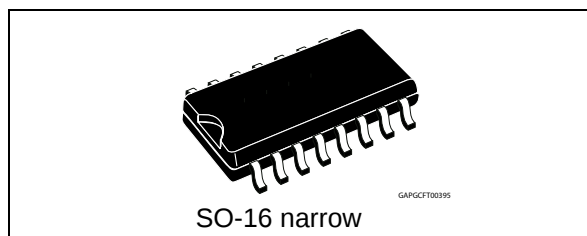


## Smart Power driver for motorbike blinker

Datasheet - production data



### Description

The VN5MB02-E is a Smart Power driver for motorbike blinker; it is connected between the battery positive terminal ( $V_{CC}$  pin) and a mechanical switch to the right or left side. As soon as the series switch connects the OUT pin to the bulbs, the device begins to turn on/off with a 50% duty cycle.

External low voltage capacitors are needed for supplying the device ( $C_{EXT}$ ), for stabilizing the internal voltage regulator output ( $C_{REG}$ ) and for setting the oscillating frequency ( $C_{FREQ}$ ).

When a low load is detected, output current lower than  $I_{df}$ , flashing frequency is automatically doubled.

The internal current shutdown latches the VN5MB02-E when a heavy overload occurs; thermal limitation reduces the stress on the device if the junction temperature raises (for instance when a soft over current event, not triggering the current latch protection, happens). If the overload condition lasts more than a time  $t_{fault}$ , the VN5MB02-E is latched.

### Features

| Type      | $R_{DS(on)}$  | $I_{Isd}$ (Typ) | $V_{CC}$ |
|-----------|---------------|-----------------|----------|
| VN5MB02-E | 0.08 $\Omega$ | 30 A            | 41 V     |

- Complete direction indicator in a SMD package
- Double frequency flashing in low load conditions
- High accuracy in setting operating frequency and low load detection
- Maximum current protection with latch
- Reverse battery protected
- Cycle by cycle thermal limitation
- Suitable for load configuration up to 2 x 10 W + 3.4 W
- Open-load detection for FAST lane change (patent pending)

Table 1. Device summary

| Package      | Order codes |               |
|--------------|-------------|---------------|
|              | Tube        | Tape and reel |
| SO-16 narrow | VN5MB02-E   | VN5MB02TR-E   |

# Contents

|          |                                           |           |
|----------|-------------------------------------------|-----------|
| <b>1</b> | <b>Block diagram and pin descriptions</b> | <b>5</b>  |
| <b>2</b> | <b>Electrical specifications</b>          | <b>7</b>  |
| 2.1      | Absolute maximum rating                   | 7         |
| 2.2      | Thermal data                              | 7         |
| 2.3      | Electrical characteristics                | 8         |
| 2.4      | Waveforms                                 | 10        |
| <b>3</b> | <b>Functional description</b>             | <b>14</b> |
| 3.1      | Normal operation                          | 14        |
| 3.2      | Low load condition                        | 14        |
| 3.3      | Current protection and thermal limitation | 14        |
| <b>4</b> | <b>Package and PCB thermal data</b>       | <b>16</b> |
| 4.1      | SO-16 narrow thermal data                 | 16        |
| <b>5</b> | <b>Package and packing information</b>    | <b>17</b> |
| 5.1      | ECOPACK <sup>®</sup> packages             | 17        |
| <b>6</b> | <b>Revision history</b>                   | <b>19</b> |

## List of tables

|           |                                                      |    |
|-----------|------------------------------------------------------|----|
| Table 1.  | Device summary . . . . .                             | 1  |
| Table 2.  | Pin functions . . . . .                              | 6  |
| Table 3.  | Absolute maximum ratings . . . . .                   | 7  |
| Table 4.  | Thermal data. . . . .                                | 7  |
| Table 5.  | Features . . . . .                                   | 8  |
| Table 6.  | Protection . . . . .                                 | 8  |
| Table 7.  | Electrical transient requirements (part 1) . . . . . | 9  |
| Table 8.  | Electrical transient requirements (part 2) . . . . . | 9  |
| Table 9.  | Electrical transient requirements (part 3) . . . . . | 9  |
| Table 10. | SO-16 narrow mechanical data . . . . .               | 18 |
| Table 11. | Document revision history . . . . .                  | 19 |

## List of figures

|            |                                                                           |    |
|------------|---------------------------------------------------------------------------|----|
| Figure 1.  | Block diagram . . . . .                                                   | 5  |
| Figure 2.  | Configuration diagram (top view) . . . . .                                | 5  |
| Figure 3.  | Application diagram . . . . .                                             | 6  |
| Figure 4.  | First turn-on . . . . .                                                   | 10 |
| Figure 5.  | Normal operation . . . . .                                                | 10 |
| Figure 6.  | Low load condition . . . . .                                              | 11 |
| Figure 7.  | $I_{SD}$ shutdown . . . . .                                               | 11 |
| Figure 8.  | Thermal limitation event duration $> t_{FAULT}$ . . . . .                 | 12 |
| Figure 9.  | Thermal limitation with duration $< t_{FAULT}$ . . . . .                  | 12 |
| Figure 10. | Open-load detection for FAST lane change (OFF) . . . . .                  | 13 |
| Figure 11. | Open-load detection for FAST lane change (ON) . . . . .                   | 13 |
| Figure 12. | ISO pulse test circuit . . . . .                                          | 15 |
| Figure 13. | SO-16 narrow PC board . . . . .                                           | 16 |
| Figure 14. | $R_{thj-amb}$ vs PCB copper area in open box free air condition . . . . . | 16 |
| Figure 15. | SO-16 narrow package dimensions . . . . .                                 | 17 |

# 1 Block diagram and pin descriptions

Figure 1. Block diagram

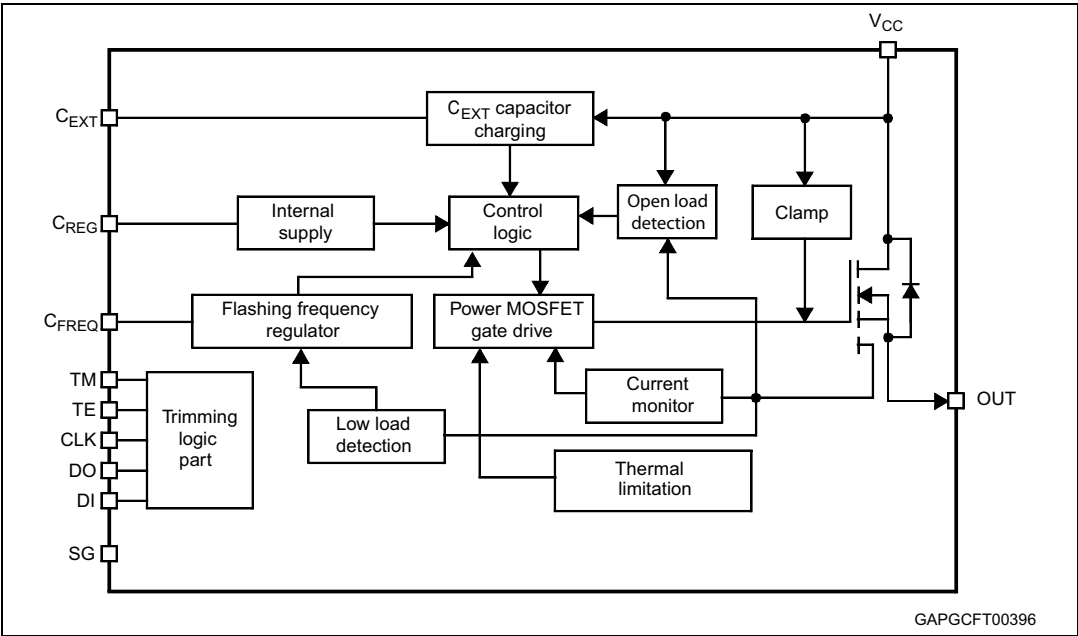


Figure 2. Configuration diagram (top view)

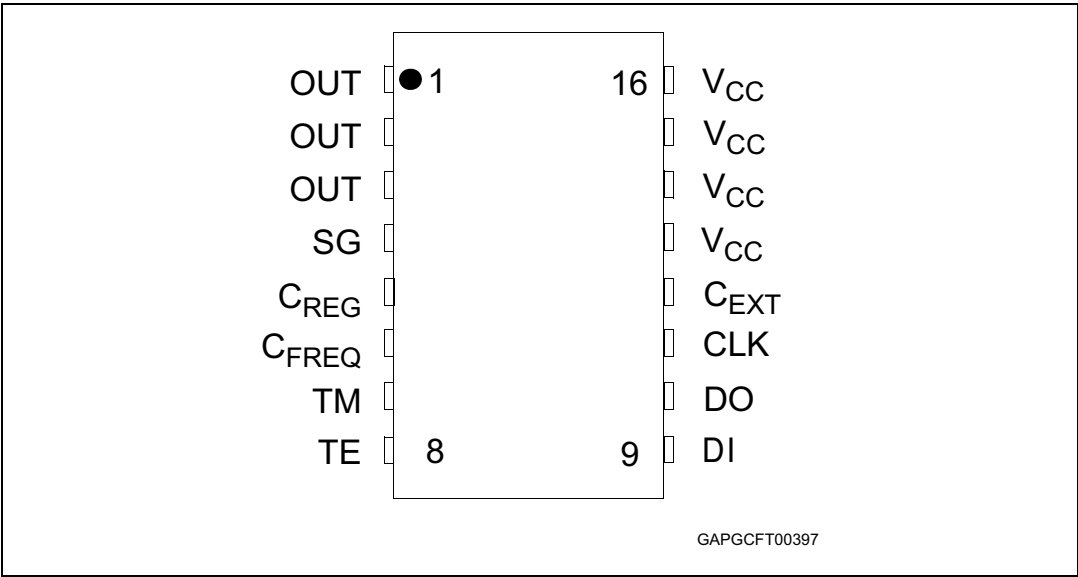
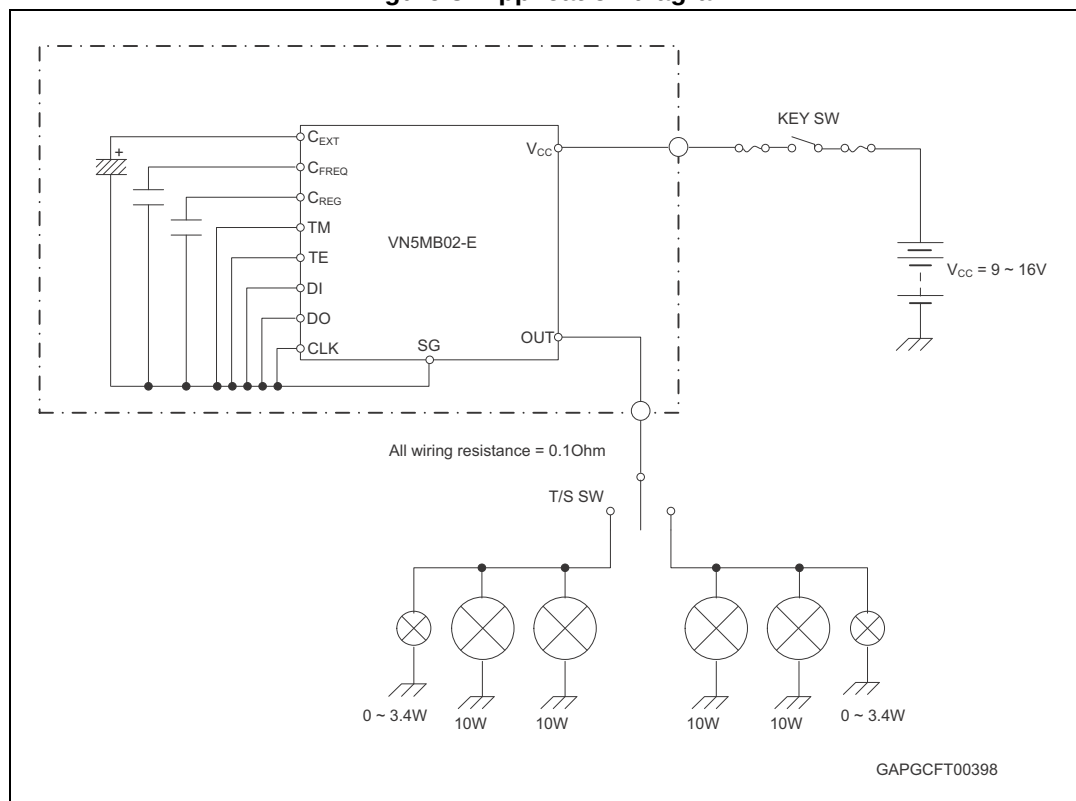


Table 2. Pin functions

| Name              | Pin number     | Function                                                                                                 |
|-------------------|----------------|----------------------------------------------------------------------------------------------------------|
| OUT               | 1, 2, 3        | Power output                                                                                             |
| SG                | 4              | Control stage signal ground.                                                                             |
| C <sub>REG</sub>  | 5              | Internal voltage regulator output, it needs a stability capacitor $C > 220$ nF                           |
| C <sub>FREQ</sub> | 6              | Needed for generating the internal sawtooth signal It is connected to an external capacitor $C = 1.5$ nF |
| TM                | 7              | Test mode pin. Must be connected to SG.                                                                  |
| TE                | 8              | Test mode enable. Must be connected to SG.                                                               |
| DI                | 9              | SPI data input. Must be connected to SG.                                                                 |
| DO                | 10             | SPI data output. Must be connected to SG.                                                                |
| CLK               | 11             | SPI clock. Must be connected to SG.                                                                      |
| C <sub>EXT</sub>  | 12             | Device supply, connected to an electrolytic capacitor $C > 220$ $\mu$ F                                  |
| V <sub>CC</sub>   | 13, 14, 15, 16 | Battery connection                                                                                       |

Figure 3. Application diagram



## 2 Electrical specifications

### 2.1 Absolute maximum rating

Stressing the device above the rating listed in [Table 3](#) may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Table 3. Absolute maximum ratings**

| Symbol     | Parameter                                                                       | Value              | Unit             |
|------------|---------------------------------------------------------------------------------|--------------------|------------------|
| $V_{CC}$   | DC supply voltage                                                               | 37                 | V                |
| $V_{CCPK}$ | Transient supply voltage ( $t < 400$ ms, $T_j = 25^\circ\text{C}$ )             | 41                 | V                |
| $C_{EXT}$  | $C_{EXT}$ voltage                                                               | -0.3 to 20         | V                |
| $C_{REG}$  | $C_{REG}$ voltage                                                               | -0.3 to 3.6        | V                |
| $C_{FREQ}$ | $C_{FREQ}$ voltage                                                              | -0.3 to 3.6        | V                |
| TM         | Test mode voltage                                                               | -0.3 to 3.6        | V                |
| $I_D$      | Maximum DC drain current                                                        | Internally limited | A                |
| $-I_D$     | Reverse DC output current                                                       | 5                  | A                |
| $V_{ESD}$  | Electrostatic discharge (human body model: $R = 1.5$ K $\Omega$ ; $C = 100$ pF) |                    |                  |
|            | – OUTPUT                                                                        | 4000               | V                |
|            | – $V_{CC}$                                                                      | 4000               | V                |
|            | – $C_{EXT}$                                                                     | 2000               | V                |
|            | – $C_{FREQ}$                                                                    | 2000               | V                |
|            | – $C_{REG}$                                                                     | 2000               | V                |
|            | – TM                                                                            | 2000               | V                |
| $V_{esd}$  | Electrostatic discharge CDM                                                     | 750                | V                |
| $T_j$      | Junction operating temperature                                                  | Internally limited | $^\circ\text{C}$ |
| $T_{stg}$  | Storage temperature                                                             | -55 to 150         | $^\circ\text{C}$ |

### 2.2 Thermal data

**Table 4. Thermal data**

| Symbol        | Parameter                                 | Value                         | Unit               |
|---------------|-------------------------------------------|-------------------------------|--------------------|
| $R_{thj-amb}$ | Thermal resistance junction-ambient (max) | See <a href="#">Figure 14</a> | $^\circ\text{C/W}$ |

## 2.3 Electrical characteristics

Values specified in this section are for  $9\text{ V} < V_{CC} < 16\text{ V}$ ;  $-40^{\circ}\text{C} < T_j < 150^{\circ}\text{C}$ , unless otherwise specified.

**Table 5. Features**

| Symbol                          | Parameter                                 | Test conditions                                                                                               | Min. | Typ. | Max. | Unit |
|---------------------------------|-------------------------------------------|---------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{\text{clamp}}$              | $V_{\text{DS}}$ clamp voltage             | $I_{\text{OUT}} = 2\text{ A}$                                                                                 | 41   |      |      | V    |
| $R_{\text{ON}}$                 | On-state resistance                       | $I_{\text{OUT}} = 2\text{ A}; T_j = 25^{\circ}\text{C}$                                                       |      |      | 80   | mΩ   |
|                                 |                                           | $I_{\text{OUT}} = 2\text{ A}; T_j = 150^{\circ}\text{C}$                                                      |      |      | 160  | mΩ   |
| $I_{\text{freq}}$               | Oscillating frequency current             |                                                                                                               | -3%  | 10.5 | 3%   | μA   |
| Duty                            | Duty cycle                                |                                                                                                               | 47   |      | 53   | %    |
| $K_{\text{freq}}$               | Fault frequency vs normal frequency ratio |                                                                                                               | 2.15 |      | 2.3  |      |
| $V_{\text{ch}} - V_{\text{cl}}$ | Internal sawtooth delta limit             |                                                                                                               | -2%  | 1.15 | 2%   | V    |
| $C_{\text{ext\_clamp}}$         | Cext voltage charging limit               | $V_{CC} = 20\text{ V};$<br>$-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$                                   | 14   | 16   | 18   | V    |
| $\text{del}_{\text{ON}}$        | Delay at first ON                         | $V_{CC} = 9\text{ V}; C_{\text{EXT}} = 220\text{ μF};$<br>$-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$    |      | 85   | 100  | ms   |
| $t_{\text{firstON}}$            | Minimum first $t_{\text{ON}}$             | $V_{CC} = 13.5\text{ V}; C_{\text{EXT}} = 220\text{ μF};$<br>$-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$ | 200  |      |      | ms   |
| $I_{\text{cext\_Charge}}$       | Cext voltage charging current             | $V_{CC} = 9\text{ V}; V_{\text{CEXT}} = 0\text{ V};$<br>$-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$      | 50   | 80   |      | mA   |
| $I_{\text{s\_ON}}$              | Current consumption in ON state           | $V_{CC} = 9\text{ V};$<br>$-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$                                    |      | 2    | 2.1  | mA   |
| $I_{\text{OL}}$                 | Max open load current                     | $-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$                                                              |      | 250  | 740  | mA   |
| $V_{\text{OL}}$                 | Max open load voltage                     | $-40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$                                                              |      | 5.7  | 6.5  | V    |

**Table 6. Protection**

| Symbol                | Parameter                           | Test conditions                                                        | Min.  | Typ.  | Max.  | Unit |
|-----------------------|-------------------------------------|------------------------------------------------------------------------|-------|-------|-------|------|
| $I_{\text{Isd}}$      | Current shutdown                    | $-40^{\circ}\text{C} < T_j < 25^{\circ}\text{C}$                       | 27    | 30    |       | A    |
|                       |                                     | $T_j = 85^{\circ}\text{C}$                                             | 25    |       |       | A    |
| $T_{\text{jsh}}$      | Overtemperature shutdown            |                                                                        |       | 175   |       | °C   |
| $\Delta T_{\text{h}}$ | Temperature hysteresis              |                                                                        |       | 14    |       | °C   |
| $t_{\text{fault}}$    | Fault time                          |                                                                        |       | 10    |       | ms   |
| $I_{\text{df1\_9V}}$  | Double frequency flashing threshold | $V_{CC} = 9\text{ V}; -40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$  | 0.911 | 0.987 | 1.063 | A    |
| $I_{\text{df1\_13V}}$ | Double frequency flashing threshold | $V_{CC} = 13\text{ V}; -40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$ | 1.112 | 1.210 | 1.308 | A    |
| $I_{\text{df1\_16V}}$ | Double frequency flashing threshold | $V_{CC} = 16\text{ V}; -40^{\circ}\text{C} < T_j < 85^{\circ}\text{C}$ | 1.245 | 1.358 | 1.470 | A    |

Table 7. Electrical transient requirements (part 1)

| ISO 7637-2:<br>2004(E)<br>Test pulse | Test levels <sup>(1)</sup> |        | Number of<br>pulses or<br>test times | Burst cycle/pulse<br>repetition time |        | Delays and<br>impedance  |
|--------------------------------------|----------------------------|--------|--------------------------------------|--------------------------------------|--------|--------------------------|
|                                      | III                        | IV     |                                      |                                      |        |                          |
| 1                                    | -75 V                      | -100 V | 5000<br>pulses                       | 0.5 s                                | 5 s    | 2 ms, 10 $\Omega$        |
| 2a                                   | +37 V                      | +50 V  | 5000<br>pulses                       | 0.2 s                                | 5 s    | 50 $\mu$ s, 2 $\Omega$   |
| 3a                                   | -100 V                     | -150 V | 1 h                                  | 90 ms                                | 100 ms | 0.1 $\mu$ s, 50 $\Omega$ |
| 3b                                   | +75 V                      | +100 V | 1 h                                  | 90 ms                                | 100 ms | 0.1 $\mu$ s, 50 $\Omega$ |
| 4                                    | -6 V                       | -7 V   | 1 pulse                              |                                      |        | 100 ms, 0.01 $\Omega$    |
| 5b <sup>(2)</sup>                    | +65 V                      | +87 V  | 1 pulse                              |                                      |        | 400 ms, 2 $\Omega$       |

1. The above test levels must be considered referred to  $V_{CC} = 13.5$  V except for pulse 5b
2. Valid in case of external load dump clamp: 40V maximum referred to OUT.

Table 8. Electrical transient requirements (part 2)

| ISO 7637-2:<br>2004(E)<br>Test pulse | Test level results <sup>(1)</sup> |    |
|--------------------------------------|-----------------------------------|----|
|                                      | III                               | IV |
| 1                                    | C                                 | C  |
| 2a                                   | C                                 | C  |
| 3a                                   | C                                 | C  |
| 3b                                   | C                                 | C  |
| 4                                    | C                                 | C  |
| 5b <sup>(2)</sup>                    | C                                 | C  |

1. The above test levels must be considered referred to  $V_{CC} = 13.5$  V except for pulse 5b
2. Valid in case of external load dump clamp: 40 V maximum referred to OUT.

Table 9. Electrical transient requirements (part 3)

| Class | Contents                                                                                                                                                                 |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C     | All functions of the device are performed as designed after exposure to disturbance.                                                                                     |
| E     | One or more functions of the device are not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device. |

2.4 Waveforms

Figure 4. First turn-on

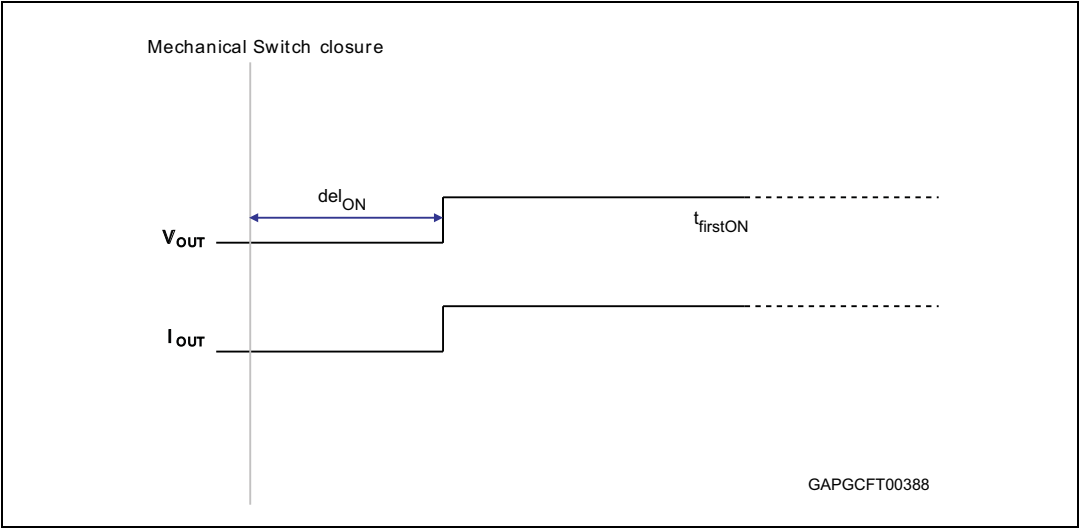


Figure 5. Normal operation

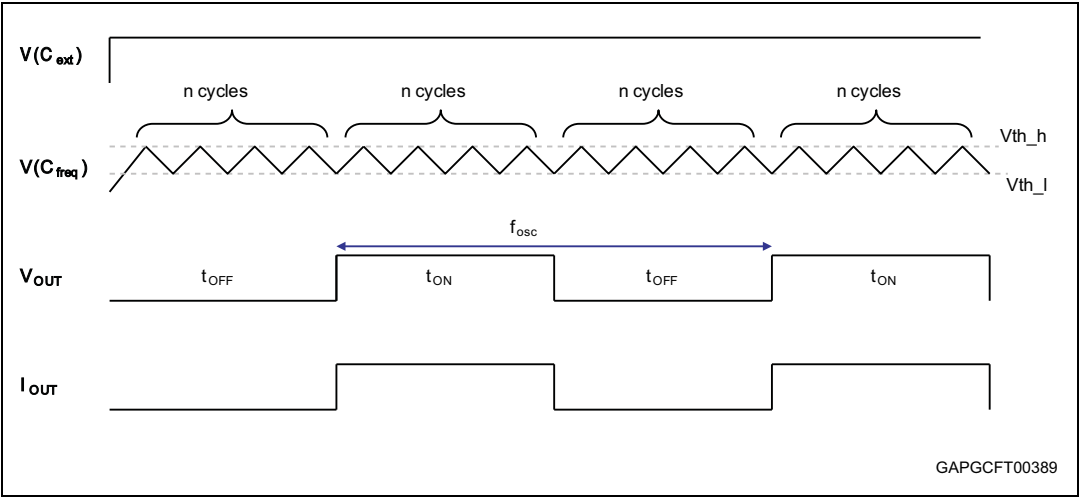


Figure 6. Low load condition

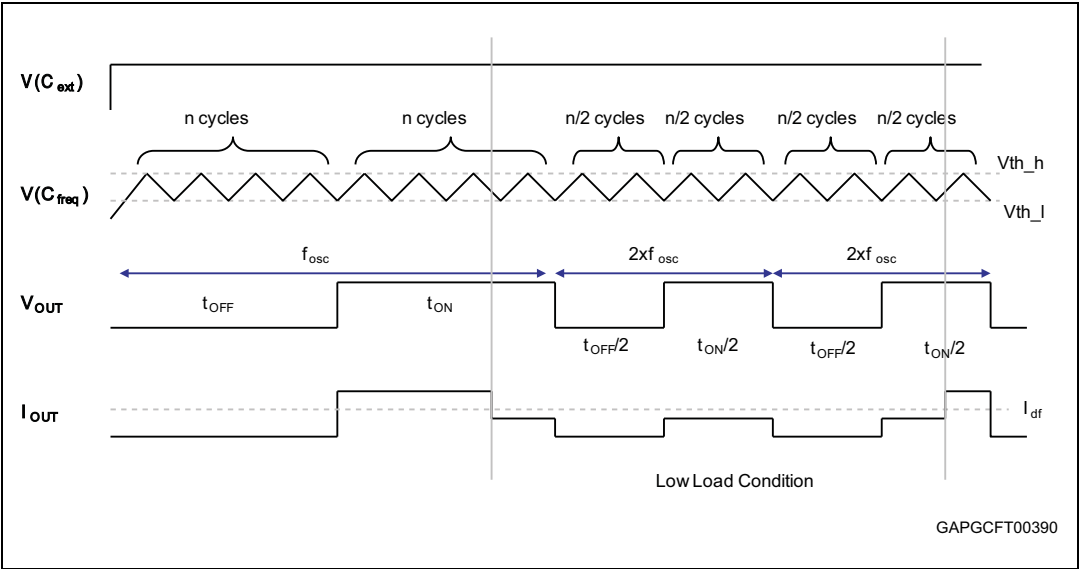


Figure 7.  $I_{SD}$  shutdown

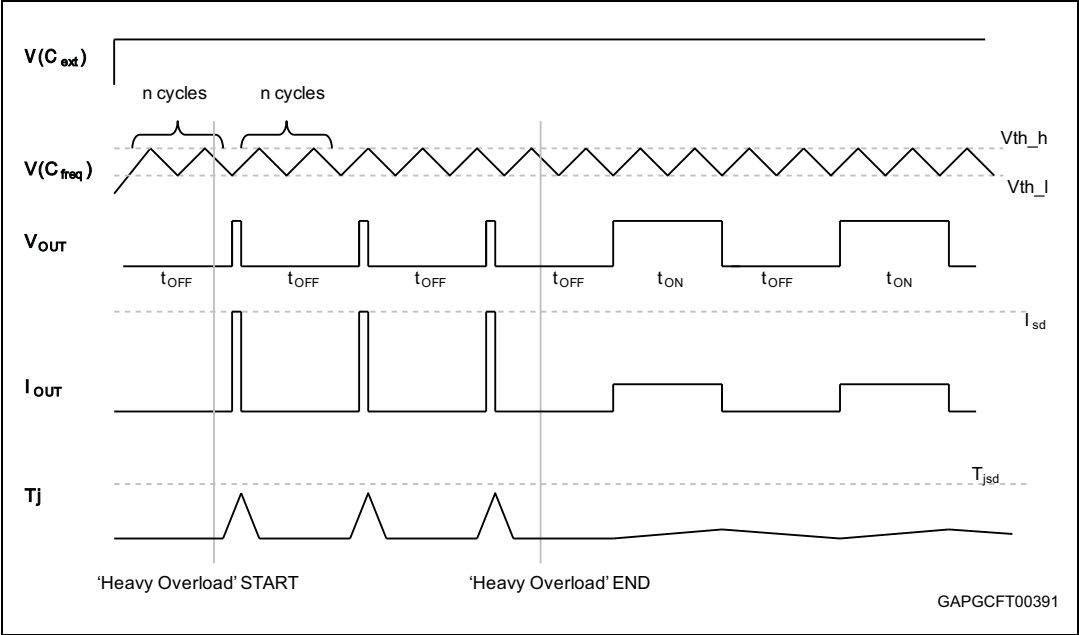


Figure 8. Thermal limitation event duration >  $t_{\text{FAULT}}$

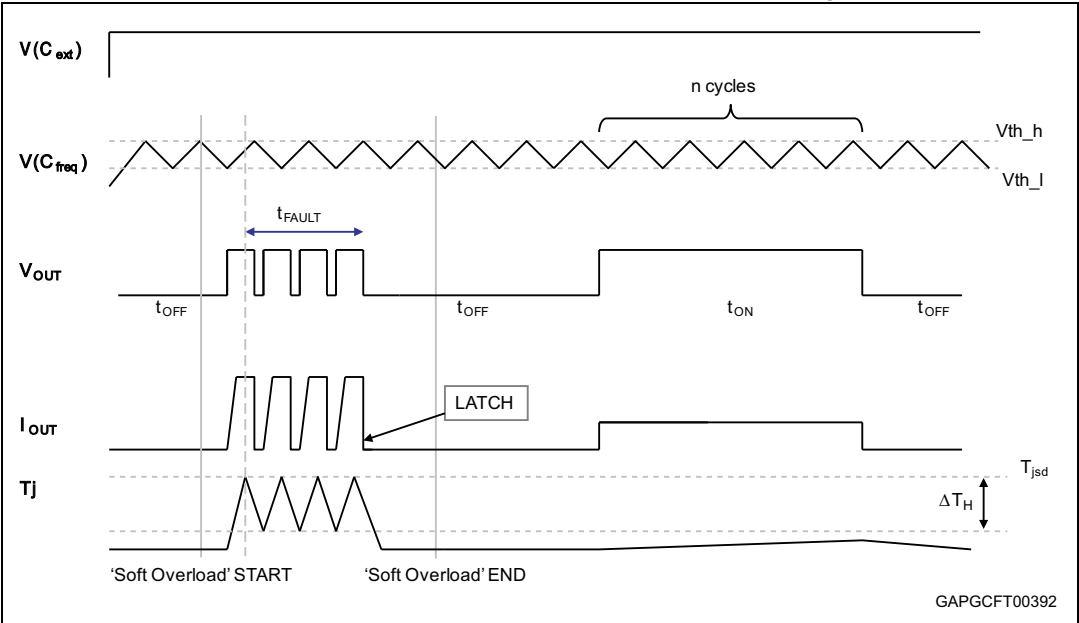


Figure 9. Thermal limitation with duration <  $t_{\text{FAULT}}$

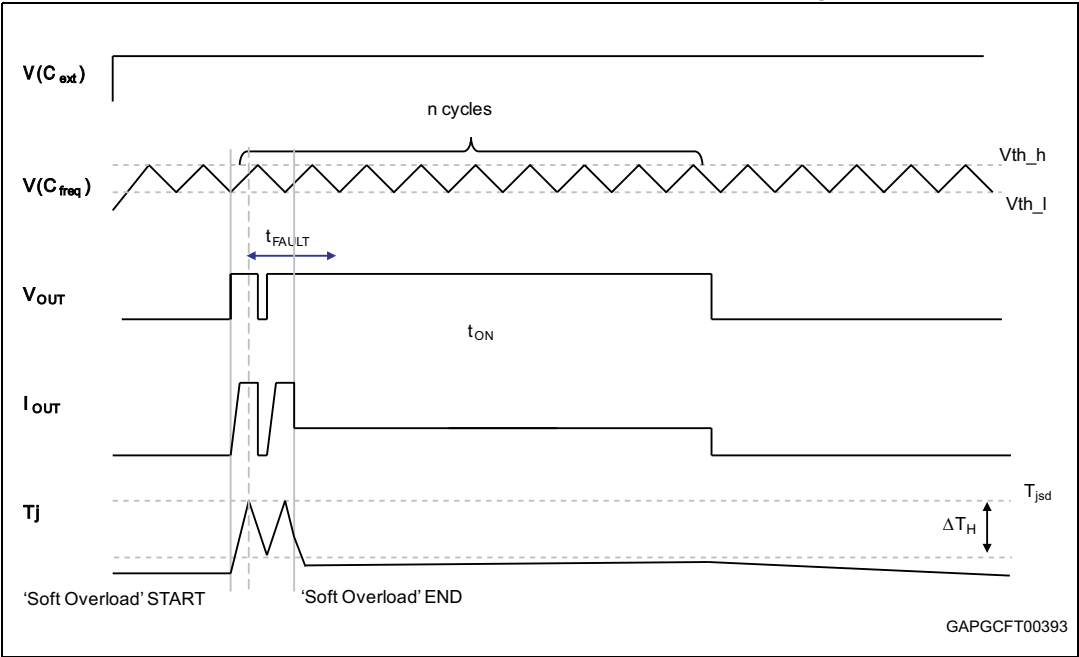


Figure 10. Open-load detection for FAST lane change (OFF)

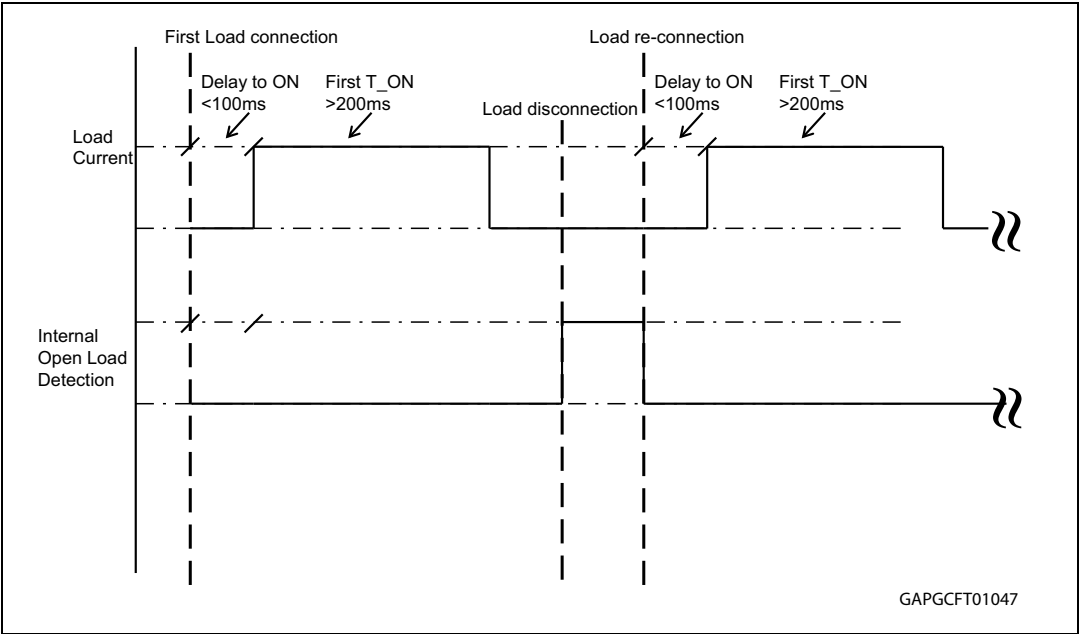
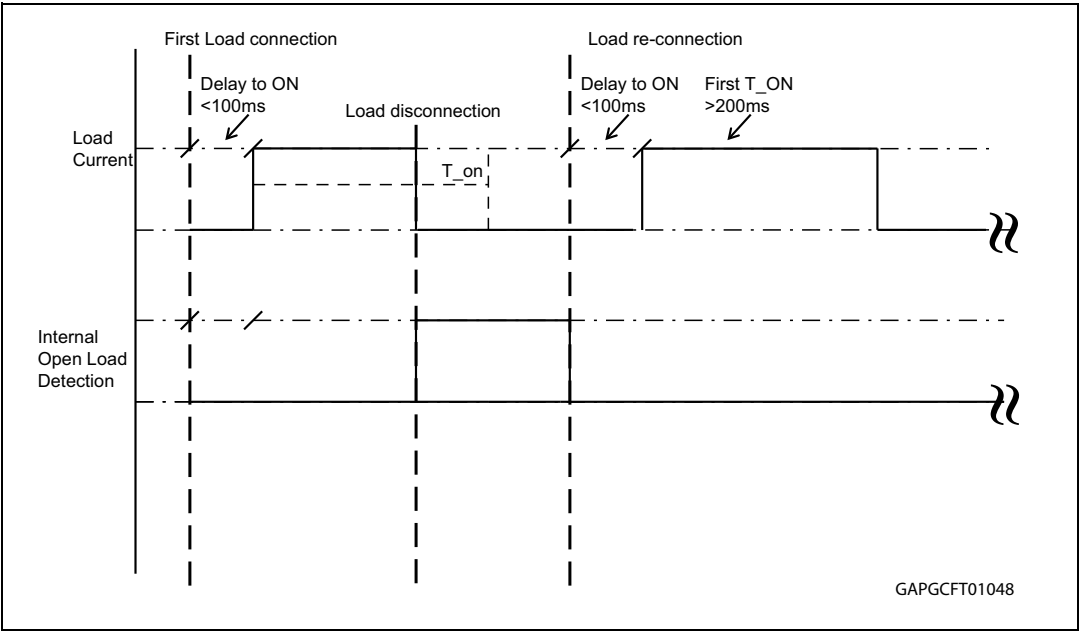


Figure 11. Open-load detection for FAST lane change (ON)



## 3 Functional description

### 3.1 Normal operation

When a nominal load is connected to the OUT pin, the device oscillates by charging the  $C_{EXT}$  capacitor up to the threshold voltage  $V_{ch}$  quickly, and then slowly discharging  $C_{EXT}$  to the threshold voltage  $V_{cl}$  by a constant current  $I_{CEXT}$ .

The self oscillating frequency of the device is determined by the relation:

$$f_{OSC} = \frac{I_{freq}}{4 \times n \times C_{freq} \times (V_{ch} - V_{cl})}$$

$n$  is the internal digital counter (equal to 1066).

### 3.2 Low load condition

If the load current is lower than  $I_{df}$ , the device will detect the low load at the end of the ON phase, and will double the oscillating frequency.

$$F(\text{fault}) = f_{OSC} \times K_{freq}$$

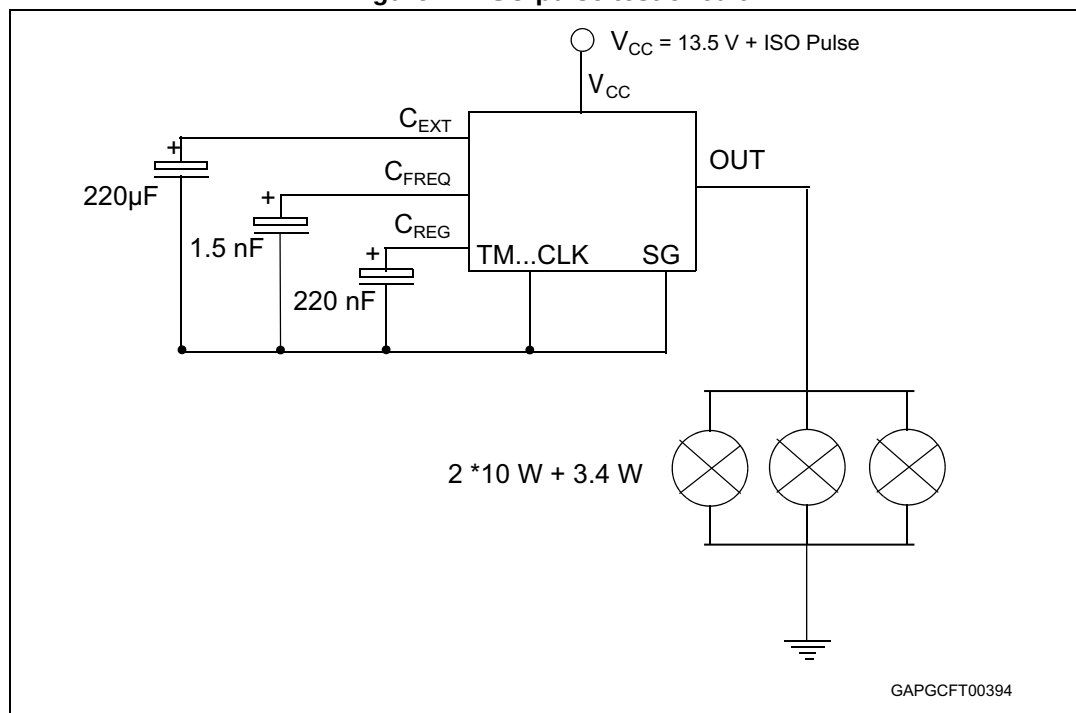
### 3.3 Current protection and thermal limitation

The internal current shutdown latches the VN5MB02-E when a heavy overload occurs and, if the overload even is removed, the device may be turned on at the following on time.

The thermal limitation reduces the stress on the device if the junction temperature rises (for instance when a soft over current event, not triggering the current latch protection, happens).

If the overload condition lasts more than a time  $t_{fault}$ , the VN5MB02-E is latched; when the overload condition is not anymore present, device can be turned on at the following on time.

Figure 12. ISO pulse test circuit

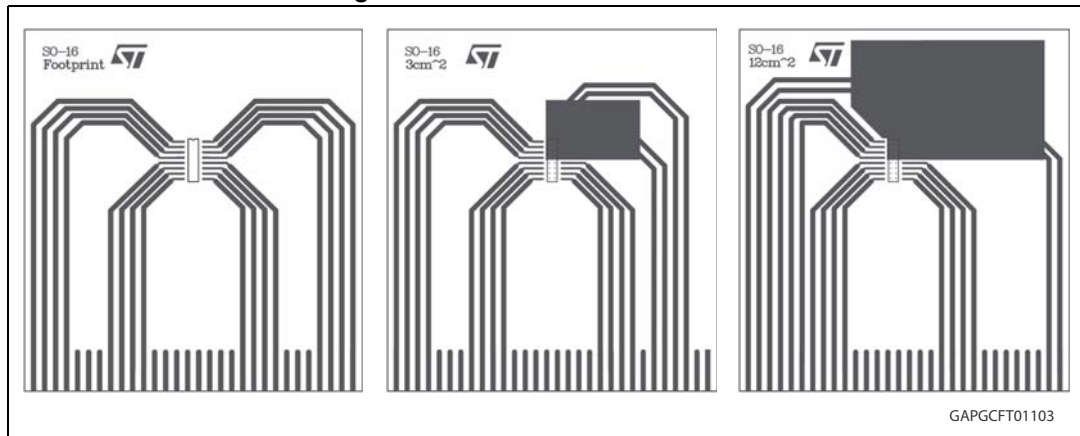


1. For pulse 5b an external protection is needed: see [Table 7](#).

## 4 Package and PCB thermal data

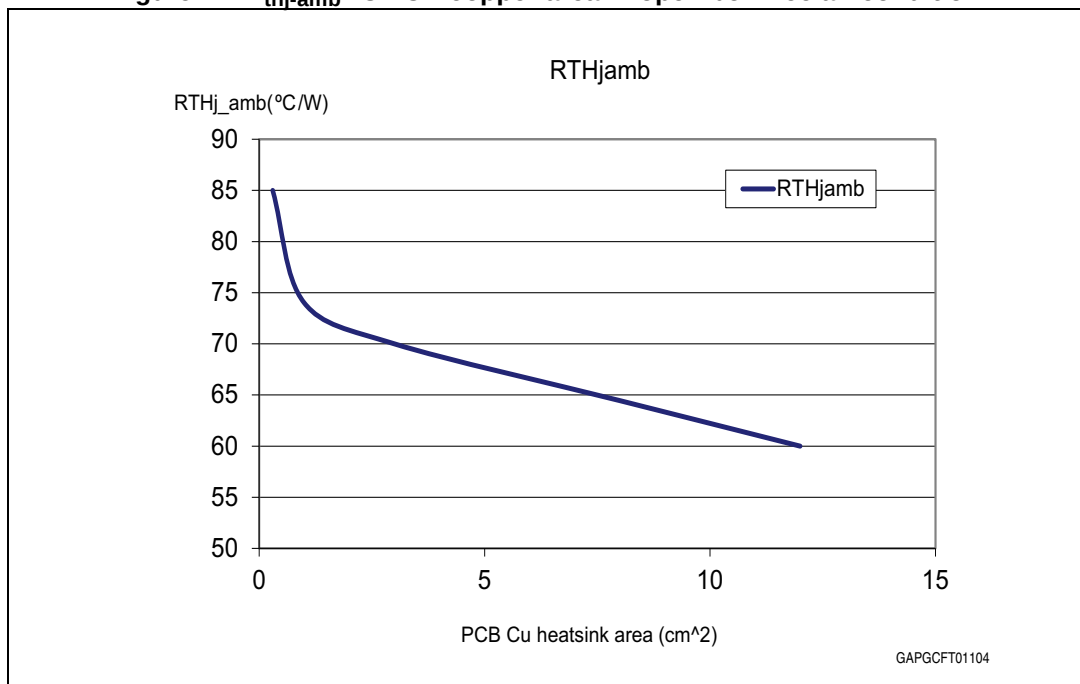
### 4.1 SO-16 narrow thermal data

Figure 13. SO-16 narrow PC board



1. Board finish thickness 1.6 mm +/- 10%; Board double layer; Board dimension 129 mm x 60 mm; Board Material FR4; Cu thickness 0.070 mm (front and back side); Thermal vias separation 1.2 mm; Thermal via diameter 0.3 mm +/- 0.08 mm; Cu thickness on vias 0.025 mm

Figure 14.  $R_{thj-amb}$  vs PCB copper area in open box free air condition



## 5 Package and packing information

### 5.1 ECOPACK® packages

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

ECOPACK® is an ST trademark.

Figure 15. SO-16 narrow package dimensions

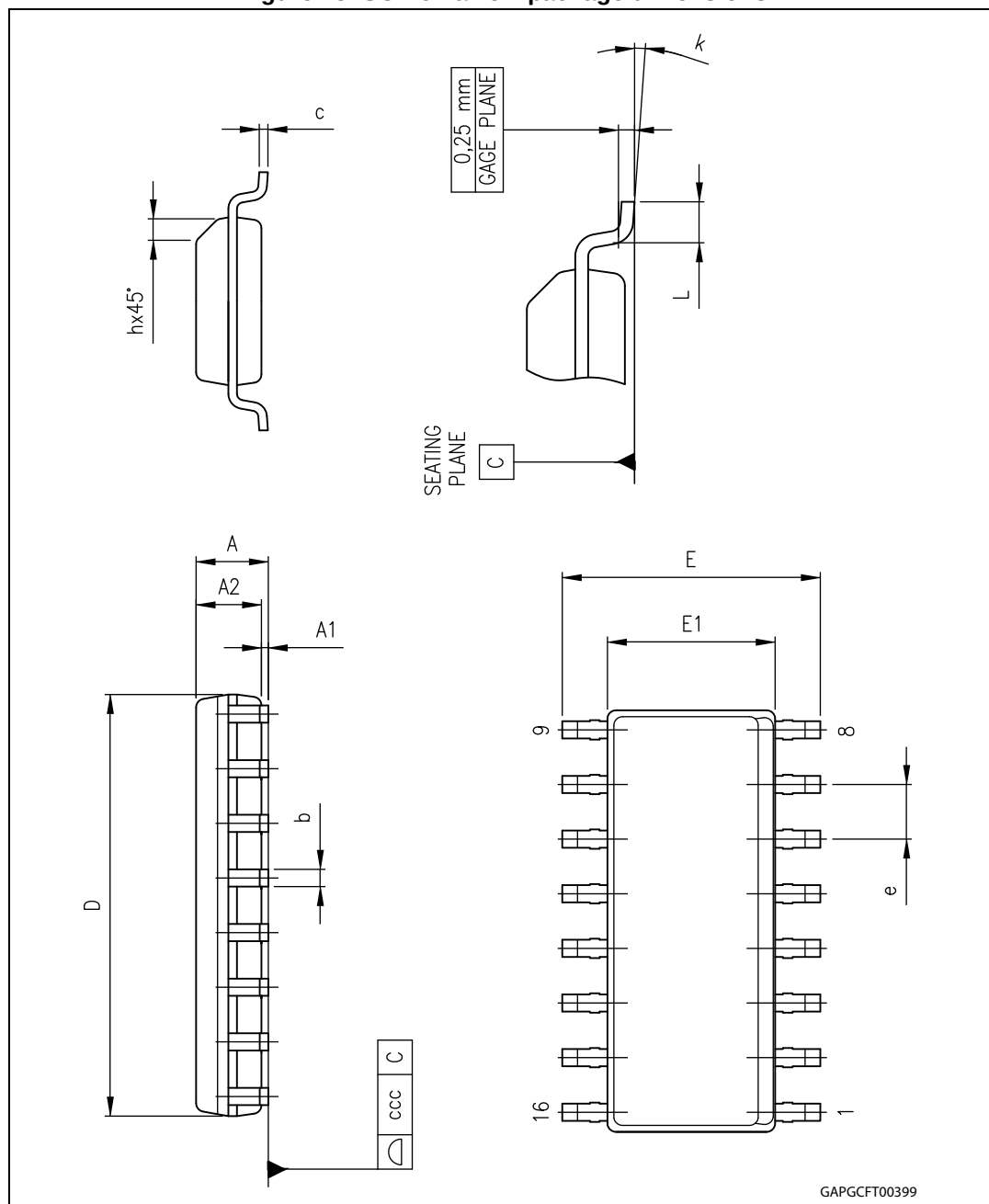


Table 10. SO-16 narrow mechanical data

| DIM. | mm.  |      |      |
|------|------|------|------|
|      | Min. | Typ. | Max. |
| A    |      |      | 1.75 |
| A1   | 0.1  |      | 0.25 |
| A2   | 1.25 |      |      |
| b    | 0.31 |      | 0.51 |
| c    | 0.17 |      | 0.25 |
| D    | 9.8  | 9.9  | 10   |
| E    | 5.8  | 6    | 6.2  |
| E1   | 3.8  | 3.9  | 4    |
| e    |      | 1.27 |      |
| h    | 0.25 |      | 0.5  |
| L    | 0.4  |      | 1.27 |
| k    | 0    |      | 8    |
| ccc  |      |      | 0.1  |

## 6 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17-Oct-2012 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 06-Dec-2012 | 2        | <p><a href="#">Table 3: Absolute maximum ratings:</a></p> <ul style="list-style-type: none"> <li>– <math>I_D</math>: updated value</li> </ul> <p><a href="#">Table 4: Thermal data:</a></p> <ul style="list-style-type: none"> <li>– <math>R_{thj-case}</math>: removed row</li> </ul> <p><a href="#">Table 5: Features:</a></p> <ul style="list-style-type: none"> <li>– <math>I_{freq}</math>: updated minimum and maximum values</li> <li>– <math>V_{ch}</math>, <math>V_{cl}</math>: removed rows</li> <li>– <math>V_{ch} - V_{cl}</math>, <math>I_{OL}</math>, <math>V_{OL}</math>: added row</li> </ul> <p>Added <a href="#">Chapter 4: Package and PCB thermal data</a></p> |
| 12-Dec-2012 | 3        | <p><a href="#">Table 5: Features:</a></p> <ul style="list-style-type: none"> <li>– <math>V_{ch} - V_{cl}</math>: added typical value</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 09-Jan-2014 | 4        | <p>Updated <a href="#">Figure 14: <math>R_{thj-amb}</math> vs PCB copper area in open box free air condition</a></p> <p>Updated <a href="#">Section 3.1: Normal operation</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 28-Jul-2014 | 5        | Changed document status from “Preliminary data” to “Production data”                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 29-Oct-2015 | 6        | <p><a href="#">Table 5: Features:</a></p> <ul style="list-style-type: none"> <li>– <math>I_{freq}</math>, <math>V_{ch} - V_{cl}</math>: updated values</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

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