



**VB025SP**

## HIGH VOLTAGE IGNITION COIL DRIVER POWER IC

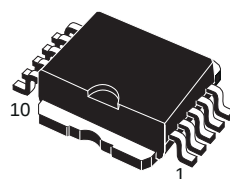
| TYPE    | $V_{cl}$ | $I_{cl}$ | $I_d$  |
|---------|----------|----------|--------|
| VB025SP | 380 V    | 9 A      | 100 mA |

- PRIMARY COIL VOLTAGE INTERNALLY SET
- COIL CURRENT LIMIT INTERNALLY SET
- LOGIC LEVEL COMPATIBLE INPUT
- DRIVING CURRENT QUASI PROPORTIONAL TO COLLECTOR CURRENT
- SINGLE FLAG-ON COIL CURRENT

### DESCRIPTION

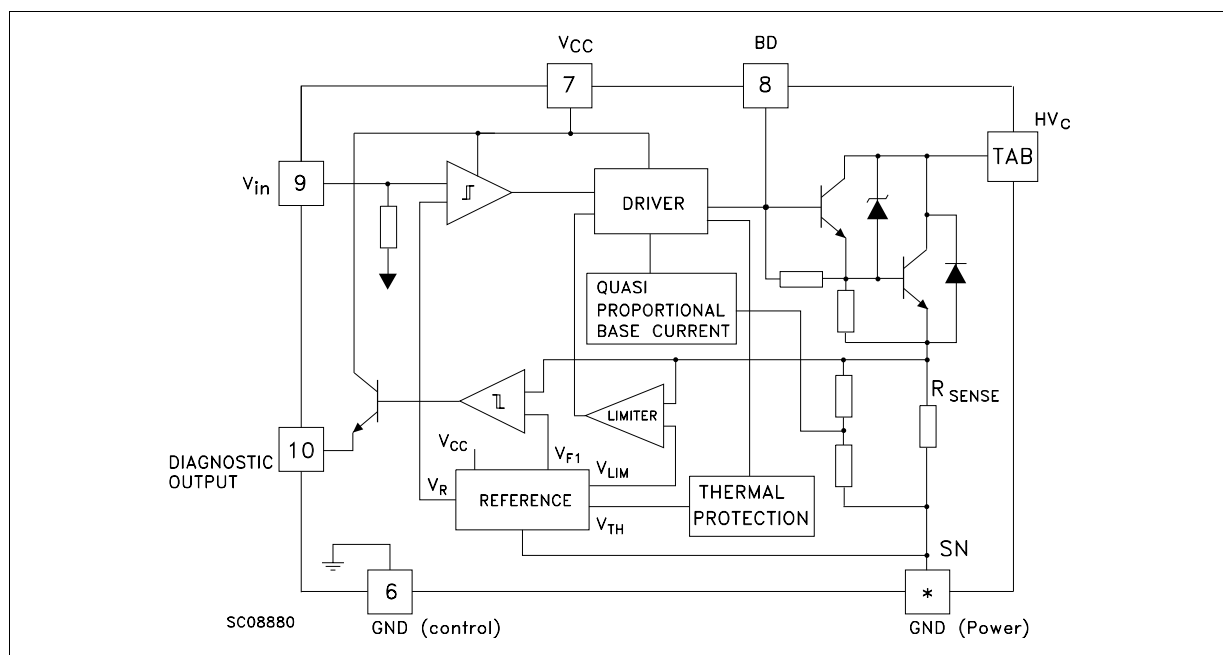
The VB025SP is a high voltage power integrated circuit made using STMicroelectronics VIPower Technology, with vertical current flow power darlington and logic level compatible driving circuit.

Built-in protection circuits for coil current limiting and collector voltage clamping allows the VB025SP to be used as a smart, high voltage, high current interface in advanced electronic ignition systems.



**PowerSO-10**

### BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATING

| Symbol                 | Parameter                                      | Value                         | Unit |
|------------------------|------------------------------------------------|-------------------------------|------|
| HV <sub>C</sub>        | Collector Voltage (Internally Limited)         | -0.3 to V <sub>clamp</sub>    | V    |
| I <sub>C</sub>         | Collector Current (Internally Limited)         | 10                            | A    |
| I <sub>C(gnd)</sub>    | DC Current on Emitter Power                    | ± 10.5 (*)                    | A    |
| V <sub>CC</sub>        | Driving Stage Supply Voltage                   | -0.3 to 7                     | V    |
| I <sub>S</sub>         | Driving Circuitry Supply Current               | ± 200                         | mA   |
| I <sub>S(gnd)</sub>    | DC Current on Ground Pin                       | ± 1                           | A    |
| V <sub>in</sub>        | Input Voltage                                  | -0.3 to V <sub>CC</sub> + 0.3 | V    |
| I <sub>in</sub>        | Maximum Input Current                          | 100                           | mA   |
| f <sub>in</sub>        | Logic Input Frequency in Operative Mode        | DC to 150                     | Hz   |
| V <sub>out(flag)</sub> | Output Voltage Primary Threshold Current Level | -0.3 to V <sub>CC</sub> + 0.3 | V    |
| I <sub>out(flag)</sub> | Flag Output Current                            | 100                           | mA   |
| P <sub>max</sub>       | Power Dissipation (TC = 105 °C)                | TBD                           | W    |
| E <sub>s/b</sub>       | Clamped Energy During Output Power Clamping    | 300                           | mJ   |
| V <sub>ESD</sub>       | ESD Voltage (HVC Pin)                          | ± 4                           | KV   |
| V <sub>ESD</sub>       | ESD Voltage (Other Pins)                       | ± 2                           | KV   |
| I <sub>BD</sub>        | Input Darlington Base Current                  | 150                           | mA   |
| V <sub>BD</sub>        | Input Darlington Base Voltage                  | Internally Limited            | V    |
| T <sub>j</sub>         | Operating Junction Temperature                 | -40 to 150                    | °C   |
| T <sub>stg</sub>       | Storage Temperature Range                      | -55 to 150                    | °C   |

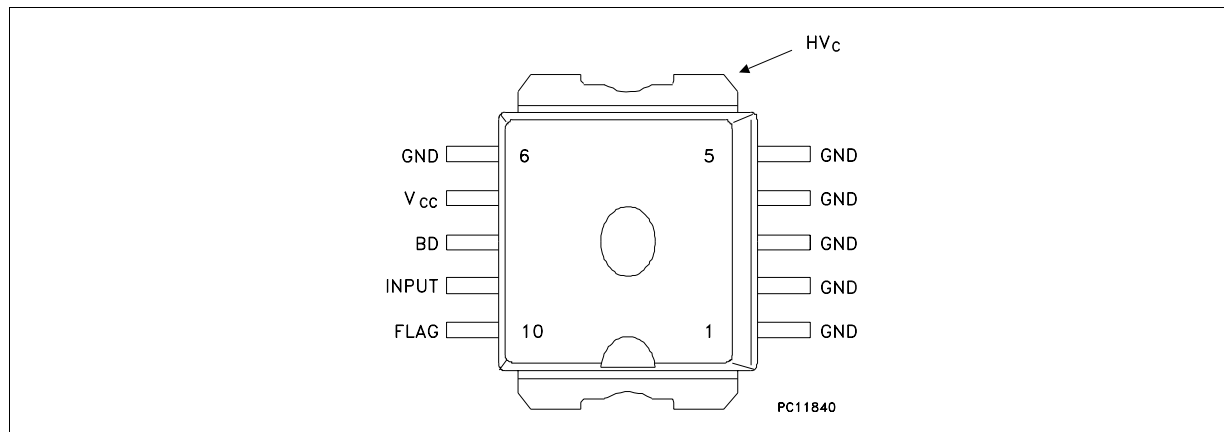
(\*) With 10 mils Al wire

## THERMAL DATA

|                       |                                               |       |         |      |
|-----------------------|-----------------------------------------------|-------|---------|------|
| R <sub>thj-case</sub> | Thermal Resistance Junction Case              | (MAX) | 1.2     | °C/W |
| R <sub>thj-h</sub>    | Thermal Resistance Junction Heatsink with FR4 | (MAX) | TBD (★) | °C/W |
| T <sub>sold</sub>     | Lead Temperature During Soldering             | (MAX) | TBD (★) | °C   |

(★) see application note AN515/1094 on VIPower data-book 1<sup>st</sup> edition.

## CONNECTION DIAGRAM



## PIN FUNCTION

| No  | NAME            | FUNCTION                                    |
|-----|-----------------|---------------------------------------------|
| 1-5 | GND             | Emitter Power Ground                        |
| 6   | GND             | Control Ground (*)                          |
| 7   | V <sub>CC</sub> | Logic Supply Voltage                        |
| 8   | BD              | Base Darlington                             |
| 9   | INPUT           | Logic Input Channel (Internal Pull Down)    |
| 10  | FLAG            | Diagnostic Output Signal (Open Emitter)     |
| TAB | HVC             | Primary Coil Output Driver (Open Collector) |

(\*) Pin 6 must be connected to pins 1-5 externally

**ELECTRICAL CHARACTERISTICS** ( $5.3V < V_b < 24V$ ;  $V_{CC} = 5V \pm 10\%$ ;  $-40^{\circ}C < T_j < 125^{\circ}C$ ;  
 $R_{coil} = 580\ m\Omega$ ;  $L_{coil} = 3.75\ mH$ ; unless otherwise specified; see note 1)

| Symbol                 | Parameter                                  | Test Conditions                                                                               | Min. | Typ. | Max. | Unit |
|------------------------|--------------------------------------------|-----------------------------------------------------------------------------------------------|------|------|------|------|
| V <sub>cl</sub>        | High Voltage Clamp                         | I <sub>coil</sub> = 6.5 A                                                                     | 320  | 380  | 420  | V    |
| V <sub>ce(sat)</sub>   | Saturation Voltage of The Power Stage      | I <sub>c</sub> = 6.5A; V <sub>in</sub> = 4V                                                   |      | 1.5  | 2    | V    |
| I <sub>CC(stdby)</sub> | Stand-by Supply Current                    | IN = OFF                                                                                      |      |      | 10   | mA   |
| I <sub>CC</sub>        | DC Logic Current                           | V <sub>b</sub> = 16 V I <sub>c</sub> = 6.5 A f = 100 Hz<br>Load = Coil V <sub>CC</sub> = 5.5V |      |      | 40   | mA   |
| I <sub>CC(peak)</sub>  | Peak DC Logic Current During On Phase      | I <sub>c</sub> = 6.5 A (see figure 1)                                                         |      | 100  | 150  | mA   |
| V <sub>CC</sub>        | DC Logic Voltage                           |                                                                                               | 4.5  |      | 5.5  | V    |
| I <sub>cl</sub>        | Coil Current Limit                         | -40°C < T <sub>j</sub> < 125°C<br>(see note 2 and figure 1)                                   | 8.25 |      | 10   | A    |
| I <sub>c(leak)</sub>   | Output leakage Current                     | IN = OFF V <sub>HVC</sub> = 24V                                                               |      |      | 0.8  | mA   |
| I <sub>c(infl)</sub>   | Collector Current with Floating Input      | V <sub>CC</sub> = 5 V V <sub>Bat</sub> = 13.5 V<br>R <sub>LOAD</sub> = 1KΩ; Input Floating    |      |      | 0.8  | mA   |
| T <sub>IC_ctr</sub>    | Thermal Temperature Output Current Control | OUT = ON (see figure 2)                                                                       | 150  |      | (*)  | °C   |

## ELECTRICAL CHARACTERISTICS (continued)

| Symbol           | Parameter                           | Test Conditions                                                    | Min.       | Typ. | Max.     | Unit    |
|------------------|-------------------------------------|--------------------------------------------------------------------|------------|------|----------|---------|
| $V_{inH}$        | High Level Input Voltage            | $V_{CC} = 4.5V$                                                    | 4          |      | $V_{CC}$ | V       |
| $V_{inL}$        | Low Level Input Voltage             | $V_{CC} = 5.5V$                                                    | -0.3       |      | 0.8      | V       |
| $V_{in(hys)}$    | Input Threshold Hysteresis          |                                                                    | 0.4        |      |          | V       |
| $I_{inH}$        | High Level Input Current            | $V_{in} = 4 V$                                                     |            |      | 100      | $\mu A$ |
| $I_{inL}$        | Low Level Input Current             | $V_{in} = 0.8 V$                                                   |            |      | -100     | $\mu A$ |
| $I_{inpd}$       | Input Active Pull-Down              | $V_{in} = 4 V$                                                     | 10         |      | 100      | $\mu A$ |
| $V_{diagH}$      | High Level Flag Output Voltage      | $R_{EXT} = 22 K\Omega$ $C_{EXT} = 1 nF$<br>(see note 3)            | $V_{CC}-1$ |      | $V_{CC}$ | V       |
| $V_{diagL}$      | Low Level Flag Output Voltage       | $R_{EXT} = 22 K\Omega$ $C_{EXT} = 1 nF$<br>(see note 3)            |            |      | 0.5      | V       |
| $I_{diagTH}$     | Coil Current Level Threshold        | $T_j = 25^{\circ}C$ (see figure 1)                                 | 4.25       | 4.5  | 4.75     | A       |
| $I_{diagTD}$     | Coil Current Level Threshold Drift  | (see figure 3)                                                     |            |      |          |         |
| $I_{diag}$       | High Level Flag Output Current      | $I_C > I_{diagTH}$ $V_{diag} = 3 V$                                | 0.5        | TBD  |          | mA      |
| $I_{diag(leak)}$ | Leakage Current On Flag Output      | $V_{in} = LOW$ $V_{CC} = 5.5V$                                     |            |      | 10       | $\mu A$ |
| $V_F$            | Antiparallel Diode Forward Voltage  | $I_C = -1 A$                                                       |            |      | 2        | V       |
| $E_{s/b}$        | Single Pulse Avalanche Energy       | $L = 6 mH$ $I_C = 8 A$<br>(see figure 4)                           | 180        |      |          | mJ      |
| $t_{pHL}$        | Turn-on Delay Time of Coil Current  | $R_C = 0.5 \Omega$ $L_C = 3.75 mH$<br>(see figure 5)               |            | TBD  |          | $\mu s$ |
| $t_{pLH}$        | Turn-off Delay Time of Coil Current | $R_C = 0.5 \Omega$ $L_C = 3.75 mH$ $I_C = 6.5 A$<br>(see figure 5) |            | TBD  |          | $\mu s$ |

Note 1: Parametric degradation are allowed with  $5.3 < V_b < 10V$  and  $V_b > 24V$ .

Note 2: The primary coil current value  $I_{di}$  must be measured 1ms after desaturation of the power stage.

Note 3: No Internal Pull-Down

(\*) Internally limited

## PRINCIPLE OF OPERATION

The VB025SP is mainly intended as a high voltage power switch device driven by a logic level input and interfaces directly to a high energy electronic ignition coil.

The input  $V_{in}$  of the VB025SP is fed from a low power signal generated by an external controller that determines both dwell time and ignition point. During  $V_{in}$  high ( $\geq 4V$ ) the VB025SP increases current in the coil to the desired, internally set current level.

After reaching this level, the coil current remains constant until the ignition point, that corresponds to the transition of  $V_{in}$  from high to low (typ. 1.9V threshold).

During the coil current switch-off, the primary

voltage  $HV_c$  is clamped at an internally set value  $V_{cl}$ , typically 380V.

The transition from saturation to desaturation, coil current limiting phase, must have the ability to accommodate an overvoltage. A maximum overshoot of 20V is allowed.

## FEEDBACK

When the collector current exceeds 4.5A, the feedback signal is turned high and it remains so, until the input voltage is turned-off.

## OVERVOLTAGE

The VB025SP can withstand the following transients of the battery line:

-100V/2msec ( $R_i = 10 \Omega$ )

+100V/0.2msec ( $R_i = 10 \Omega$ )

+50V/400msec ( $R_i = 4.2 \Omega$ , with  $V_{IN} = 3 V$ )

Fig. 1 Main Waveforms During On Phase

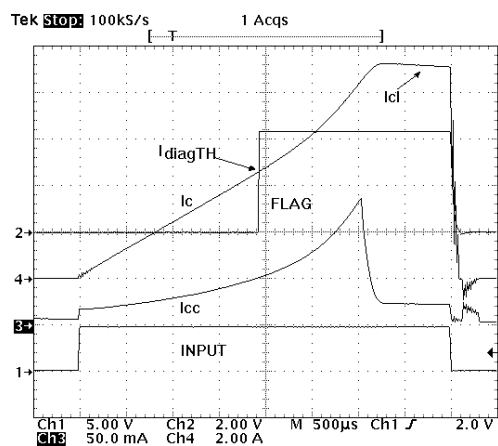


Fig. 2 Output Current Waveform After Thermal Protection Activation

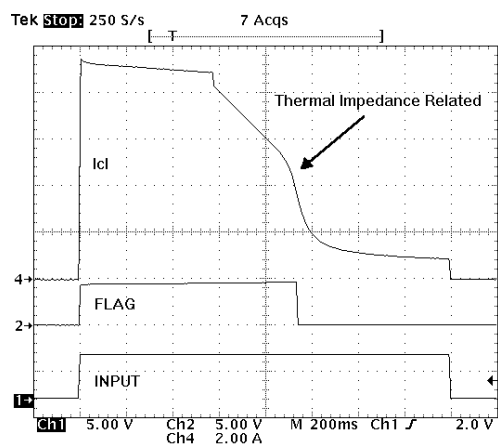


Fig. 3 Flag Current Versus Temperature

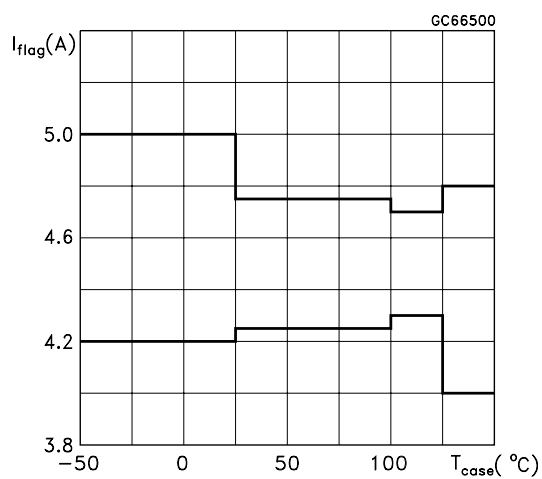
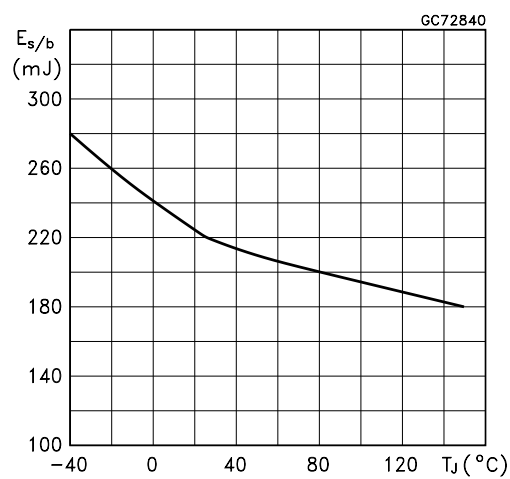
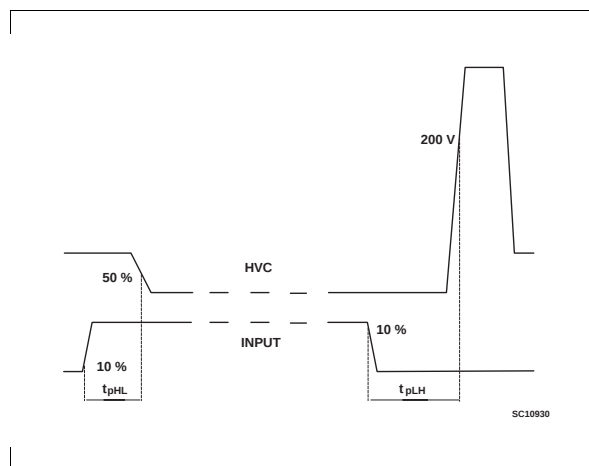
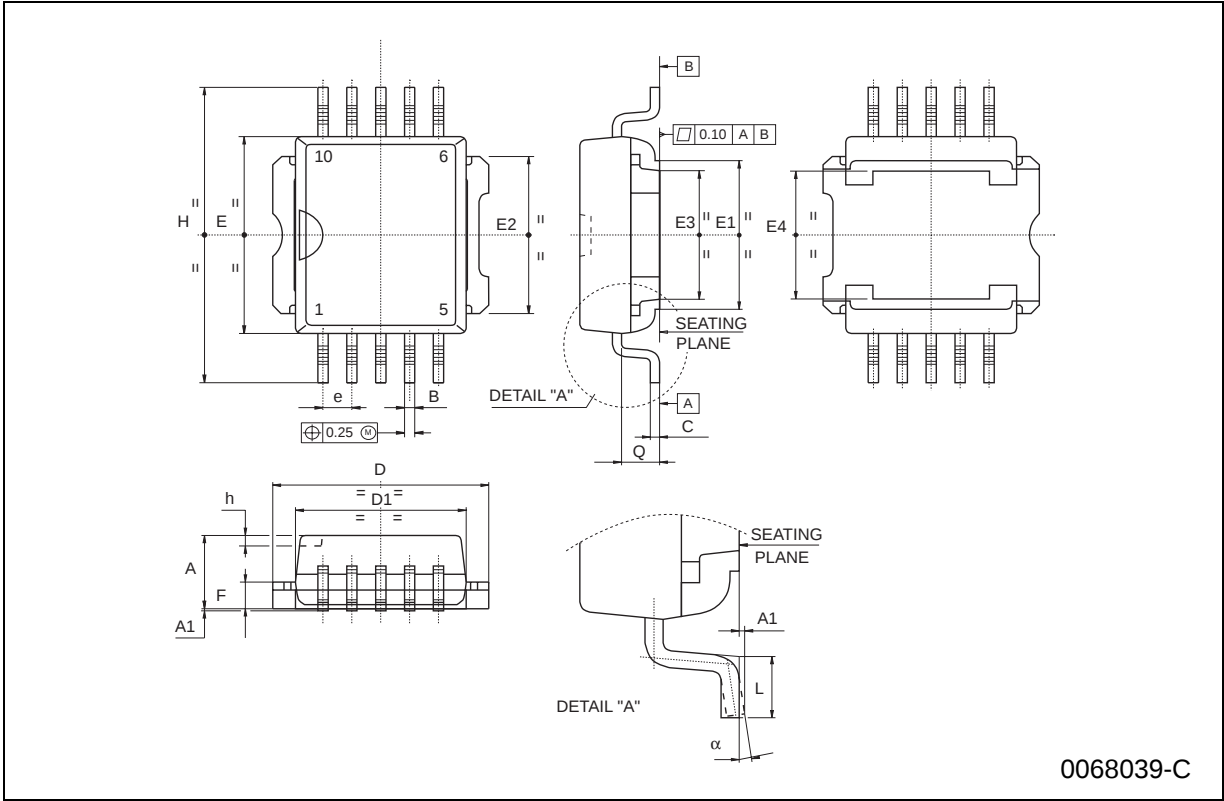
FIG. 4 Single Pulse Typical  $E_s/b$  Curve

FIG. 5 Propagation Times Definitions.



PowerSO-10 MECHANICAL DATA

| DIM. | mm    |      |       | inch  |       |       |
|------|-------|------|-------|-------|-------|-------|
|      | MIN.  | TYP. | MAX.  | MIN.  | TYP.  | MAX.  |
| A    | 3.35  |      | 3.65  | 0.132 |       | 0.144 |
| A1   | 0.00  |      | 0.10  | 0.000 |       | 0.004 |
| B    | 0.40  |      | 0.60  | 0.016 |       | 0.024 |
| c    | 0.35  |      | 0.55  | 0.013 |       | 0.022 |
| D    | 9.40  |      | 9.60  | 0.370 |       | 0.378 |
| D1   | 7.40  |      | 7.60  | 0.291 |       | 0.300 |
| E    | 9.30  |      | 9.50  | 0.366 |       | 0.374 |
| E1   | 7.20  |      | 7.40  | 0.283 |       | 0.291 |
| E2   | 7.20  |      | 7.60  | 0.283 |       | 0.300 |
| E3   | 6.10  |      | 6.35  | 0.240 |       | 0.250 |
| E4   | 5.90  |      | 6.10  | 0.232 |       | 0.240 |
| e    |       | 1.27 |       |       | 0.050 |       |
| F    | 1.25  |      | 1.35  | 0.049 |       | 0.053 |
| H    | 13.80 |      | 14.40 | 0.543 |       | 0.567 |
| h    |       | 0.50 |       |       | 0.002 |       |
| L    | 1.20  |      | 1.80  | 0.047 |       | 0.071 |
| q    |       | 1.70 |       |       | 0.067 |       |
| α    | 0°    |      | 8°    |       |       |       |



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