VREF voltage from the resistance connected between RNF and GND by the following expression.

$$I_{OUT} = (VREF/5)/RNF$$
 resistance

The voltage input to the VREF pin can be switched to four-step settings depending on the statuses of the two inputs, ATT1 and ATT2. This is effective for reducing power consumption when motor holding current is supplied.

Attenuation function for VREF input voltage

ATT1	ATT2	Current setting reference voltage attenuation ratio
Low	Low	100%
High	Low	80%
Low	High	60%
High	High	40%

The formula used to calculate the output current when using the function for attenuating the VREF input voltage is given below.

 $I_{OUT} = (VREF/5) \times (attenuation ratio)/RNF resistance$ 

Example : At VREF of 1.0V, a reference voltage setting of 100% [(ATT1, ATT2) = (L, L)] and an RNF resistance of  $0.5\Omega$ , the output current is set as shown below.

$$I_{OUT} = 1.0V/5 \times 100\%/0.5\Omega = 400 \text{mA}$$

If, in this state, (ATT1, ATT2) is set to (H, H), IOUT will be as follows :

$$I_{OUT} = 400 \text{mA} \times 40\% = 160 \text{mA}$$

In this way, the output current is attenuated when the motor holding current is supplied so that power can be conserved.

<sup>\*</sup> The above setting is the output current at 100% of each excitation mode.

#### (10) Chopping frequency setting

For constant-current control, this IC performs chopping operations at the frequency determined by the capacitor (Cchop) connected between the CHOP pin and GND.

The chopping frequency is set as shown below by the capacitor (Cchop) connected between the CHOP pin and GND.

Tchop 
$$\approx C \times V \times 2 / I$$
 (s)

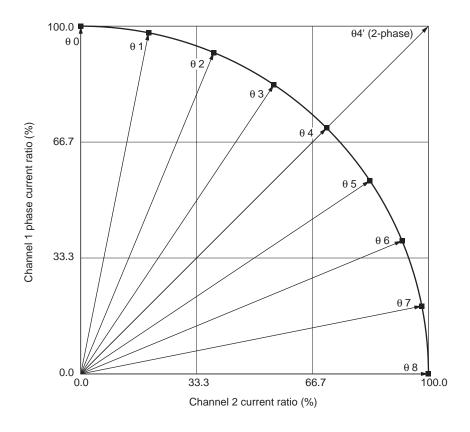
V: Width of suresshu voltage, typ 0.5V

I: Charge/discharge current, typ 10μA

For instance, when Cchop is 200pF, the chopping frequency will be as follows:

Fchop 
$$\approx 1 / \text{Tchop (Hz)}$$

#### (11) Output current vector locus (one step is normalized to 90 degrees)

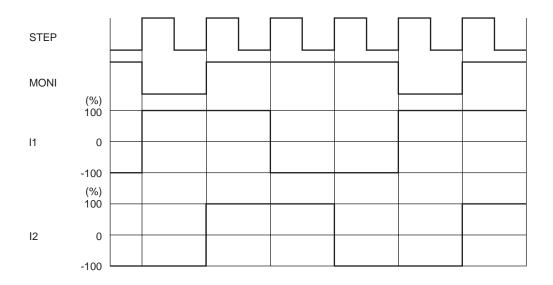


Setting current ration in each excitation mode

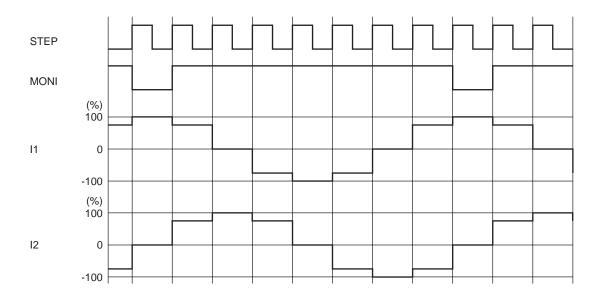
STEP	2W1-2 phase (%)		W1-2 phase (%)		1-2 phase (%)		2-phase (%)	
	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2	Channel 1	Channel 2
θ0	100	0	100	0	100	0		
θ1	98	20						
θ2	92	38	92	38				
θ3	83	55						
θ4	70	70	70	70	70	70	100	100
θ5	55	83						
θ6	38	92	38	92				
θ7	20	98						
θ8	0	100	0	100	0	100		

## (12) Typical current waveform in each excitation mode

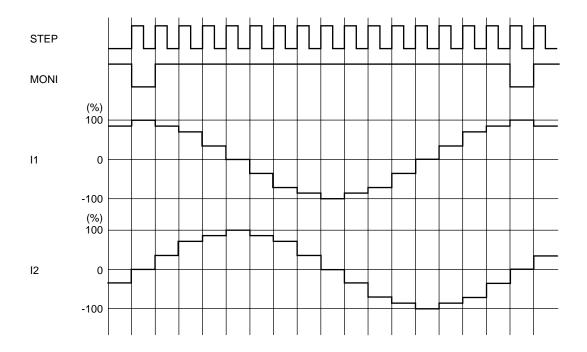
2-phase excitation (CW mode)



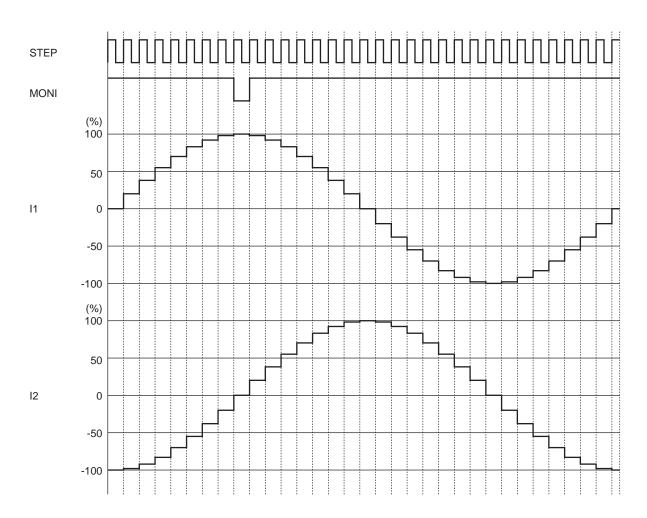
## 1-2 phase excitation (CW mode)



W1-2 phase excitation (CW mode)

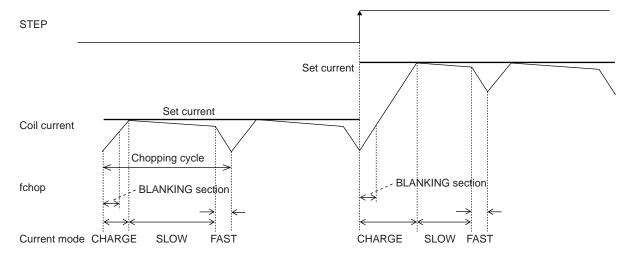


2W1-2 phase excitation (CW mode)

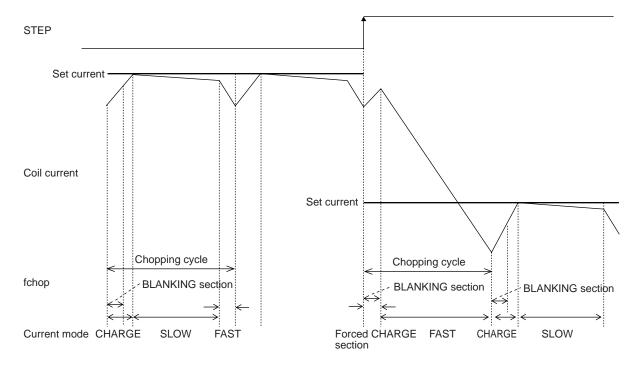


#### (13) Current control timing chart(Chopping operation)

(Sine wave increasing direction)



(Sine wave decreasing direction)



In each current mode, the operation sequence is as described below:

- At rise of chopping frequency, the CHARGE mode begins. (The Blanking section in which the CHARGE mode is forced regardless of the magnitude of the coil current (ICOIL) and set current (IREF) exists for 1μs.)
- The coil current (ICOIL) and set current (IREF) are compared in this blanking time.

When (ICOIL < IREF) state exists;

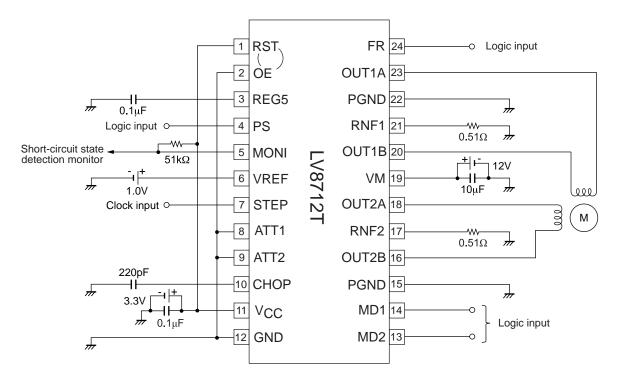
The CHARGE mode up to ICOIL  $\geq$  IREF, then followed by changeover to the SLOW DECAY mode, and finally by the FAST DECAY mode for approximately 1 $\mu$ s.

When (ICOIL < IREF) state does not exist;

The FAST DECAY mode begins. The coil current is attenuated in the FAST DECAY mode till one cycle of chopping is over.

Above operations are repeated. Normally, the SLOW (+FAST) DECAY mode continues in the sine wave increasing direction, then entering the FAST DECAY mode till the current is attenuated to the set level and followed by the SLOW DECAY mode.

#### **Application Circuit Example**



The formulae for setting the constants in the examples of the application circuits above are as follows: Constant current (100%) setting

When VREF = 1.0V 
$$I_{OUT} = VREF/5/RNF \text{ resistance}$$
$$= 1.0V/5/0.51\Omega = 0.392A$$
Chopping frequency setting 
$$Fchop = Ichop/(Cchop \times Vtchop \times 2)$$

$$Fchop = Ichop/ (Cchop \times Vtchop \times 2)$$
  
= 10\mu A/ (220pF \times 0.5V \times 2) = 45kHz

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