STK672-740AN-E

Allowable Operating Ranges at Tc=25°C

Parameter	Symbol	Conditions	Ratings	unit
Operating supply voltage 1	V_{CC}	With signals applied	0 to 42	V
Operating supply voltage 2	V_{DD}	With signals applied	5±5%	V
Input high voltage	V_{IH}	Pins 10, 12, 13, 14, 15, 17, V_{DD}=5±5%	2.5 to V_{DD}	V
Input low voltage	V_{IL}	Pins 10, 12, 13, 14, 15, 17, V_{DD}=5±5%	0 to 0.8	V
Output current 1	$I_{OH}1$	Tc=105°C, More than 200Hz , Continuous operation, duty=100%	3.0	A
Output current 2	$I_{OH}2$	Tc=80°C, More than 200Hz, Continuous operation, duty=100%, See the motor current (I_{OH}) derating curve	3.3	A
Recommended operating substrate temperature	Tc	No condensation	0 to 105	°C
Recommended Vref range	Vref	Tc=105°C	0.14 to 1.31	V

> Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

Electrical Characteristics at Tc=25°C, V_{CC}=24V, V_{DD}=5.0V *1

| Parameter		Symbol	Conditions	min	typ	max	unit
V_{DD} supply current		I_{CCO}	V_{DD}=5.0V, ENABLE=Low		4.4	8.0	mA
Output average current *2		Ioave	R/L=1Ω/0.62mH in each phase	0.519	0.625	0.731	A
FET diode forward voltage		Vdf	If=1A (R_L=23Ω)		0.83	1.5	V
Output saturation voltage		Vsat	R_L=23Ω		0.20	0.33	V
Control Input pin	Input high voltage	V_{IH}	Pins 10, 12, 13, 14, 15, 17	2.5		V_{DD}	V
	Input low voltage	V_{IL}	Pins 10, 12, 13, 14, 15, 17	−0.3		0.8	V
	5V level input current	I_{ILH}	Pins 10, 12, 13, 14, 15, 17=5V		50	75	μA
	GND level input current	I_{ILL}	Pins 10, 12, 13, 14, 15, 17=GND			10	μA
FAULT pin	Output low voltage	V_{OLF}	Pin 16 (I_O=5mA)		0.25	0.5	V
	5V level leakage current	I_{ILF}	Pin 16 =5V			10	μA
Vref input bias current		I_{IB}	Pin 19 =1.0V		10	15	μA
PWM frequency		Fc		29	45	61	kHz
Overheat detection temperature		TSD	Design guarantee		144		°C
Drain-source cut-off current		I_{DSS}	V_{DS}=100V, Pins 2, 6, 9, 18=GND			1	μA

Notes

*1: A fixed-voltage power supply must be used.

*2: The value for Ioave assumes that the lead frame of the product is soldered to the mounting circuit board.

> Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.
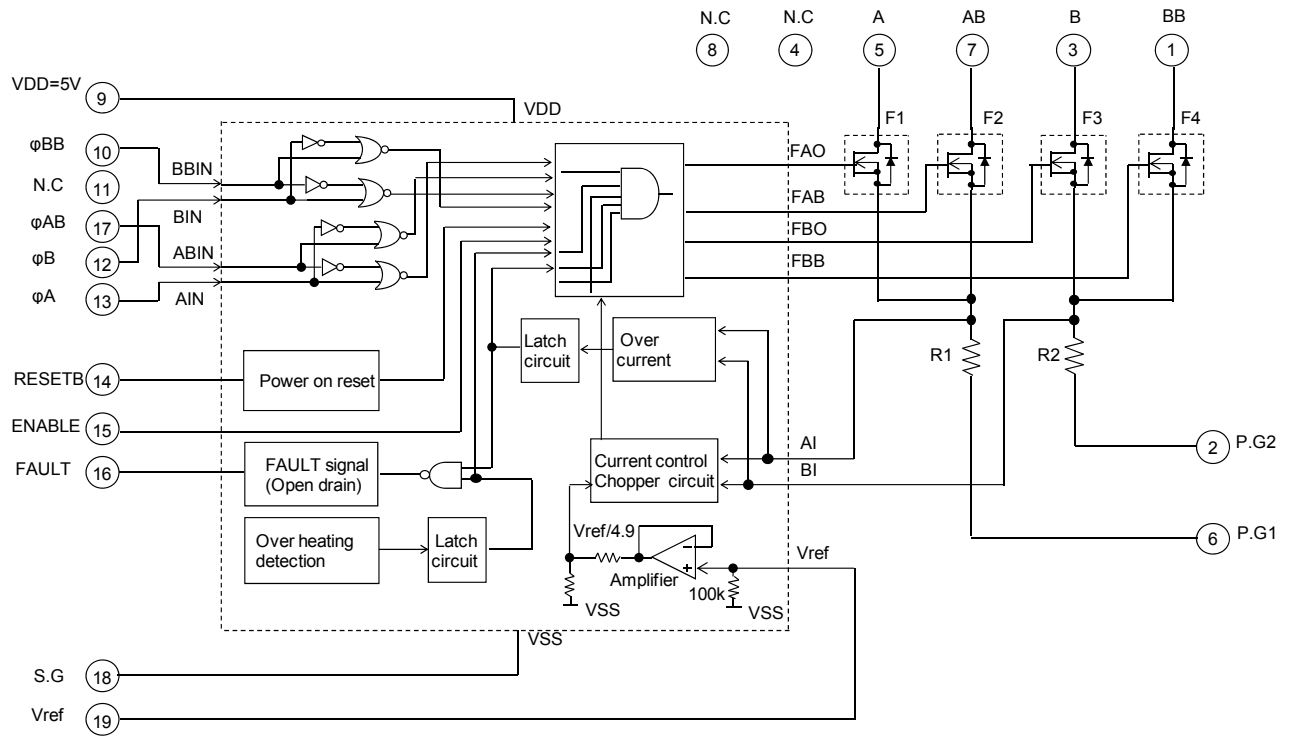
Derating Curve of Motor Current, I_{OH}, vs. STK672-740AN-E Operating Substrate Temperature, Tc
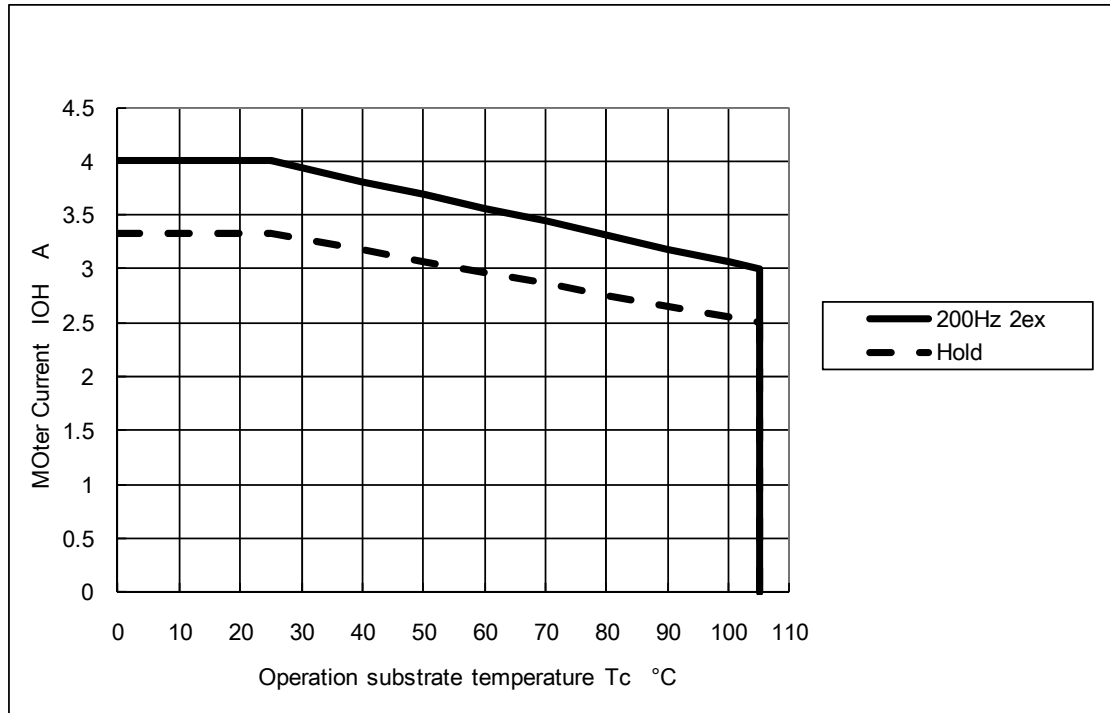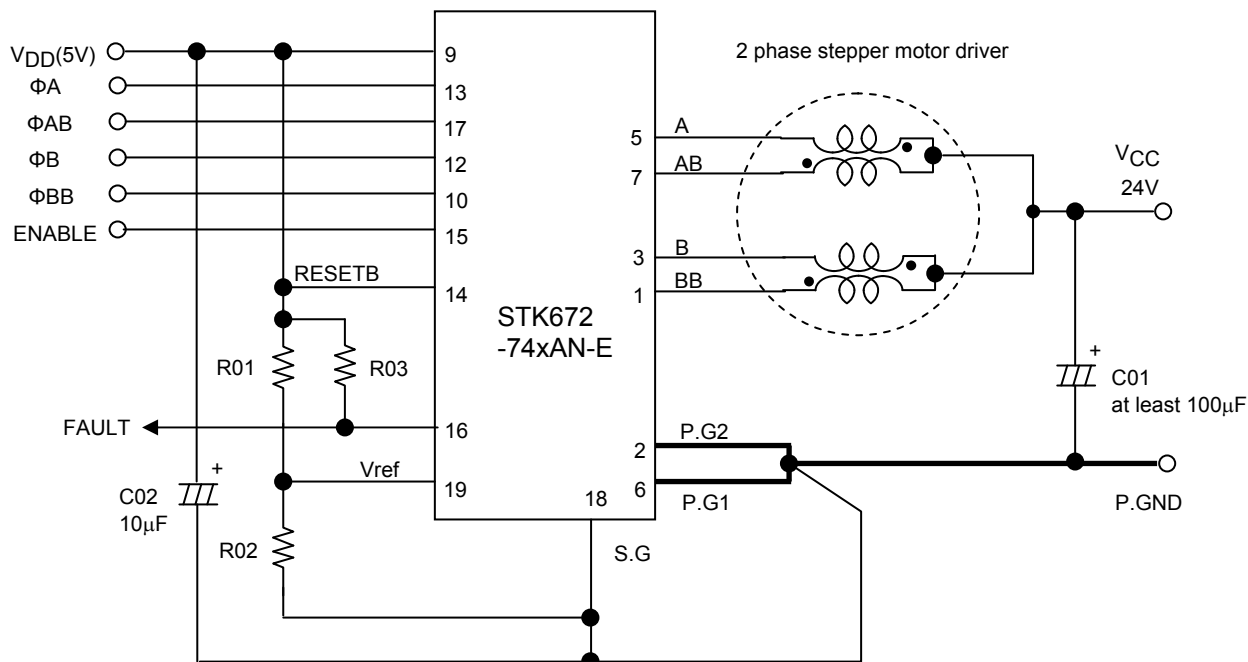

Notes
- The current range given above represents conditions when output voltage is not in the avalanche state.
- If the output voltage is in the avalanche state, see the allowable avalanche energy for STK672-7** series hybrid ICs given in a separate document.
- The operating substrate temperature, Tc, given above is measured while the motor is operating.
  Because Tc varies depending on the ambient temperature, Ta, the value of I_{OH}, and the continuous or intermittent operation of I_{OH}, always verify this value using an actual set.
- The Tc temperature should be checked in the center of the metal surface of the product package.

Block Diagram

Measurement Circuit

(The terminal which is not appointed is open. The measurement circuit of STK672-740AN-E is the same as STK672-732AN-E.)

1. Vdf

2. IILF,IILH,IILL,IIB

3. Vsat

4. Icco, Ioave, fc,VOLF

Close SW at
mesurement of VOLF

Sample Application Circuit

Precautions

[GND wiring]
- To reduce noise on the 5V/24V system, be sure to place the GND of C01 in the circuit given above as close as possible to Pin 2 and Pin 6 of the hybrid IC.
  In addition, in order to set the current accurately, the GND side of RO2 of Vref must be connected to the shared ground terminal used by the Pin 18 (S.G) GND, P.G1 and P.G2.

[Input pins]
- If V_{DD} is being applied, use care that each input pin does not apply a negative voltage less than -0.3V to S. GND, Pin 18. Measures must also be taken so that a voltage equal to or greater than V_{DD} is not input.
- Do not wire by connecting the circuit pattern on the P.C.B side to Pins 4, 8, or 11 on the N.C. shown in the internal block diagram.
- Apply 2.5V high level input to pins 10, 12, 13, 14, 15, and 17.
- Since the input pins do not have built-in pull-up resistors, when the open-collector type pins 10, 12, 13, 14, 15, and 17 are used as inputs, a 1 to 20kΩ pull-up resistor (to V_{DD}) must be used.
  At this time, use a device for the open collector driver that has output current specifications that pull the voltage down to less than 0.8V at Low level (less than 0.8V at Low level when I_{OL}=5mA).

[Current setting Vref]
Considering the specifications for the Vref input bias current IIB, we recommend a value 1kΩ or less for R02.
If the motor current is temporarily reduced, the circuit given below(STK672-740AN: I_{OH}>0.3A) is recommended.
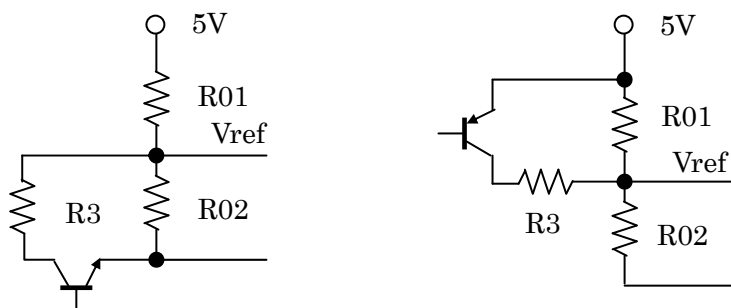
[Setting the motor current]

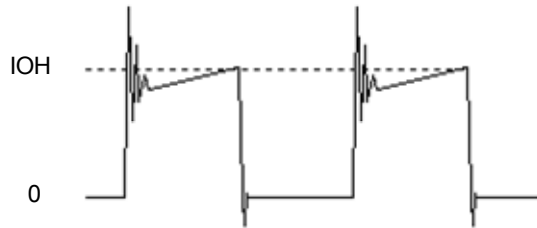The motor current, I_{OH}, is set using the Pin 19 voltage, Vref, of the hybrid IC.

Equations related to I_{OH} and Vref are given below.

$Vref \approx (RO2 \div (RO2+RO1)) \times V_{DD}(5V)$ ·· (1)

$I_{OH} \approx (Vref \div 4.9) \div Rs$ ··· (2)

The value of 4.9 in Equation (2) above represents the Vref voltage as divided by a circuit inside the control IC.

Rs : 0.089Ω (Current detection resistor inside the hybrid IC)

[Smoke Emission Precuations]

If Pin 18 (S.G terminal) is attached to the board without using solder, overcurrent may flow into the MOSFET at $V_{CC}ON$ (24V ON), causing the STK672-740AN-E to emit smoke because 5V circuits cannot be controlled.

In addition, as long as one of the output Pins, 1, 3, 5, or 7, is open, inductance energy stored in the motor results in electrical stress on the driver, possibly resulting in the emission of smoke.

Input Pin Functions

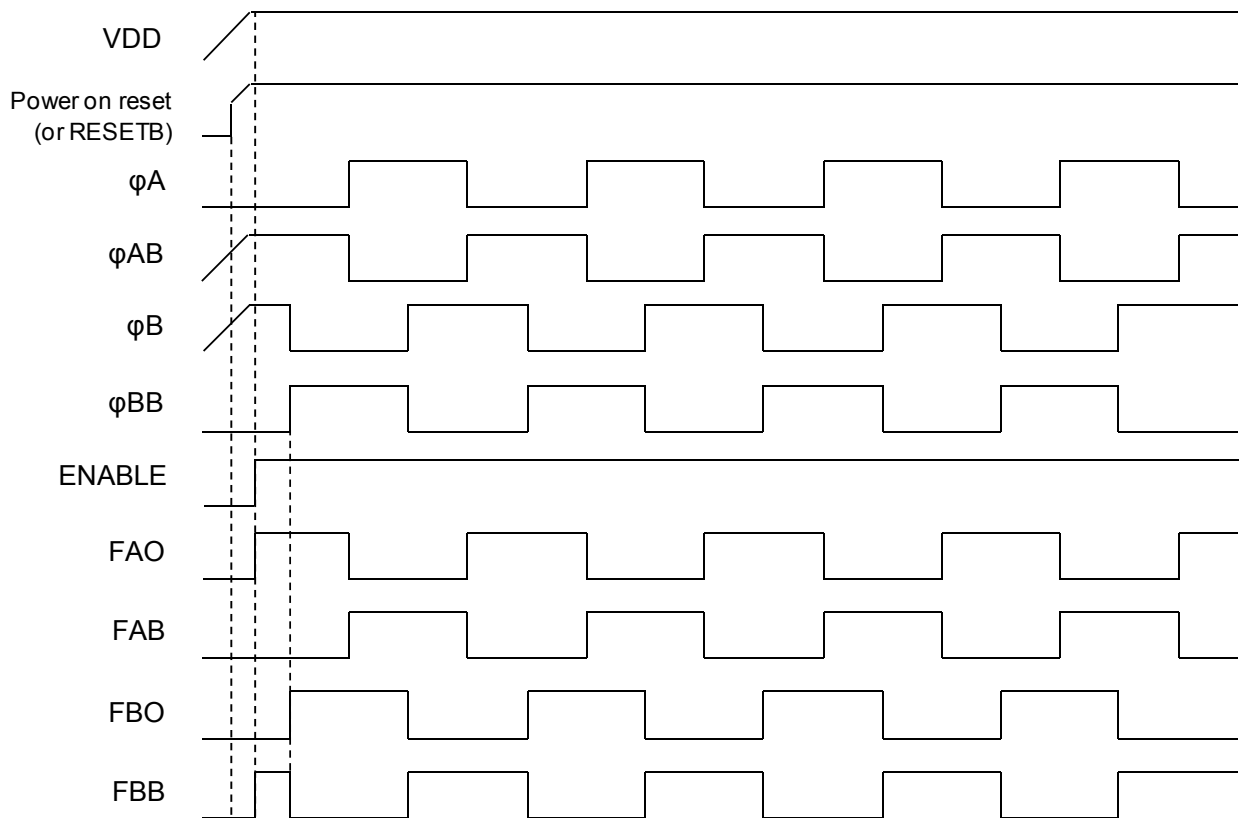| Pin Name	Pin No.	Function	Input Conditions When Operating
ΦA	13	Phase signal input of 5pin (phase A output).	Low active(with a function to prevent simultaneous ON of ΦA and ΦAB ,or ΦB and ΦBB.
ΦAB	17	Phase signal input of 7pin (phase AB output).	
ΦB	12	Phase signal input of 3pin (phase B output).	
ΦBB	10	Phase signal input of 1pin (phase BB output).	
RESETB	14	System reset Initial state of A and BB phase excitation in the timing charts is set by switching from low to high.	A reset is applied by a low level
ENABLE	15	The A, AB, B, and BB outputs are turned off, and after operation is restored by returning the ENABLE pin to the high level, operation continues with the same excitation timing as before the low-level input.	The A, AB, B, and BB outputs are turned off by a low-level input.

Output Pin Functions

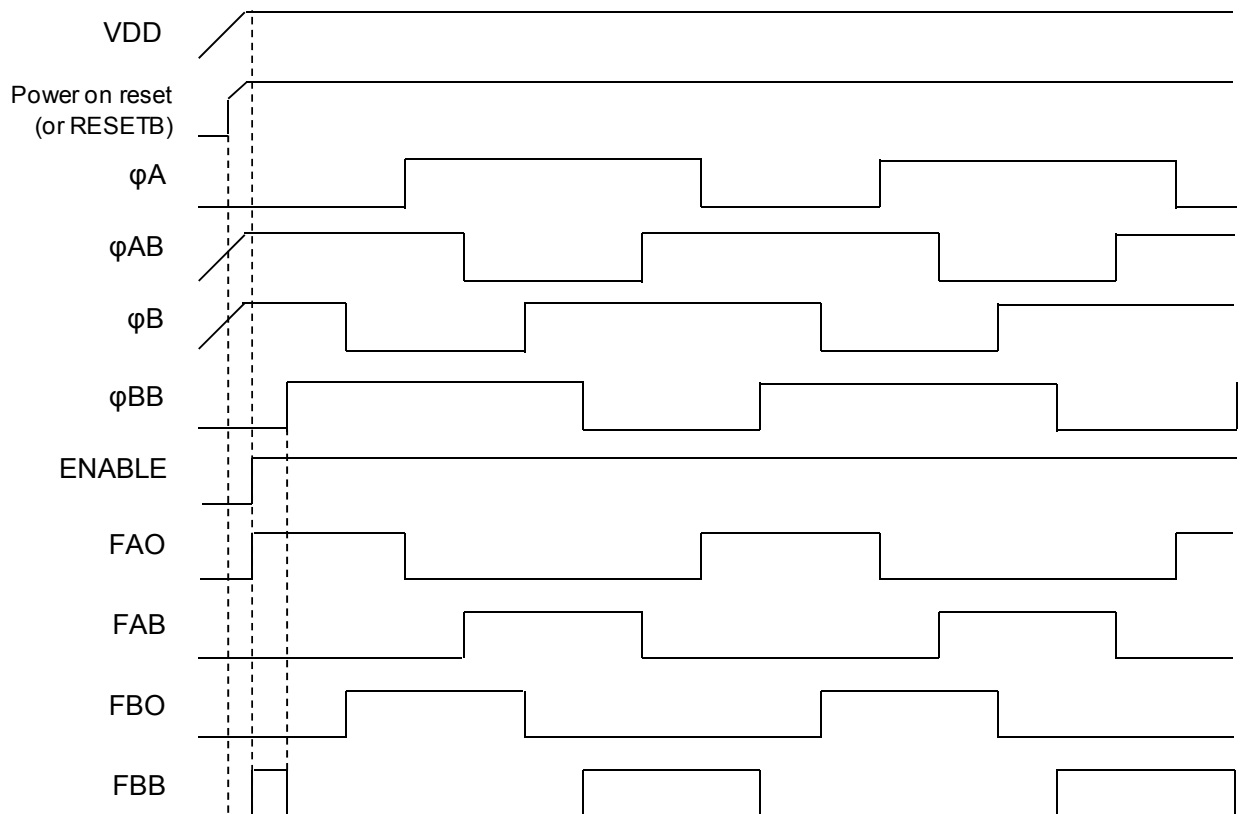| Pin Name	Pin No.	Function	Input Conditions When Operating
FAULT	16	Monitor pin used when over-current detection or overheat detection function is activated.	Low level is output when detected.

Note : See the timing chart for the concrete details on circuit operation.
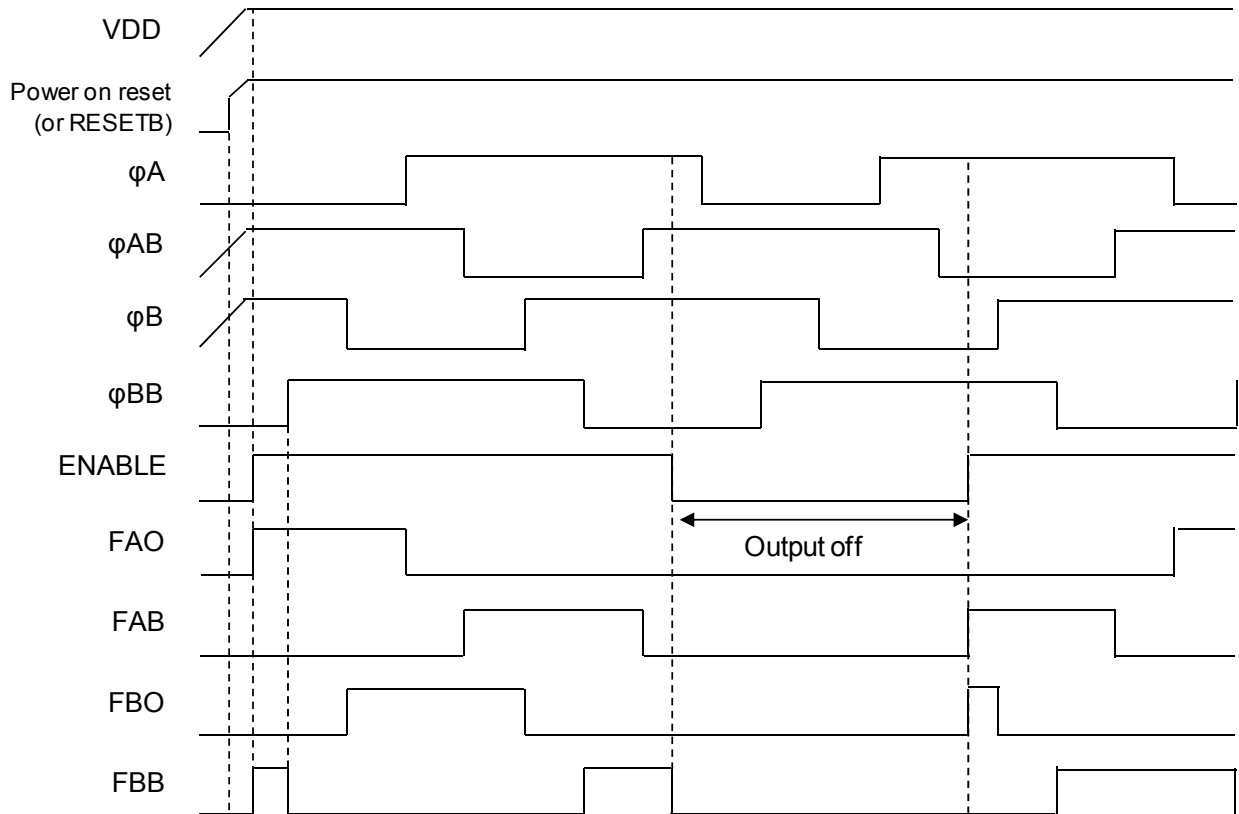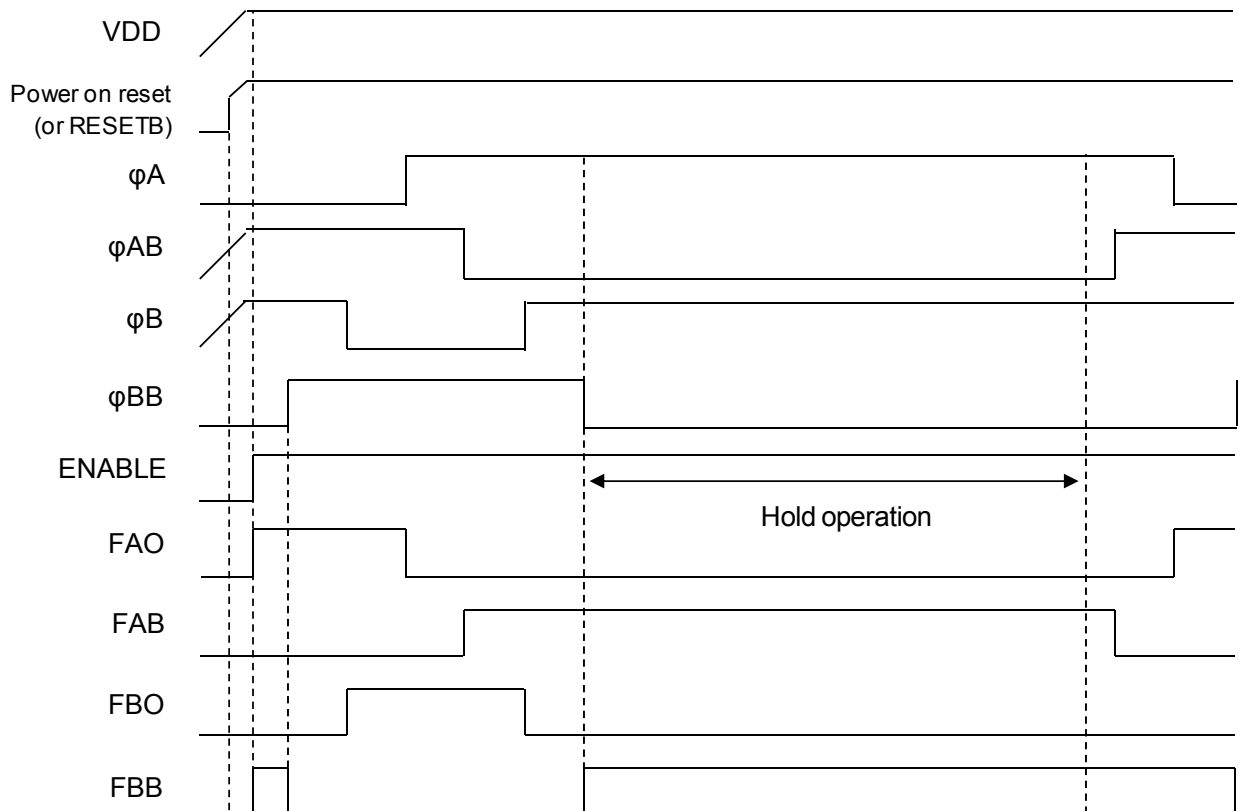
Timing Charts

2-phase excitation

1-2 phase excitation

STK672-740AN-E

1-2 phase excitation (ENABLE)

VDD	
Power on reset (or RESETB)	
φA	
φAB	
φB	
φBB	
ENABLE	
FAO	Output off
FAB	
FBO	
FBB	

1-2 phase excitation (Hold operation results during fixed CLOCK)

VDD	
Power on reset (or RESETB)	
φA	
φAB	
φB	
φBB	
ENABLE	
FAO	Hold operation
FAB	
FBO	
FBB	

Package Dimensions

unit : mm

SIP19 29.2x14.4
CASE 127CF
ISSUE O

STK672-740AN-E
Technical data

1. I/O Pins and Functions of the Control Block

[Pin description]

HIC pin	Pin Name	Function
14	RESETB	System reset
15	ENABLE	Motor current OFF
16	FAULT	Overcurrent/over-heat detection output
19	Vref	Current value setting

Description of each pin

1-1.[RESETB (System-wide reset)]

The reset signal is formed by the power-on reset function built into the HIC and the RESETB terminal.

When activating the internal circuits of the HIC using the power-on reset signal within the HIC, be sure to connect Pin 14 of the HIC to V_{DD}.

1-2. [ENABLE (Forcible OFF control of excitation drive output A, AB, B, and BB, and selecting operation/hold status inside the HIC)]

ENABLE=1: Normal operation

When ENABLE=0: Motor current goes OFF, and excitation drive output is forcibly turned OFF.

The system clock inside the HIC stops at this time, with no effect on the HIC even if input pins other than RESET input vary. In addition, since current does not flow to the motor, the motor shaft becomes free.

If the ϕA to ϕBB signal input used for motor rotation suddenly stops, the motor shaft may advance beyond the control position due to inertia. A SLOW DOWN setting where the ϕA to ϕBB signal input cycle gradually decreases is required in order to stop at the control position.

1-3. [FAULT]

FAULT is an open drain output. It outputs low level when overcurrent, or overheat is detected.

1-4. [Vref (Voltage setting to be used for the current setting reference)]

Input voltage is in the voltage range of 0.14V to 1.31V.

The recommended Vref voltage is 0.14V or higher because the output offset voltage of Vref/4.9 amplifier cannot be controlled down to 0V.

Note: Pin type is analog input configuration and input pull-down resistance 100 kΩ.

The internal impedance 100 kΩ is designed so that the increase in current is prevented while Pin 19 is open.

1-5. [Input timing]

The control IC of the driver is equipped with a power on reset function capable of initializing internal IC operations when power is supplied. A 4V typ setting is used for power on reset. Because the specification for the MOSFET gate voltage is 5V±5%, conduction of current to output at the time of power on reset adds electromotive stress to the MOSFET due to lack of gate voltage. To prevent electromotive stress, be sure to set ENABLE=Low while V_{DD}, which is outside the operating supply voltage, is less than 4.75V.
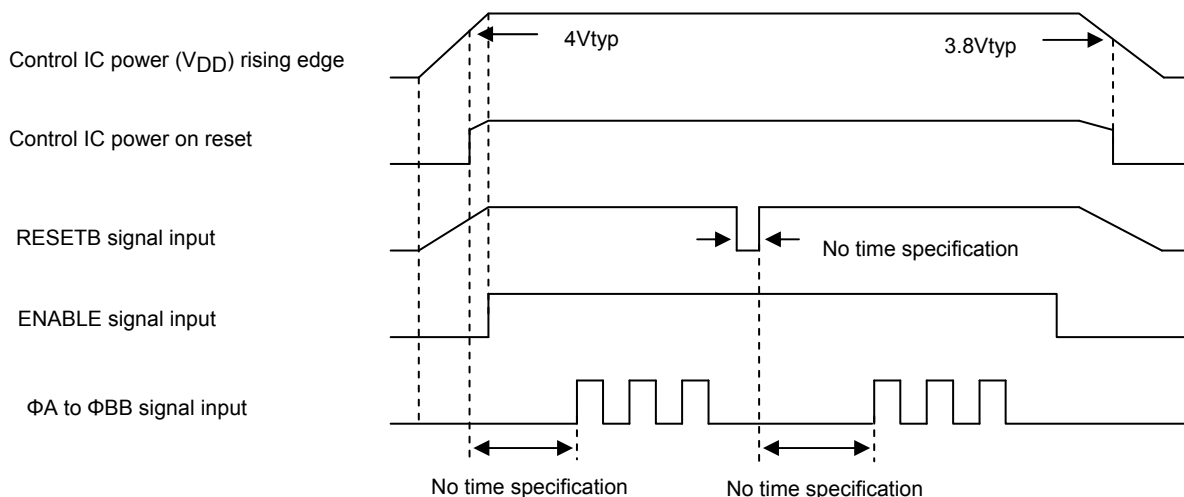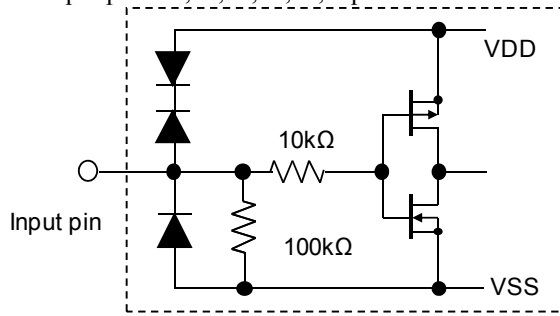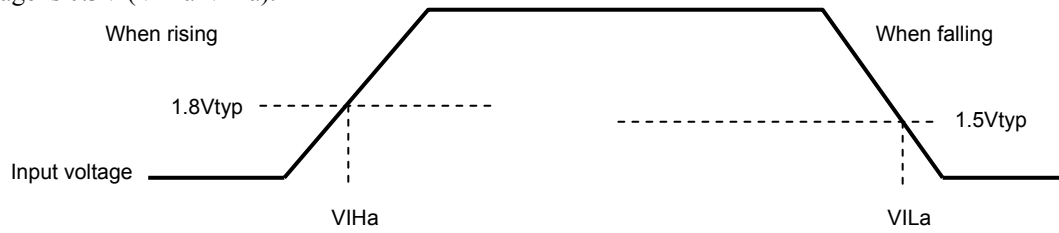

RESETB, ENABLE, ϕA to ϕBB Signals Input Timing

1-6. [Configuration of control block I/O pins]

    <Configuration of the ϕA, ϕAB, ϕB, ϕBB, ENABLE, and RESETB input pins>

      Input pins 13,17,12,10,15,14pin

The input pins of this driver all use Schmitt input. Typical specifications at Tc=25°C are given below. Hysteresis voltage is 0.3V (VIHa-VILa).

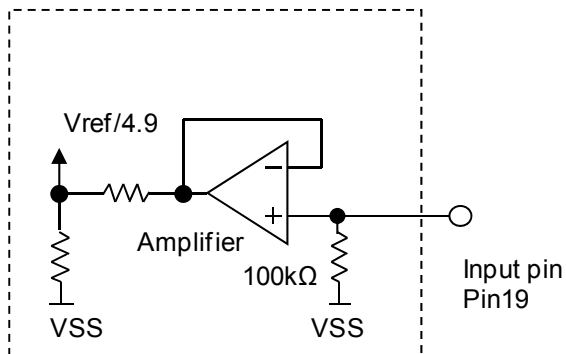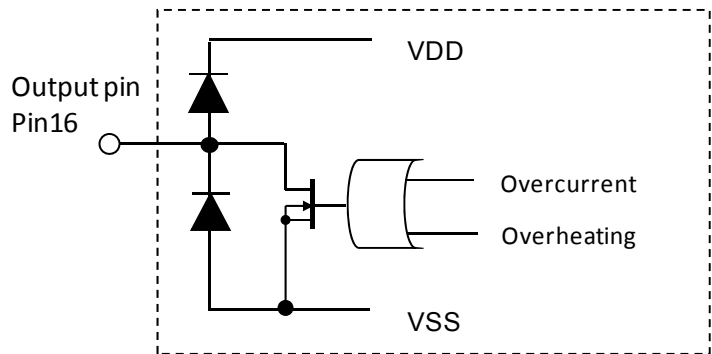Input voltage specifications are as follows.

    V_{IH}=2.5Vmin

    V_{IL}=0.8Vmax

<Configuration of the Vref input pin>

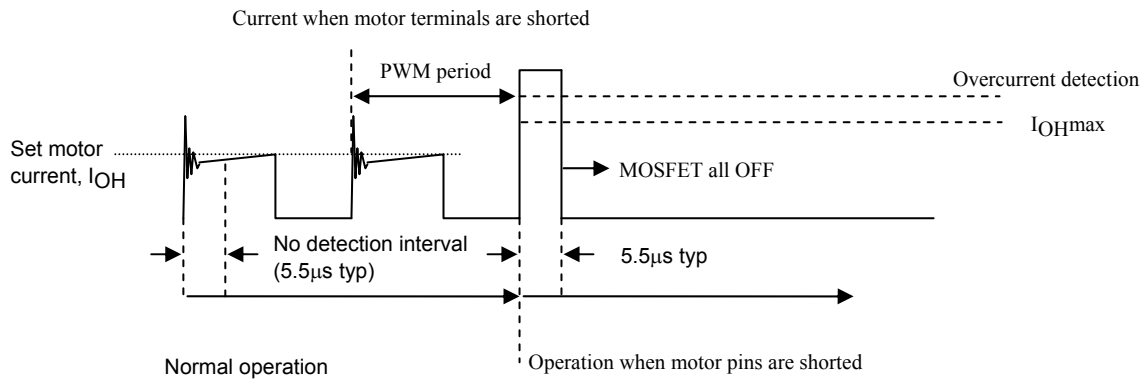<Configuration of the FAULT output pin>

2. Overcurrent detection, overheat detection functions

Each detection function operates using a latch system and turns output off. Because a RESET signal is required to restore output operations, once the power supply, V_{DD}, is turned off, you must either again apply power on reset with $V_{DD}ON$ or apply a RESETB=High→Low→High signal.

2-1.[Overcurrent detection]

This hybrid IC is equipped with a function for detecting overcurrent that arises when the motor burns out or when there is a short between the motor terminals.
Overcurrent detection occurs at 3.5A typ with the STK672-732AN-E, and 5.5A typ with the STK672-740AN-E.

Current when motor terminals are shorted

PWM period

Overcurrent detection

$I_{OH}max$

Set motor current, I_{OH}

MOSFET all OFF

No detection interval (5.5μs typ)

5.5μs typ

Normal operation

Operation when motor pins are shorted

Overcurrent detection begins after an interval of no detection (a dead time of 5.5μs typ) during the initial ringing part during PWM operations. The no detection interval is a period of time where overcurrent is not detected even if the current exceeds I_{OH}.

2-2. [Overheat detection]

Rather than directly detecting the temperature of the semiconductor device, overheat detection detects the temperature of the aluminum substrate (144°C typ).
Within the allowed operating range recommended in the specification manual, if a heat sink attached for the purpose of reducing the operating substrate temperature, Tc, comes loose, the semiconductor can operate without breaking.
However, we cannot guarantee operations without breaking in the case of operations other than those recommended, such as operations at a current exceeding I_{OH} max that occurs before overcurrent detection is activated.

3. Allowable Avalanche Energy Value

(1) Allowable Range in Avalanche Mode

When driving a 2-phase Stepper motor with constant current chopping using an STK672-7** Series hybrid IC, the waveforms shown in Figure 1 below result for the output current, I_D, and voltage, V_{DS}.
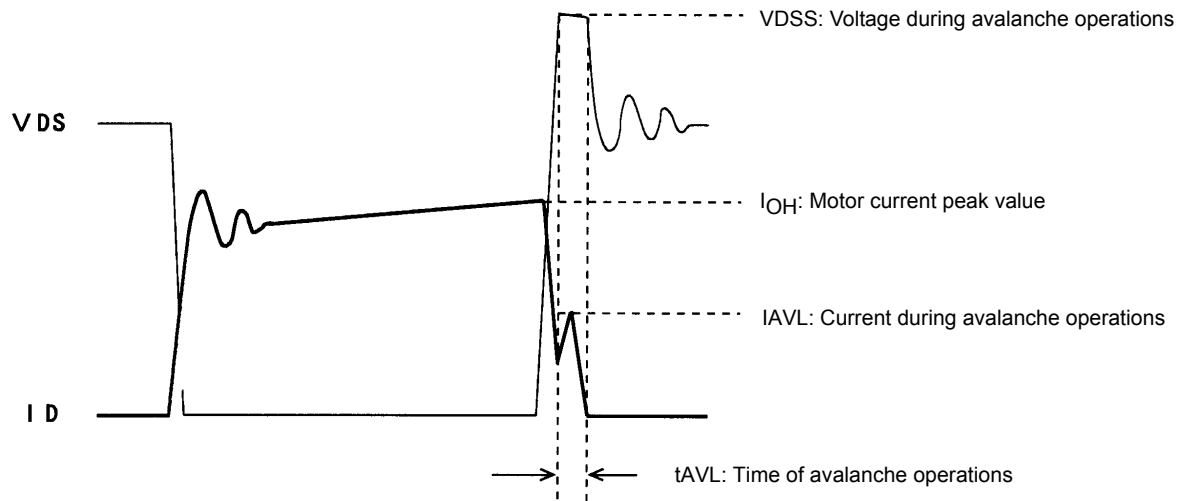

VDSS: Voltage during avalanche operations

I_{OH}: Motor current peak value

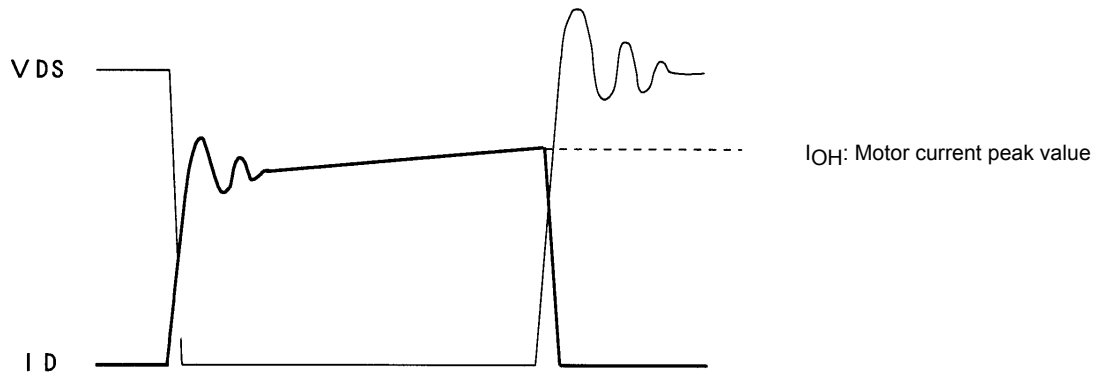IAVL: Current during avalanche operations

tAVL: Time of avalanche operations

Figure 1 Output Current, I_D, and Voltage, V_{DS}, Waveforms 1 of the STK672-7** Series when Driving a 2-Phase Motor with Constant Current Chopping

When operations of the MOSFET built into STK672-7** Series ICs is turned off for constant current chopping, the I_D signal falls like the waveform shown in the figure above. At this time, the output voltage, V_{DS}, suddenly rises due to electromagnetic induction generated by the motor coil.

In the case of voltage that rises suddenly, voltage is restricted by the MOSFET V_{DSS}. Voltage restriction by V_{DSS} results in a MOSFET avalanche. During avalanche operations, I_D flows and the instantaneous energy at this time, EAVL1, is represented by Equation (3-1).

$$EAVL1=V_{DSS}\times IAVL\times0.5\times tAVL \text{ -- (3-1)}$$
V_{DSS}: V units, IAVL: A units, tAVL: sec units

The coefficient 0.5 in Equation (3-1) is a constant required to convert the IAVL triangle wave to a square wave.

During STK672-7** Series operations, the waveforms in the figure above repeat due to the constant current chopping operation. The allowable avalanche energy, EAVL, is therefore represented by Equation (3-2) used to find the average power loss, PAVL, during avalanche mode multiplied by the chopping frequency in Equation (3-1).

$$PAVL=V_{DSS}\times IAVL\times0.5\times tAVL\times fc \text{ -------------------------------- (3-2)}$$
fc: Hz units (fc is set to the PWM frequency of 50kHz.)

For V_{DSS}, IAVL, and tAVL, be sure to actually operate the STK672-7** Series and substitute values when operations are observed using an oscilloscope.

Ex. If V_{DSS}=110V, IAVL=1A, tAVL=0.2μs, the result is:
$PAVL=110\times1\times0.5\times0.2\times10^{-6}\times50\times10^{3}=0.55W$
V_{DSS}=110V is a value actually measured using an oscilloscope.

The allowable loss range for the allowable avalanche energy value, PAVL, is shown in the graph in Figure 3.
When examining the avalanche energy, be sure to actually drive a motor and observe the I_D, V_{DSS}, and tAVL waveforms during operation, and then check that the result of calculating Equation (3-2) falls within the allowable range for avalanche operations.

(2) I_D and V_{DSS} Operating Waveforms in Non-avalanche Mode

Although the waveforms during avalanche mode are given in Figure 1, sometimes an avalanche does not result during actual operations.

Factors causing avalanche are listed below.

- Poor coupling of the motor's phase coils (electromagnetic coupling of A phase and AB phase, B phase and BB phase).
- Increase in the lead inductance of the harness caused by the circuit pattern of the board and motor.
- Increases in V_{DSS}, tAVL, and IAVL in Figure 1 due to an increase in the supply voltage from 24V to 36V.

If the factors above are negligible, the waveforms shown in Figure 1 become waveforms without avalanche as shown in Figure 2.

Under operations shown in Figure 2, avalanche does not occur and there is no need to consider the allowable loss range of PAVL shown in Figure 3.

Figure 2 Output Current, I_D, and Voltage, V_{DS}, Waveforms 2 of the STK672-7** Series when Driving a 2-Phase Stepper Motor with Constant Current Chopping

Figure 3 Allowable Loss Range, PAVL-I_{OH} During STK672-740AN-E Avalanche Operations
PAVL-IOH
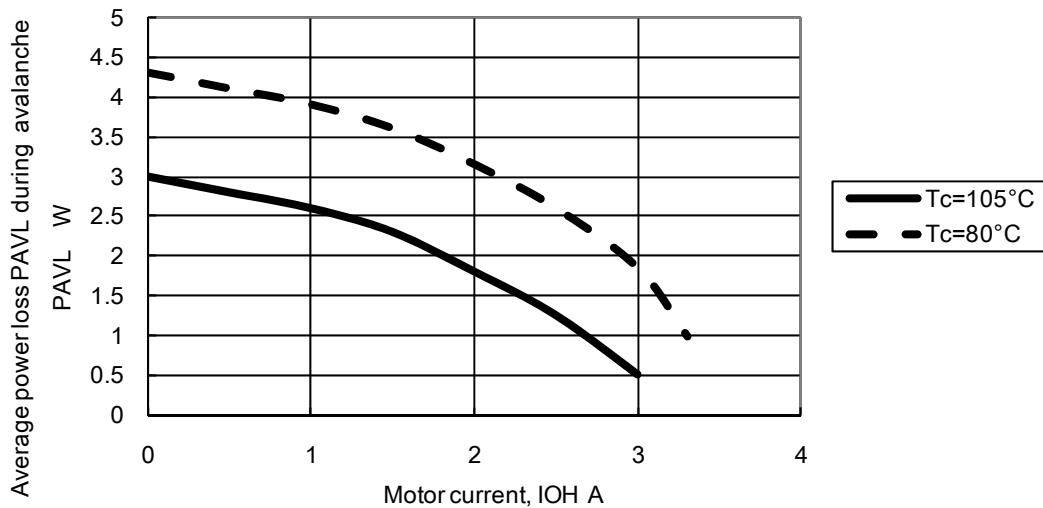
Note :

The operating conditions given above represent a loss when driving a 2-phase stepper motor with constant current chopping.

Because it is possible to apply 3W or more at I_{OH}=0A, be sure to avoid using the MOSFET body diode that is used to drive the motor as a zener diode.

4. Calculating STK672-740AN-E HIC Internal Power Loss

The average internal power loss in each excitation mode of the STK672-740AN-E can be calculated from the following formulas. *1

Each excitation mode
2-phase excitation mode
$2PdAVex = (Vsat+Vdf) \times (1/(t1+t2+t3)) \times IOH \times t2 + (1/(t1+t2+t3)) \times IOH \times (Vsat \times t1 + Vdf \times t3)$

1-2 Phase excitation mode
$1\text{-}2PdAVex = (Vsat+Vdf) \times (1/(t1+t2+t3)) \times IOH \times t2 + (1/(t1+t2+t3)) \times IOH \times (Vsat \times t1 + Vdf \times t3)$

Motor hold mode
$HoldPdAVex = (Vsat+Vdf) \times I_{OH}$

      Vsat : Combined voltage represented by the Ron voltage drop+shunt resistor
      Vdf : Combined voltage represented by the MOSFET body diode+shunt resistor

t1, t2, and t3 represent the waveforms shown in the figure below.
      t1 : Time required for the winding current to reach the set current (I_{OH})
      t2 : Time in the constant current control (PWM) region
      t3 : Time from end of phase input signal until inverse current regeneration is complete
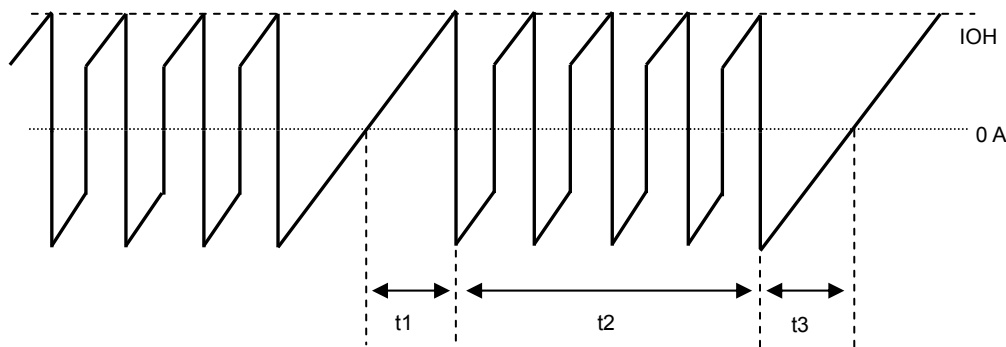
Motor COM Current Waveform Model

$t1 = (-L/(R+0.20)) \ln (1-(((R+0.20)/V_{CC}) \times I_{OH}))$
$t3 = (-L/R) \ln ((V_{CC}+0.20)/(I_{OH} \times R + V_{CC}+0.20))$
V_{CC} : Motor supply voltage (V)
L   : Motor inductance (H)
R   : Motor winding resistance (Ω)
I_{OH} : Motor set output current crest value (A)

For the values of Vsat and Vdf, be sure to substitute from Vsat vs I_{OH} and Vdf vs I_{OH} at the setting current value I_{OH}.
(See pages to follow)
Then, determine if a heat sink is necessary by comparing with the ΔTc vs Pd graph (see next page) based on the calculated average output loss, HIC.
For heat sink design, be sure to see '5. Thermal Design'.
The HIC average power, PdAVex described above, represents loss when not in avalanche mode.

To add the loss in avalanche mode, be sure to add PAVL using the formula (for average power loss , PAVL, for STK672-7** during avalanche mode, described below to PdAVex described above.)
When using this IC without a fin, always check for temperature increases in the set, because the HIC substrate temperature, Tc, varies due to effects of convection around the HIC.

4-2. [Calculating the average power loss, PAVL, during avalanche mode]

The allowable avalanche energy, EAVL, during fixed current chopping operation is represented by Equation (3-2) used to find the average power loss, PAVL, during avalanche mode that is calculated by multiplying Equation (3-1) by the chopping frequency.

$$PAVL = V_{DSS} \times IAVL \times 0.5 \times tAVL \times fc \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad (3\text{-}2)$$

fc : Hz units (fc is set to the PWM frequency of 50kHz.)

Be sure to actually operate an STK672-7** series and substitute values found when observing operations on an oscilloscope for V_{DSS}, IAVL, and tAVL.

The sum of PAVL values for each excitation mode is multiplied by the constants given below and added to the average internal HIC loss equation, except in the case of 2-phase excitation.

1-2 excitation mode and higher: $PAVL(1) = 0.7 \times PAVL \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4\text{-}1)$

During2-phase excitation mode and motor hold: $PAVL(1) = 1 \times PAVL \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4\text{-}2)$

STK672-740AN-E
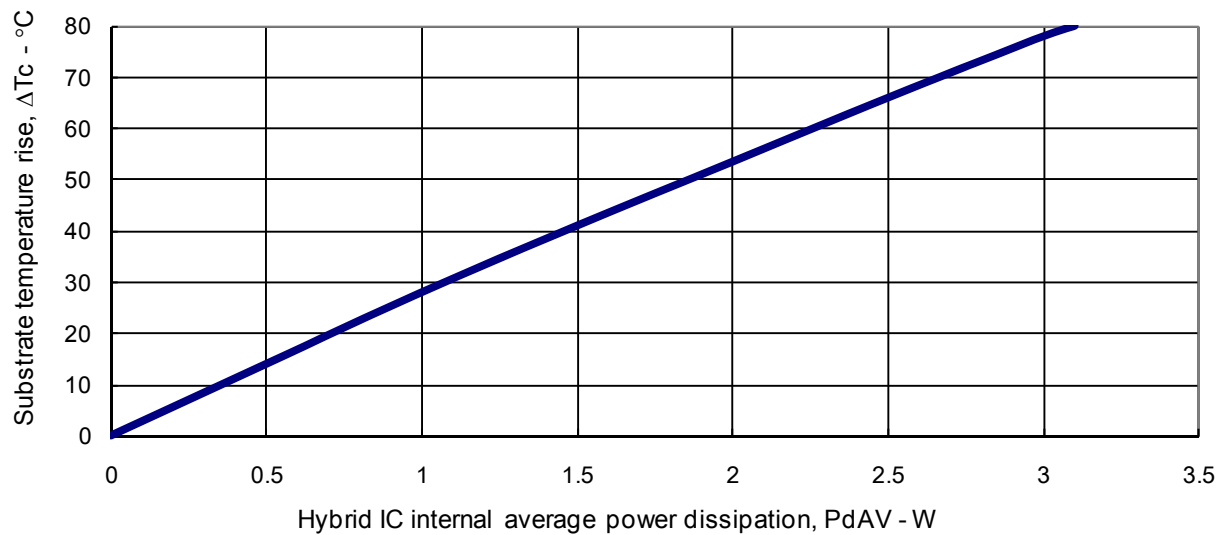
STK672-740AN-E Output Saturation Voltage Vsat vs. Output Current
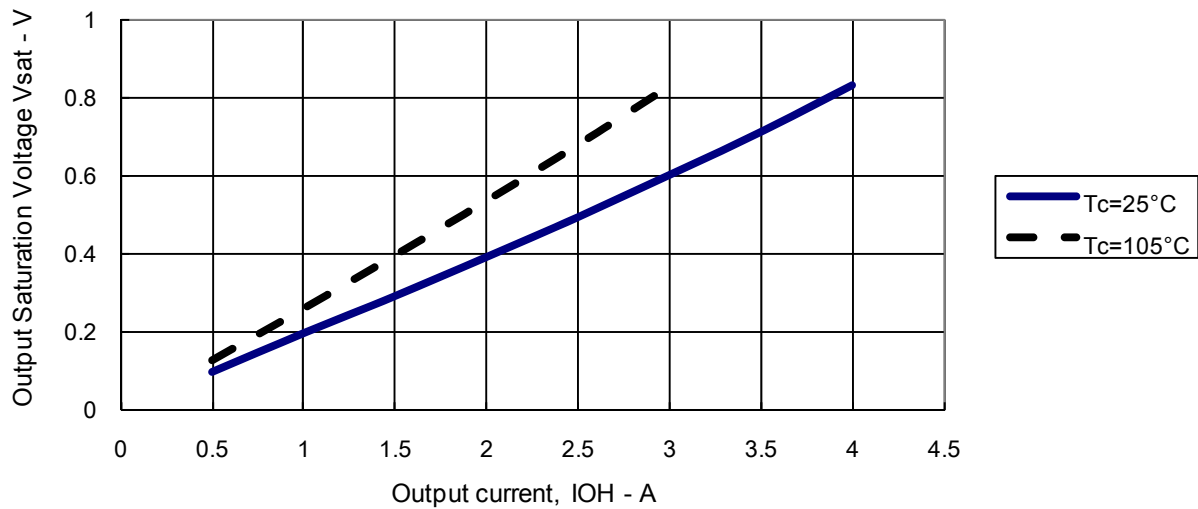
STK672-740AN-E   Forward voltage, Vdf -Output current, IOH
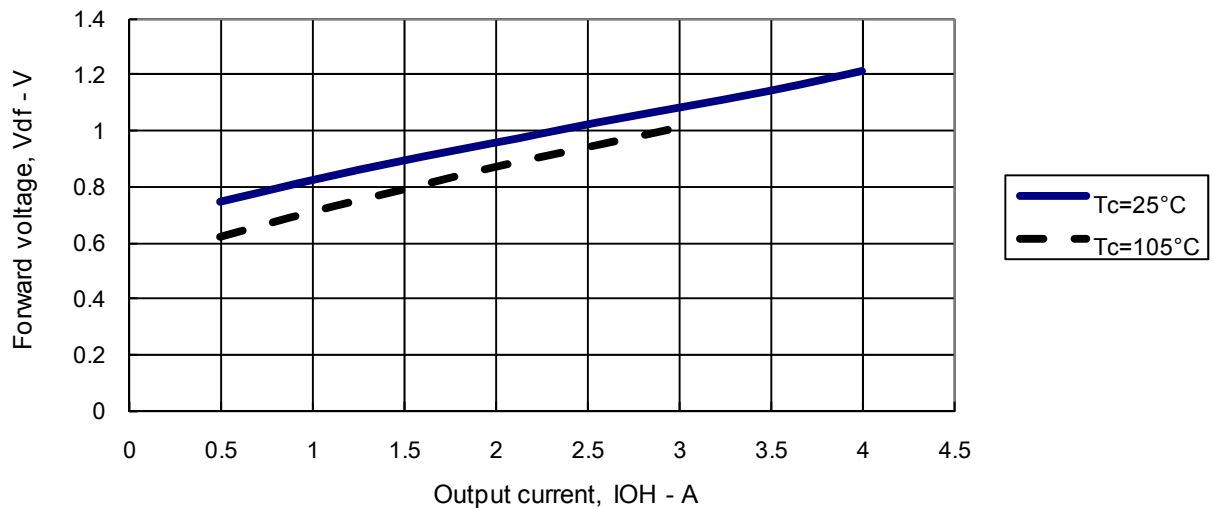
Substrate temperature rise, ΔTc (no heat sink) - Internal average power dissipation, PdAV

5. Thermal design

[Operating range in which a heat sink is not used]

  Use of a heat sink to lower the operating substrate temperature of the HIC (Hybrid IC) is effective in increasing the quality of the HIC.

  The size of heat sink for the HIC varies depending on the magnitude of the average power loss, PdAV, within the HIC. The value of PdAV increases as the output current increases. To calculate PdAV, refer to "Calculating Internal HIC Loss" in the specification document.

  Calculate the internal HIC loss, PdAV, assuming repeat operation such as shown in Figure 1 below, since conduction during motor rotation and off time both exist during actual motor operations,
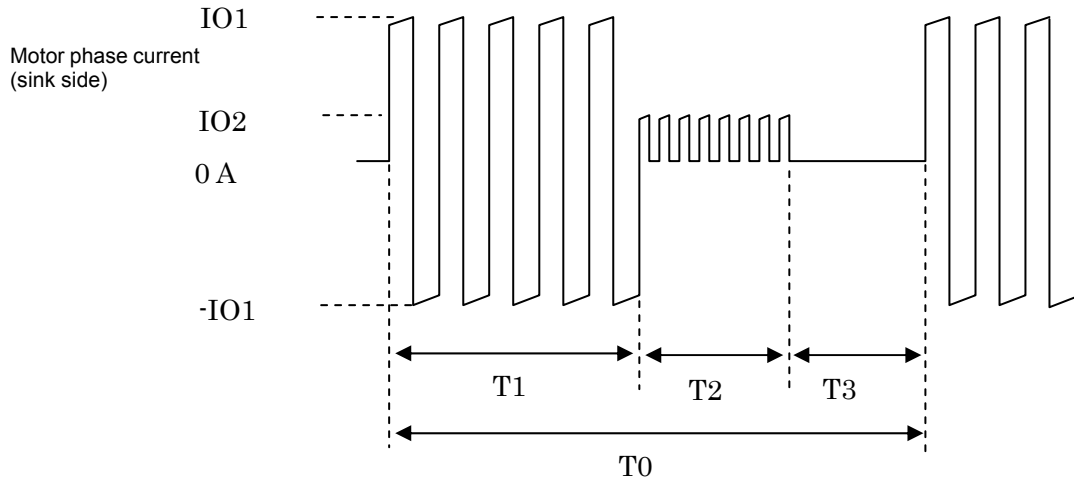
Figure 1 Motor Current Timing

  T1 : Motor rotation operation time
  T2 : Motor hold operation time
  T3 : Motor current off time
  T2 may be reduced, depending on the application.
  T0 : Single repeated motor operating cycle
  I_O1 and I_O2 : Motor current peak values
  Due to the structure of motor windings, the phase current is a positive and negative current with a pulse form.
  Note that figure 1 presents the concepts here, and that the on/off duty of the actual signals will differ.
  The hybrid IC internal average power dissipation PdAV can be calculated from the following formula.

$$PdAV= (T1{\times}P1+T2{\times}P2+T3{\times}0) \div TO \text{ --------------------------- (I)}$$
$$\text{(Here, P1 is the PdAV for } I_O1 \text{ and P2 is the PdAV for } I_O2)$$

  If the value calculated using Equation (I) is 1.5W or less, and the ambient temperature, Ta, is 60°C or less, there is no need to attach a heat sink. Refer to Figure 2 for operating substrate temperature data when no heat sink is used.

[Operating range in which a heat sink is used]

  Although a heat sink is attached to lower Tc if PdAV increases, the resulting size can be found using the value of θc-a in Equation (II) below and the graph depicted in Figure 3.

$$\theta c\text{-}a= (Tc \text{ max-}Ta) \div PdAV \text{ ---------------------------- (II)}$$
$$Tc \text{ max : Maximum operating substrate temperature =105°C}$$
$$Ta\text{: HIC ambient temperature}$$

  Although a heat sink can be designed based on equations (I) and (II) above, be sure to mount the HIC in a set and confirm that the substrate temperature, Tc, is 105°C or less.

  The average HIC power loss, PdAV, described above represents the power loss when there is no avalanche operation. To add the loss during avalanche operations, be sure to add Equation (3-2), "Allowable STK672-7** Avalanche Energy Value", to PdAV.
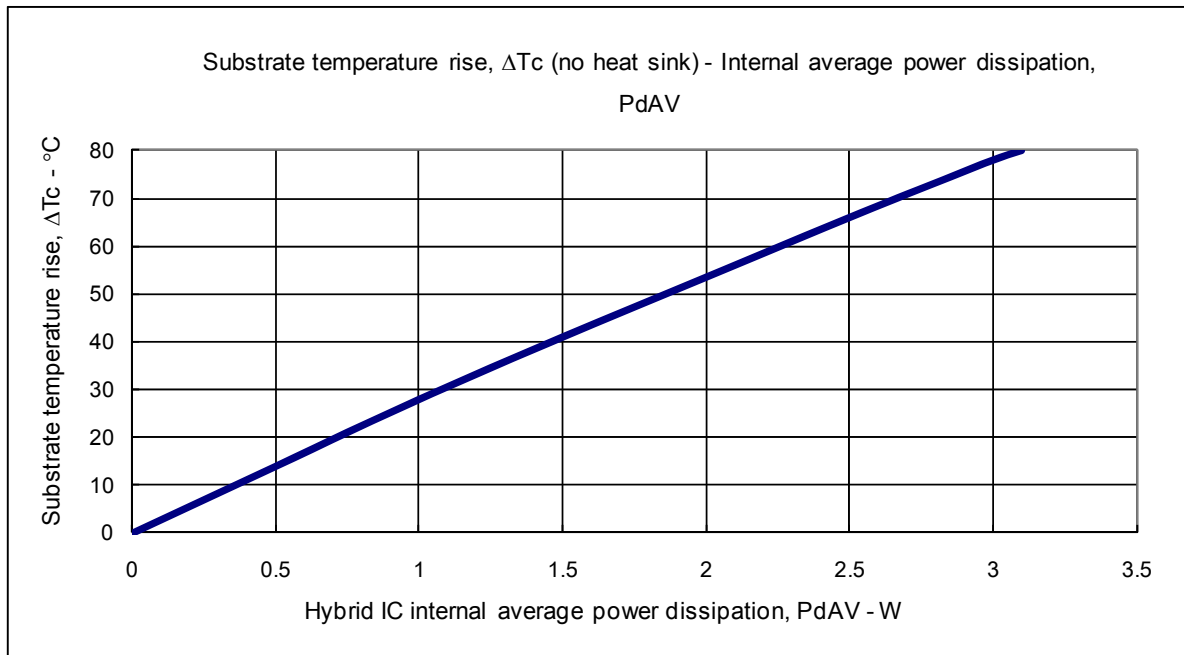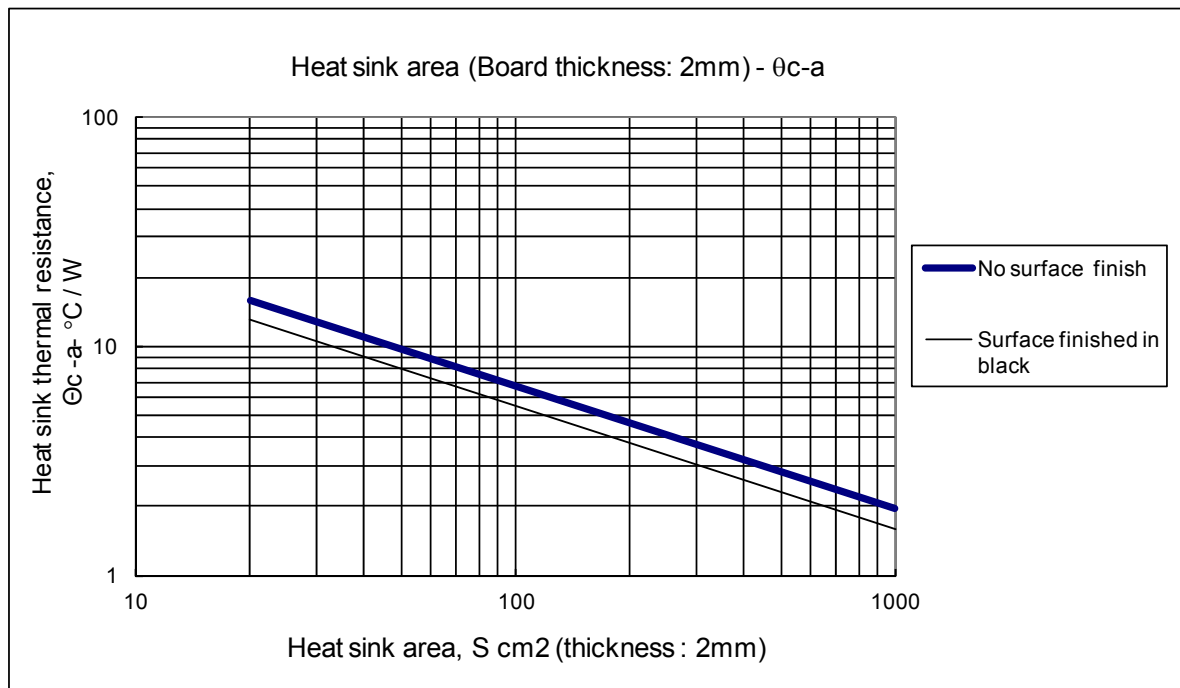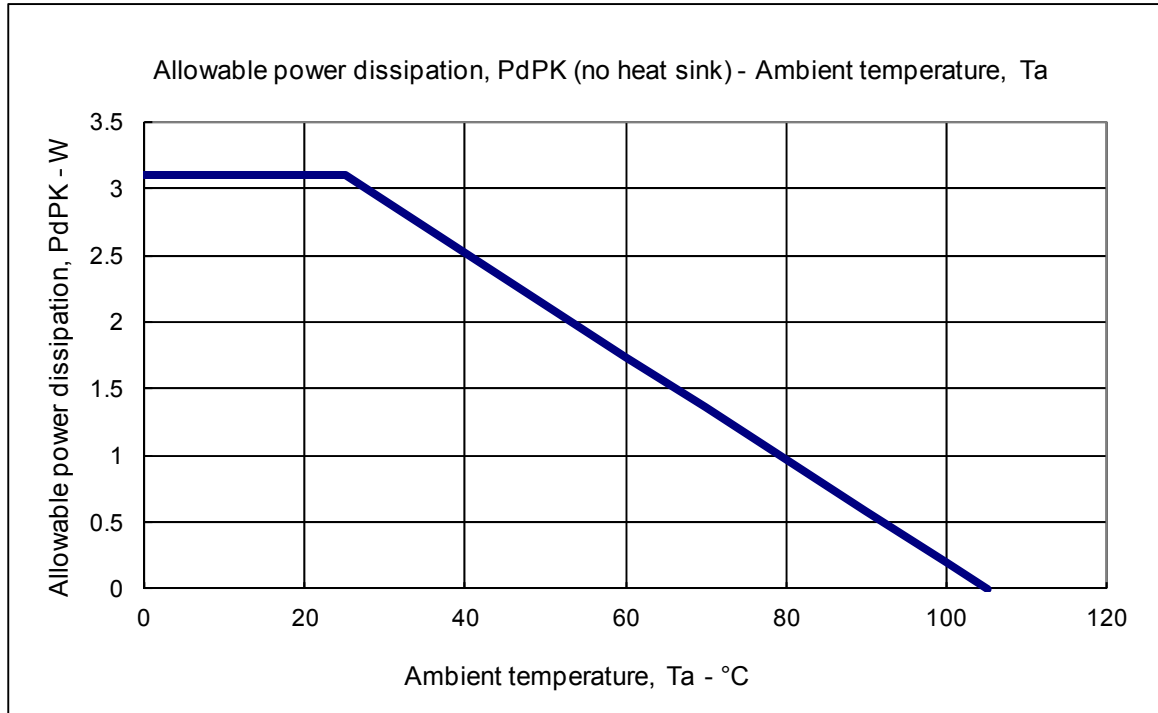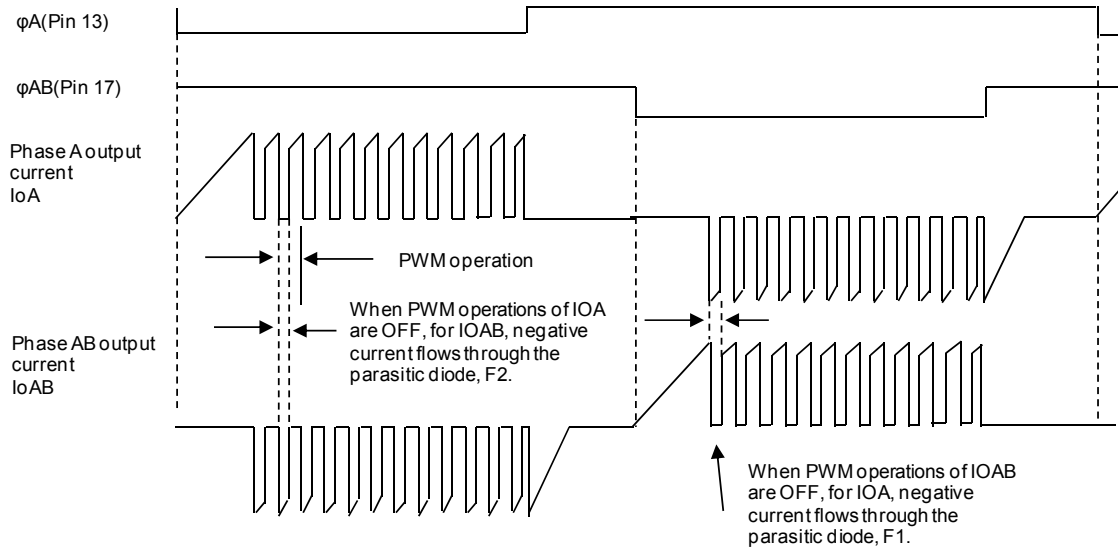
Figure 2

Substrate temperature rise, ΔTc (no heat sink) - Internal average power dissipation, PdAV

Substrate temperature rise, ΔTc - °C

Hybrid IC internal average power dissipation, PdAV - W

Figure 3

Heat sink area (Board thickness: 2mm) - θc-a

Heat sink thermal resistance, Θc -a- °C / W

No surface finish

Surface finished in black

Heat sink area, S cm2 (thickness : 2mm)

6. Mitigated Curve of Package Power Loss, PdPK, vs. Ambient Temperature, Ta

Package power loss, PdPK, refers to the average internal power loss, PdAV, allowable without a heat sink.
The figure below represents the allowable power loss, PdPK, vs. fluctuations in the ambient temperature, Ta.
Power loss of up to 3.1W is allowable at Ta=25°C, and of up to 1.75W at Ta=60°C.
* The package thermal resistance θc-a is 25.8°C/W.

Allowable power dissipation, PdPK (no heat sink) - Ambient temperature, Ta

Allowable power dissipation, PdPK - W

Ambient temperature, Ta - °C

7. Example of Stepper Motor Driver Output Current Path (1-2 phase excitation)

2 Phase stepper motor

IoA

IoAB

A   AB   B   BB

VDD

BBIN

BIN

ABIN

AIN

F1   F2   F3   F4

FAO

FAB

FBO

FBB

Vcc
24V

RESETB

ENABLE

FAULT

Power on reset

FAULT signal (Open drain)

Over heat detection

Latch

Latch

Over current detection

Chopper circuit

Vref /4.9

Amp

100k

VSS

VSS

AI

BI

R1   R2

+ C02
at least 100μF

P.G2

P.G1

P.GND

Vref

VSS

φA(Pin 13)

φAB(Pin 17)

Phase A output current
IoA

PWM operation

When PWM operations of IOA are OFF, for IOAB, negative current flows through the parasitic diode, F2.

Phase AB output current
IoAB

When PWM operations of IOAB are OFF, for IOA, negative current flows through the parasitic diode, F1.

8. Other usage notes

In addition to the "Notes" indicated in the Sample Application Circuit, care should also be given to the following contents during use.

(1) Allowable operating range

Operation of this product assumes use within the allowable operating range. If a supply voltage or an input voltage outside the allowable operating range is applied, an overvoltage may damage the internal control IC or the MOSFET.

If a voltage application mode that exceeds the allowable operating range is anticipated, connect a fuse or take other measures to cut off power supply to the product.

(2) Input pins

If the input pins are connected directly to the board connectors, electrostatic discharge or other overvoltage outside the specified range may be applied from the connectors and may damage the product. Current generated by this overvoltage can be suppressed to effectively prevent damage by inserting 100Ω to $1k\Omega$ resistors in lines connected to the input pins.

Take measures such as inserting resistors in lines connected to the input pins.

(3) Power connectors

If the motor power supply V_{CC} is applied by mistake without connecting the GND part of the power connector when the product is operated, such as for test purposes, an overcurrent flows through the V_{CC} decoupling capacitor, C1, to the parasitic diode between the V_{DD} of the internal control IC and GND, and may damage the power supply pin block of the internal control IC.

To prevent damage in this case, connect a 10Ω resistor to the V_{DD} pin, or insert a diode between the V_{CC} decoupling capacitor C1 GND and the V_{DD} pin.
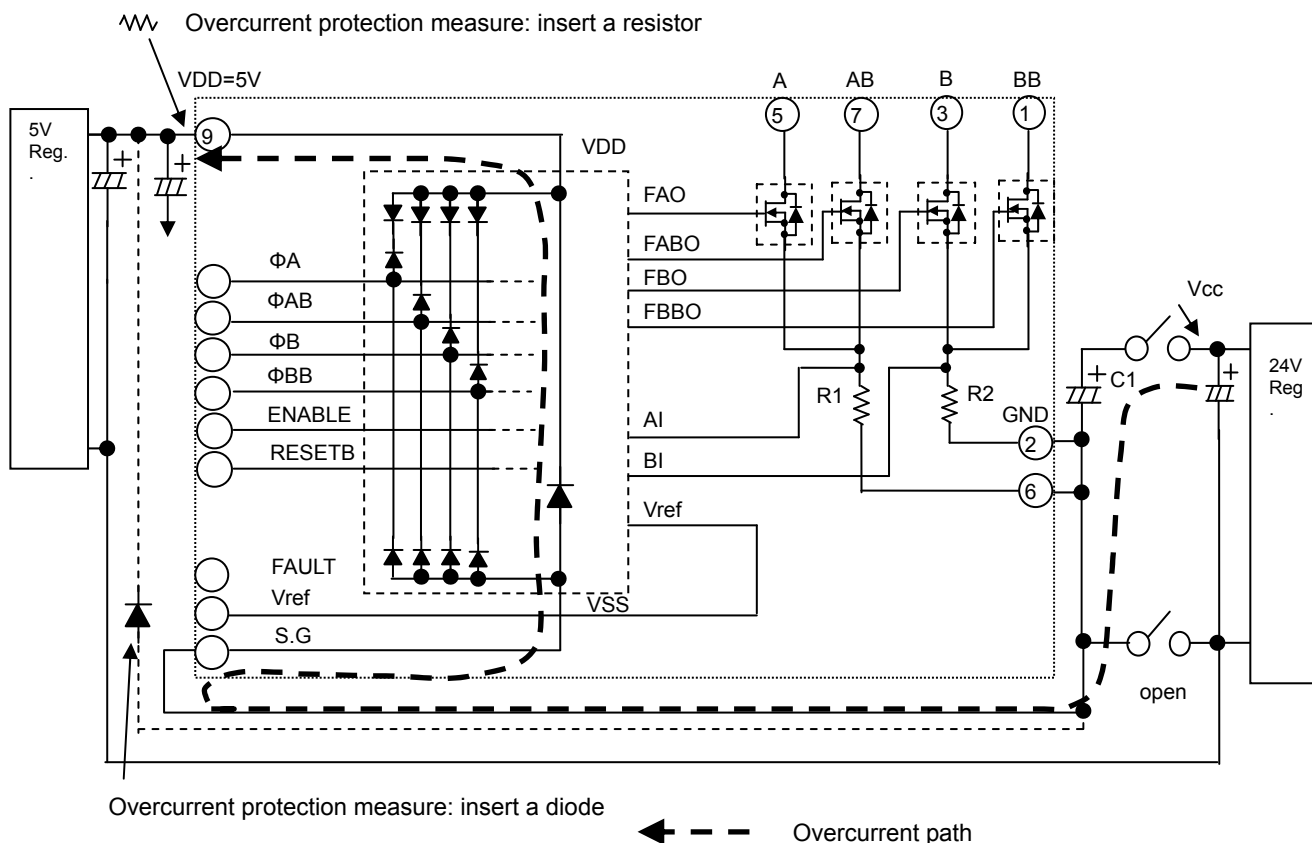
(4) Input Signal Lines

1) Do not use an IC socket to mount the driver, and instead solder the driver directly to the board to minimize fluctuations in the GND potential due to the influence of the resistance component and inductance component of the GND pattern wiring.

2) To reduce noise caused by electromagnetic induction to small signal lines, do not design small signal lines (sensor signal lines, and 5V or 3.3V power supply signal lines) that run parallel in close proximity to the motor output line A (Pin 5), AB (Pin 7), B (Pin 3), or BB (Pin 1) phases.

(5) When mounting multiple drivers on a single board

   When mounting multiple drivers on a single board, the GND design should mount a V_{CC} decoupling capacitor, C1, for each driver to stabilize the GND potential of the other drivers. The key wiring points are as follows.
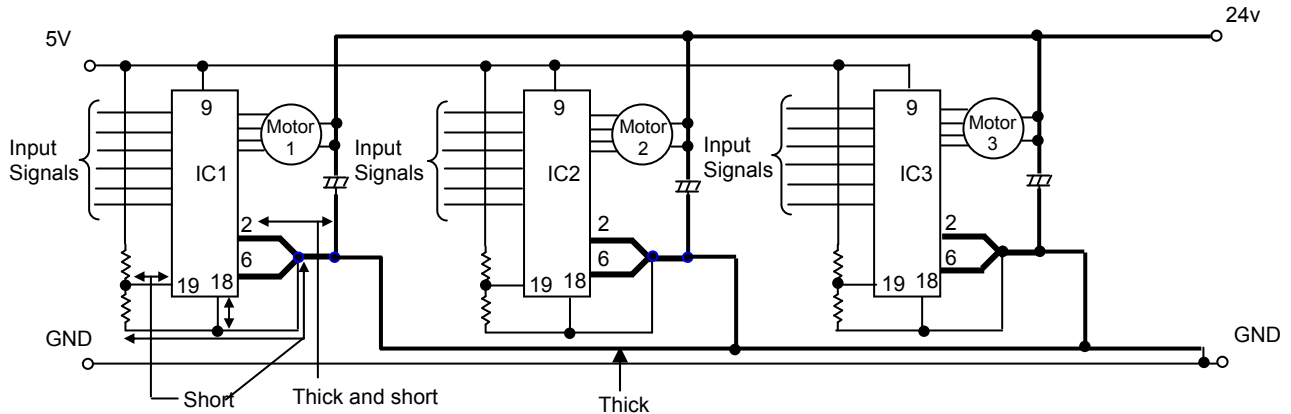
(6) V_{CC} operating limit

   When the output (for example F1) of a 2-phase stepper motor driver is turned OFF, the AB phase back electromotive force eab produced by current flowing to the paired F2 parasitic diode is induced in the F1 side, causing the output voltage VFB to become twice or more the V_{CC} voltage. This is expressed by the following formula.

   $$VFB = V_{CC} + eab$$
   $$= V_{CC} + V_{CC} + I_{OH} \times RM + Vdf (1.5V)$$

   V_{CC}: Motor supply voltage, I_{OH}: Motor current set by Vref

   Vdf: Voltage drop due to F2 parasitic diode and current detection resistor R1, RM: Motor winding resistance value Using the above formula, make sure that VFB is always less than the MOSFET withstand voltage of 100V. This is because there is a possibility that operating limit of V_{CC} falls below the allowable operating range of 42V, due to the RM and I_{OH} specifications.
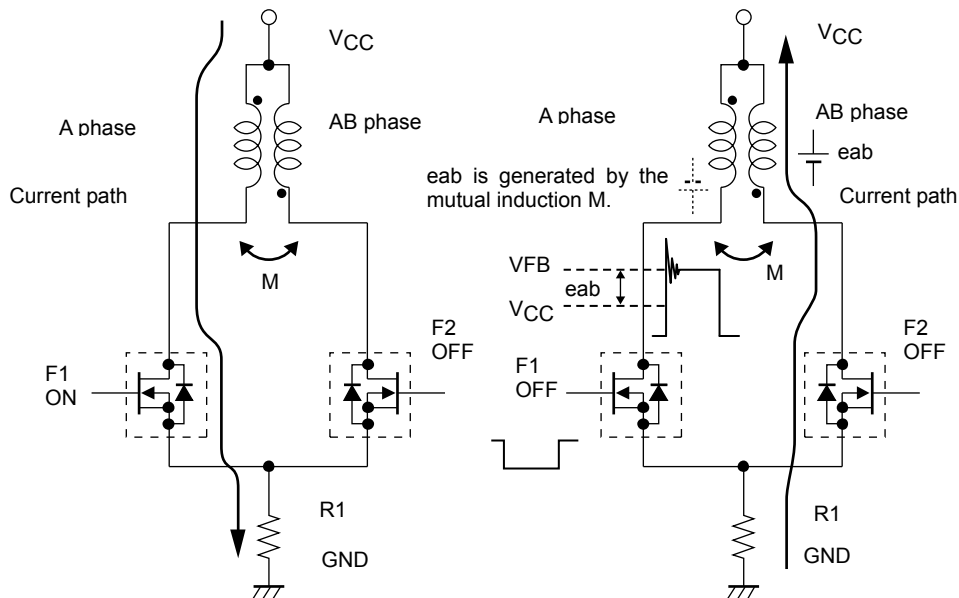
   The oscillating voltage in excess of VFB is caused by LCRM (inductance, capacitor, resistor, mutual inductance) oscillation that includes micro capacitors C, not present in the circuit. Since M is affected by the motor characteristics, there is some difference in oscillating voltage according to the motor specifications. In addition, constant voltage drive without constant current drive enables motor rotation at $V_{CC} \geq 0V$.

ORDERING INFORMATION

Device	Package	Shipping (Qty / Packing)
STK672-740AN-E	SIP-19 (Pb-Free)	15 / Tube