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STK681-332-E
STK681-352-E

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Intelligent Power Module

DC Brush Motor Driver Application Note

Overview

The STK681-332-E and STK681-352-E are IPM (Intelligent Power Module) for use in current control forward/reverse DC motor driver with brush.

Features

- Allows forward, reverse, and brake operations in accordance with the external input signal.
- 12A peak startup output current and 12A peak brake output current.
- On-chip output short-circuits detection function.
- Connecting an external current detection resistor allows overcurrent detection and peak current control in the PWM operation mode.
- Obviate the need to design for the dead time in order to turn off the upper- and lower drive devices, when switching between the forward and reverse operation mode.

Applications

- Office photocopiers, printers, etc.

Selection Guide

Parameter	STK681-332-E	STK681-352-E
Operating supply voltage 1 V_{CC}	10 to 38V	18 to 29V
Operating supply voltage 2 V_{DD}	5V±5%	No need
Output current (Tc=105°C)	5A	3.8A
Brake current	12A	12A

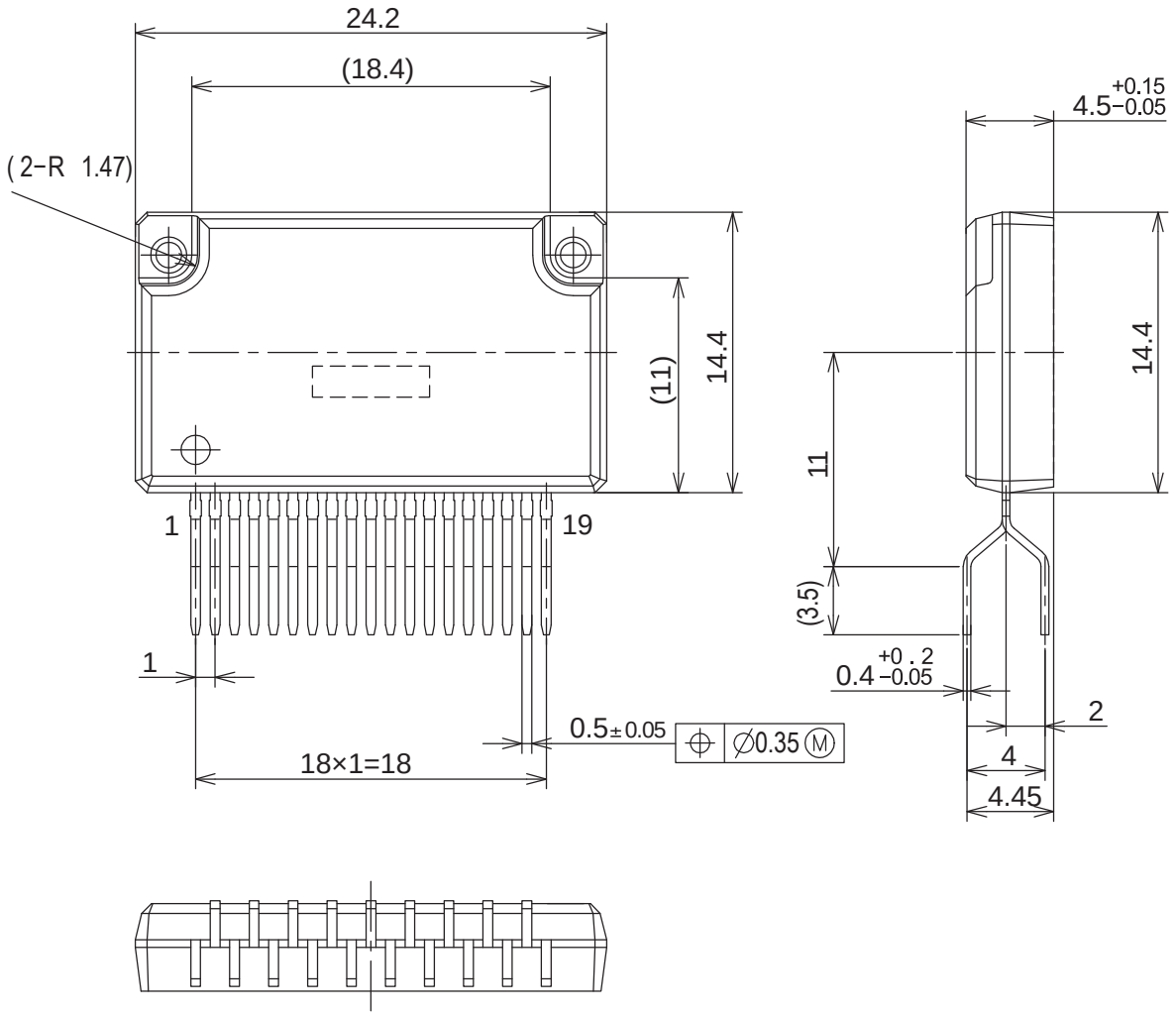
November 2014 - Rev. 1

Publication Order Number :
ANDSTK681332E352E/D

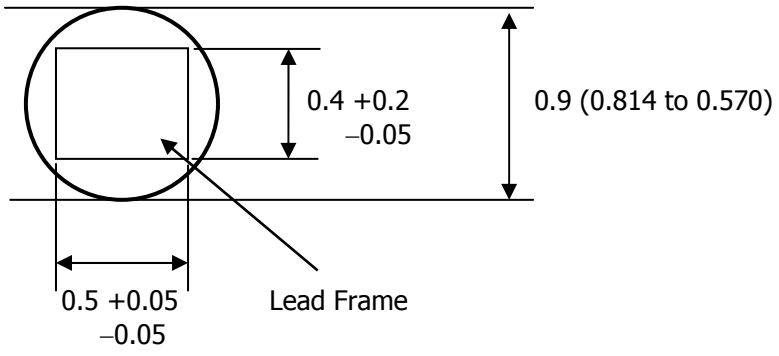
Package Dimensions

STK681-332-E
STK681-352-E
unit : mm (typ)

SIP19 24.2x14.4
CASE 127BA
ISSUE O

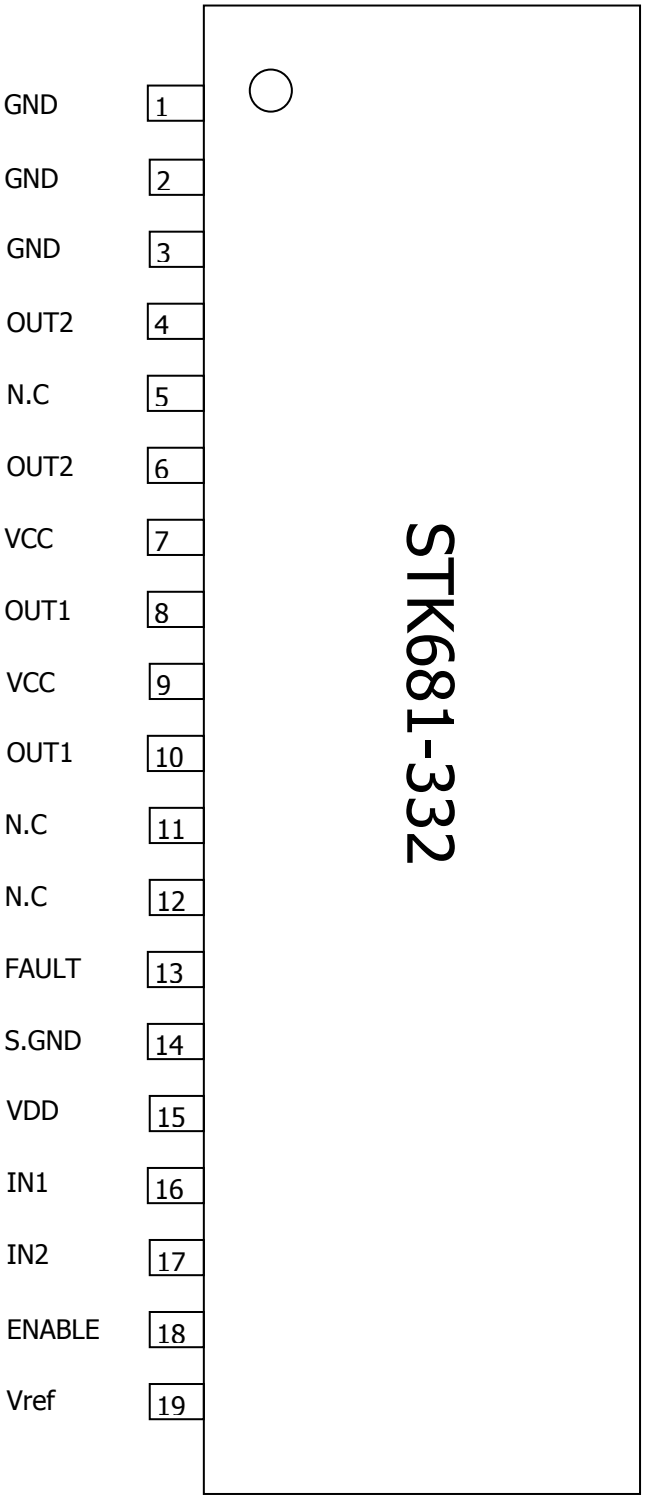


Recommend hole size for Lead Frame on PCB; 0.9 mm (max)

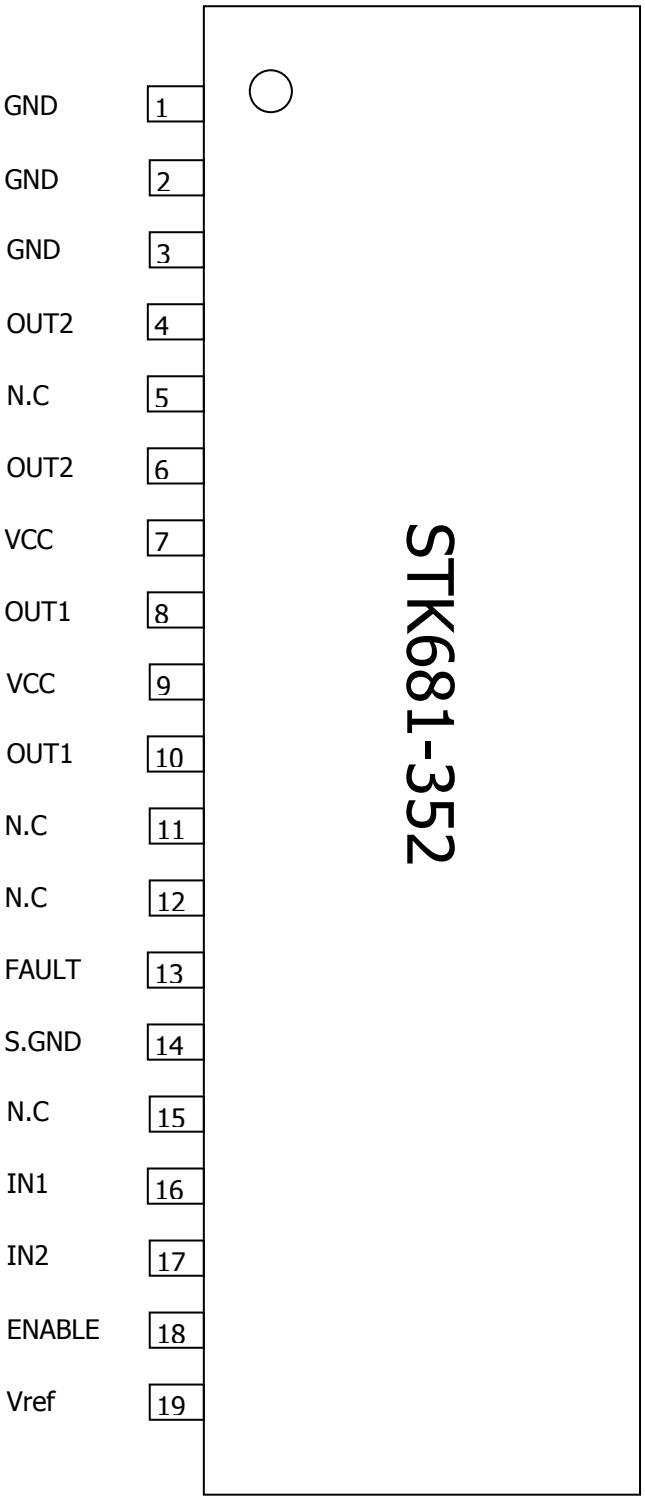


Pin Assignment

STK681-332-E

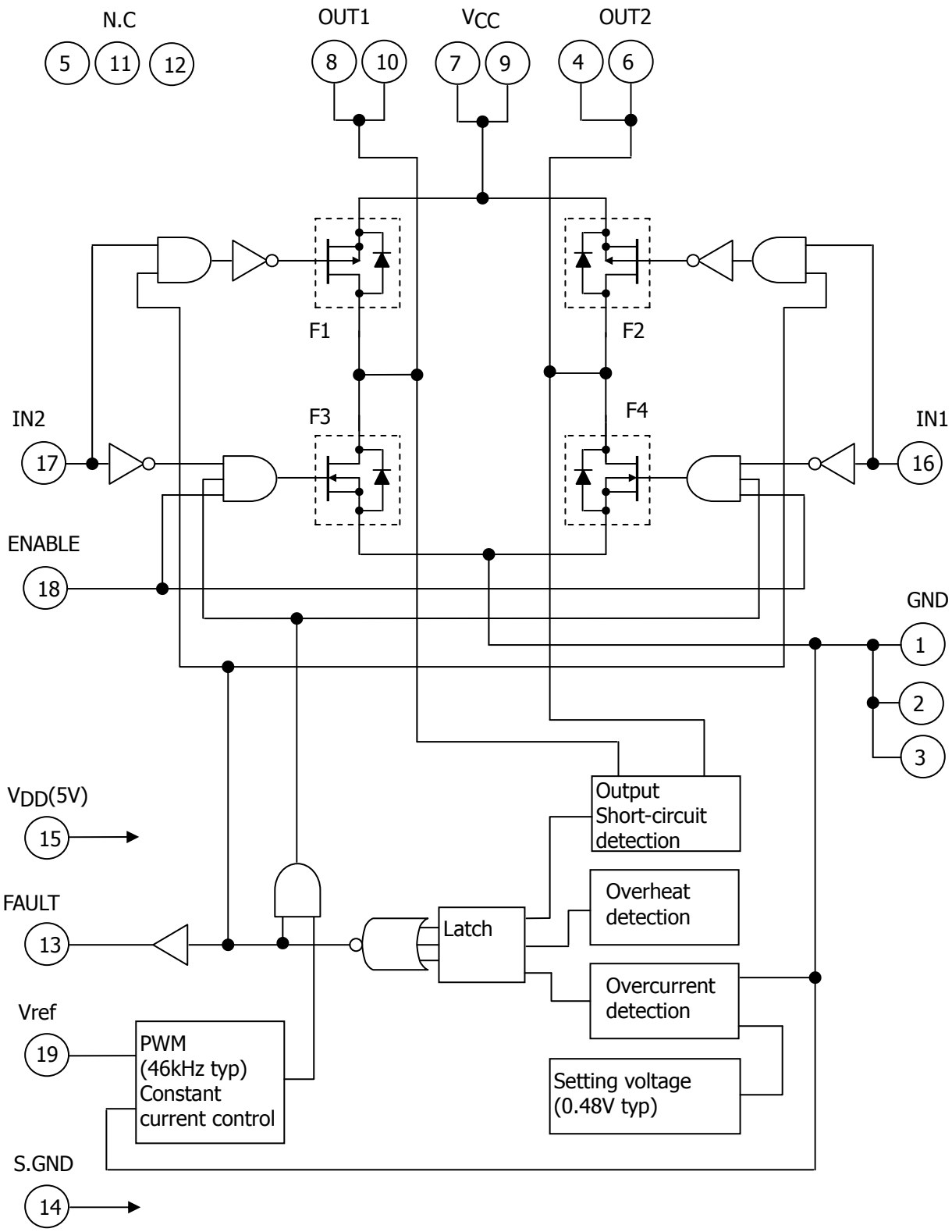


STK681-352-E

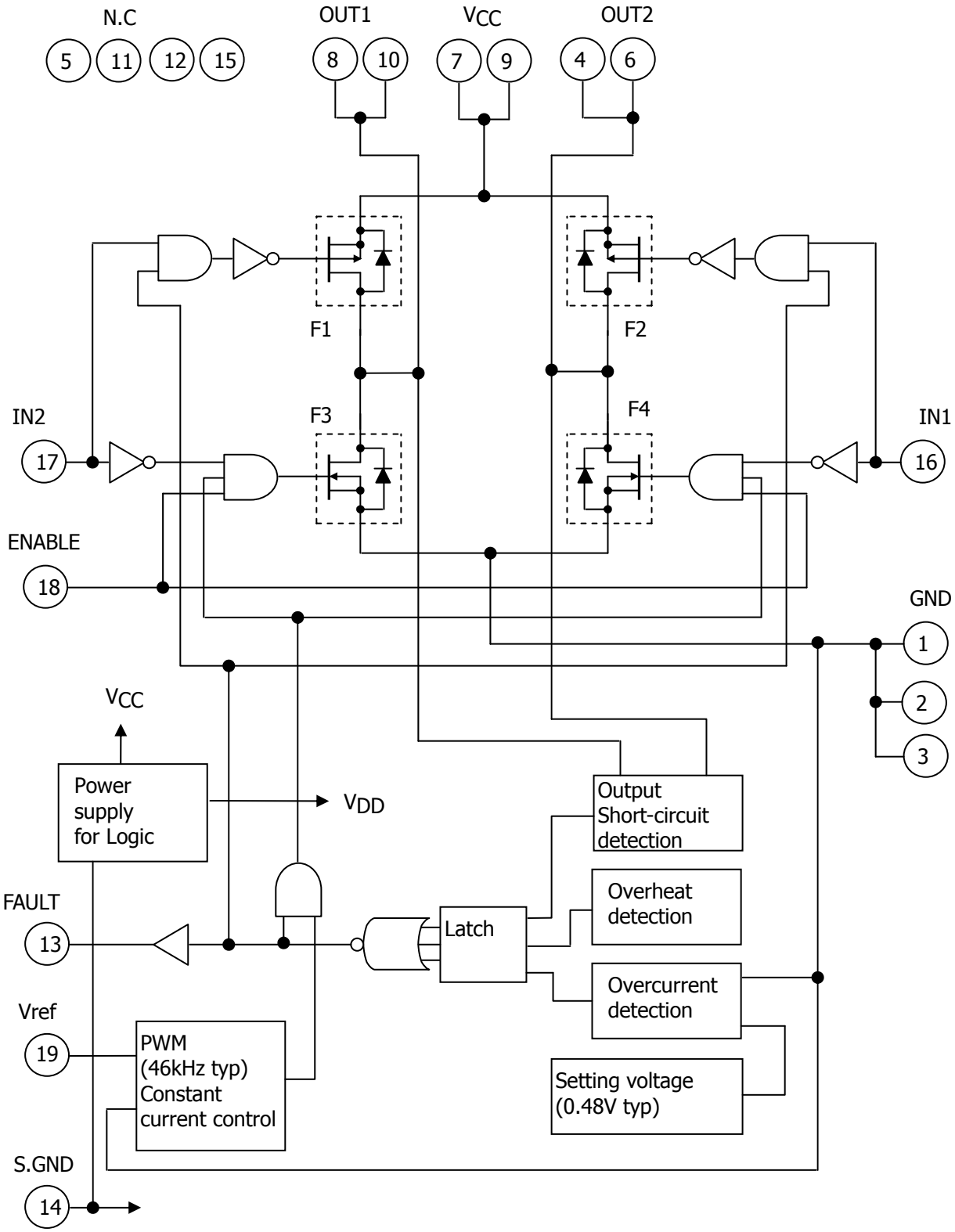

GND 1
GND 2
GND 3
OUT2 4
N.C 5
OUT2 6
VCC 7
OUT1 8
VCC 9
OUT1 10
N.C 11
N.C 12
FAULT 13
S.GND 14
N.C 15
IN1 16
IN2 17
ENABLE 18
Vref 19
STK681-352

Block Diagram

STK681-332-E



STK681-352-E


N.C
5
11
12
15
OUT1
8
10
VCC
7
9
OUT2
4
6
F1
F2
F3
F4
IN2
17
IN1
16
ENABLE
18
GND
1
2
3
VCC
Power supply for Logic
VDD
Output Short-circuit detection
Overheat detection
FAULT
13
Latch
Overcurrent detection
Vref
19
PWM (46kHz typ) Constant current control
Setting voltage (0.48V typ)
S.GND
14

Specifications

Absolute Maximum Ratings at Tc=25°C

Parameter	Symbol	Condition	Ratings		unit
			STK681-332	STK681-352	
Maximum supply voltage 1	V_{CC} max	V_{DD}=0V	52	38	V
Maximum supply voltage 2	V_{DD} max	No signal	−0.3 to 6.0		V
Input voltage	VIN max	Logic input pins	−0.3 to 6.0		V
Output current1	Io1max	V_{DD}=5.0V, DC current	8.5	6.4	A
Output current2	Io2max	V_{DD}=5.0V, Pulse current: 5ms	12	-	A
		Pulse current: 10ms	-	8	A
Brake current	IoBmax	V_{DD}=5.0V, square wave current, operating time 15ms (single pulse, low side brake)	12	12	A
Allowable power dissipation	PdPKmax	No heat sink	2.8		W
Operating substrate temperature	Tc	Metal surface temperature of the package	−20 to +105		°C
Junction temperature	Tjmax		150		°C
Storage temperature	Tstg		−40 to +125		°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

Allowable Operating Ratings at Ta=25°C

Parameter	Symbol	Condition	Ratings		unit
			STK681-332	STK681-352	
Operating supply voltage 1-1	V_{CC}-1	With signals applied(Tc=105°C)	10 to 38	18 to 29	V
Operating supply voltage 1-2	V_{CC}-2	With signals applied(Tc=90°C)	10 to 42		V
Operating supply voltage 2	V_{DD}	With signals applied	5.0±5%	-	V
Input voltage	VIN		0 to V_{DD}	0 to 5.5	V
Output current 1	Io1	V_{DD}=5.0V, DC current, Tc=80°C	6.1	4.6	A
Output current 2	Io2	V_{DD}=5.0V, DC current, Tc=105°C	5	3.8	A
Brake current	IoB	V_{DD}=5.0V, square wave current, operating time 2ms, Low side brake, Tc=105°C	12	12	A

Refer to the graph for each conduction-period tolerance range for the output current and brake current.

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

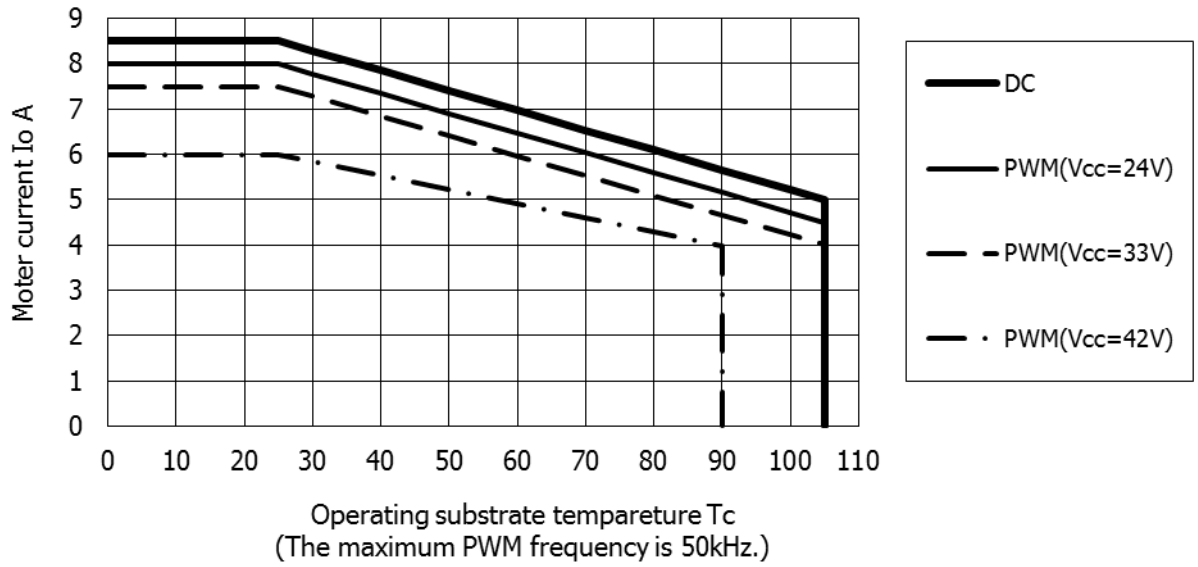
Parameter	Symbol	Conditions	Ratings			unit
			min	typ	max	
V_{DD} supply current(STK681-332-E)	Icco	Forward or reverse operation		6	9	mA
V_{CC} supply current(STK681-352-E)	Icco	ENABLE=GND, IN1=IN2=3.3V		9.3	11	mA
FET diode forward voltage (STK681-332-E)	Vdf	If=1A(RL=23Ω)		0.75	1.4	V
FET diode forward voltage (STK681-352-E)				0.76	1.4	V
Output saturation voltage 1 (STK681-332-E)	Vsat1	RL=23Ω, F1, F2		65	100	mV
Output saturation voltage 1 (STK681-352-E)				140	200	mV
Output saturation voltage 2	Vsat2	RL=23Ω, F3, F4		50	85	mV
Output leak current	IOL	F1, F2, F3, and F4 OFF operation			50	μA
Input high voltage	VIH	IN1, IN2, ENABLE pins	2.5			V
Input low voltage	VIL	IN1, IN2, ENABLE pins			0.8	V
High level input current (STK681-332-E)	IILH	IN1, IN2, ENABLE pins, VIH=5V		50	75	μA
High level input current (STK681-352-E)	IILH	IN1, IN2, ENABLE pins, VIH=3.3V		33	50	μA
Low level input current	IILL	IN1, IN2, ENABLE pins, VIL=GND			10	μA
Overcurrent detection voltage	VOC	Between pins Vref1 and S.P		0.48		V
Internal PWM frequency	fc		32	46	62	kHz
Overheat detection temperature	TSD	Design guarantee		144		°C

Notes :

A fixed-voltage power supply must be used.

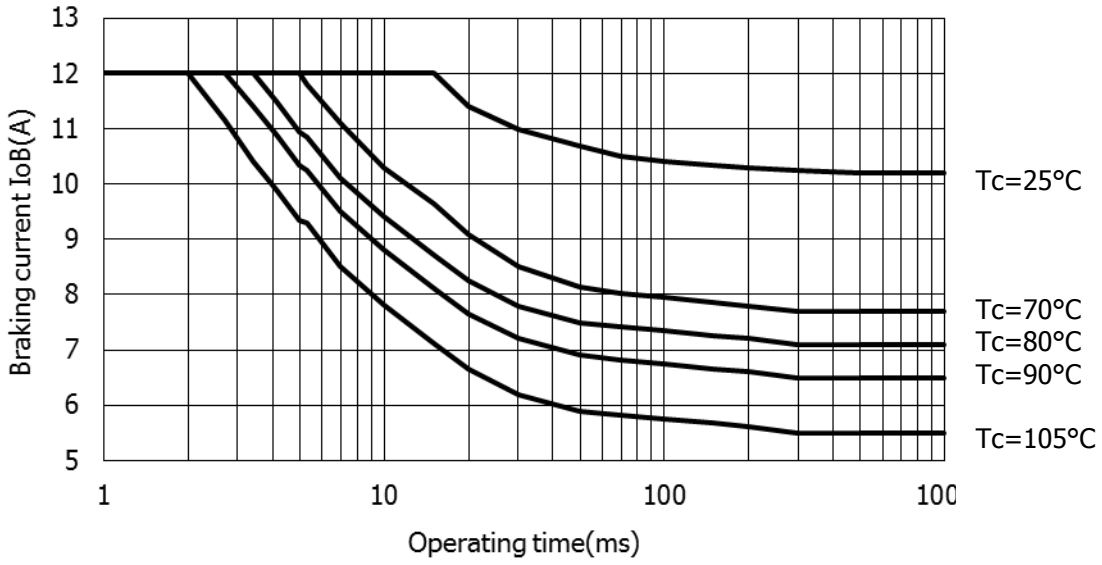
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

STK681-332-E motor current derating curve for the operating substrate temperature Tc

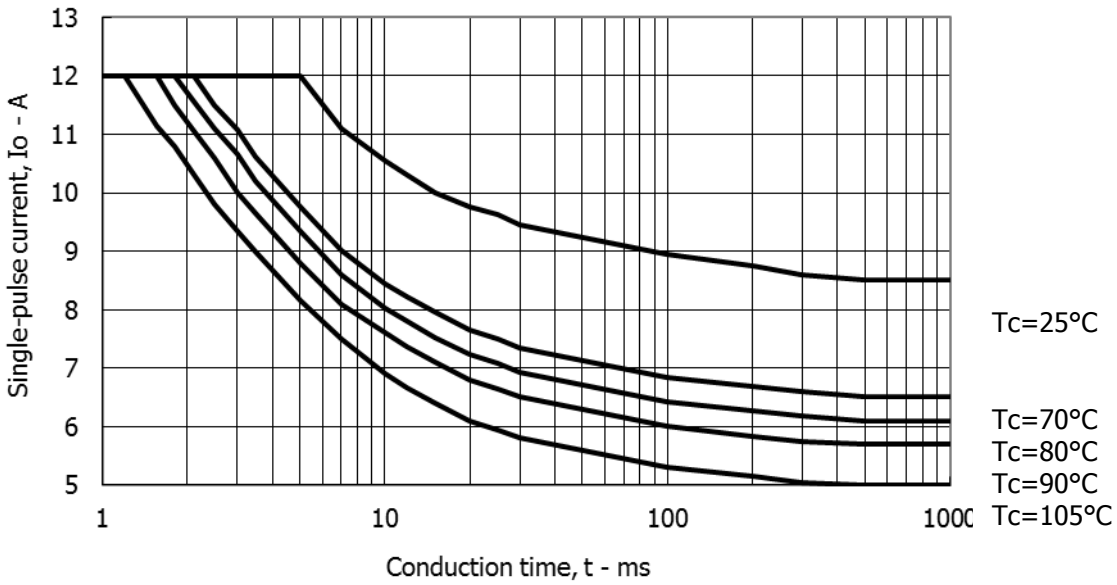


The PWM frequencies in the above graph indicate the ENABLE signal.
The same PWM Io derating curves as those shown above will be obtained when the internal PWM frequency of the STK681-332-E is used.
Increasing the Vcc supply voltage narrows the Io derating curve range, so Io should be set in reference to the above graph.
The above operating substrate temperature, Tc, is measured immediately when the motor is started.
Since Tc fluctuates due to the ambient temperature, Ta, the motor current value, and continuous or intermittent operations of the motor current, always confirms these values using an actual set.
The Tc temperature should be checked in the center of the metal surface of the product package.

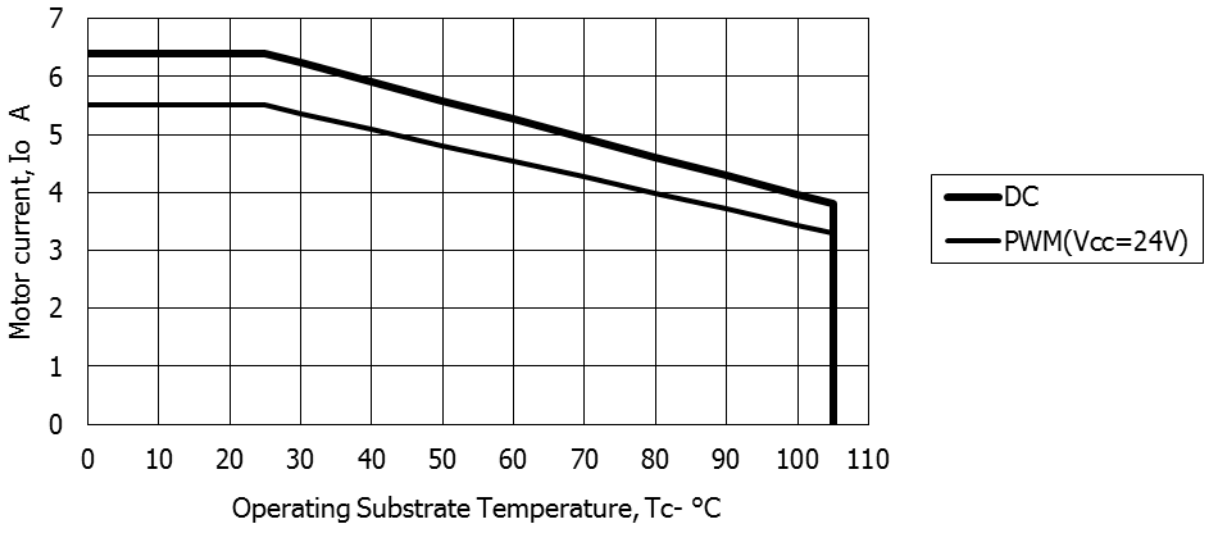
Allowable STK681-332-E braking current ranges



STK681-332-E Allowable Brake Current Range (High side: F1, F2=ON)
or Allowable Startup Current Range



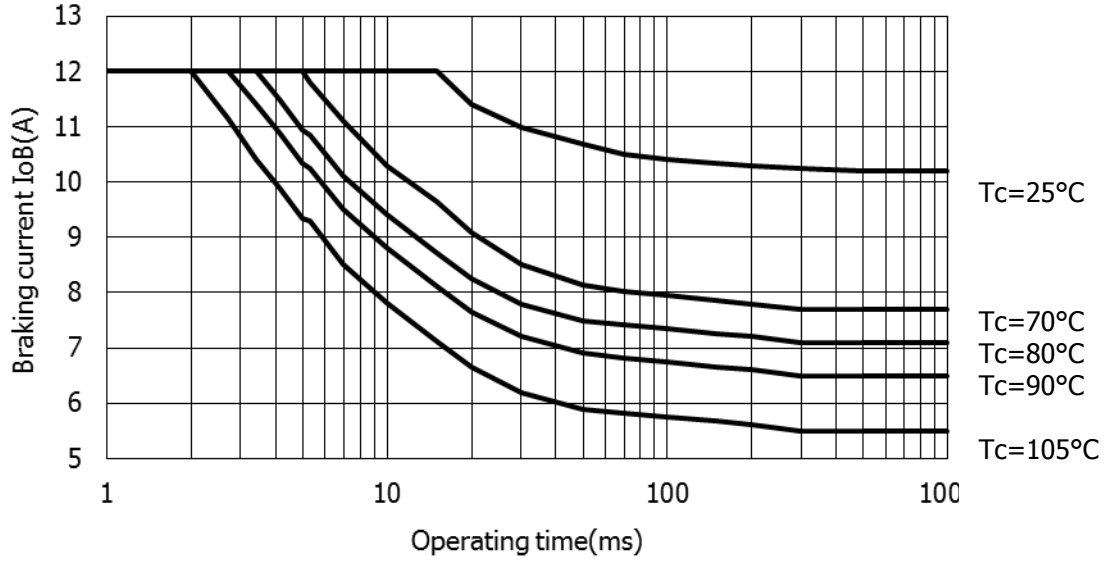
Derating Curve of Motor Current, Io, vs. STK681-352-E Operating Board Temperature, Tc



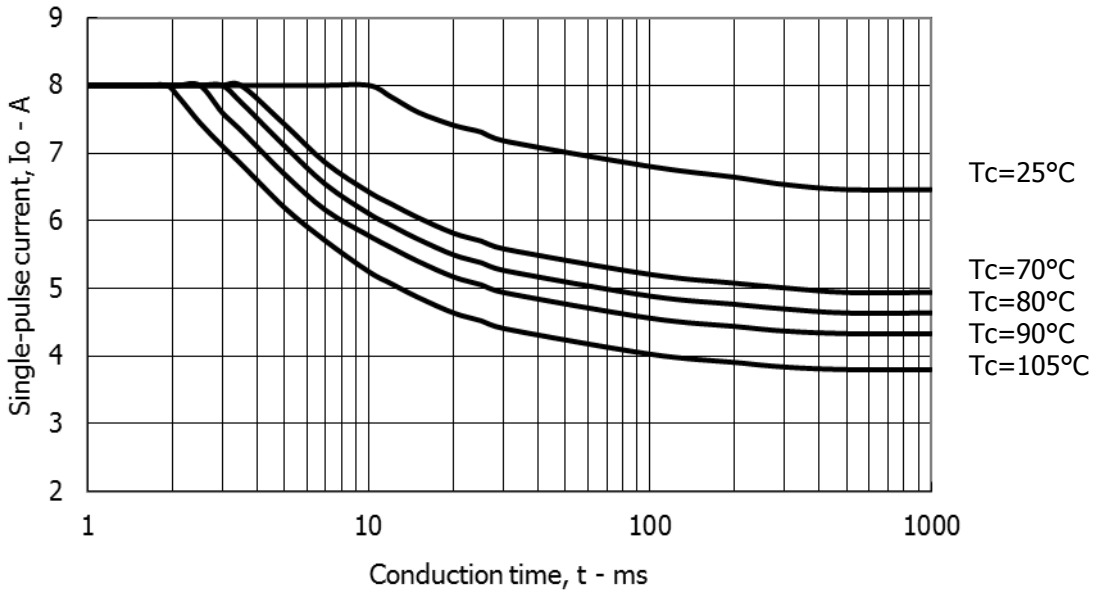
(The maximum PWM frequency is 50kHz.)

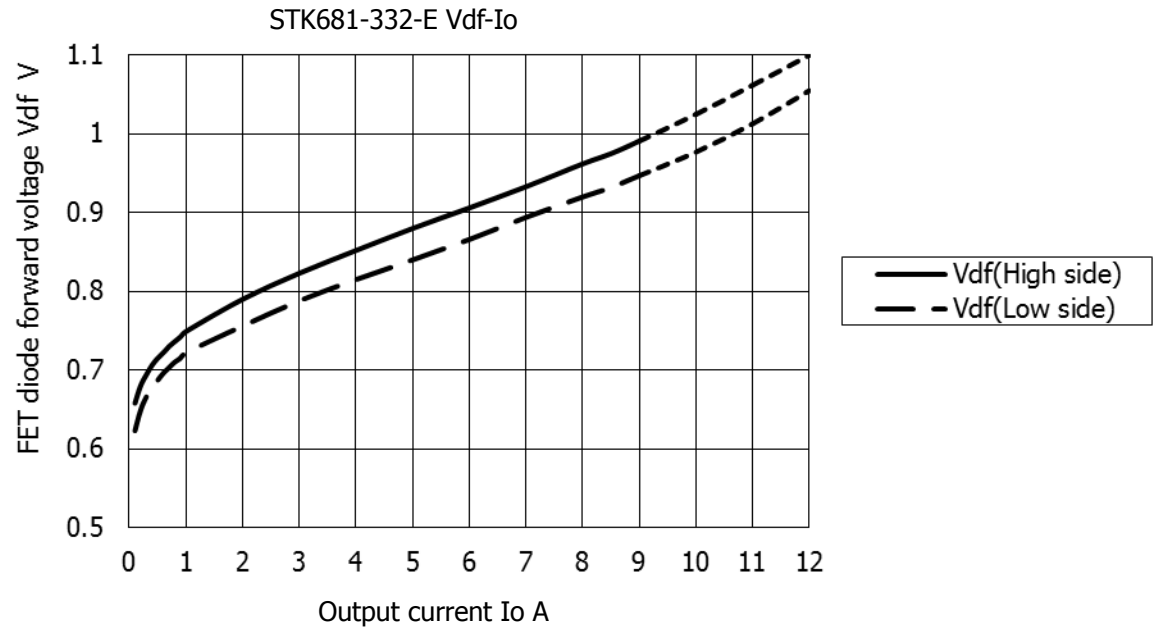
The PWM frequencies in the above graph indicate the ENABLE signal.
The same PWM Io derating curves as those shown above will be obtained when the internal PWM frequency of the STK681-352-E is used.
Increasing the Vcc supply voltage narrows the Io derating curve range, so Io should be set in reference to the above graph.
The above operating substrate temperature, Tc, is measured immediately when the motor is started.
Since Tc fluctuates due to the ambient temperature, Ta, the motor current value, and continuous or intermittent operations of the motor current, always confirms these values using an actual set.
The Tc temperature should be checked in the center of the metal surface of the product package.

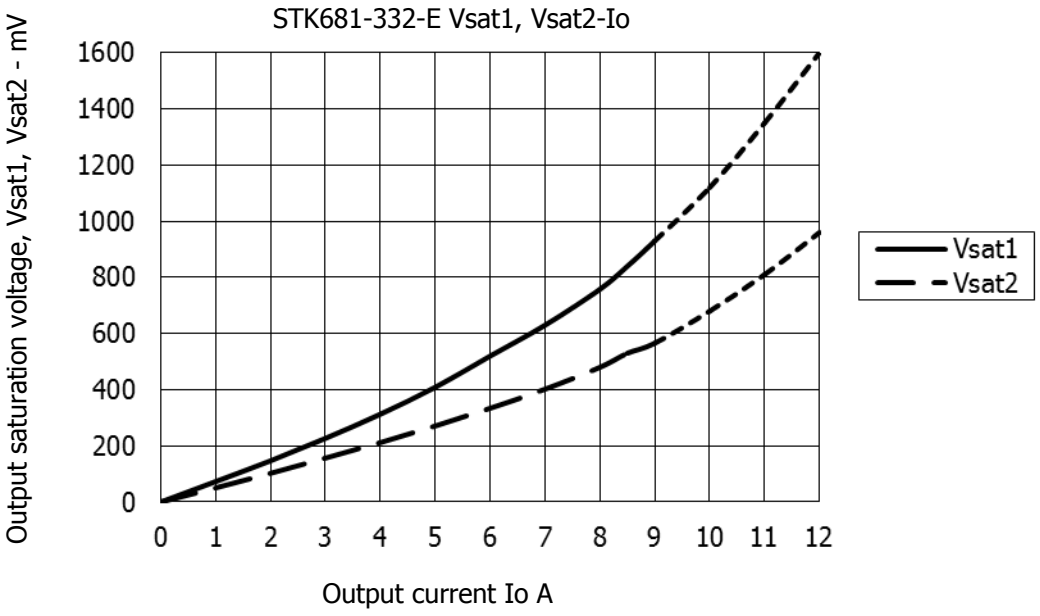
Allowable STK681-352-E braking current ranges

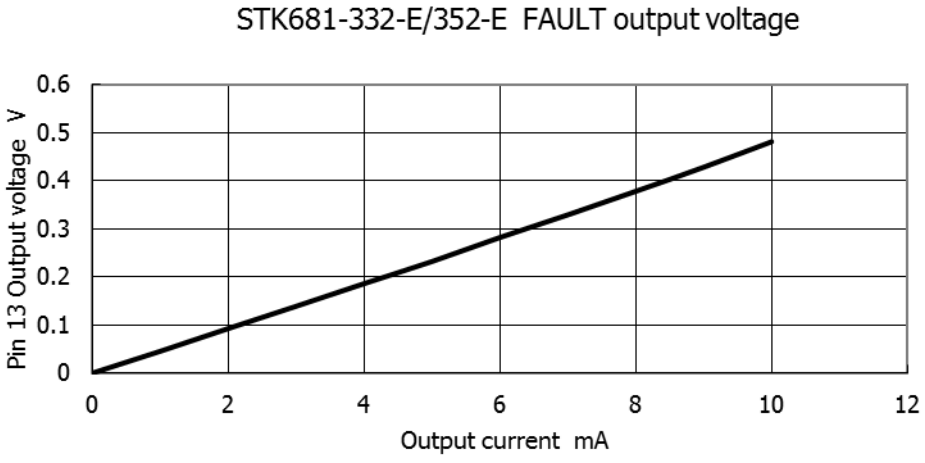


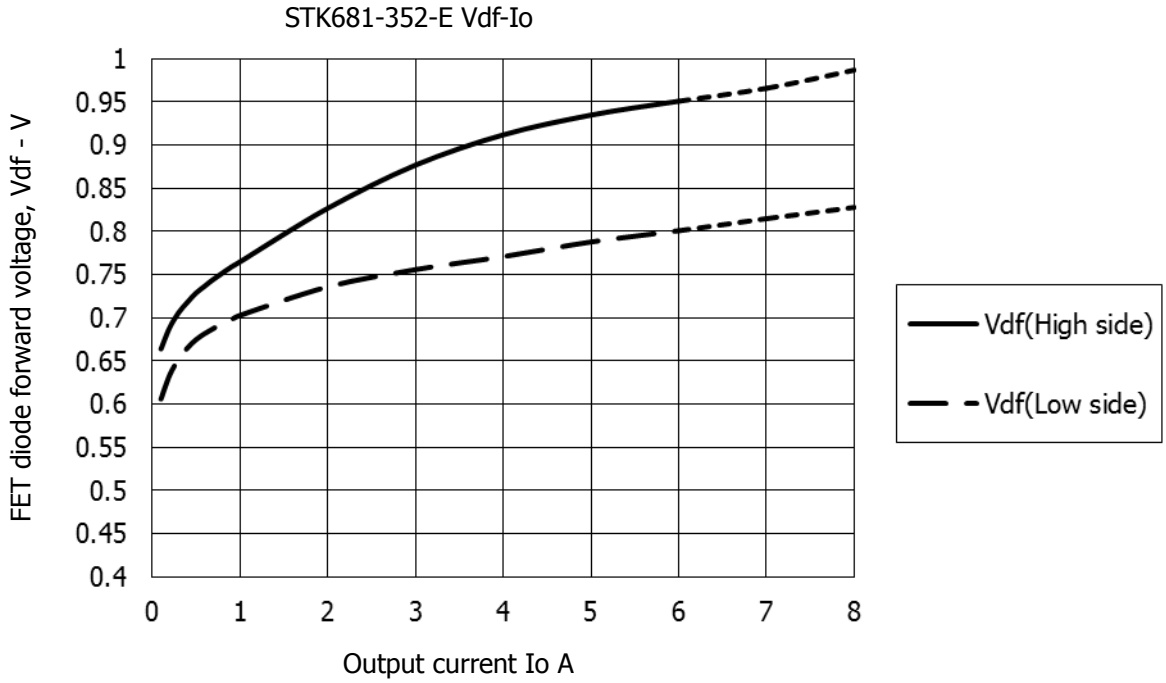
STK681-352-E Allowable Brake Current Range (High side: F1, F2=ON) or
Allowable Startup Current Range

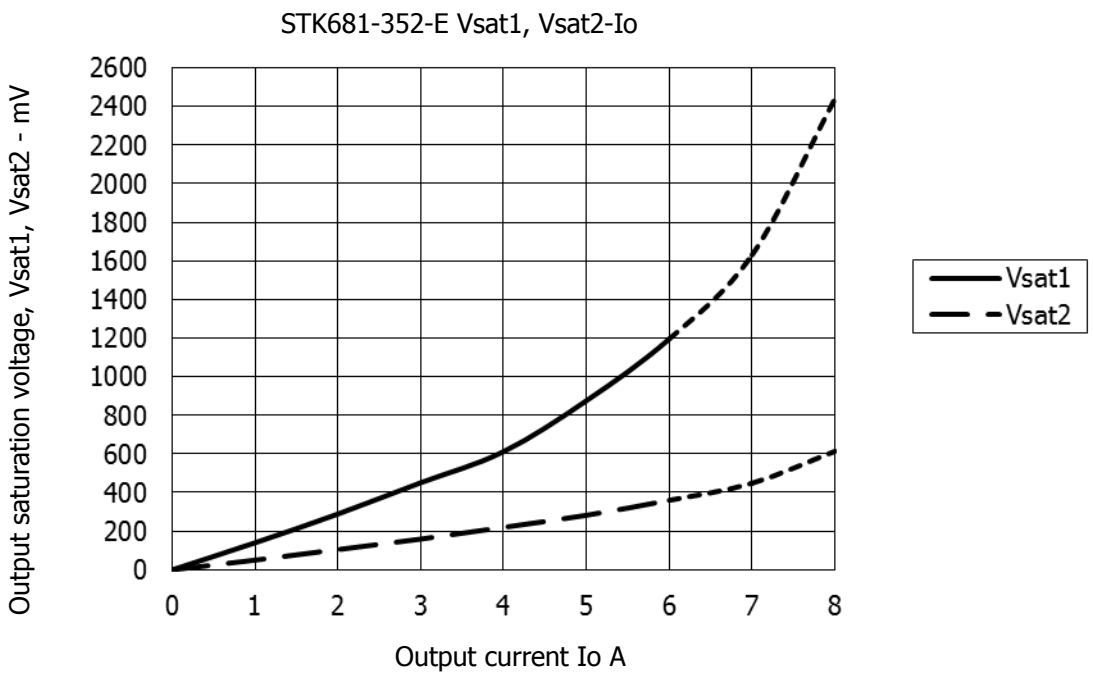



STK681-332-E Vdf-Io
FET diode forward voltage Vdf V
1.1
1
0.9
0.8
0.7
0.6
0.5
0 1 2 3 4 5 6 7 8 9 10 11 12
Output current Io A
Vdf(High side)
Vdf(Low side)

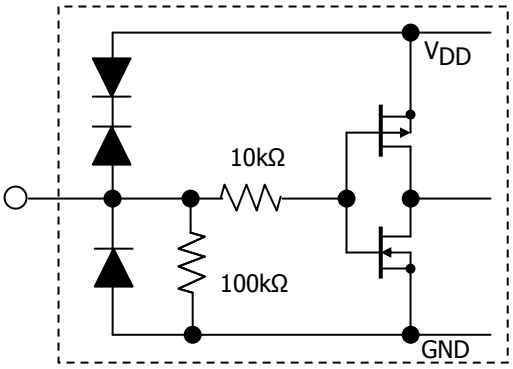
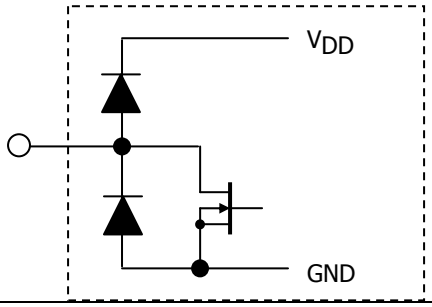
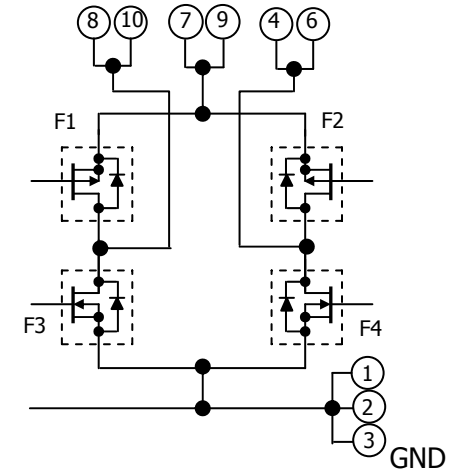
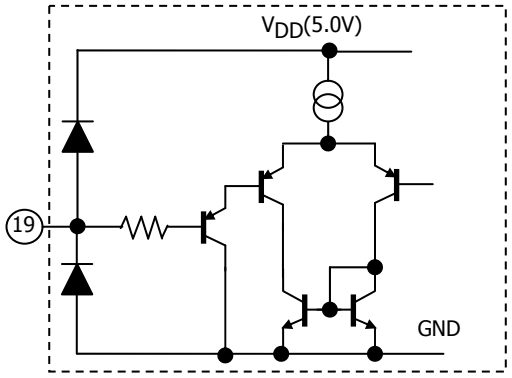

STK681-332-E Vsat1, Vsat2-Io
Output saturation voltage, Vsat1, Vsat2 - mV
1600
1400
1200
1000
800
600
400
200
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Output current Io A
Vsat1
Vsat2


STK681-332-E/352-E FAULT output voltage
Pin 13 Output voltage V
0.6
0.5
0.4
0.3
0.2
0.1
0
0 2 4 6 8 10 12
Output current mA


STK681-352-E Vdf-Io
FET diode forward voltage, Vdf - V
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0
1
2
3
4
5
6
7
8
Output current Io A
Vdf(High side)
Vdf(Low side)


STK681-352-E Vsat1, Vsat2-Io
Output saturation voltage, Vsat1, Vsat2 - mV
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
5
6
7
8
Output current Io A
Vsat1
Vsat2

Pin Functions

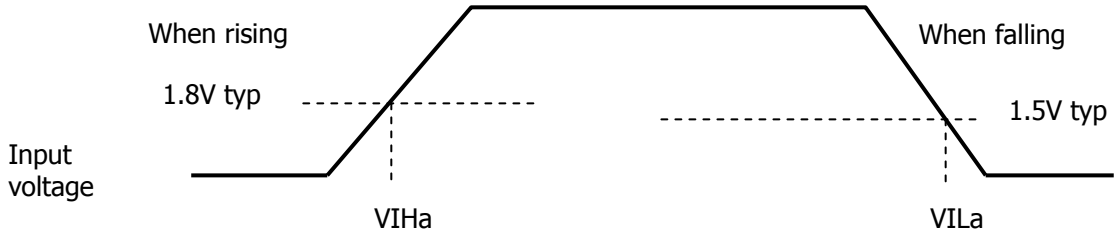
Pin Name	Pin No.	Pin Function	Equivalent circuit
IN1	16	Input pin for turning F2 and F4 ON and OFF At low level F2: ON and F4: OFF; at high level, F2: OFF and F4: ON	
IN2	17	Input pin for turning F1 and F3 ON and OFF At low level F1: ON and F3: OFF; at high level, F1: OFF and F3: ON	
ENABLE	18	Pin for turning F3 and F4 ON; At high level F31 and F42: ON ENABLE must be set Low when VDD is rising and falling. ENABLE must be set High to drive the motor.	
FAULT	13	Monitor pin used when either of the output short-circuit detector, overcurrent detector, or overheat detector is activated. When the detector is activated, this pin is set low and all of F1, F2, F3 and F4 in the final stage are latched off.	
OUT1	8, 10	This pin connects to the motor and outputs source/sync current depending on conditions at IN1 and IN2.	
OUT2	4, 6	This pin connects to the motor and outputs source/sync current depending on conditions at IN1 and IN2.	
Vref	19	This pin limits the peak current when motor startup. The current setting voltage, Vref, is set to the value of 4.9 times the voltage drop of the external current detection resistor. The internal overcurrent detection level is 0.48V, so setting Vref < 2.0V is recommended.	
GND	1, 2, 3	Power system ground	
S.GND	14	Control system ground	
Vcc	7, 9	Motor system supply voltage	
V_{DD} N.C	15	Control system supply voltage N.C	STK681-332-E STK681-352-E

Description of operation

Input pins

<IN1: pin 16, IN2: pin 17, ENABLE: pin 18>

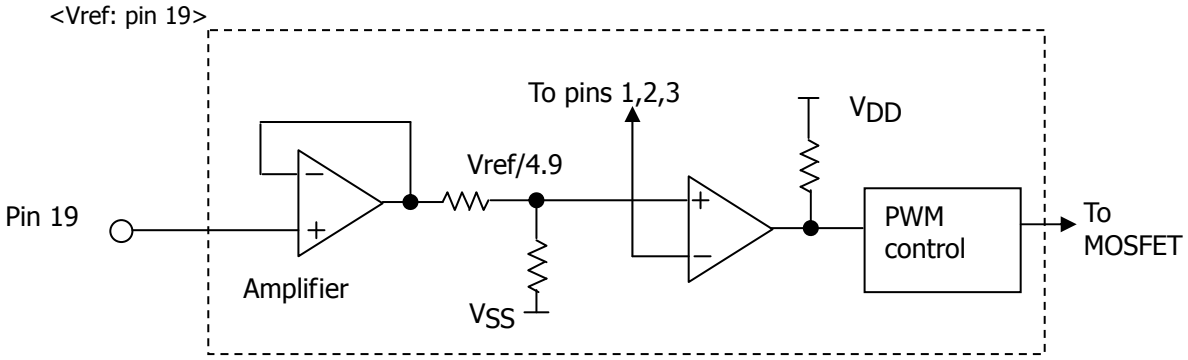
The input pins of this driver all use Schmitt input. Typical specifications at Tc=25°C are given below. Hysteresis voltage is 0.3V (VIHa-VILa).



Thus, the input voltage level must be considered as;

VIH=2.5Vmin

VIL=0.8Vmax



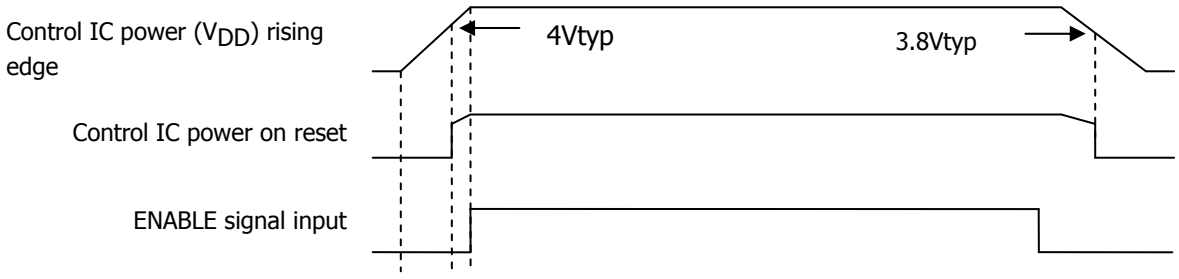
Reduced voltage detection

STK681-332-E

(1) V_{DD}

The internal control IC of the driver has a function that detects reduced voltage when V_{DD} is supplied. This reduced voltage threshold level is set to 4V (typ.), and the MOSFET gate voltage specification is 5V ±5%. So, a current flow through the output when V_{DD} is rising results in the power stress to the MOSFET due to insufficient gate voltage.

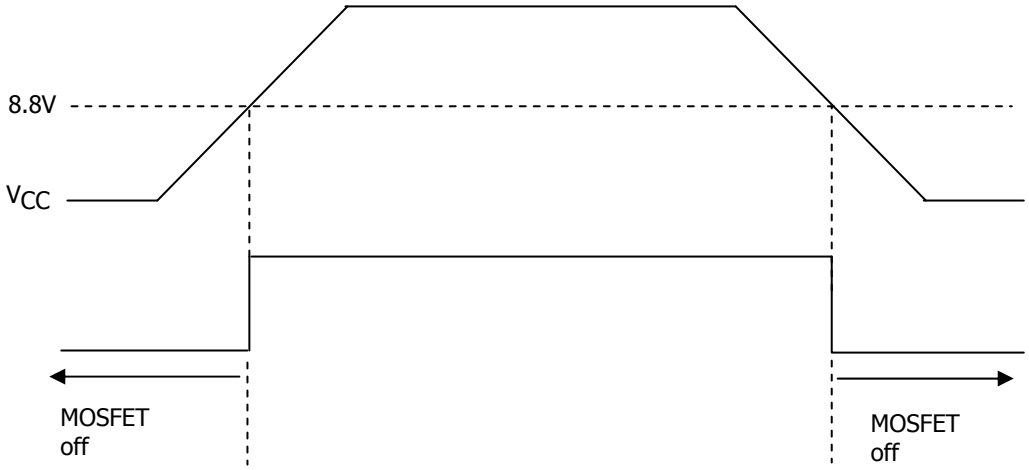
To prevent this power stress, set ENABLE = Low when V_{DD} < 4.75V, which is outside the normal operating supply voltage range of the MOSFET.



V_{DD}, ENABLE Signals Input Timing

(2) V_{CC}

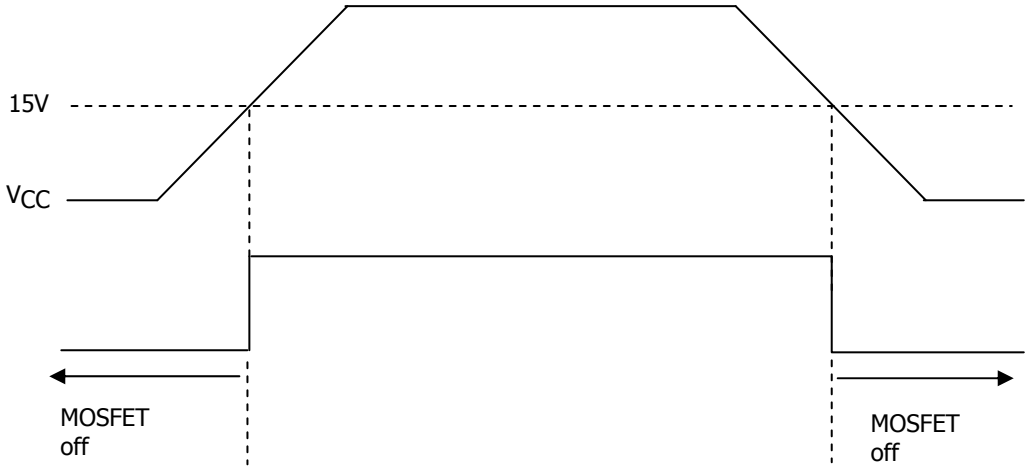
The internal control IC of the driver has a function that detects reduced voltage when V_{CC} is supplied, to prevent insufficient internal P-channel MOSFET gate voltage. The reduced voltage detection level is set to V_{CC} = 8.8V(typ.).



STK681-352-E

V_{CC} Reduced voltage detection

The internal control IC of the driver has a function that detects reduced voltage when V_{CC} is supplied, to prevent insufficient internal P-channel MOSFET gate voltage. The reduced voltage detection level is set to V_{CC} = 15V(typ.).



When V_{CC} < 15V, an internal control voltage has not risen above the preset threshold level, so ENABLE must be set to low in order to turn off the MOSFET.

Output short-circuit detection, Overcurrent Detection and Overheat Detection

Each detection function operates using a latch system and turns output off. To restore output operation, turn the V_{DD} power supply off and then on again to apply a power-on reset.

[Output Short-circuit Detection, Overcurrent Detection]

When the output pin is simply connected to the circuit GND or V_{CC}, or when the output load is short-circuited, the output short circuit detector must be activated and turn the output off.

Constant current PWM control can be performed by connecting a current detection resistor to pins 1, 2 and 3, and setting the Vref pin voltage to less than 2.0V. In addition, when this current detection resistor voltage exceeds 0.48V(typ.), the overcurrent detector is activated and shuts the output off.

[Overheat Detection]

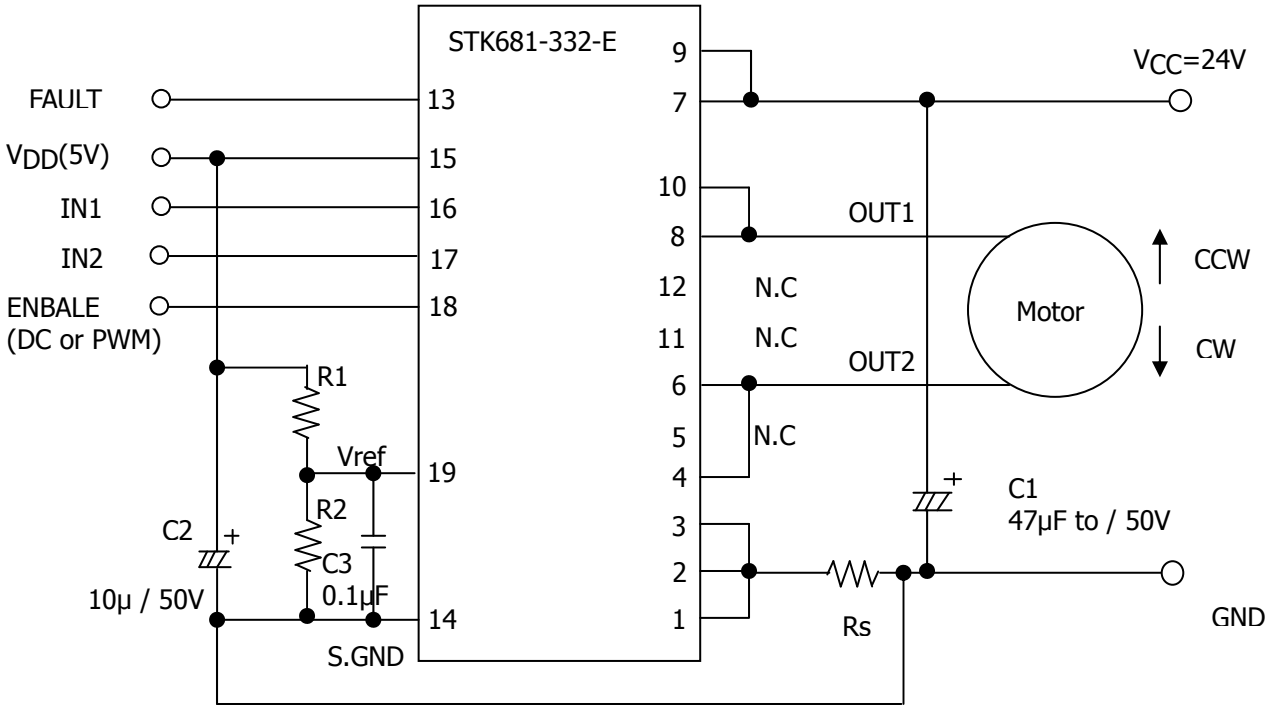
Rather than directly detecting the temperature of the semiconductor device, overheat detection detects the temperature

of the aluminum substrate (144°C typ).

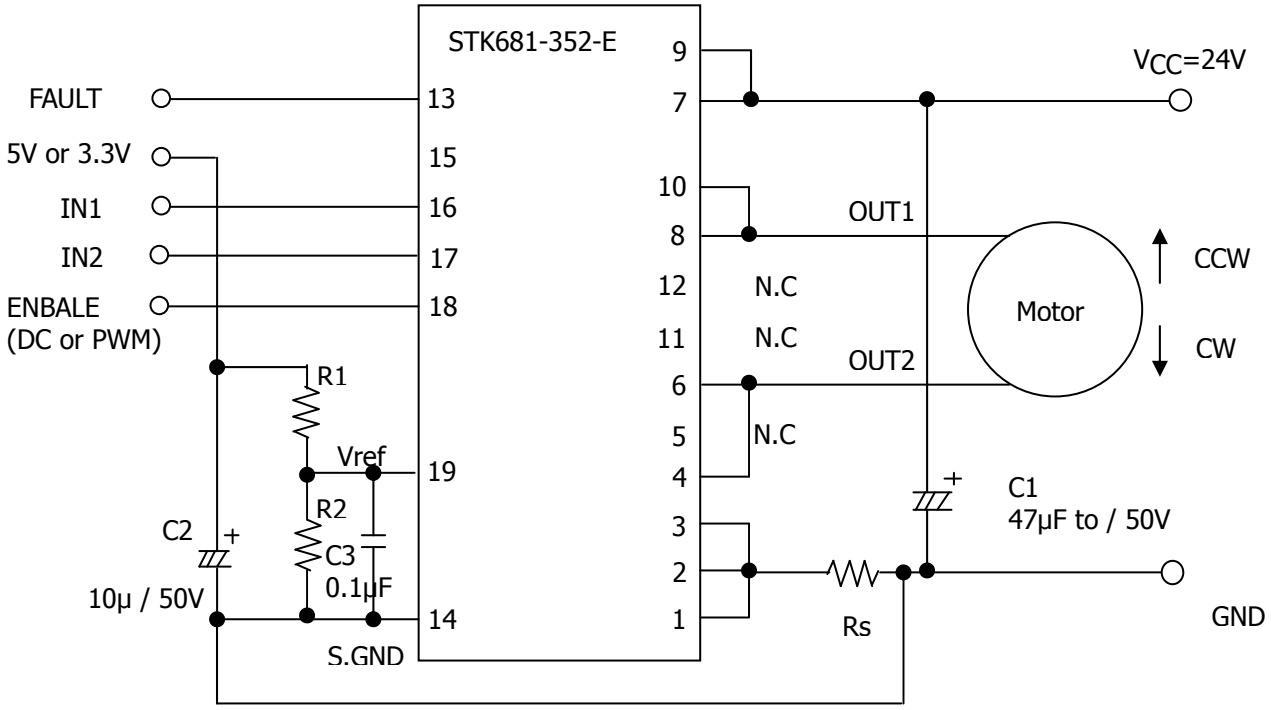
Within the allowed operating range of IO1 (6.1A:STK681-332-E, 4.6A:STK681-352-E) recommended in the specifications, if a heat sink attached for the purpose of reducing the operating substrate temperature, Tc, comes loose, the semiconductor can operate without breaking.

However, we cannot guarantee operations without breaking in the case of operation other than those recommended, such as operations at a current exceeding IOH max (6.1A:STK681-332-E, 4.6A:STK681-352-E) that occurs before overcurrent detection is activated.

Application Circuit Example (STK681-332-E)



Application Circuit Example (STK681-352-E)



Motor Drive Conditions (H: High-level input; L: Low-Level Input)

	IN1	IN2	ENABLE	Out1	Out2	Notes
Stop	H	L	L	V_{CC}	Floating	Turns the power supply OFF. ENABLE must be set Low when VDD is rising or falling.
	L	H	L	Floating	V_{CC}	
	H	H	L	Floating	Floating	
Forward (CW)	H	L	H	V_{CC}	GND	No input signal is needed that turns off the upper- and lower-side drive devices when switching the rotational direction.
			PWM	V_{CC}	PWM(F4)	
Reverse (CCW)	L	H	H	GND	V_{CC}	
			PWM	PWM(F3)	V_{CC}	
Brake	H	H	H	GND	GND	GND side MOSFET ON
			PWM	L-PWM(F3)	L-PWM(F4)	
	L	L	L or H	V_{CC}	V_{CC}	Vcc side MOSFET ON

STK681-332

Output control is enabled by applying an external PWM signal to the ENABLE pin.

The product can run at a minimum external PWM pulse width of 1μs. In the case when the high pulse width is less than 16μs, however, the IC may fail to detect a short-circuit condition when an output short-circuit occurs.

If V_{DD} is turned off in the condition with the ENABLE pin set to high during motor rotation or PWM operation, the FAULT signal is output when V_{DD} is falling, indicating error condition. For this reason, ENABLE must be set to low when V_{DD} is rising or falling.

When both IN1 and IN2 are set low, the MOSFET on the V_{CC} side is driven. To minimize the loss when stopped, set IN1 = IN2 = High and ENABLE = Low to turn off the gate signal to the V_{CC} side MOSFETs.

STK681-352

Output control is enabled by applying an external PWM signal to the ENABLE pin.

The product can run at a minimum external PWM pulse width of 1μs. In the case when the high pulse width is less than 16μs, however, the IC may fail to detect a short-circuit condition when an output short-circuit occurs.

FAULT signal is generated to indicate an error condition if V_{CC} falls below the allowable operating range when the ENABLE pin is set to high during motor rotation or PWM operation. For this reason, ENABLE must be set to low when V_{CC} is rising or falling.

When both IN1 and IN2 are set low, the MOSFET on the V_{CC} side is driven. To minimize the loss when stopped, set IN1 = IN2 = High and ENABLE = Low to turn off the gate signal to the V_{CC} side MOSFETs.

Setting the current limit using the Vref pin

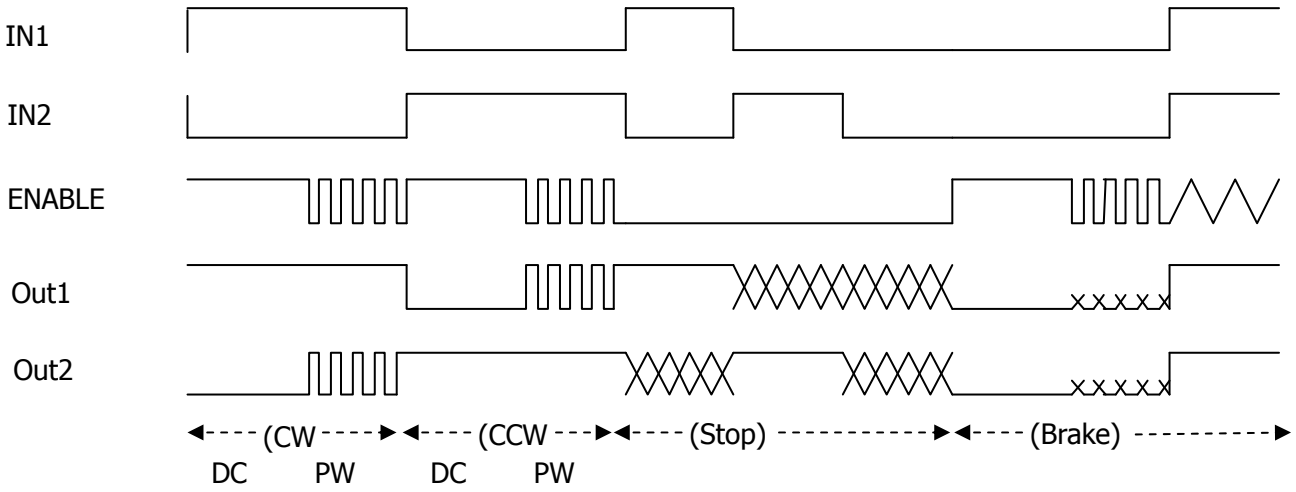
Output current peak(Iop)=(Vref÷4.9)÷Rs

"4.9" in the above formula indicates the portion of the Vref voltage that is divided using the circuit inside the control IC.

Vref=(R2÷(R1+R2))×5.0V(or 3.3V)

Rs is the external current detection resistance value of the HIC, and Vref ≤ 2.0V must be satisfied so that overcurrent detection is not triggered.

Sample Timing Diagram



Notes

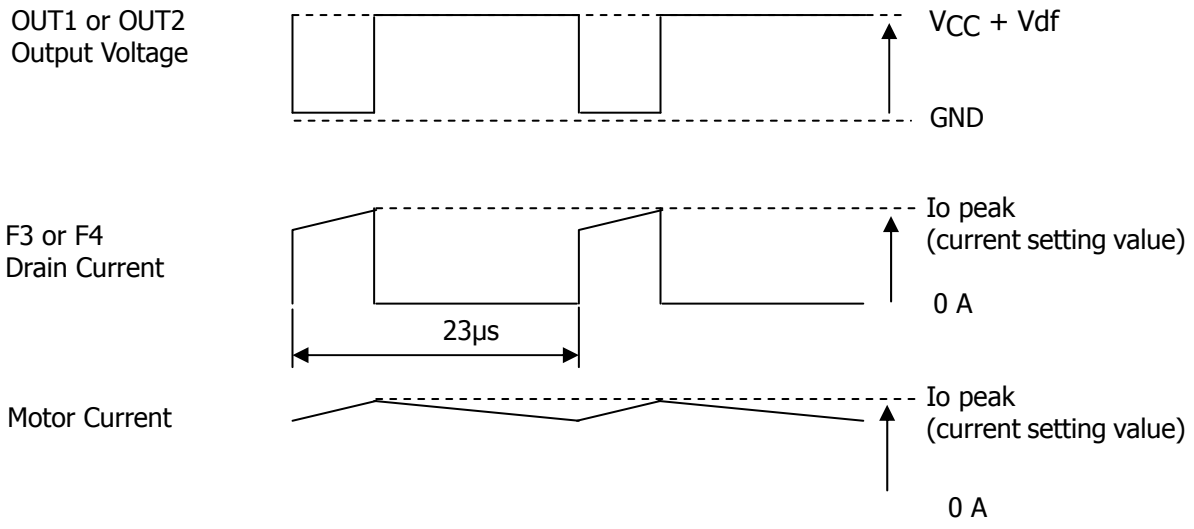
(1) Be sure to set the capacitance of the power supply bypass capacitor, C1, so that the ripple current of the capacitor, which varies as motor current increases, falls within the allowed range.

(2) Chopping operations based on F3 and F4 are used for current control. The timing given below is used for OUT1 or OUT2 voltage output and for F3 or F4 drain current.

(3) Do not connect the N.C pins (5, 11, 12 pin) shown in the internal block diagram or sample application circuit to a circuit pattern on the PCB.

(4) If the current detection resistor, Rs, connected to pin1, pin2, and pin3 is short-circuited, the overcurrent detection circuit does not operate. If the output pin is short-circuited directly to V_{CC} or connected directly to GND, an output short-circuit condition is detected and the output is latched in the off state. To restart the operation, turn on V_{DD} again.
(In case of STK681-352-E, to restart the operation, turn on V_{CC} again.)

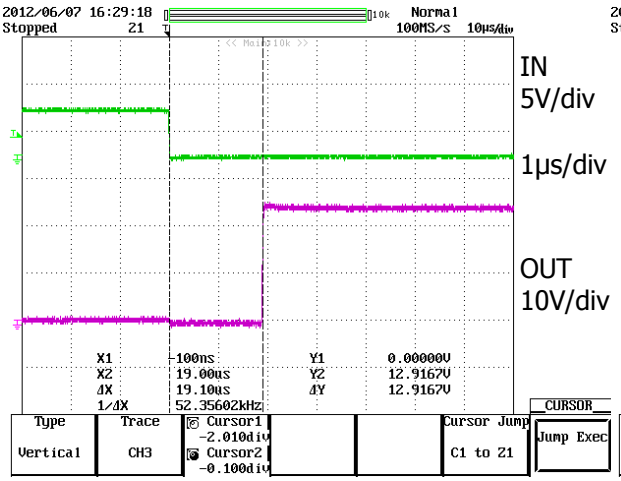
(5) Smoke Emission Precautions: There is a possibility of smoke emission if the hybrid IC is subjected to physical or electrical damage as the result of being used without compliance with the specifications.



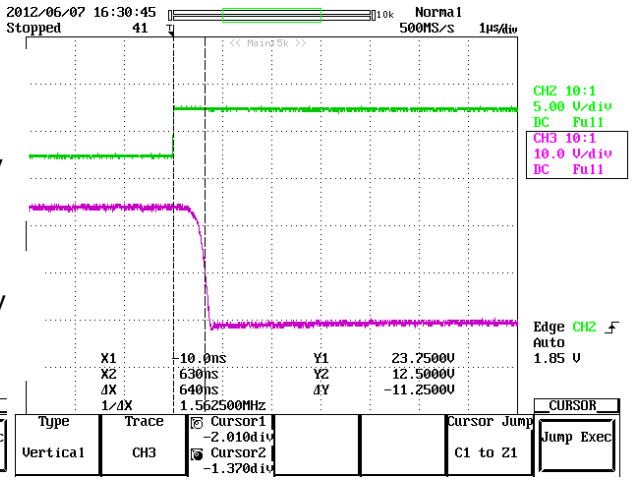
Delay time

V_{CC}=24V, V_{DD}=5.0V, Load:8Ω + 5mH, IN1 or IN2:1kHz/50%
STK681-332-E,352-E

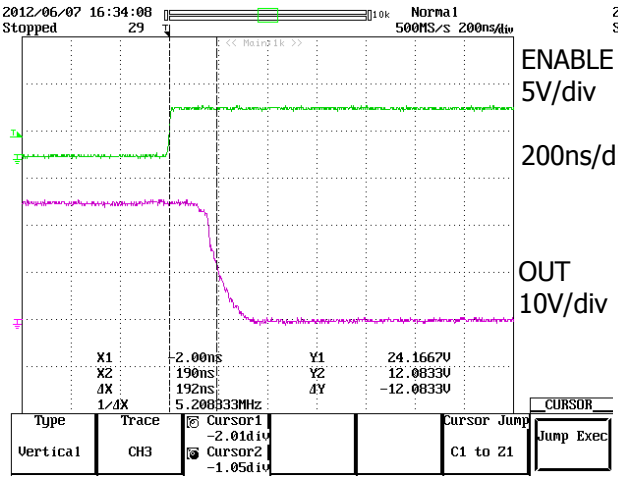
Turn-on delay time



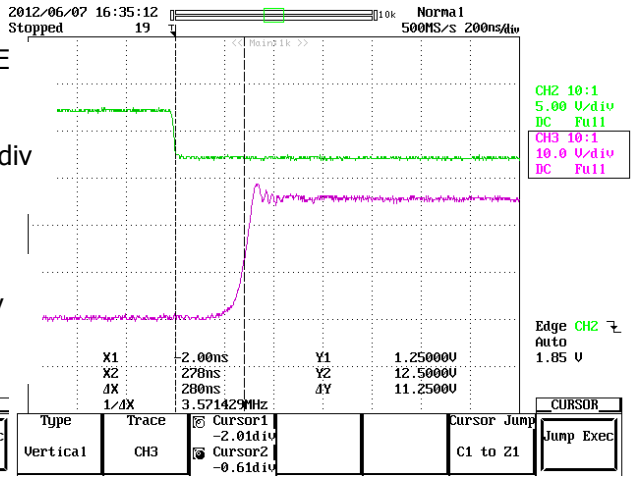
Turn-off delay time



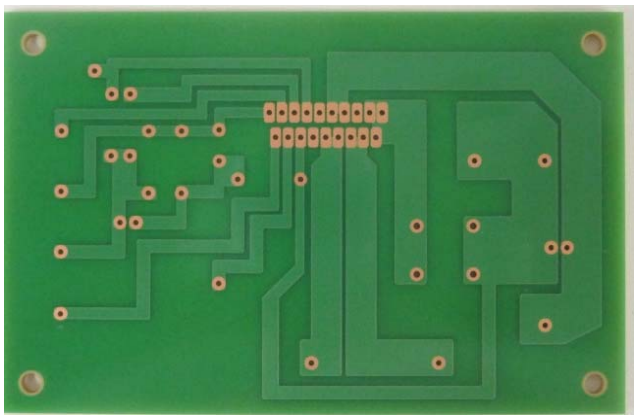
ENABLE Turn-on delay
(Low side MOSFET turn on)



ENABLE Turn-off delay
(Low side MOSFET turn off)

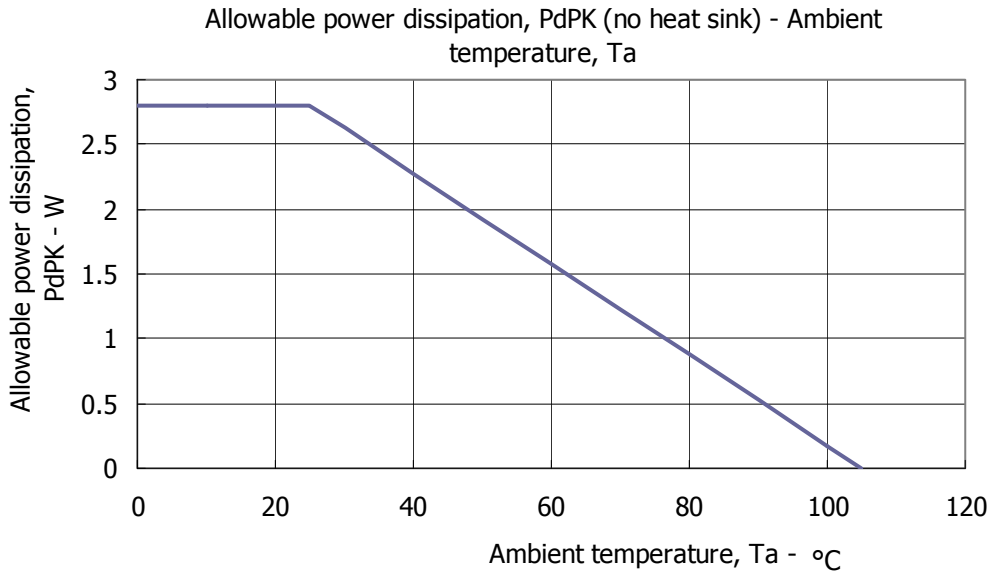


Substrate Specifications (Substrate recommended for operation of STK681-332/352-E)
Size: 100mm × 65mm × 1.6mm 1-layer board
Material: Phenol



Copper side (35μ)

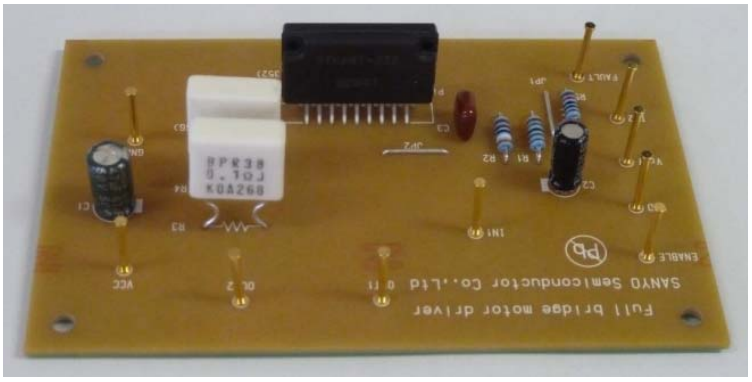
Allowable power dissipation (Reference value)

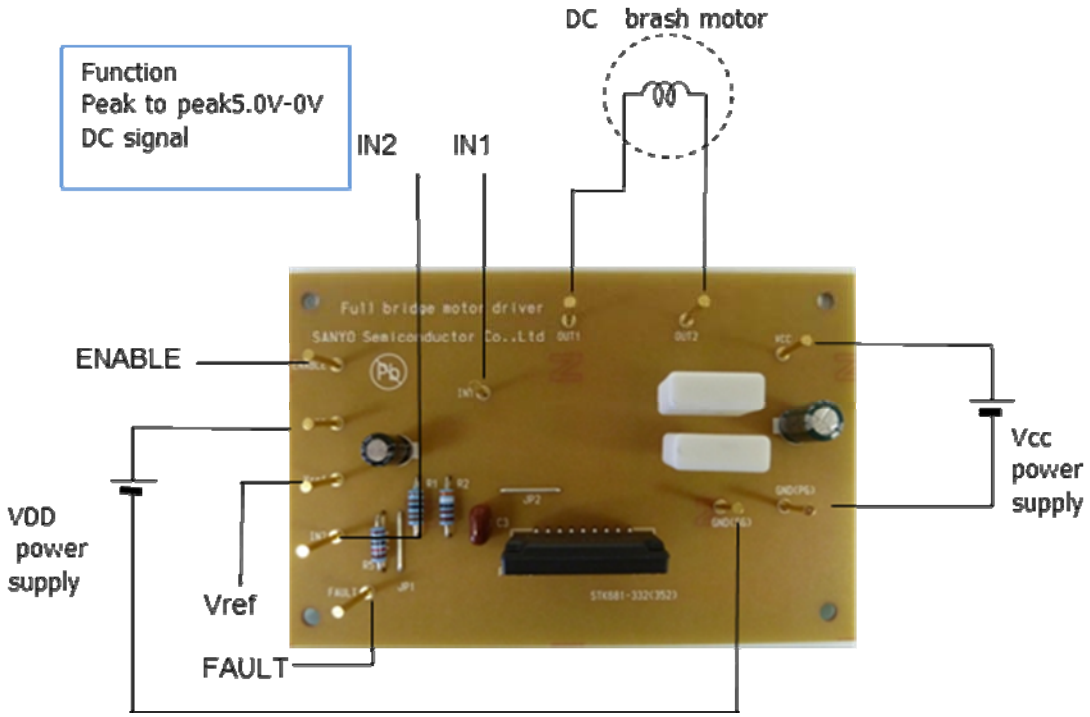


If you need heat sink to STK681-332 and 352, mount heat sink with something such as clips.

Evaluation board

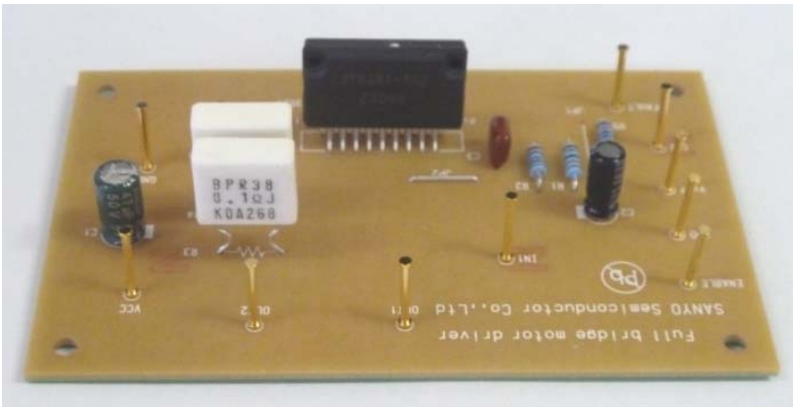
STK681-332-E (100.0mm x 65.0mm x 1.6mm, phenol 1-layer board)

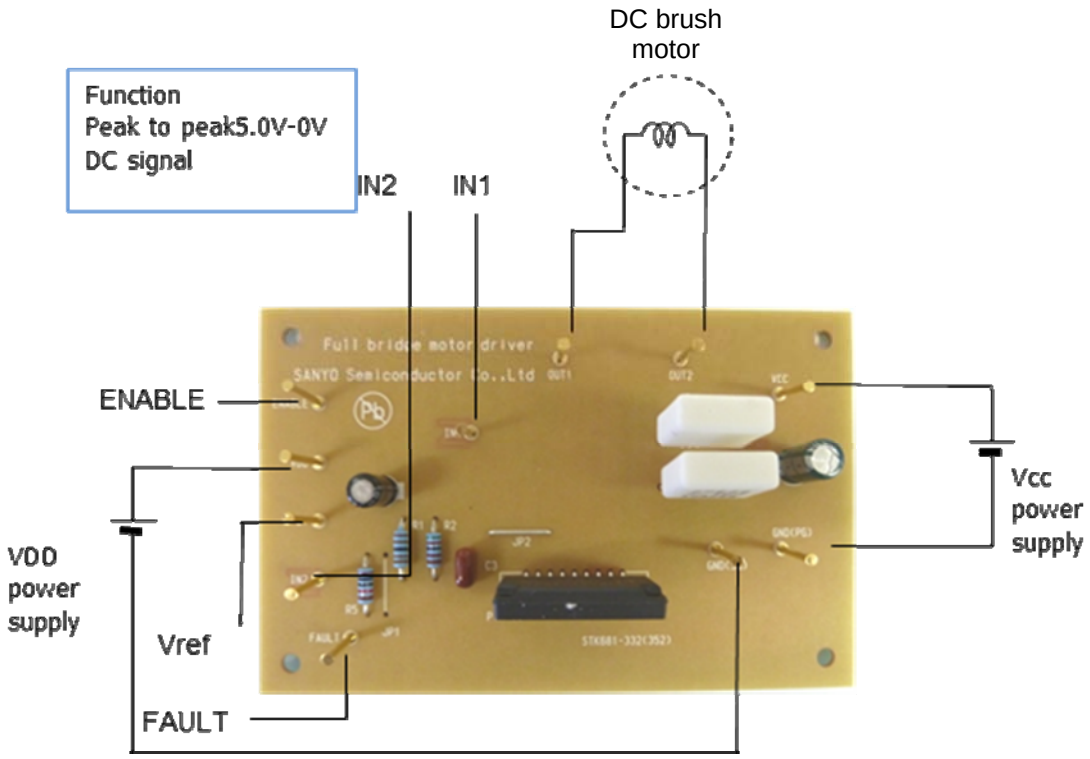




Evaluation board

STK681-352-E (100.0mm x 65.0mm x 1.6mm, phenol 1-layer board)



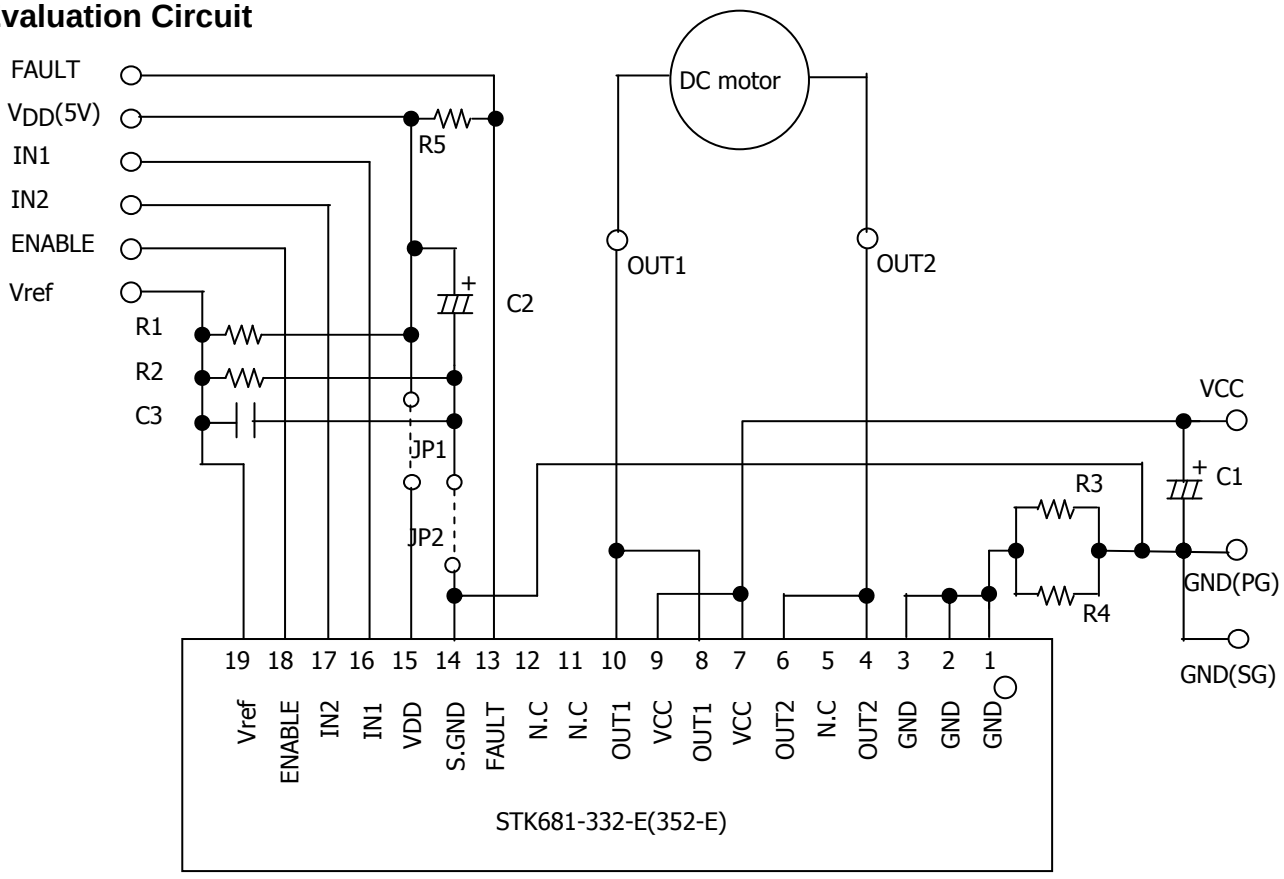


Bill of Materials for STK681-332/352-E Evaluation Board

Designator	Quantity	Description	Value	Tolerance	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
C1	1	V_{CC} Bypass Capacitor	47µF /50V	±20%		SUN ERECTRONICS	50ME47CA	YES	YES
C2	1	V_{DD} Bypass Capacitor	10µF /50V	±20%		SUN ERECTRONICS	50ME10CA	YES	YES
C3	1	Vref stabilization Capacitor	0.1µF /50 V	±10%		Panasonic	ECQV1H104JL2	YES	YES
R1	1	Resistor to set Vref		±1%		AKAHANE ERECTRONICS	RN14S****FK	YES	YES
R2	1	Resistor to set Vref		±1%		AKAHANE ERECTRONICS	RN14S****FK	YES	YES
R3, R4	2	Output current detective resistor	0.1Ω	±5%		KOA	BPR38CFR10J	YES	YES
R5	1	Pull-up Resistor	10 kΩ	±5%		AKAHANE ERECTRONICS	RN14S103JK	YES	YES
HIC	1	IPM				ON Semiconductor	STK681-332	NO	YES
JP1, JP2	2	Jumper for STK681-332				Mac-Eight	JR-4	YES	YES
JP2	1	Jumper for STK681-352				Mac-Eight	JR-4	YES	YES
TP1 to TP11	11	Test Point				Mac-Eight	ST-1-3	YES	YES

Notes: R1 and R2 are used to Vref for current setting. Therefore their value do not mention on this table.

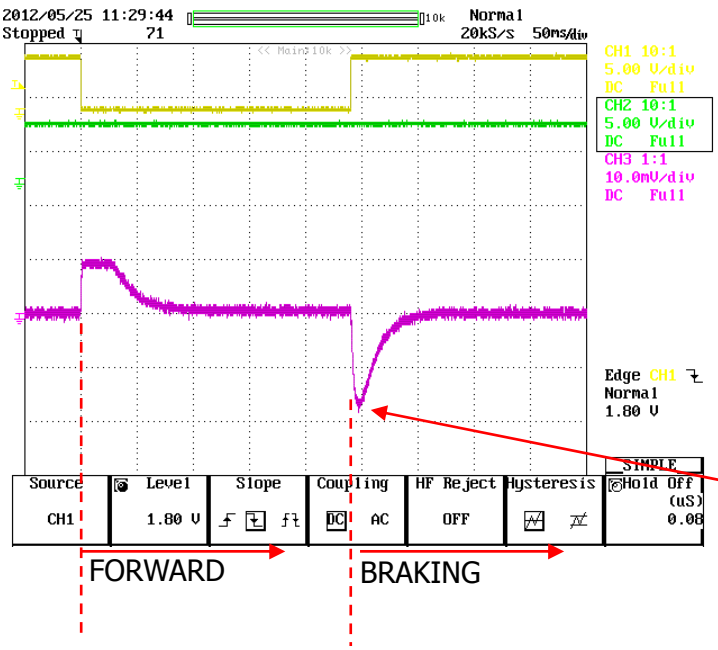
Evaluation Circuit



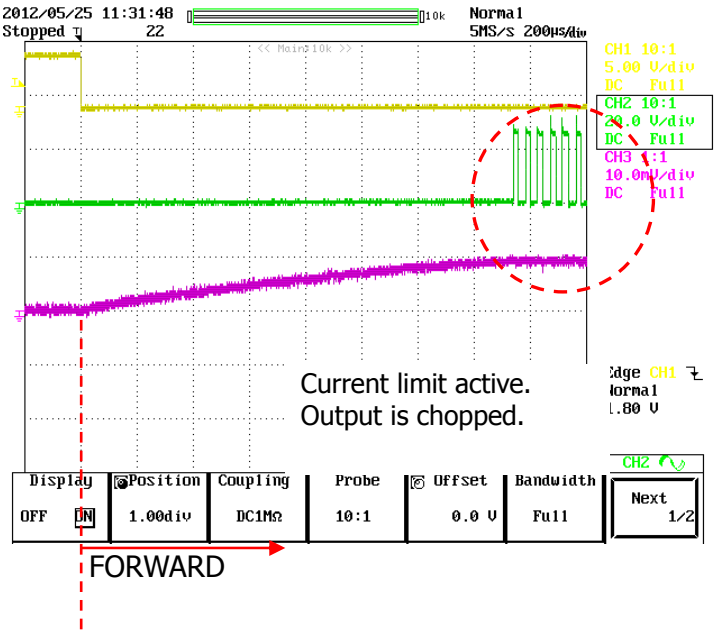
Notes: Open JP1 with STK681-352-E.

Waveform example

STK681-332(Current limit 5A setting)
IN1 and IN2; 5V/div, Output current; 5A/div

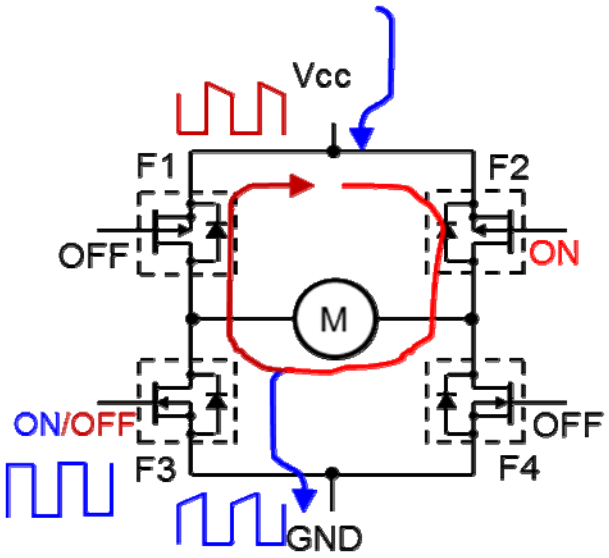


STK681-332(Current limit 5A setting)
IN1 5V/div, OUT2 20V/div, Output current; 5A/div

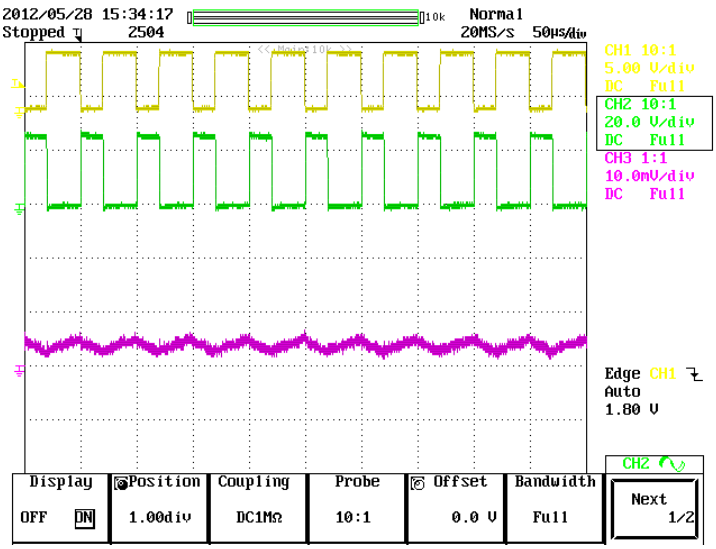


Current control is slow decay.

STK681-332 and 352 control MOSFET at Low side by constant-current PWM control system.
Current control enters Slow decay mode.



STK681-332 and 352 have ENABLE terminal built-in, which controls motor rotation.
At the point of ENABLE=High, F3 or F4 at Low side turns on.
STK681-332, 352(ENABLE: 20kHz)
ENABLE ; 5V/div, OUT1 ; 20V/div, Output current; 0.5A/div



ENABLE High duty 60%

OUT1

Output current

Evaluation Board Manual

[Supply Voltage] V_{CC} (10 to 38V: STK681-332-E): Power Supply for stepping motor
V_{CC} (10 to 29V: STK681-352-E): Power Supply for stepping motor

Vref (0 to 2.0V): Const. Current Control for Reference Voltage
VDD (5V) : Power Supply for internal logic IC

[Operation Guide]

1. Motor Connection:
   Connect the motor to OUT1 and OUT2.

2. Initial Condition Setting:
   Set to signal condition IN1=H, IN2=H, and ENABLE=L.

3. Power Supply:
   <STK681-332-E>
   At first, supply DC voltage to V_{DD} (5.0V), and VREF.
   Next, supply DC voltage to V_{CC}.
   <STK681-352-E>
   At first, supply DC voltage to V_{DD} (3.3V or 5.0V), and VREF.
   Next, supply DC voltage to V_{CC}.

4. Set to Forward or Reverse signal condition with ENABLE=Low.
   Turn "High" ENABLE signal.
   Output current flows between OUT1 and OUT2.

5. Motor Operation

[Setting the current limit using the Vref pin]

Output current peak(Iop)=(Vref÷4.9)÷Rs
"4.9" in the above formula indicates the portion of the Vref voltage that is divided using the circuit inside the control IC.
Vref=(R2÷(R1+R2))×5.0V(or 3.3V)
Rs is the external current detection resistance value of the HIC, and Vref ≤ 2.0V must be satisfied so that overcurrent detection is not triggered.

Notes in design

(1) Allowable operating range

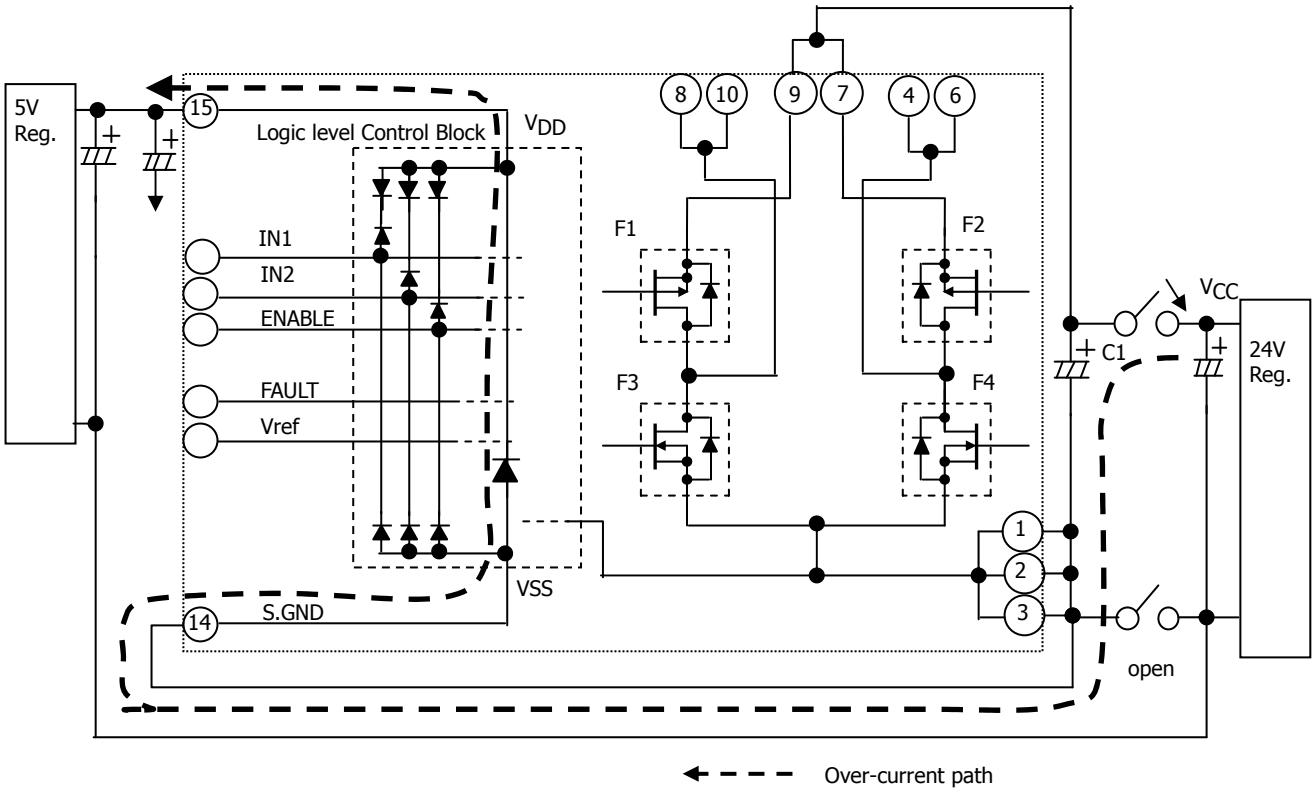
Operation of this product assumes use within the allowable operating range. If a supply voltage or an input voltage outside the allowable operating range is applied, an overvoltage may damage the internal control IC or the MOSFET.
If a voltage application mode that exceeds the allowable operating range 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 PC 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 1kΩ · resistors in lines connected to the input pins.
Take measures such as inserting resistors in lines connected to the input pins.

(3) Power connectors (STK681-332-E)

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.
Always connect the GND pin before supplying V_{CC}.



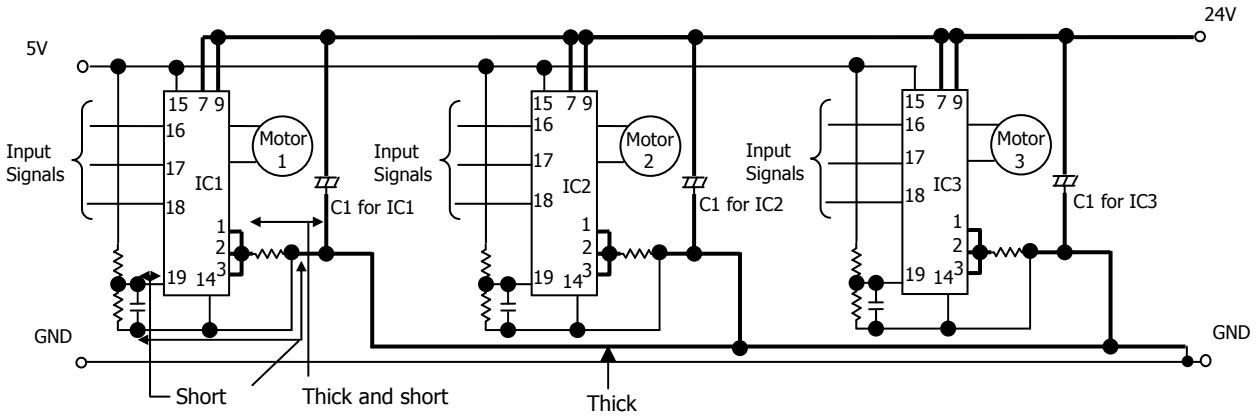
(4) Input Signal Lines

1) Do not use an IC socket to mount the driver, and instead solder the driver directly to the PC 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 due to electromagnetic induction to small signal lines, do not design small signal lines (sensor signals, 5V or 3.3V power supply signal lines) that run parallel near the motor output lines OUT1 and OUT2.
3) Pins 5, 11 and 12 of this product are N.C pins. Do not connect any wiring to these pins.

(5) When mounting multiple drivers on a single PC board

When mounting multiple drivers on a single PC 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.

STK681-332-E



STK681-352-E