



SANYO Semiconductors

## DATA SHEET

An ON Semiconductor Company

# LV8013T — Bi-CMOS IC Forward/Reverse Motor Driver

## Overview

LV8013T is a 1ch forward/reverse motor driver IC using D-MOS FET for output stage. As MOS circuit is used, it supports the PWM input. Its features are that the on resistance ( $0.3\Omega$  typ) and current dissipation are low.

It also provides protection functions such as heat protection circuit and reduced voltage detection and is optimal for the motors that need high-current.

## Functions

- 1ch forward/reverse motor driver
- Possible to respond to 3V control voltage and 6V motor voltage device
- Low power consumption
- Low-temperature resistance  $0.5\Omega$
- Built-in charge pump circuit
- Built-in low voltage reset and thermal shutdown circuit
- Four mode function forward/reverse, brake, stop.

## Specifications

Maximum Ratings at  $T_a = 25^\circ\text{C}$ , SGND = PGND = 0V

| Parameter                    | Symbol               | Conditions                               | Ratings                      | Unit |
|------------------------------|----------------------|--|------------------------------|------|
| Supply voltage (For load)    | VM max               |  | -0.5 to 16                   | V    |
| Supply voltage (For control) | V <sub>CC</sub> max  |  | -0.5 to 6.0                  | V    |
| Output current               | I <sub>O</sub> max   | DC                                       | 1.2                          | A    |
|                              | I <sub>O</sub> peak1 | $t \leq 100\text{ms}$ , $f = 5\text{Hz}$ | 2.0                          | A    |
|                              | I <sub>O</sub> peak2 | $t \leq 10\text{ms}$ , $f = 5\text{Hz}$  | 3.8                          | A    |
| Input voltage                | V <sub>IN</sub> max  |  | -0.5 to V <sub>CC</sub> +0.5 | V    |
| Allowable power dissipation  | Pd max               | Mounted on a specified board *           | 800                          | mW   |
| Operating temperature        | Topr                 |  | -20 to +75                   | °C   |
| Storage temperature          | Tstg                 |  | -55 to +150                  | °C   |

\*Specified board : 30mm × 50mm × 1.6mm, glass epoxy board.

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## Allowable Operating Conditions at Ta = 25°C, SGND = PGND = 0V

| Parameter                    | Symbol                | Conditions | Ratings      | Unit |
|------------------------------|-----------------------|------------|--------------|------|
| Supply voltage (For load)    | VM                    |            | 2.0 to 15.0  | V    |
| Supply voltage (For control) | VCC                   |            | 2.7 to 5.5   | V    |
| Input signal voltage         | VIN                   |            | 0 to VCC     | V    |
| Input signal frequency       | f max                 | Duty = 50% | 200          | kHz  |
| Capacitor for charge pump    | C1, C2,<br>CVG1, CVG2 |            | 0.001 to 0.1 | μF   |

## Electrical Characteristics at Ta = 25°C, VCC = 5.0V, VM = 12.0V, SGND = PGND = 0V, unless especially specified.

| Parameter                               | Symbol        | Conditions                              | Re-<br>marks | Ratings |      |         | Unit |
|---|---------------|---|--------------|---------|------|---------|------|
|   |               |   |              | min     | typ  | max     |      |
| Supply current for load at standby 1    | IM1           | EN = 0V                                 | 1            |         |      | 1.0     | μA   |
| Supply current for load at standby 2    | IM2           | VCC = 0V, Each input = 0V               | 1            |         |      | 1.0     | μA   |
| Supply current for control at standby   | ICO           | EN = 0V, IN1 = IN2 = 0V                 | 2            | 12.5    | 25   | 50      | μA   |
| Current drain during operation 1        | IC1           | VCC = 3.3V, EN = 3.3V, VG at no load    | 3            |         | 0.6  | 1.0     | mA   |
| Current drain during operation 2        | IC2           | VCC = 5.0V, EN = 5V, VG at no load      | 3            |         | 0.7  | 1.2     | mA   |
| H-level input voltage                   | VIH           | 2.7V ≤ VCC ≤ 5.5V                       |              | 0.6×VCC |      | VCC     | V    |
| L-level input voltage                   | VIL           | 2.7V ≤ VCC ≤ 5.5V                       |              | 0       |      | 0.2×VCC | V    |
| H-level input current (IN1, IN2, TIN)   | IiH           | VIN = 5V                                | 4            | 12.5    | 25   | 50      | μA   |
| L-level input current (IN1, IN2, TIN)   | IiL           | VIN = 0V                                | 4            | -1.0    |      |         | μA   |
| Pull-up resistance (EN)                 | RUP           |   | 4            | 100     | 200  | 400     | kΩ   |
| Pull-down resistance (EN)               | RDN           |   | 4            | 100     | 200  | 400     | kΩ   |
| Output ON resistance                    | RON           | Sum of ON resistances at top and bottom | 5            |         | 0.3  | 0.5     | Ω    |
| Charge pump voltage1                    | VG1           | VCC×2 - 5.4V CLAMP circuit              | 6            | 5.15    | 5.4  | 5.65    | V    |
| Charge pump voltage2                    | VG2           | VM + VG1 Voltage raising circuit        | 6            | 17.1    | 17.4 | 17.6    | V    |
| Low-voltage detection operation voltage | VCS           | VCC voltage                             | 7            | 2.1     | 2.25 | 2.4     | V    |
| Thermal shutdown operation temperature  | Tth           | Design guarantee                        | 8            | 150     | 180  | 210     | °C   |
| Charge pump capacity 1                  | VG1LOAD       | IG1 = 500μA                             | 9            | 5.0     | 5.3  |         | V    |
| Charge pump capacity 2                  | VG2LOAD       | IG2 = 500μA                             | 9            | 16.0    | 16.5 |         | V    |
| IG current dissipation (Fin = 20kHz)    | IG            |   | 10           |         |      | 350     | μA   |
| Charge pump start time                  | TVG           | CVG = 0.1μF                             | 11           |         |      | 1.0     | ms   |
| Output block                            | Turn on time  | TPLH                                    | 12           |         | 0.5  | 1.0     | μs   |
|   | Turn off time | TPHL                                    | 12           |         | 0.5  | 1.0     | μs   |
| TOUT                                    | Turn on time  | TON                                     | 12           |         | 0.5  | 20      | μs   |
|   | Turn off time | TOFF                                    | 12           |         | 0.5  | 20      | μs   |
| TOUT output voltage H                   | TOH           | C = 500pF                               |              | VG2-0.1 | VG2  |         | V    |
| TOUT output voltage L                   | TOL           | C = 500pF                               |              |         | 0.05 | 0.1     | V    |

\* Design guarantee : This characteristics is not measured.

Refer to next page for remarks.

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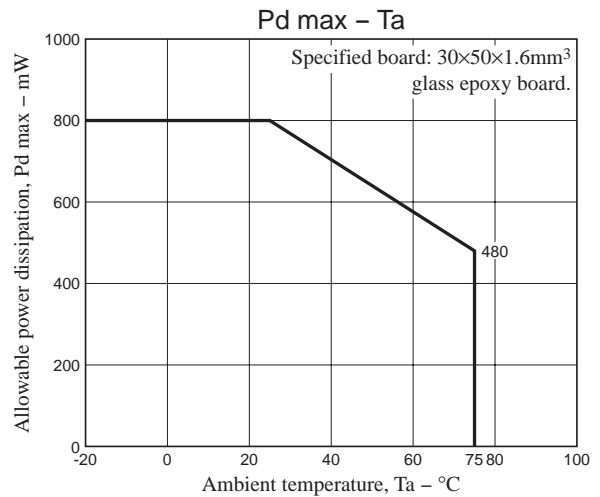
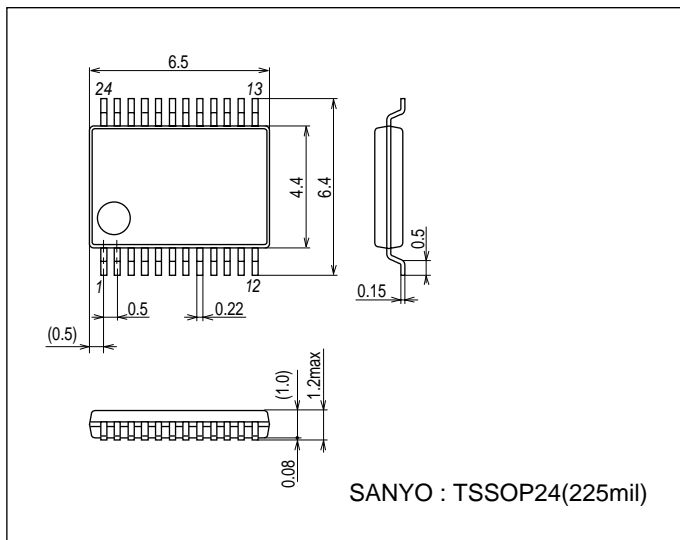
## Remarks

1. It shows current dissipation of VM pin in output OFF state.
2. It shows current dissipation of V<sub>CC</sub> pin in stand-by state.  
(The standard current depends on EN pin pull-down resistor.)
3. It shows current dissipation of V<sub>CC</sub> pin in state of EN = 5V (stand-by), including current dissipation of VG pin.
4. IN1, IN2 and TIN pin are built-in pull-down resistor, EN pin is built-in pull-up resistor.
5. It shows sum of upper and lower saturation voltages of OUT pin.
6. It controls charge-pump oscillation and makes specified voltage.
7. When low voltage is detected, the lower output is turned OFF.
8. When thermal protection circuit is activated, the lower output is turned OFF.  
When the heat temperature is fallen, it is turned ON again.
9. IG (VG pin load current) = 500μA
10. It shows VG pin current dissipation in state of PWM input for IN pin.
11. It specifies start-up time from 10% to 90% when VG is in non-load state  
(when setting the capacitor between VG and GND to 0.1μF and V<sub>CC</sub> is 5V).
12. It specifies 10% to 90% for start-up and 90% to 10% for shut-down.

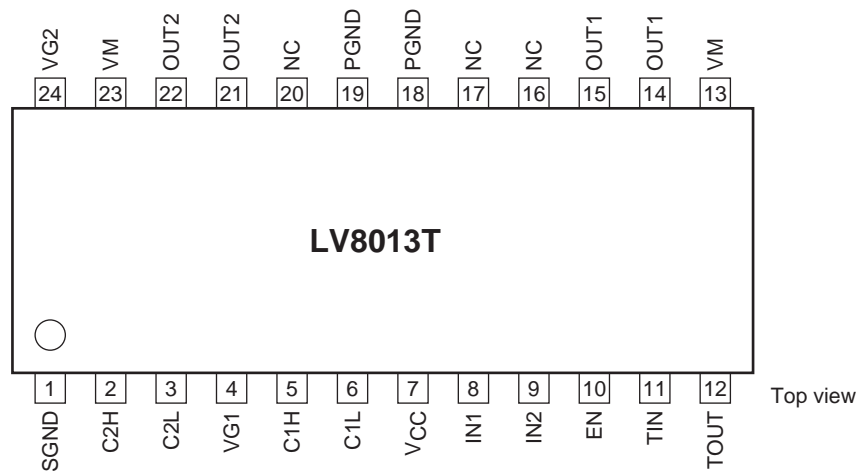
## Package Dimensions

unit : mm (typ)

3260A

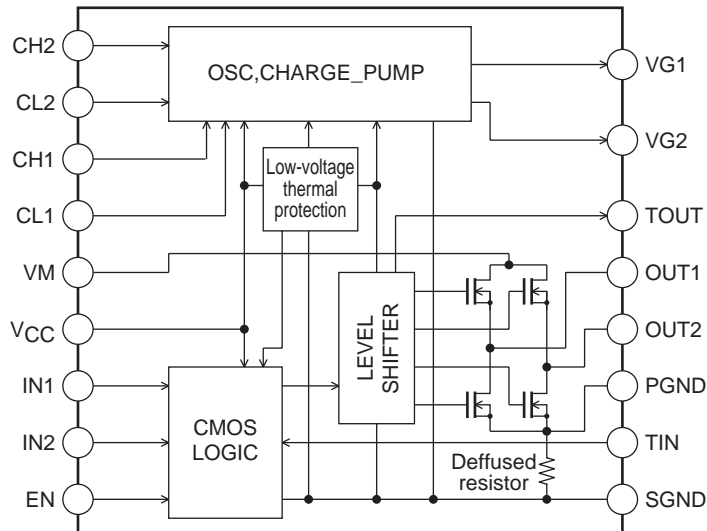


## Pin Assignment



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## Block Diagram



## Truth Table

| EN | IN1 | IN2 | TIN | OUT1 | OUT2 | TOUT | Charge Pump | Mode    |
|----|-----|-----|-----|------|------|------|-------------|---------|
| H  | H   | H   | -   | L    | L    | -    | ON          | Brake   |
|    | H   | L   | -   | H    | L    | -    |             | Forward |
|    | L   | H   | -   | L    | H    | -    |             | Reverse |
|    | L   | L   | -   | Z    | Z    | -    |             | Standby |
|    | -   | -   | L   | -    | -    | L    |             | Tr-OFF  |
|    | -   | -   | H   | -    | -    | H    |             | Tr-ON   |
| L  | -   | -   | -   | L    | L    | L    | OFF         | Standby |

- : Don't care, Z : High-Impedance

- Current drain becomes zero in the standby mode. (Leak current from EN pin is excluded)
- The output side becomes OFF, with motor drive stopped, during voltage reduction and thermal protection. Also, the charge of VG2 is discharged with an internal circuit at decreasing voltage.

## Pin Function

| Pin No.      | Pin name          | Function  | Equivalent circuit |
|--------------|-------------------|---|--------------------|
| 6            | C1L               | Voltage raising capacitor connection pin.   |                    |
| 5            | C1H               | Voltage raising capacitor connection pin.   |                    |
| 8<br>9<br>11 | IN1<br>IN2<br>TIN | <ul style="list-style-type: none"> <li>• Driver output changeover.</li> <li>• TOUT output control pin. (Built-in pull-down resistor)</li> </ul> |                    |

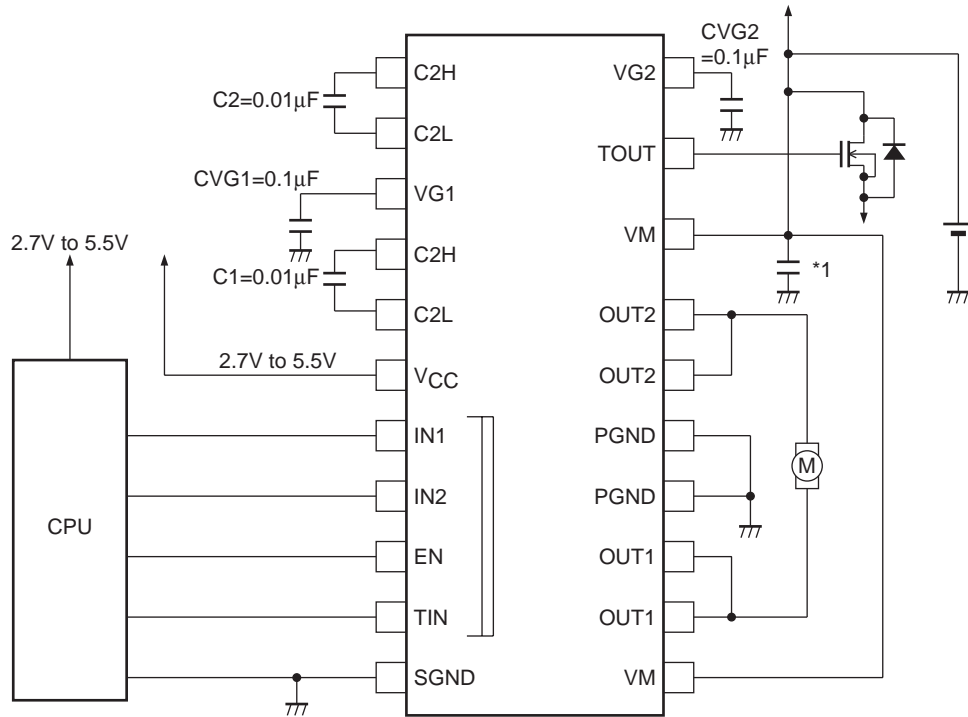
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| Pin No.                          | Pin name                                     | Function   | Equivalent circuit |
|----------------------------------|--|--|--------------------|
| 10                               | EN   | Logic enable pin.<br>(Built-in pull-up resistor)   |                    |
| 14<br>15<br>21<br>22<br>18<br>19 | OUT1<br>OUT1<br>OUT2<br>OUT2<br>PGND<br>PGND | Driver output pin.   |                    |
| 12                               | TOUT   | Voltage raising output pin.  |                    |
| 13<br>23                         | VM<br>VM                                     | Motor power supply.<br>(both terminals to be connected)  |                    |
| 7                                | VCC  | Logic power supply.  |                    |
| 4                                | VG1  | Voltage raising circuit 1.<br>$V_{CC} \times 2$<br>Clamped to 5.4V   |                    |
| 24<br>2<br>3                     | VG2<br>C2H<br>C2L                            | <ul style="list-style-type: none"> <li>Voltage raising circuit 2.<br/><math>VM + VG1</math></li> <li>Voltage raising capacitor connection pin.<br/>VG2 is discharged in abnormal.</li> </ul> |                    |
| 1                                | SGND   | Logic GND  |                    |
| 18<br>19                         | PGND<br>PGND                                 | Driver GND<br>(both terminals to be connected)   |                    |

Application Circuit Example



\*1 : Connect a kickback absorption capacitor directly near IC. Coil kick-back may cause rise of the voltage of VM line, and the voltage exceeding the maximum rating may be applied momentarily, resulting in deterioration or damage of IC.

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