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# STK681-360-E

Thick-Film Hybrid IC

## Forward/Reverse Motor Driver

### Overview

The STK681-360-E is a hybrid IC for use in PWM current control forward/reverse DC motor driver with brush.

### Applications

- Office photocopiers, printers, etc.

### Features

- Allows forward, reverse, and brake operations in accordance with the external input PWM signal.
- 5.8A peak startup output current and 8A peak brake output current.
- Built-in current detection resistor ( $0.05\Omega$  : resistor tolerance  $\pm 2\%$ ) and supports constant-current control.
- 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.

### Specifications

**Absolute maximum ratings** at  $T_c = 25^\circ\text{C}$

| Parameter                       | Symbol               | Conditions   | Ratings      | unit |
|---------------------------------|----------------------|--|--------------|------|
| Maximum supply voltage 1        | V <sub>cc1</sub> max | V <sub>cc2</sub> =0V   | 52           | V    |
| Maximum supply voltage 2        | V <sub>cc2</sub> max | No signal  | -0.3 to +7.0 | V    |
| Input voltage                   | V <sub>IN</sub> max  | Logic input pins   | -0.3 to +7.0 | V    |
| Output current1                 | I <sub>O</sub> max   | V <sub>DD</sub> =5.0V, DC current  | 5.8          | A    |
| Brake current                   | I <sub>OB</sub> max  | V <sub>DD</sub> =5.0V, square wave current, operating time 60ms (single pulse ,low side brake) | 8            | A    |
| Allowable power dissipation     | PdPK max             | No heat sink   | 3.1          | W    |
| Operating substrate temperature | T <sub>c</sub>       | Metal surface temperature of the package   | 105          | °C   |
| Junction temperature            | T <sub>j</sub> max   |  | 150          | °C   |
| Storage temperature             | T <sub>stg</sub>     |  | -40 to +125  | °C   |

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.

### ORDERING INFORMATION

See detailed ordering and shipping information on page 12 of this data sheet.

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## Allowable Operating Ranges at $T_a = 25^\circ\text{C}$

| Parameter                                   | Symbol          | Conditions   | Ratings   | unit |
|---|-----------------|--|-----------|------|
| Operating supply voltage 1                  | Vcc1            | With signals applied   | 10 to 30  | V    |
| Operating supply voltage 2                  | Vcc2            | With signals applied   | 5±5%      | V    |
| Input voltage                               | V <sub>IN</sub> | 10,11,12,13,14,15,17pin  | 0 to Vcc2 | V    |
| Output current 1 *1,3                       | I <sub>O1</sub> | Vcc2=5.0V, DC current, Tc ≤ 70°C   | 4.5       | A    |
| Output current 2 *1,3                       | I <sub>O2</sub> | Vcc2=5.0V, DC current, Tc=90°C   | 3.7       | A    |
| Output current 2 *1,3                       | I <sub>O3</sub> | Vcc2=5.0V, DC current, Tc=105°C  | 3.0       | A    |
| Brake current *1                            | I <sub>OB</sub> | Vcc2=5.0V, square wave current, operating time 3.6ms, Low side brake, Tc=105°C | 8.0       | A    |
| PMM pin frequency range *2                  | PWM             | Minimum pulse width: at least 10μs   | 0 to 20   | kHz  |
| Recommended operating substrate temperature | Tc              | No condensation  | 0 to 105  | °C   |

### Notes

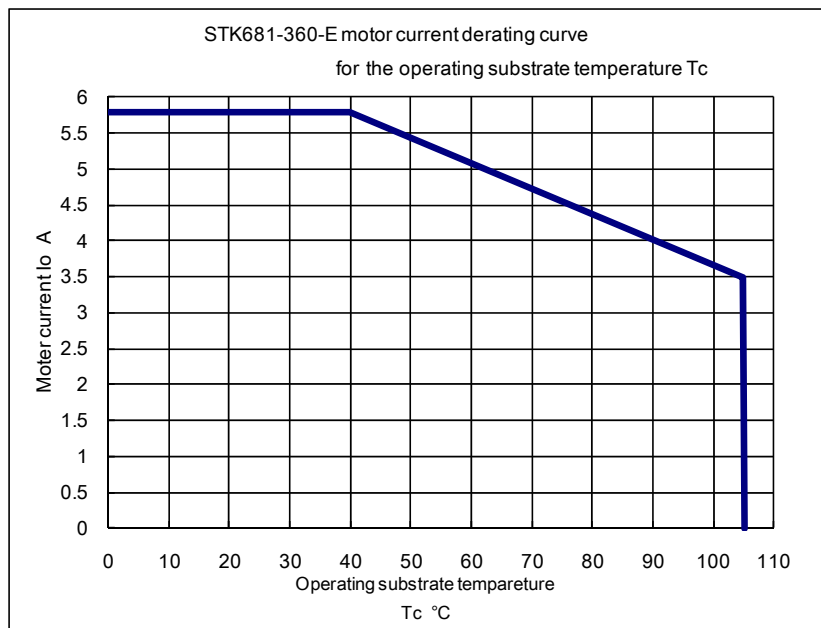
- \*1 Refer to the graph for each conduction-period tolerance range for the output current and brake current.
- \*2 PWM pin (14pin) is active Low.
- \*3 Io1, Io2, Io3 connect Vref2 pin to GND and a current value when over-heating current control does not work.

## Electrical Characteristics at Tc=25°C, VCC=24V, VDD=5.0V \*4

| Parameter                   | Symbol            | Conditions  | min | typ  | max  | unit |
|-----------------------------|-------------------|---|-----|------|------|------|
| VCC2 supply current         | I <sub>CCO</sub>  | Forward or reverse operation                            |     | 2.6  | 3.5  | mA   |
| FET diode forward voltage   | V <sub>df</sub>   | If=1A (R <sub>L</sub> =23Ω)                             |     | 0.8  | 1.4  | V    |
| Output saturation voltage 1 | V <sub>sat1</sub> | R <sub>L</sub> =23Ω, F1, F2                             |     | 0.09 | 0.15 | V    |
| Output saturation voltage 2 | V <sub>sat2</sub> | R <sub>L</sub> =23Ω, F3, F4+ current detection resistor |     | 0.11 | 0.17 | V    |
| Output leak current         | I <sub>OL</sub>   | F1, F2, F3, and F4 OFF operation                        |     |      | 50   | μA   |
| Input high voltage 1        | V <sub>IH1</sub>  | IN1, IN2 pin  | 4.5 |      |      | V    |
| Input high voltage 2        | V <sub>IH2</sub>  | PWM pin   | 4.5 |      |      | V    |
| Input low voltage           | V <sub>IL</sub>   | IN1, IN2 and PWM pins                                   |     |      | 0.6  | V    |
| Input current               | I <sub>IH1</sub>  | IN1, IN2 pins, V <sub>IH1</sub> =5V                     | 0.1 | 0.2  | 0.4  | mA   |
| Current setting voltage     | V <sub>ref1</sub> | Between V <sub>ref1</sub> and S.P pins                  |     | 0.29 |      | V    |
| PWM Input current           | I <sub>ILP</sub>  | PWM pin, V <sub>IL</sub> =GND                           | 0.1 | 0.6  | 0.65 | mA   |
| PWM pin turn-on delay time  | ton-*             | Output current 1A                                       |     | 0.8  |      | μs   |
| PWM pin turn-on delay time  | toff-*            | Output current 1A                                       |     | 3.5  |      | μs   |

### Notes

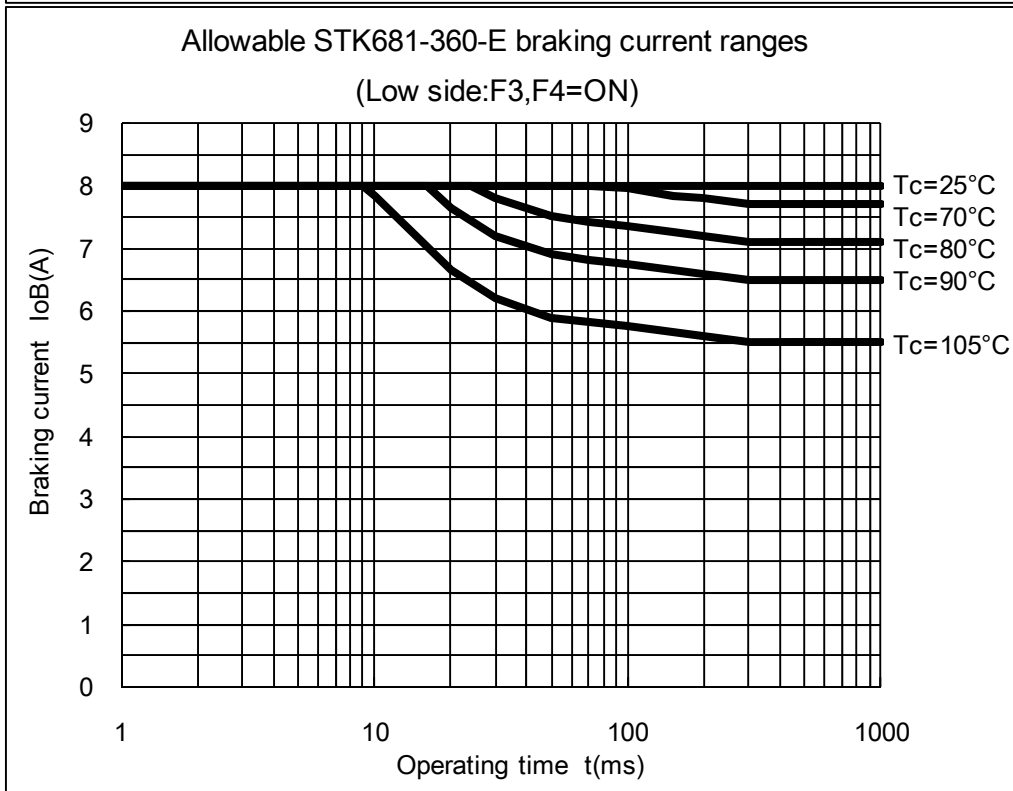
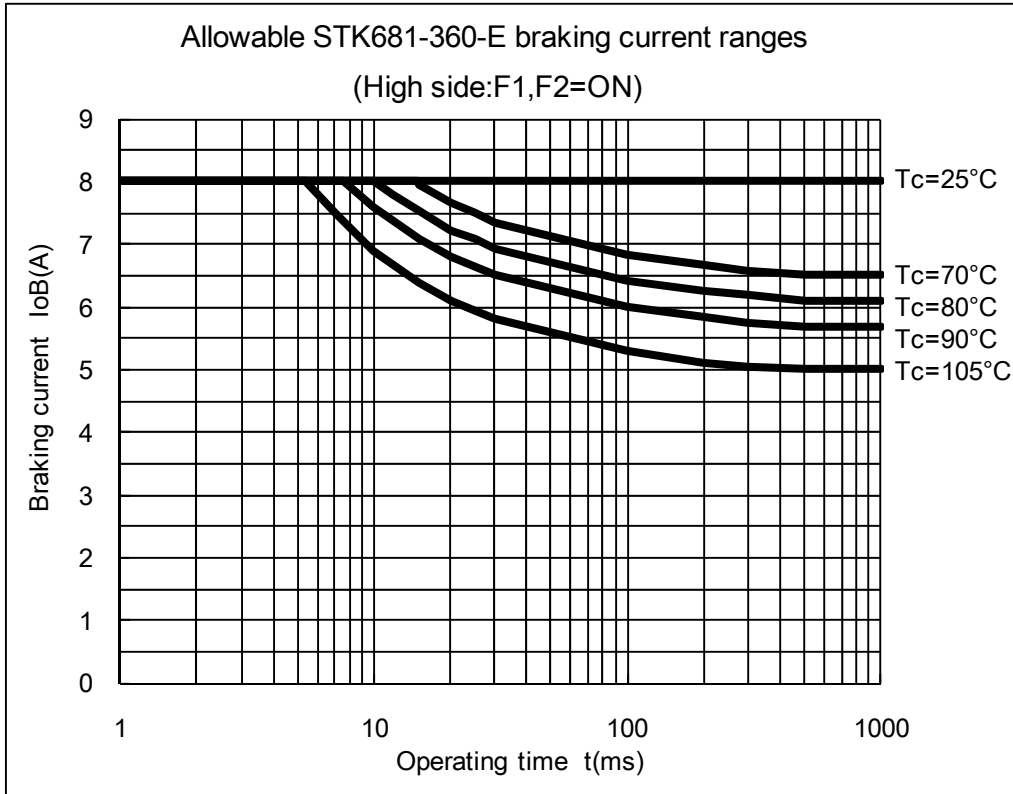
- \*4: A fixed-voltage power supply must be used.



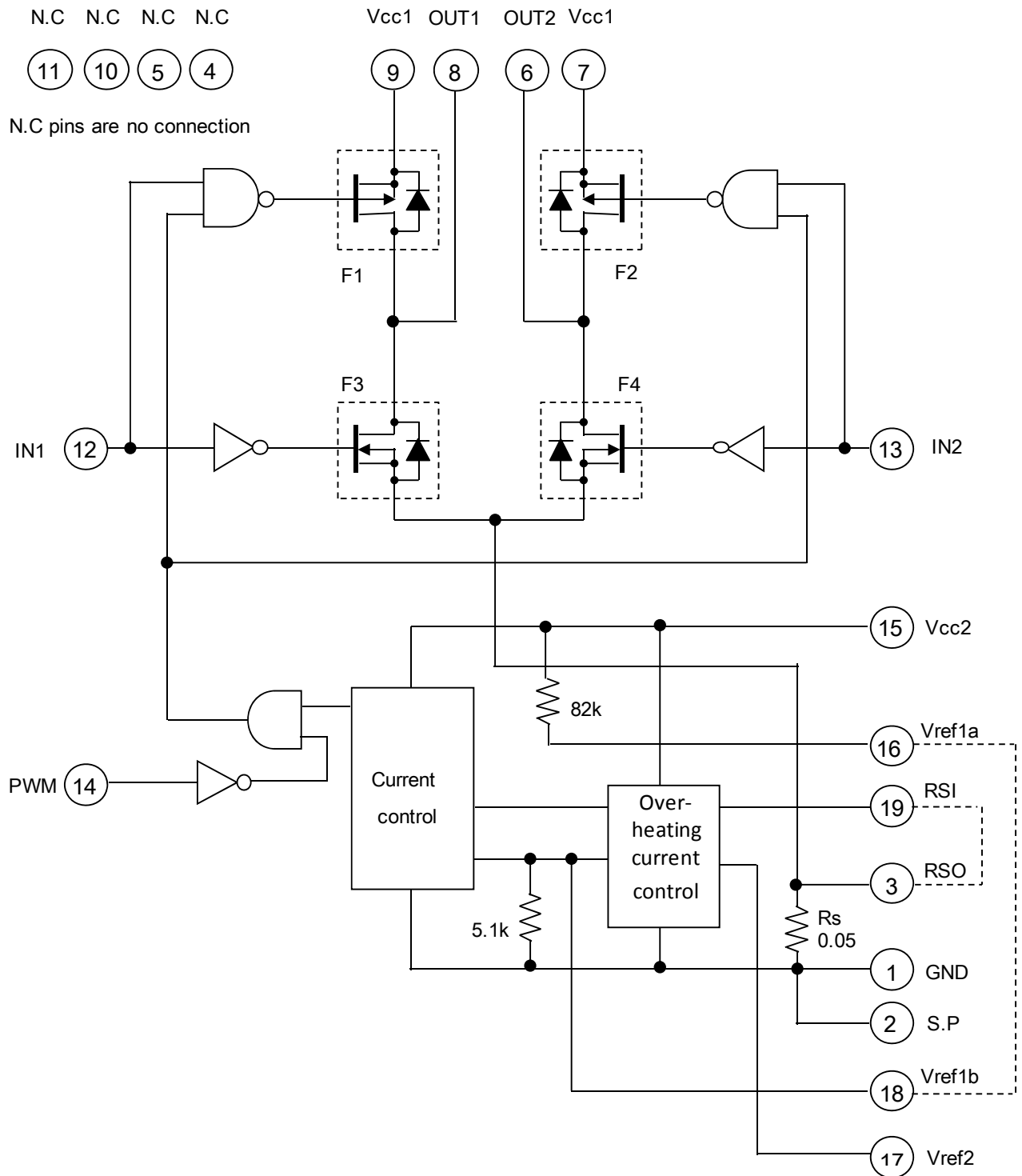
# STK681-360-E

## Notes

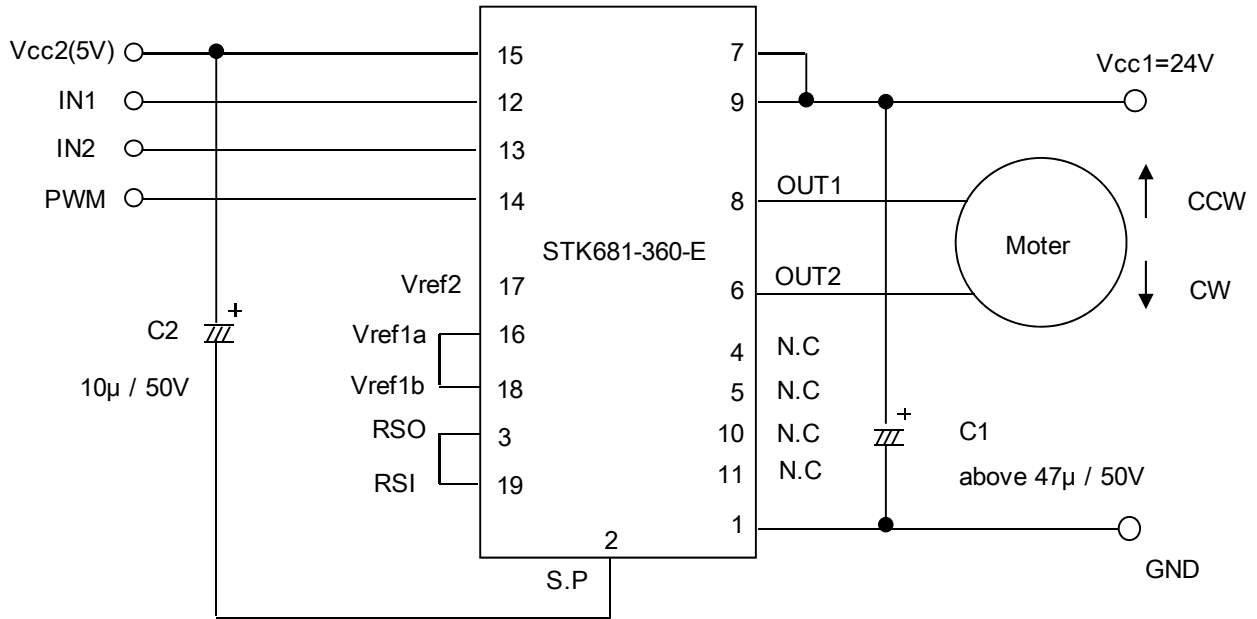
- The motor current  $I_o$  shown above is the range for DC and chopping operation.  
The DC operating current range is within both the allowable  $V_{cc1}$  operating range and the derating curve shown in the figure.
- The operating substrate temperatures in the figure above are values measured when the motor is operating.  
The temperature  $T_c$  varies with the ambient temperature  $T_a$ , the motor drive current, and whether the motor current is continuous or the state of its intermittent operation. Therefore  $T_c$  must be verified in an actual end product system.
- The  $T_c$  temperature should be checked in the center of the metal surface of the product package.



Block Diagram



Sample Application Circuit



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

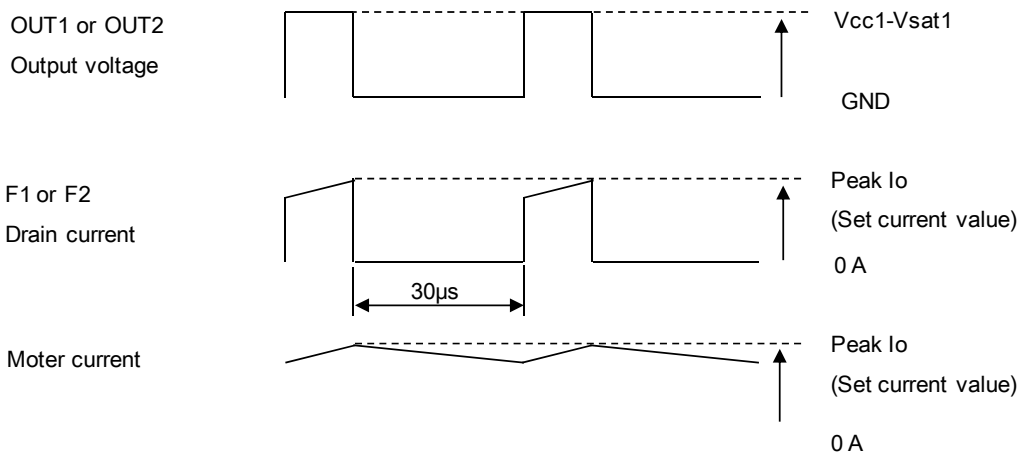
|  | IN1 | IN2 | PWM    | Function  |
|--|-----|-----|--------|---|
| Stop 1 (Standby)   | H   | H   | L or H | The state where the motor is not turning  |
| Stop 2 (Power supply to the motor is off due to an input during motor operation) | H   | H   | H      | Power supply to the motor was turned off due to a stop signal being applied during motor operation.                   |
|  | H   | L   | H      |   |
|  | L   | H   | H      |   |
| Forward(CW)  | H   | L   | L      | An input signal that turns off the high and low side drive elements during forward/reverse switching is not required. |
| Reverse(CCW)   | L   | H   | L      |   |
| Brake  | L   | L   | L or H | The ground side MOSFET is in the on state.  |

\* The state IN1 = IN2 = high, PWM = L is illegal during motor operation.

\* PWM pin (14pin) is active Low.

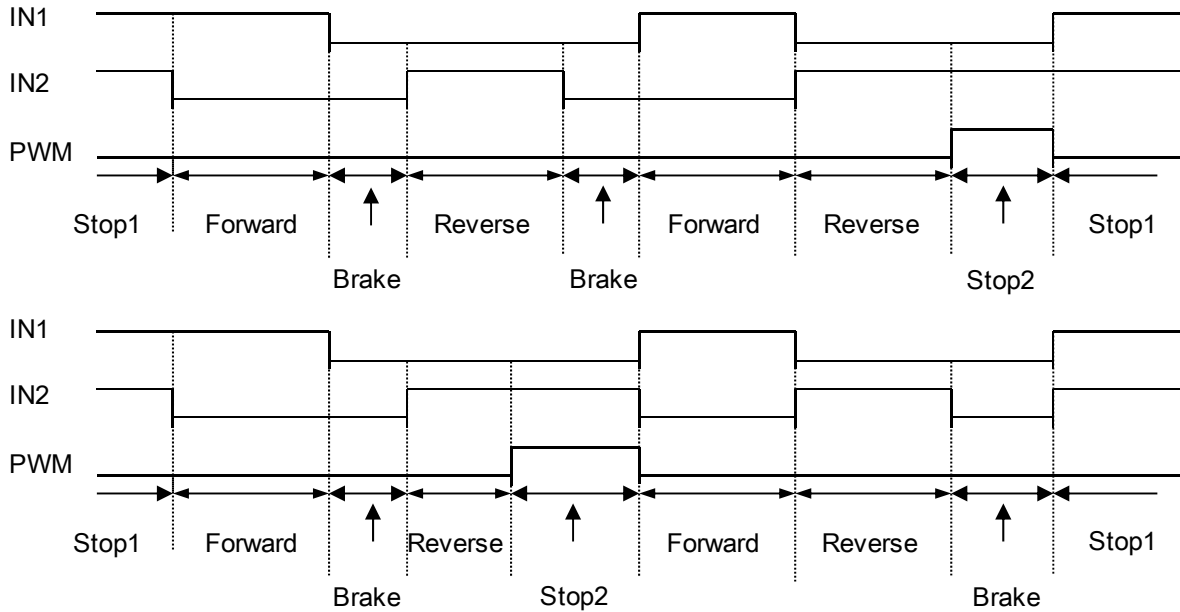
Notes

- (1) The value of the power supply bypass capacitor C1 must be set so that the capacitor ripple current, which changes with the motor current, remains within the allowable range.
- (2) While the Vref2 pin is normally handled by being left open, note that the thermal protection circuit will no longer operate if this pin is connected to ground or the P.S pin.
- (3) Current is controlled by a constant-current chopping operation by transistors F1 and F2. The timing for the OUT1 or OUT2 output voltage and the F1 or F2 drain current is shown below.
- (4) Do not connect or wire any of the NC (unused) pins that appear in either the block diagram or the application circuit examples to the circuit pattern on the PCB.



(5) Since the response time of the ground side drive element during forward/reverse direction switching is a few tens of microseconds, this product is not appropriate for H bridge applications. This device should only be used as a DC motor driver.

(6) Timing Charts



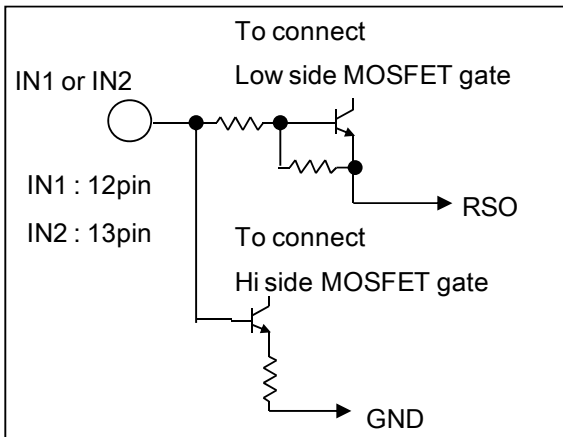
(7) Smoke emission warning: This hybrid IC may emit smoke if it is used under conditions that exceed its specifications.

**I/O Functions of Each Pin**

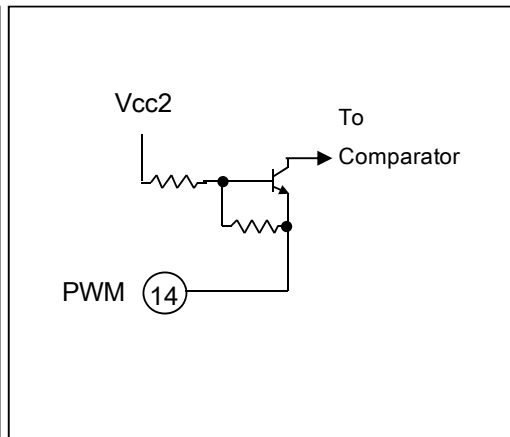
| Pin name | Pin No | Functions  |
|----------|--------|--|
| IN1      | 12     | Input that controls the on/off state of F1 and F3. When high: F1: on, F3: off, when low: F1: off, F3: on.                    |
| IN2      | 13     | Input that controls the on/off state of F2 and F4. When high: F2: on, F4: off, when low: F2: off, F4: on.                    |
| PWM      | 14     | Input that forces F1 and F2 to the off state: when high F1 and F2 will be off. When low F1 and F2 will be on,                |
| OUT1     | 8      | Motor connection that outputs a source or sink current depending on the states of IN1 and IN2.                               |
| OUT2     | 6      | Motor connection that outputs a source or sink current depending on the states of IN1 and IN2.                               |
| Vref1a   | 16     | The current setting voltage (Vref1) is used by connecting Vrefa to Vrefb   |
| Vref1b   | 18     | The peak Io level is determined by $I_{o(peak)} = V_{ref1} \div R_s$ .   |
| Vref2    | 17     | This pin should normally be left open. Connecting this pin to ground or the S.P pin disables the thermal protection circuit. |
| S.P      | 2      | The Vref1 voltage can be reduced by connecting a resistor between Vref1 and the S.P pin.                                     |
| RSO      | 3      | This pin can be used to monitor the voltage across the current detection resistor $R_s$ and is connected to the RSI pin.     |
| RSI      | 19     | Input for the circuit that compares with Vref1. This pin is used connected to the RSO pin.                                   |

**Configuration of I/O Pin**

<IN1,IN2>



<PWM>

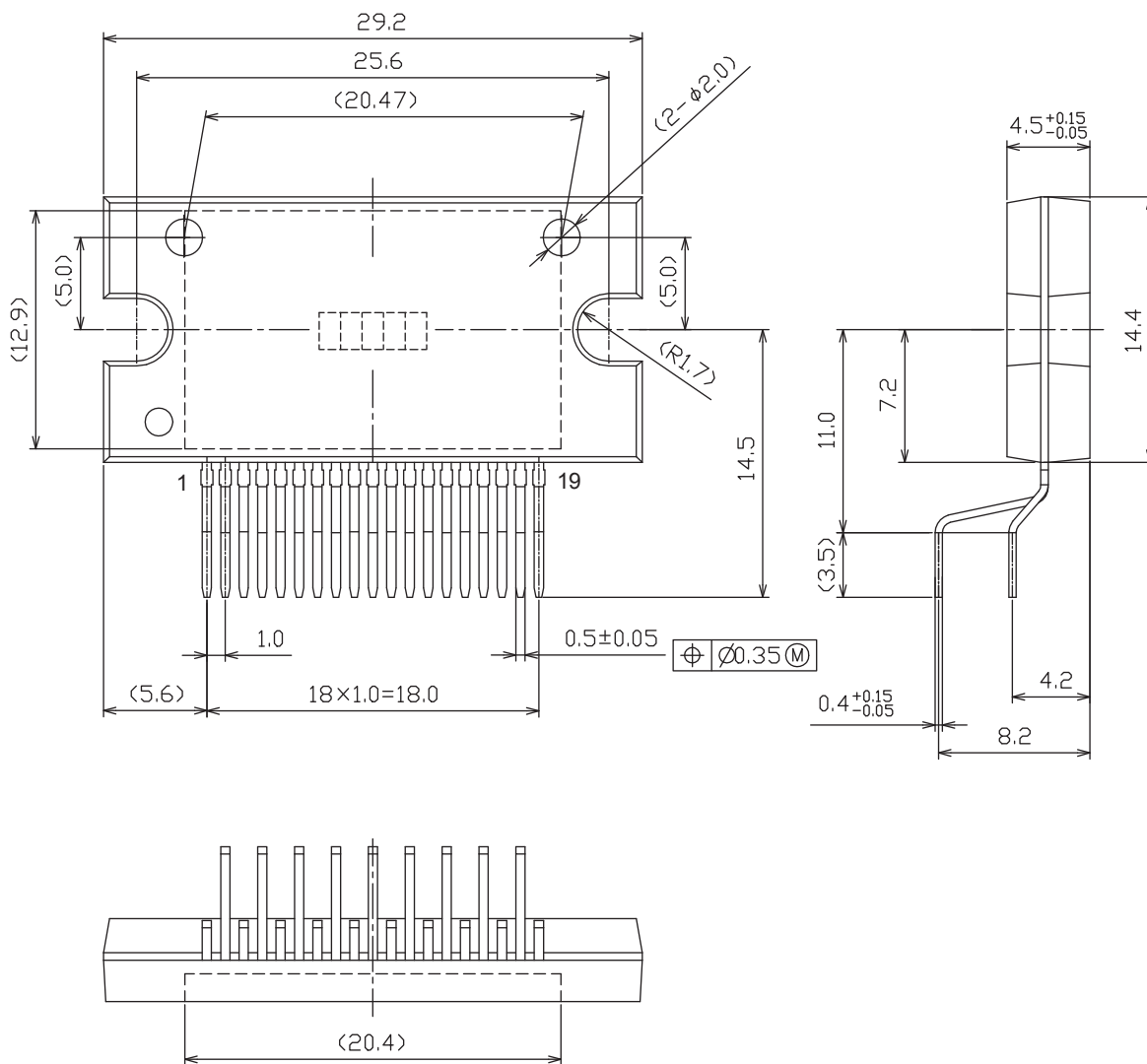


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## Package Dimensions

unit : mm

SIP19 29.2x14.4  
CASE 127CF  
ISSUE 0

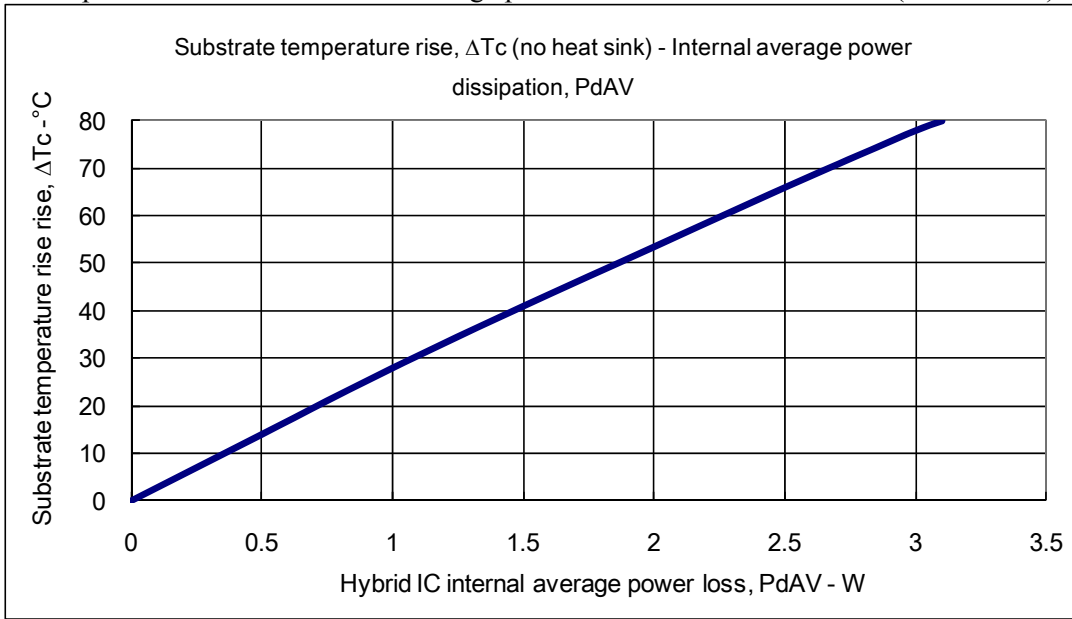


## Technical data

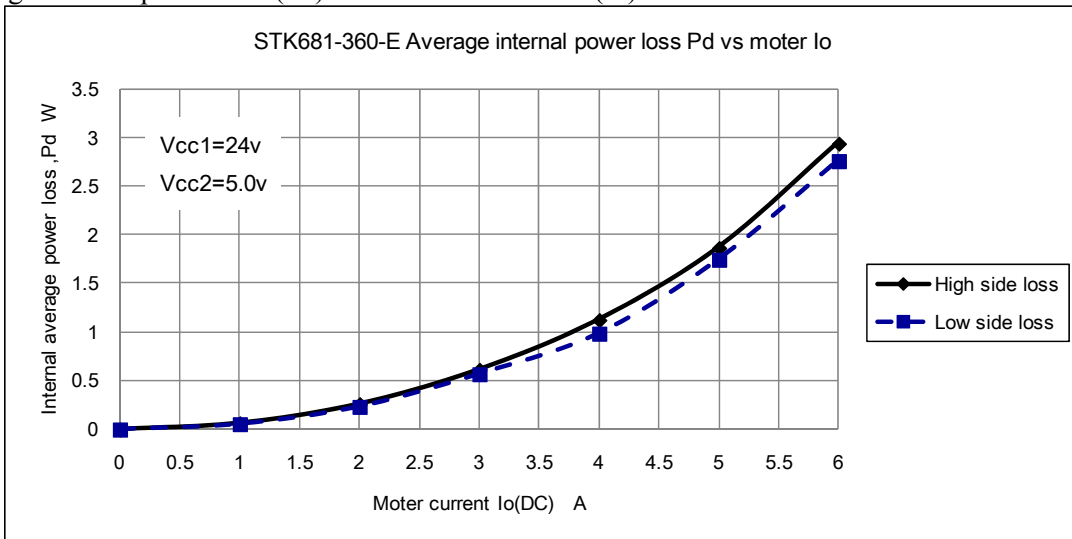
1. Substrate temperature rise  $\Delta T_c$  -Internal average power loss PdAV characteristics  
(no heat sink)
2. Average internal power loss (Pd) at DC - motor current ( $I_o$ ) characteristics.
3. Over temperature current suppression characteristics:  $I_o - T_c$ .
4. Package power loss PdPK derating curve for the ambient temperature  $T_a$ .
5. Electrical characteristics  
Vdf vs If  
Vsat1 , Vsat2 vs  $I_o$
6. A.S.O(F1,F2,F3,F4)

# STK681-360-E

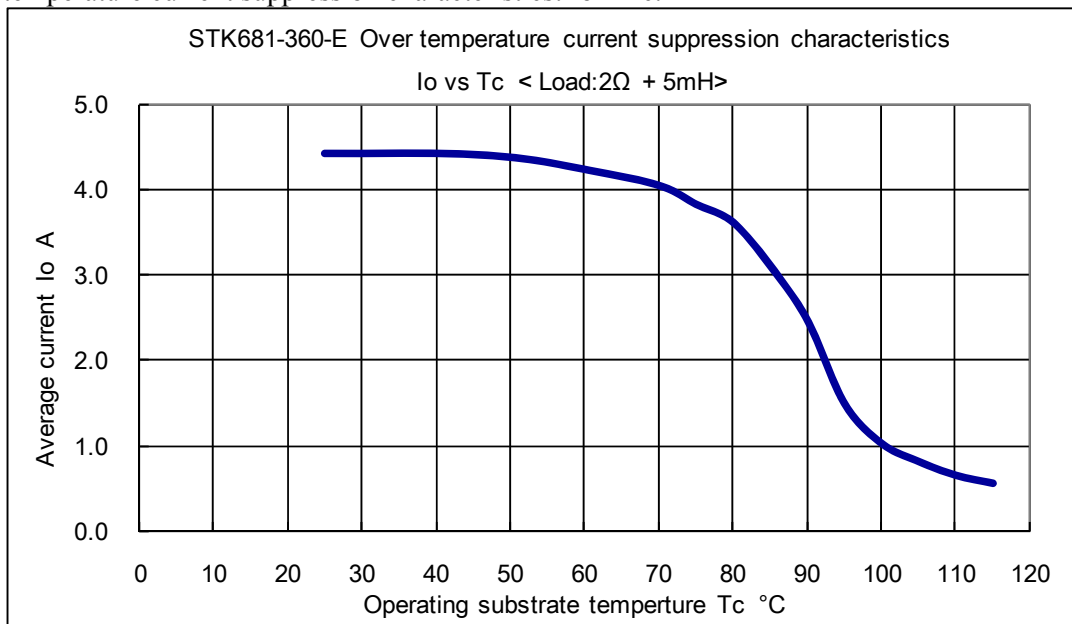
## 1. Substrate temperature rise $\Delta T_c$ - Internal average power loss PdAV characteristics (no heat sink)



## 2. Average internal power loss (Pd) at DC - motor current (Io) characteristics.



## 3. Over temperature current suppression characteristics: Io - Tc.

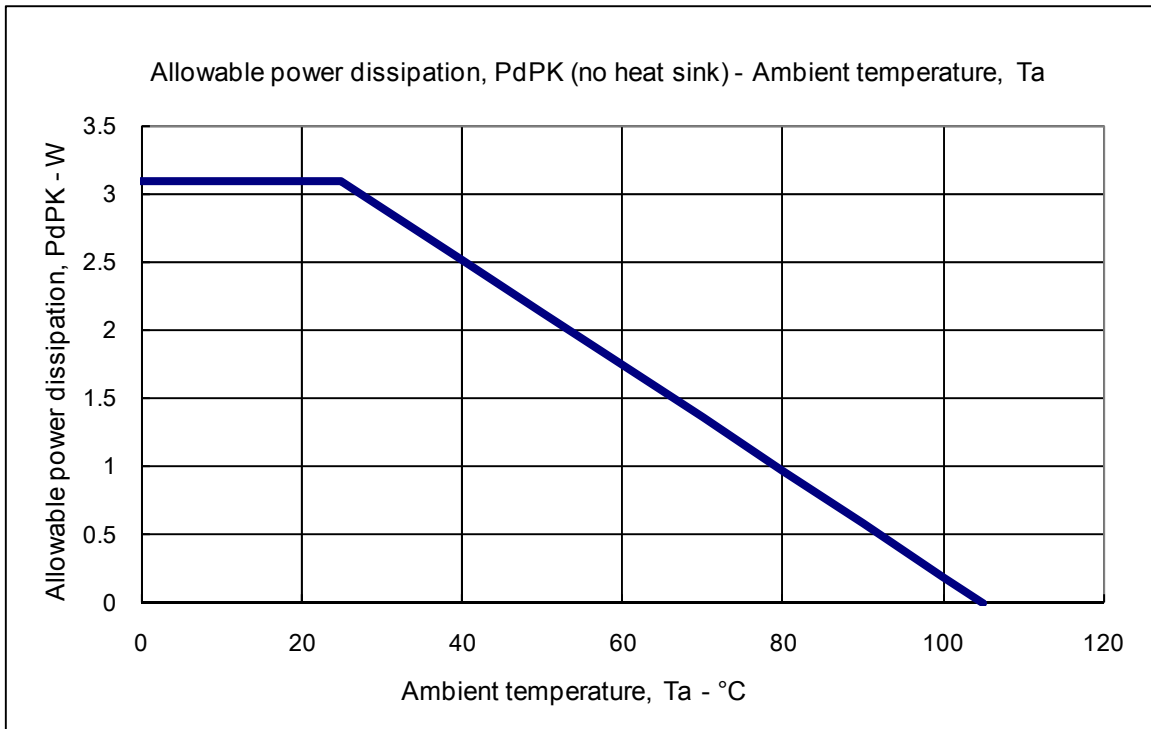


The over temperature current suppression function protects the driver from destruction when an abnormal motor locked (physically constrained) state occurs.

## STK681-360-E

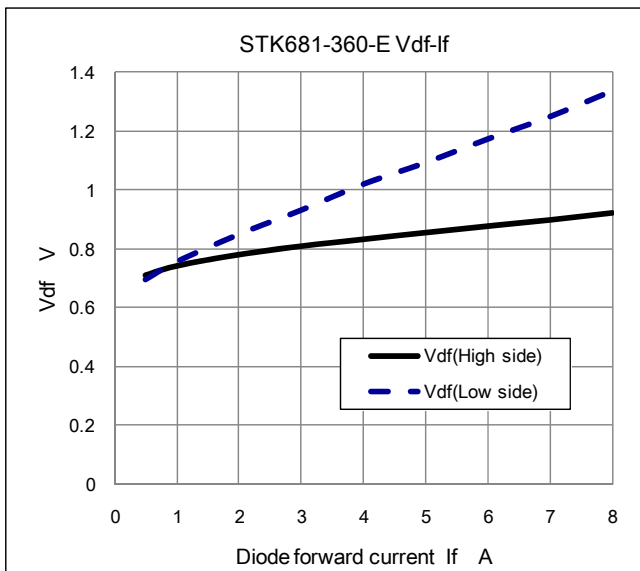
### 4. Package power loss PdPK derating curve for the ambient temperature Ta.

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  $\theta_{c-a}$  is 25.8°C/W.

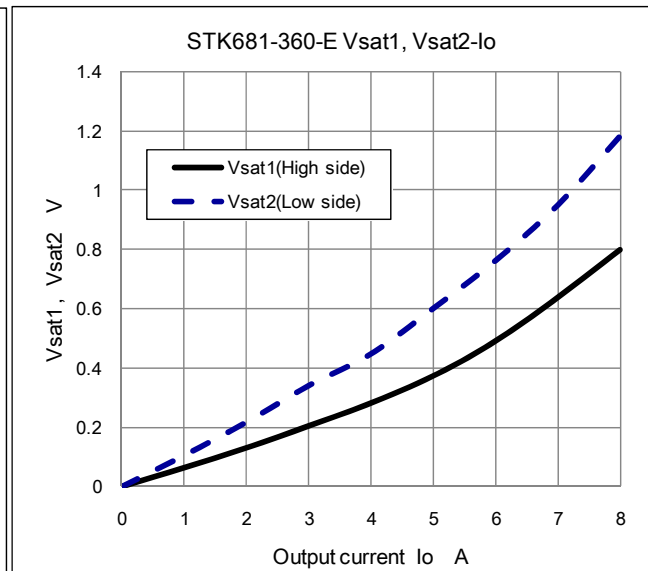


### 5. Electrical characteristics

<Vdf vs If>

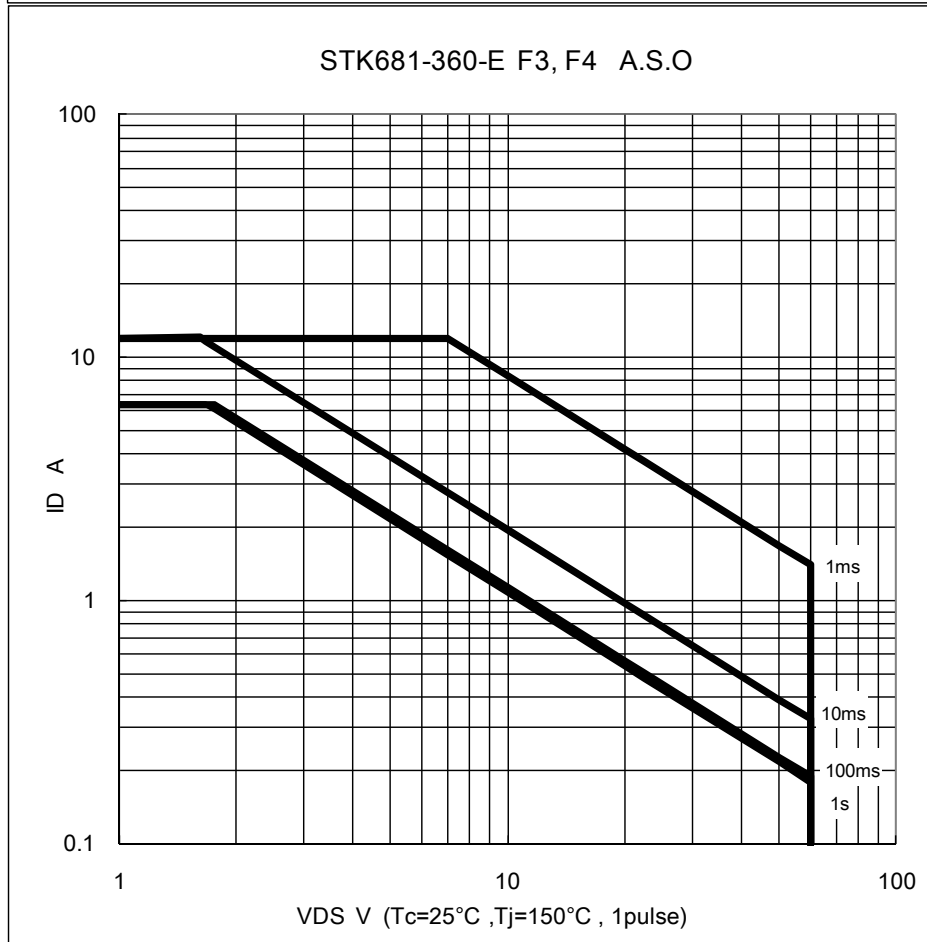
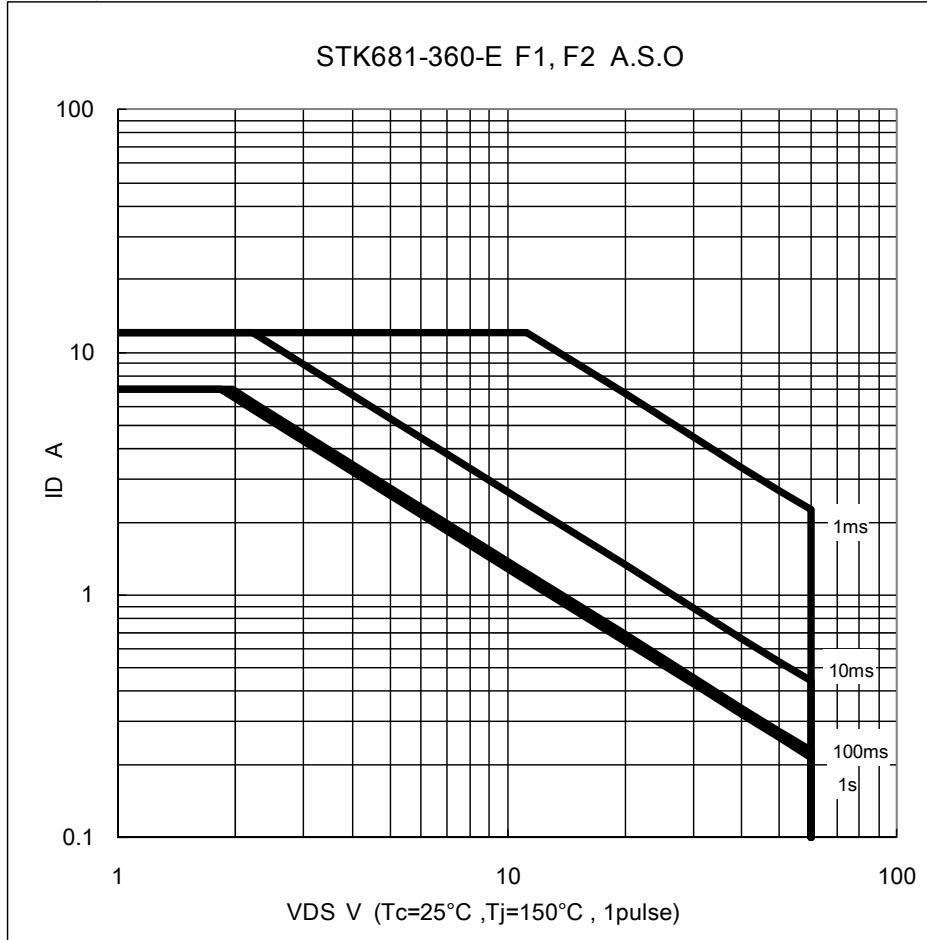


<Vsat1 / Vsat2 vs Io>



# STK681-360-E

## 7. A.S.O(F1,F2,F3,F4)



# STK681-360-E

## ORDERING INFORMATION

| Device       | Package             | Shipping (Qty / Packing) |
|--------------|---------------------|--------------------------|
| STK681-360-E | SIP-19<br>(Pb-Free) | 15 / Tube                |

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