Ordering number : ENN7464

SANYO Semiconductors
DATA SHEET

Unipolar Constant-Current Chopper

STK672-210 — Two-Phase Stepping Motor Driver Output Current: 1.4 A

Overview

The STK672-210 is two-phase stepping motor driver hybrid IC (H-IC) that features further miniaturization and improved input logic flexibility as compared to the STK6712 series products.

Applications

The STK672-210 is optimal for use as a stepping motor driver in printers, copiers, XY plotters, and similar equipment.

Features

- Built-in common-mode input protection circuit
- The input signal logic lines are provided as active-high and active-low pairs, and thus support switching the motor wiring.
- Built-in current detection resistor for reduced external component mounting area on the printed circuit board.
- Wide motor operating range (10 to 45 V)

Specifications

Absolute Maximum Ratings at Tc = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage 1	$V_{CC}1$ max	No signal	52	V
Maximum supply voltage 2	$V_{CC}2$ max	No signal	–0.3 to +7.0	V
Input voltage	V_{IN} max	Logic input pins	–0.3 to +7.0	V
Phase output current	I_{OH} max	0.5 s, 1 pulse, when $V_{CC}1$ is applied	2.2	A
Repeated avalanche capacity	Ear max		25	mJ
Allowable power dissipation	Pd max	With an arbitrarily large heat sink. Per MOSFET	6.5	W
Operating substrate temperature	Tc max		105	°C
Junction temperature	Tj max		150	°C
Storage temperature	Tstg		–40 to +125	°C

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Allowable Operating Ranges at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	$V_{CC}1$	With signals applied	10 to 45	V
Supply voltage 2	$V_{CC}2$	With signals applied	5.0 ± 5%	V
Input voltage	V_{IH}		0 to $V_{CC}2$	V
Phase driver withstand voltage	V_{DSS}	I_D = 1 mA (Tc = 25°C)	100	V
Phase current 1	I_{OH} max 1	When the pin 6 to 9 signals are ≥ 100 Hz, Tc = 105°C, 50% duty	1.4	A
Phase current 2	I_{OH} max 2	When the pin 6 to 9 signals are ≥ 100 Hz, Tc = 90°C, 50% duty	1.6	A

Electrical Characteristics at Tc = 25°C, $V_{CC}1$ = 24 V, $V_{CC}2$ = 5 V

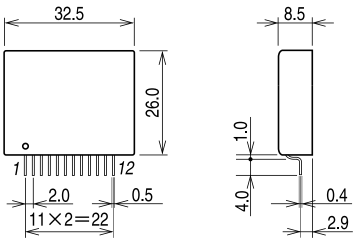
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Control supply current	I_{CCO}	With all inputs at the $V_{CC}2$ level		3.3	10	mA
Output current (average)	I_O ave	With R/L = 3.5 Ω/3.8 mH in each phase	0.405	0.450	0.505	A
FET diode forward voltage	Vdf	If = 1.0 A		1.1	1.8	V
Output saturation voltage	Vsat	R_L = 24 Ω		0.8	1.2	V
Vref input voltage	VrH	Pin 12	0		3.5	V
Vref input bias current	I_{IB}	With pin 12 at 1 V		50	500	nA
[Control Input Pins]						
Input voltage	V_{IH}	H-IC pins 6 to 9	3.5			V
	V_{IL}	H-IC pins 6 to 9			0.7	V
Input current	I_{IH}	H-IC pins 6 to 9, V_{IN} = $V_{CC}2$		310		µA
	I_{IL}	H-IC pins 6 to 9, V_{IN} = 0 V		2.5		µA

Note: A fixed-voltage power supply must be used.

Package Dimensions

unit : mm

4168



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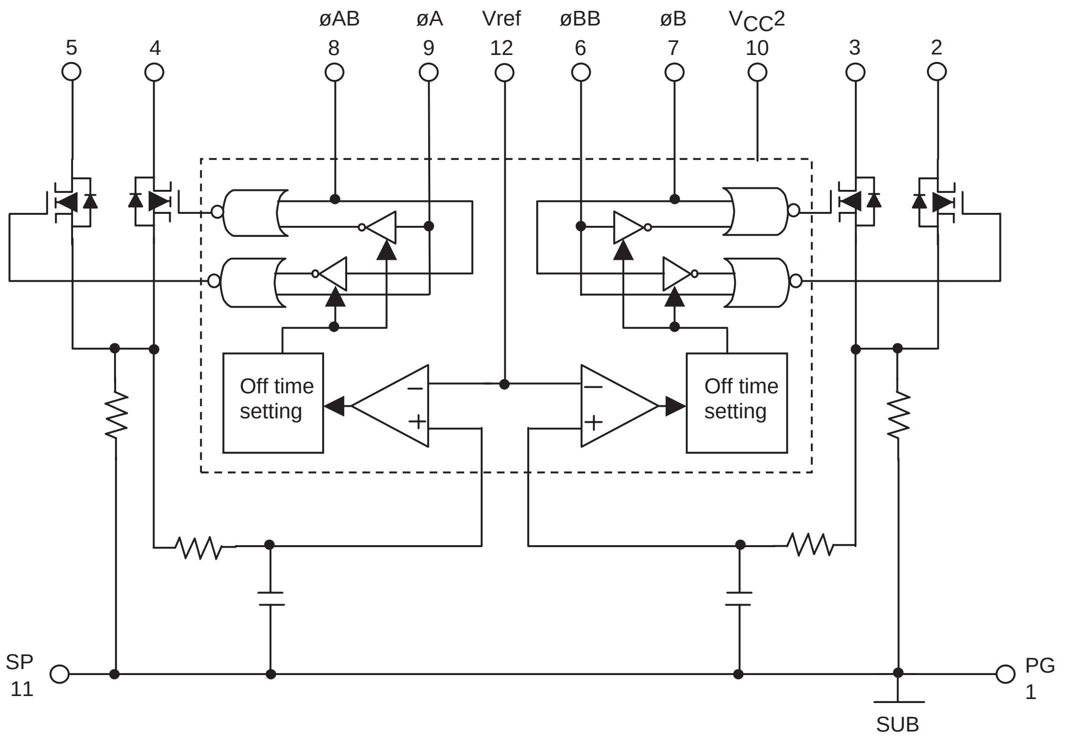
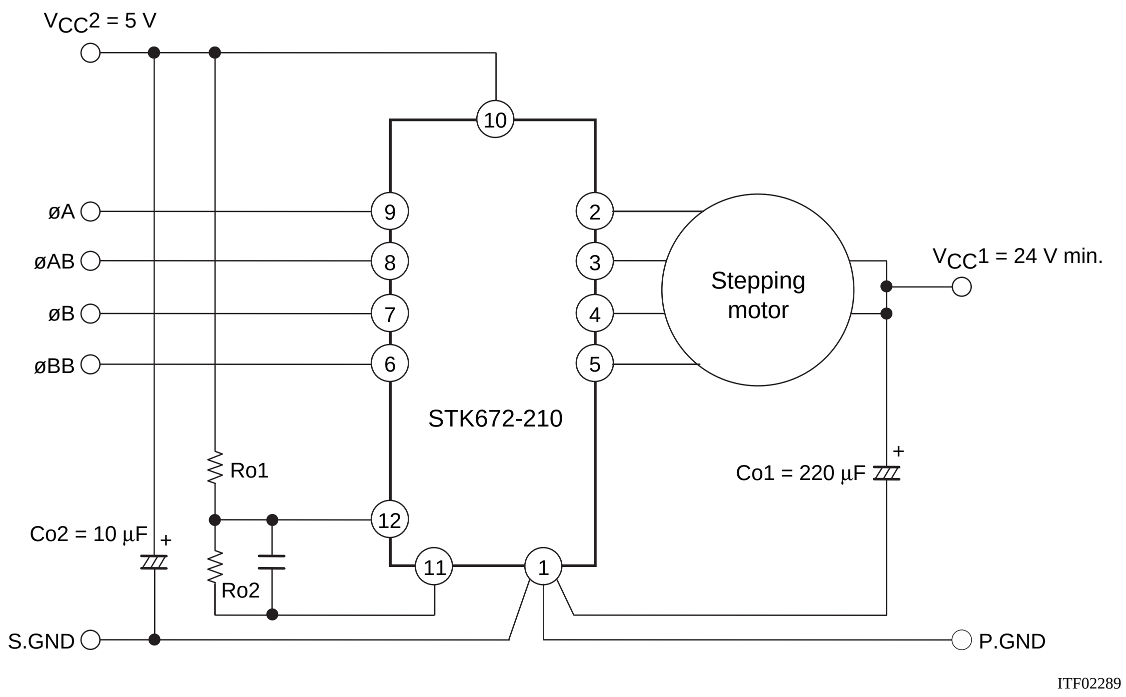
Internal Circuit



Sample Application Circuit

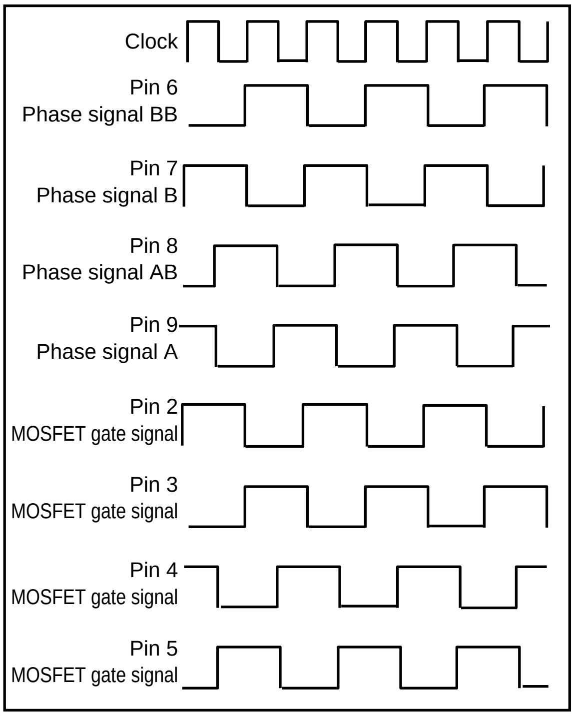


- The Co1 ground lead must be connected as close as possible to pin 1 on the hybrid IC.
- HC type CMOS levels are recommended as the input specifications for pins 6 to 9.
- Pull-up resistors must be used for TTL level inputs. (Recommended value: 2 kΩ)
- Excitation control input specifications

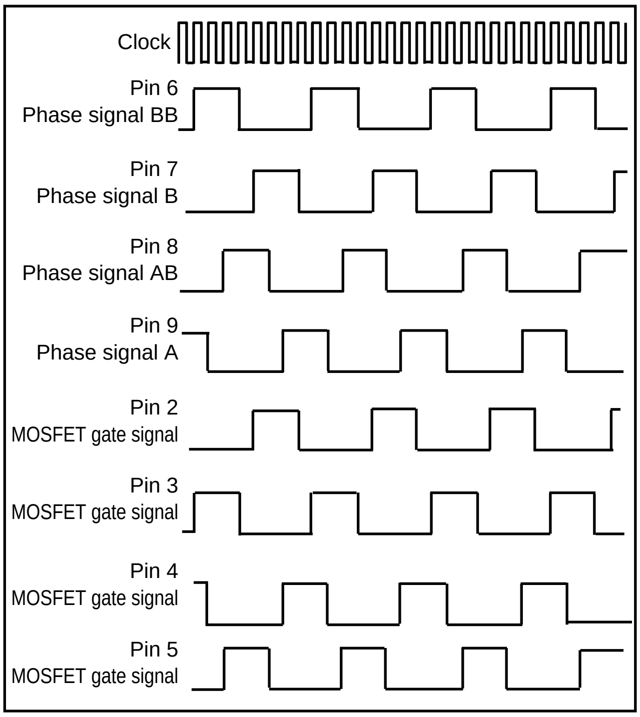
Corresponding output pin	Corresponding excitation control input signal	
	Active: High	Activ: Low
2	øB	øBB
3	øBB	øB
4	øA	øAB
5	øAB	øA

Phase signal: Active low input

2-phase excitation

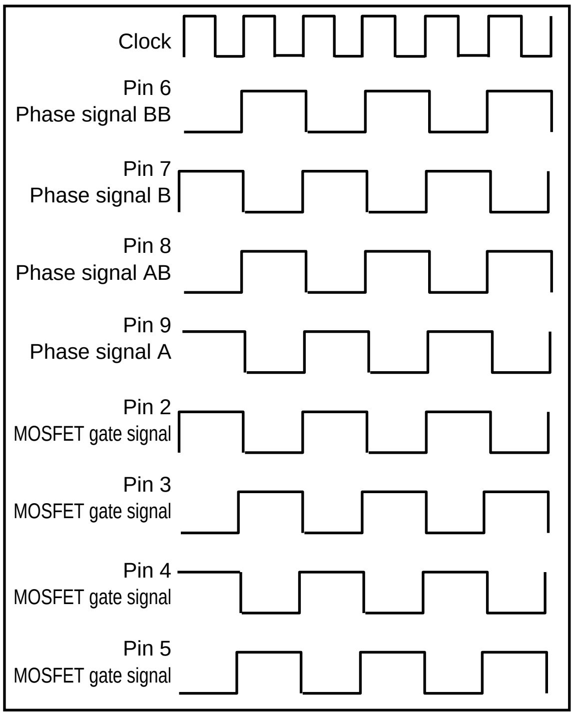


1-2 phase excitation

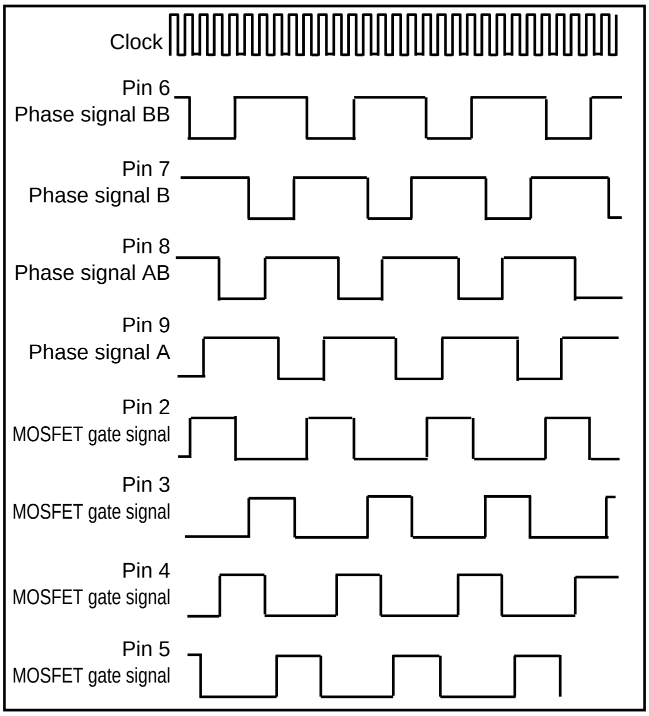


Phase signal: Active high input

2-phase excitation

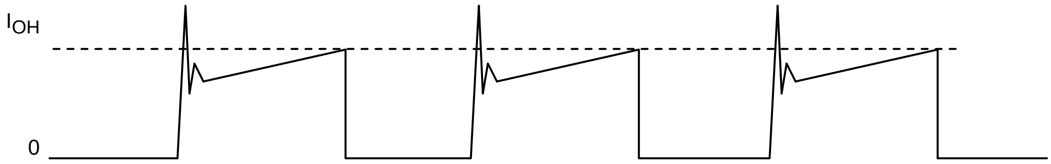


1-2 phase excitation



Setting the Motor Current Peak Value (I_{OH})

$I_{OH} \approx \text{Vref} \div \text{Rs}$
Vref: STK672-210 pin 12 input voltage
Rs: STK672-210 internal current detection resistor (0.195 Ω ±2%)

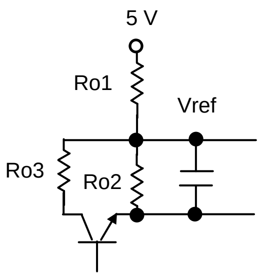


Model of the Motor Phase Current Flowing into the Driver IC (pins 2, 3, 4, and 5)

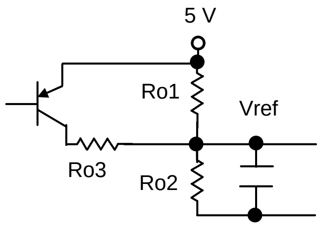
$\text{Vref} = (\text{Ro2} \div (\text{Ro1} + \text{Ro2})) \times V_{CC}2$
$V_{CC}2 = 5\text{ V}$

Current Switching Techniques

Due to the input bias current (I_{IB}) specifications, Ro1 must be under 100 kΩ.
The figures below present sample circuits that temporarily switch the motor current when, for example a held motor stops.
We recommend using the circuit structure in the figure at the left to minimize as much as possible the effects of the saturation voltage of the reference voltage switching transistor.

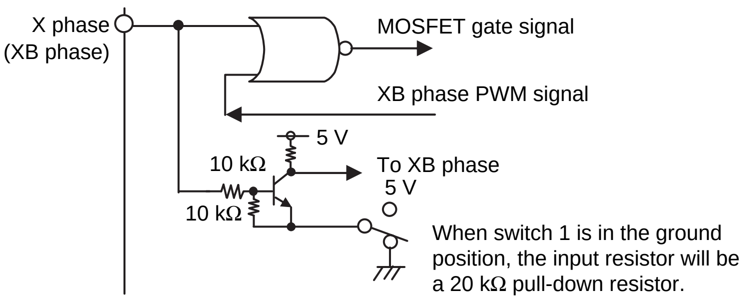
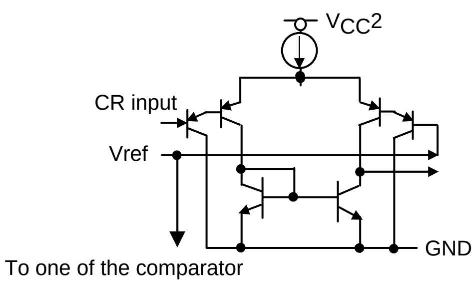


Switching Circuit 1



Switching Circuit 2

Input Pin Circuits

Input pin	Circuit type
Pin 6, 7, 8, and 9	
Pin 12	

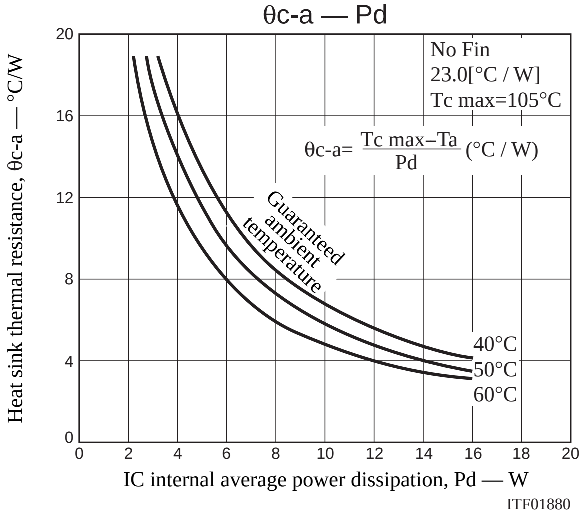
Thermal Design

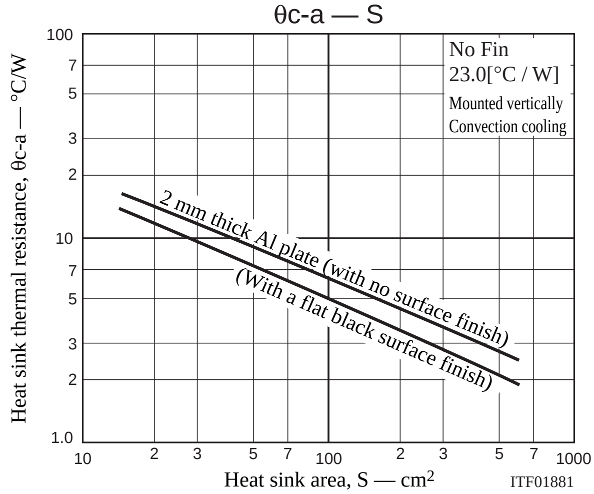
The size of the heat sink required for the STK672-210 depends on the motor output current I_{OH} (A), the electrical characteristics of the motor, the excitation mode, and the basic drive frequency.
The thermal resistance (θc-a) of the required heat sink can be determined from the following formula.

$$\theta c - a = \frac{Tc\ max - Ta}{Pd}\ (°C/W)$$

Tcmax: The STK672-210 substrate temperature (°C)
Ta: The STK672-210 ambient temperature (°C)
Pd: The average internal power dissipation in the STK672-210 (W)

For example, the required area for a heat sink made from 2 mm thick aluminum can be determined from the graph at the right below. Note that the ambient temperature is greatly influenced by the ventilation and air flow patterns within the application. This means that the size of the heat sink must be determined with care so that the STK672-210 back surface (aluminum substrate) temperature Tc in the mounted state never exceeds, under any conditions that might occur, the temperature Tc = 105 °C.





STK672-210 Average Internal Power Dissipation Pd

Of the devices that contribute to the STK672-210 average internal power supply, the devices with the largest power dissipation are the current control devices, the diodes that handle the regenerative current, the current detection resistor, and the predriver circuit.
The following presents formulas for calculating the power dissipation for the different excitation (drive) modes.
2 phase excitation mode
$Pd_{2EX} = (Vsat + Vdf) \times 0.5 \times Clock \times I_{OH} \times t2 + 0.5 \times Clock \times I_{OH} \times (Vsat \times t1 + Vdf \times t3)$
1-2 phase excitation mode
$Pd_{1\text{-}2EX} = (Vsat + Vdf) \times 0.25 \times Clock \times I_{OH} \times t2 + 0.25 \times Clock \times I_{OH} \times (Vsat \times t1 + Vdf \times t3)$
Motor hold mode
$Pd_{HOLDEX} = (Vsat + Vdf) \times I_{OH}$
Vsat: Ron voltage drop + shunt resistor combined voltage
Vdf: FET internal diode Vdf + shunt resistor combined voltage
Clock: Input clock CLK (the reference frequency prior to splitting into 4 phases)

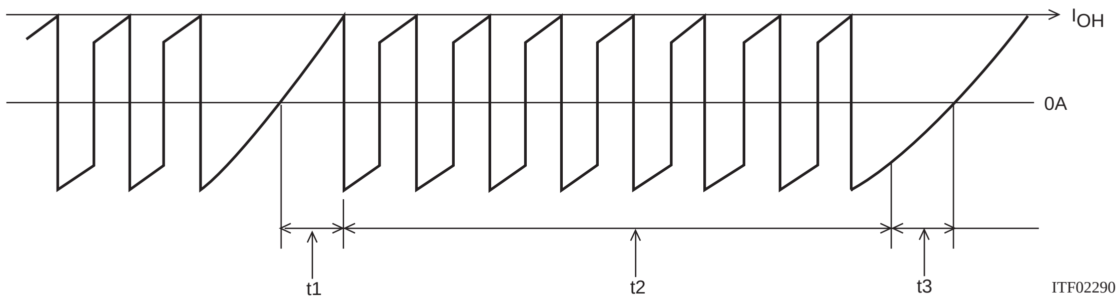


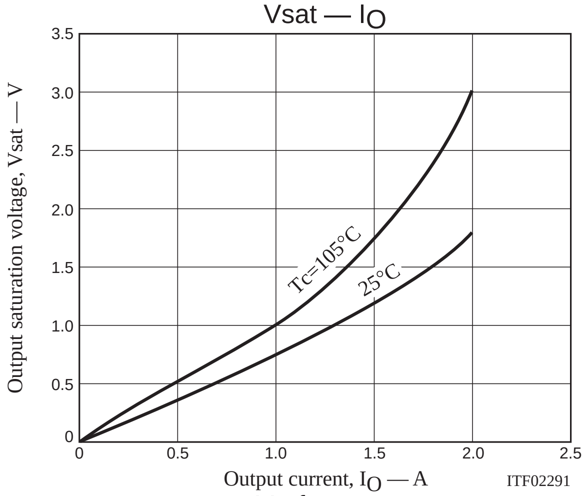
Figure 1 Motor Output Current Waveform Model (Commutation Current)

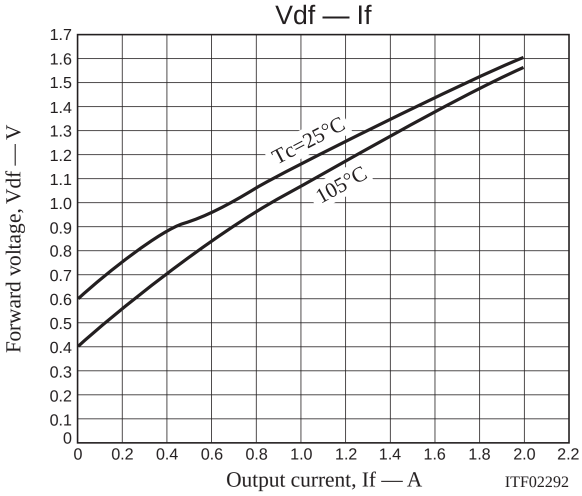
t1: The time until the winding current reaches its rated current (I_{OH})
t2: The time in the constant-current control (PWM) region
t3: The time from the point a phase signal is cut until the back EMF current is dissipated.
$t1 = (–L/(R + 0.77) \ln (1 – ((R + 0.77)/V_{CC}1) \times I_{OH})$
$t3 = (–L/R) \ln ((V_{CC}1 + 0.77)/(I_{OH} \times R + V_{CC}1 + 0.77)$

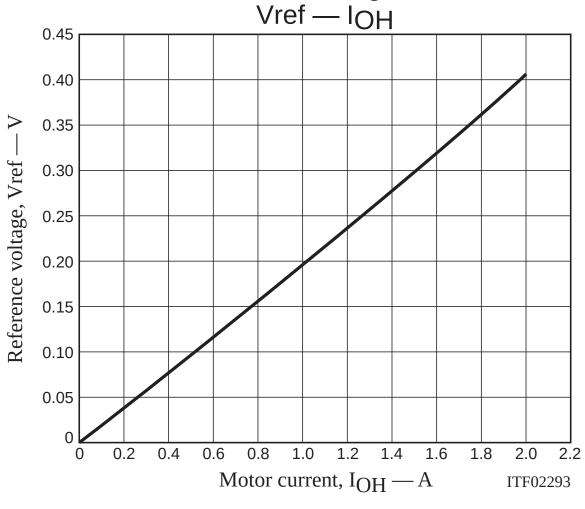
$V_{CC}1$: Motor supply voltage (V)
L: Motor inductance (H)
R: Motor winding resistance (Ω)
I_{OH}: Set motor output current wave height (A)

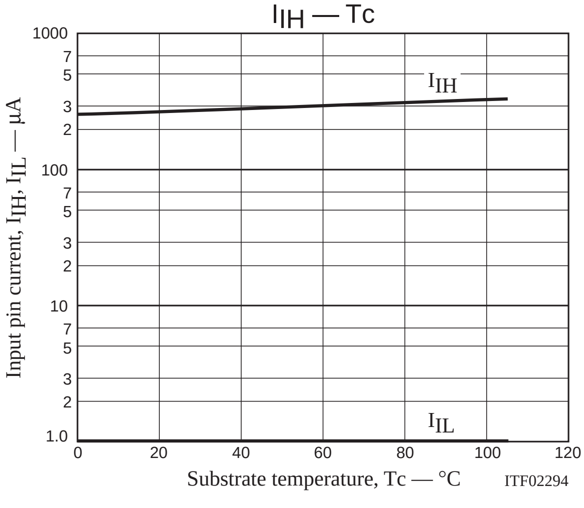
The constant-current control time t2, and the time T (= t1 + t2 + t3) that the phase signal is on in each excitation mode are as follows.
2 phase excitation mode: t2 = (2/Clock) – (t1 + t3)
1-2 phase excitation mode: t2 = (3/Clock) – t1

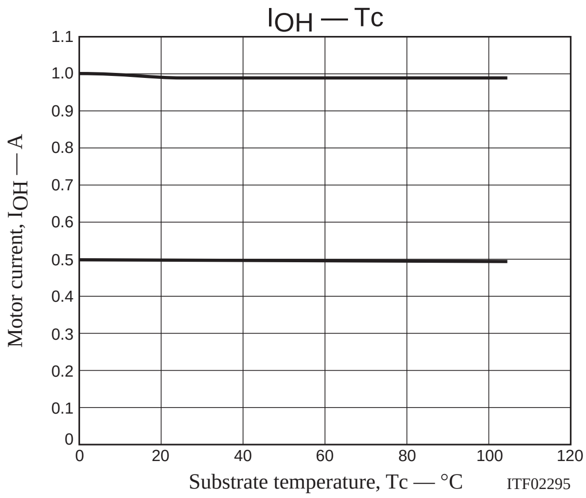
Determine the values for Vsat and Vdf by substitution using the graphs for Vsat vs I_{OH} and Vdf vs I_{OH} for the set current value for I_{OH}. Then judge whether or not a heat sink is required from the determined average power dissipation for the STK672-210 by comparison with the ΔTc vs. Pd graph.
Note that it is necessary to check the temperature rise in the actual application system case, since the STK672-210 substrate temperature Tc changes with the air convection conditions around the STK672-210 when a heat sink without fins is used.

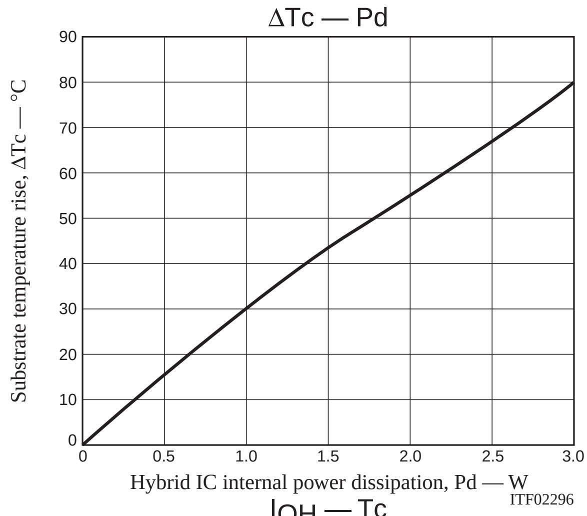


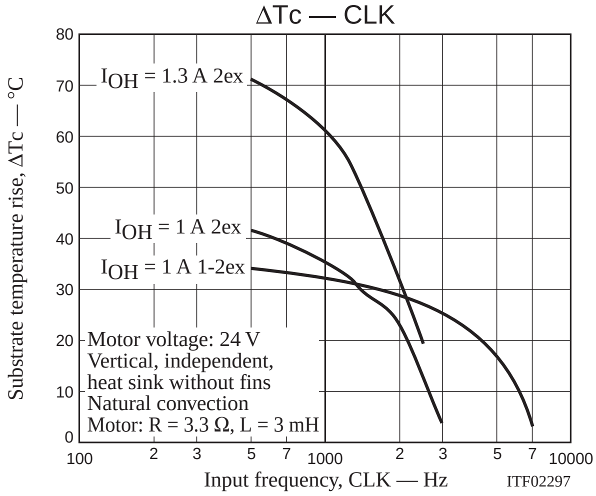


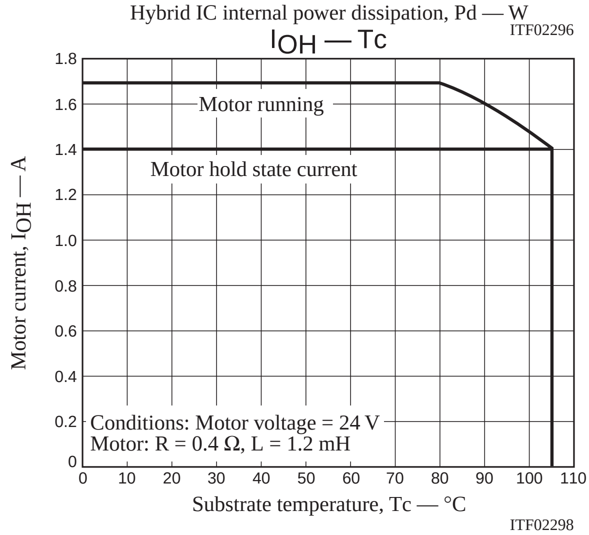












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