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# LB11685AV

Monolithic Digital IC

## 3-phase sensor less Motor driver

### Overview

The LB11685AV is a three-phase full-wave current-linear-drive motor driver IC. It adopts a sensor less control system without the use of a Hall Effect device. For quieter operation, the LB11685AV features a current soft switching circuit and be optimal for driving the cooling fan motors used in refrigerators, etc.

### Functions

- Three-phase full-wave linear drive (Hall sensor-less method)
- Built-in three-phase output voltage control circuit
- Motor lock protection detection output
- Built-in thermal shut down circuit
- Built-in current limiter circuit
- Built-in motor lock protection circuit
- FG output made by back EMF
- Beat lock prevention circuit

### Specifications

Maximum Ratings at Ta = 25°C

| Parameter                   | Symbol                | Conditions            | Ratings                      | Unit |
|-----------------------------|-----------------------|-----------------------|------------------------------|------|
| Maximum supply voltage      | V <sub>CC</sub> max   |                       | 19                           | V    |
| Input applied voltage       | V <sub>IN</sub> max   |                       | -0.3 to V <sub>CC</sub> +0.3 | V    |
| Maximum output current      | I <sub>O</sub> max *1 |                       | 1.2                          | A    |
| Allowable power dissipation | P <sub>d</sub> max    | Mounted on a board *2 | 1.05                         | W    |
| Operating temperature       | T <sub>opr</sub>      |                       | -40 to 85                    | °C   |
| Storage temperature         | T <sub>stg</sub>      |                       | -55 to 150                   | °C   |
| Junction temperature        | T <sub>j</sub> max    |                       | 150                          | °C   |

\*1: The I<sub>O</sub> is a peak value of motor-current.

\*2: Specified board: 76.1mm × 114.3mm × 1.6mm, glass epoxy board.

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.

Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

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.

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## Recommended Operating Conditions at Ta = 25°C

| Parameter                  | Symbol             | Conditions | Ratings     | Unit |
|----------------------------|--------------------|------------|-------------|------|
| Recommended Supply voltage | V <sub>CC</sub>    |            | 12.0        | V    |
| Operating supply voltage   | V <sub>CC</sub> op |            | 4.5 to 18.0 | V    |

## Electrical Characteristics at Ta = 25°C, V<sub>CC</sub> = 5.0V

| Parameter                                      | Symbol              | Conditions                                                      | Ratings |       |                     | Unit |
|------------------------------------------------|---------------------|-----------------------------------------------------------------|---------|-------|---------------------|------|
|                                                |                     |                                                                 | min     | typ   | max                 |      |
| Supply current                                 | I <sub>CC</sub>     | FC1 = FC2 = 0V                                                  | 5       | 10    | 20                  | mA   |
| Internal regulate voltage                      | V <sub>REG</sub>    |                                                                 | 3.0     | 3.3   | 3.6                 | V    |
| Output voltage (source)                        | V <sub>OSOUR</sub>  | I <sub>O</sub> = 0.8A *3                                        |         | 1.3   | 1.7                 | V    |
| Output voltage (sink)                          | V <sub>OSINK</sub>  | I <sub>O</sub> = 0.8A *3                                        |         | 0.5   | 1.3                 | V    |
| Current limiter                                | V <sub>OLIM</sub>   |                                                                 | 0.268   | 0.300 | 0.332               | V    |
| MCOM pin<br>common-input voltage range         | V <sub>INCOM</sub>  |                                                                 | 0       |       | V <sub>CC</sub> - 2 | V    |
| MCOM pin<br>Source current for hysteresis      | I <sub>COM+</sub>   | MCOM = 7V                                                       | 30      |       | 80                  | μA   |
| MCOM pin<br>Sink current for hysteresis        | I <sub>COM-</sub>   | MCOM = 7V                                                       | 30      |       | 80                  | μA   |
| MCOM pin<br>hysteresis current ratio           | R <sub>TCOM</sub>   | R <sub>TCOM</sub> = I <sub>COM+</sub> / I <sub>COM-</sub>       | 0.6     |       | 1.4                 |      |
| VCO input bias current                         | I <sub>VCO</sub>    | V <sub>CO</sub> = 2.3V                                          |         |       | 0.2                 | μA   |
| VCO oscillation minimum<br>frequency           | f <sub>VCOmin</sub> | V <sub>CO</sub> = 2.1V, CX = 0.015μF<br>Design target *2        |         | 930   |                     | Hz   |
| VCO oscillation maximum<br>frequency           | f <sub>VCOmax</sub> | V <sub>CO</sub> = 2.7V, CX = 0.015μF<br>Design target *2        |         | 8.6   |                     | kHz  |
| CX charge / discharge current                  | I <sub>CX</sub>     | V <sub>CO</sub> = 2.5V, CX = 1.6V                               | 70      | 100   | 140                 | μA   |
| CX hysteresis voltage                          | ΔV <sub>CX</sub>    |                                                                 | 0.35    | 0.55  | 0.75                |      |
| C1 (C2) charge current                         | I <sub>C1(2)+</sub> | V <sub>CO</sub> = 2.5V, C1(2) = 1.3V                            | 12      | 20    | 28                  | μA   |
| C1 (C2) discharge current                      | I <sub>C1(2)-</sub> | V <sub>CO</sub> = 2.5V, C1(2) = 1.3V                            | 12      | 20    | 28                  | μA   |
| C1 (C2) charge / discharge<br>current ratio    | R <sub>TC1(2)</sub> | R <sub>TC1(2)</sub> = I <sub>C1(2)+</sub> / I <sub>C1(2)-</sub> | 0.8     | 1.0   | 1.2                 |      |
| C1/C2 charge current ratio                     | R <sub>TCCHG</sub>  | R <sub>TCCHG</sub> = I <sub>C1+</sub> / I <sub>C2+</sub>        | 0.8     | 1.0   | 1.2                 |      |
| C1/C2 discharge current ratio                  | R <sub>TCDIS</sub>  | R <sub>TCDIS</sub> = I <sub>C1-</sub> / I <sub>C2-</sub>        | 0.8     | 1.0   | 1.2                 |      |
| C1 (C2) clamp voltage width                    | V <sub>CW1(2)</sub> |                                                                 | 1.0     | 1.3   | 1.6                 | V    |
| FG output low level voltage                    | V <sub>FGL</sub>    | I <sub>FG</sub> = 3mA                                           |         |       | 0.5                 | V    |
| RD output low level voltage                    | V <sub>RDL</sub>    | I <sub>RD</sub> = 3mA                                           |         |       | 0.5                 | v    |
| Thermal shut down operating<br>temperature *1  | T <sub>TSD</sub>    | Junction temperature<br>Design target *2                        | 150     | 180   |                     | °C   |
| Thermal shut down hysteresis<br>temperature *1 | ΔT <sub>TSD</sub>   | Junction temperature<br>Design target *2                        |         | 15    |                     | °C   |

\*1: The thermal shut down circuit is built-in for protection from damage of IC. But its operation is out of Topr. Design thermal calculation at normal operation.

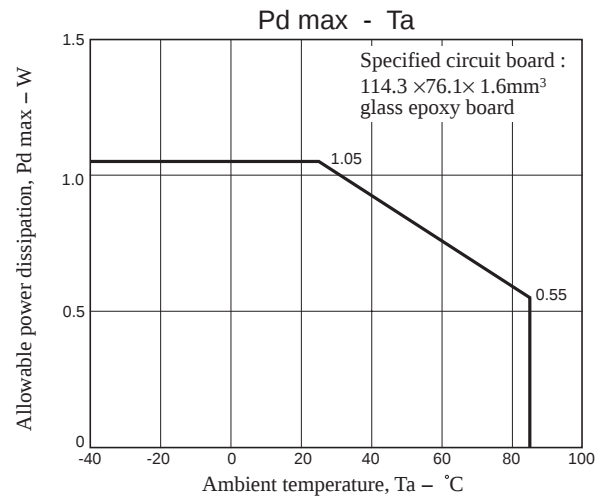
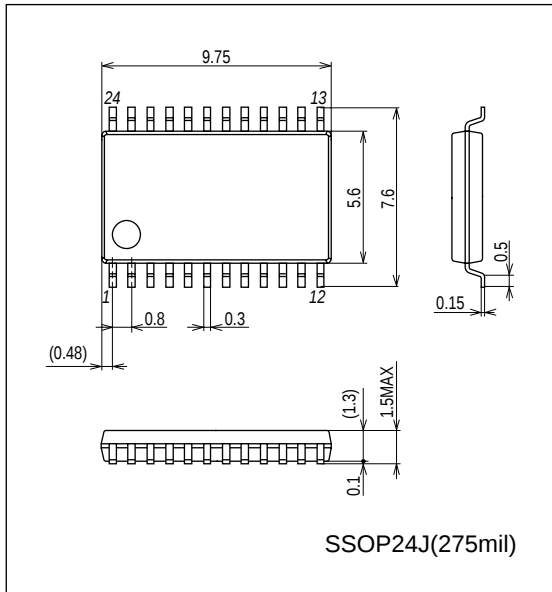
\*2: Design target value and no measurement is made.

\*3: The I<sub>O</sub> is a peak value of motor-current.

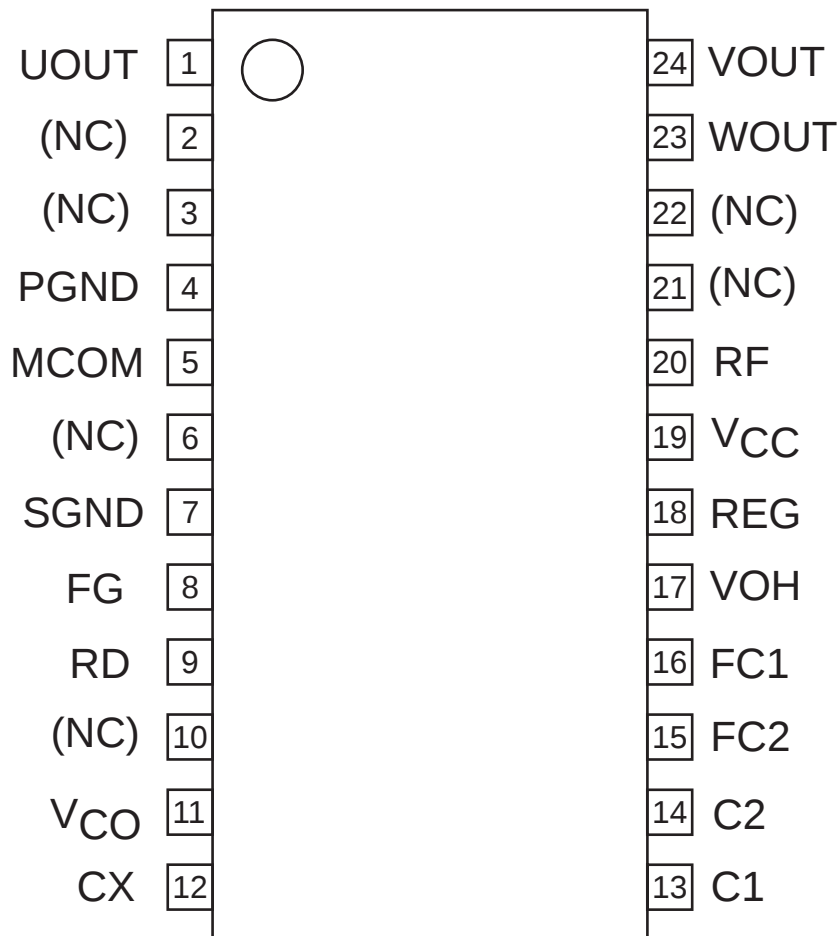
## Package Dimensions

unit : mm (typ)

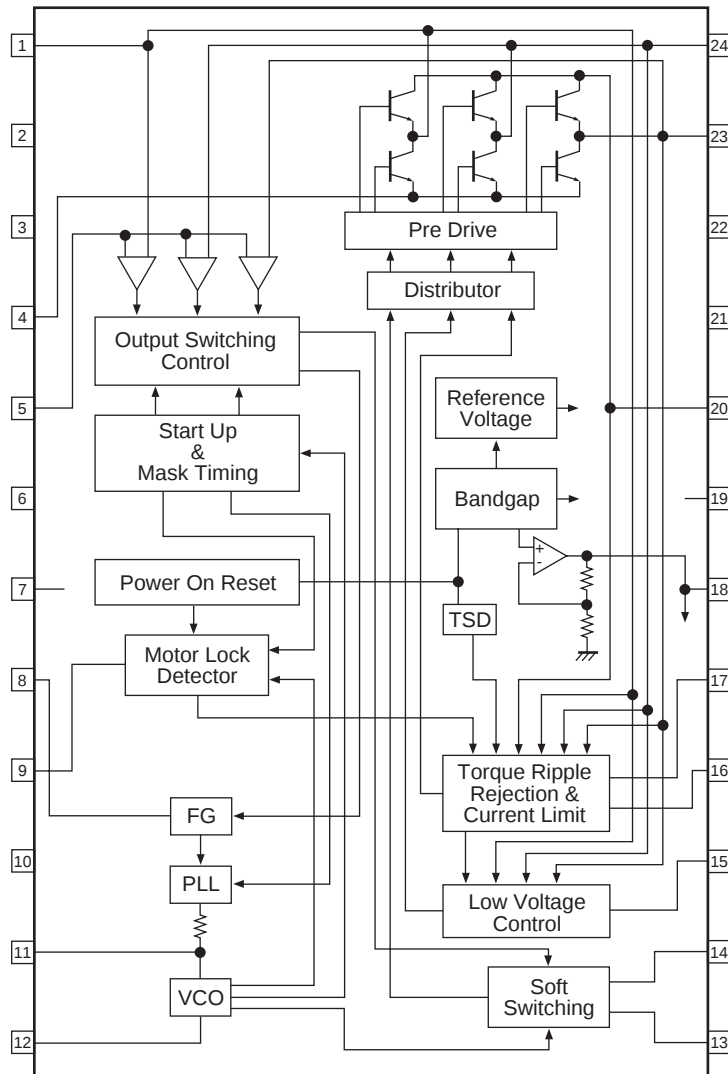
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## Pin Assignment



## Block Diagram



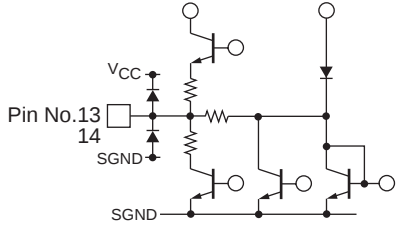
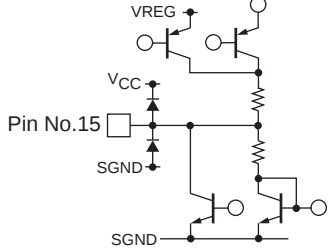
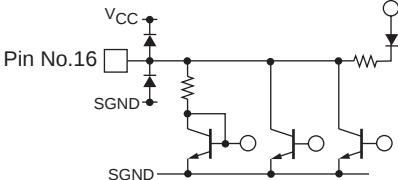
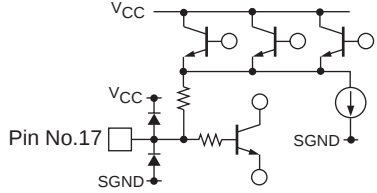
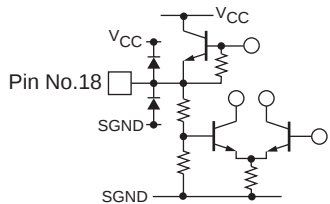
## Pin Function

| Pin No.       | Pin name             | Function                                                                                                                                                                                         | Equivalent circuit |
|---------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| 1<br>23<br>24 | UOUT<br>WOUT<br>VOUT | Each output pin of three phases.                                                                                                                                                                 |                    |
| 4             | PGND                 | GND pin in the output part.<br>This pin is connected to GND. The SGND pin is also connected to GND.                                                                                              |                    |
| 20            | RF                   | Pin to detect output current.<br>By connecting a resistor between this pin and $V_{CC}$ , the output current is detected as a voltage.<br>The current limiter is operated by this voltage.       |                    |
| 5             | MCOM                 | Motor coil midpoint input pin.<br>The coil voltage waveform is detected based on this voltage.                                                                                                   |                    |
| 7             | SGND                 | Ground pin (except the output part)<br>This pin is connected to GND.<br>The PGND pin is also connected to GND.                                                                                   |                    |
| 8             | FG                   | FG out made by back EMF pin.<br>It synchronizes FG out with inverted V-phase.<br>When don't use this function, open this pin.                                                                    |                    |
| 9             | RD                   | Motor lock protection detection output pin.<br>Output with L during rotation of motor.<br>Open during lock protection of motor (High-impedance).<br>When don't use this function, open this pin. |                    |
| 11            | VCO                  | PLL output pin and VCO input pin.<br>To stabilize PLL output, connect a capacitor between this pin and GND.                                                                                      |                    |
| 12            | CX                   | VCO oscillation output pin.<br>Operation frequency range and minimum frequency are determined by the capacity of the capacitor connected to this pin.                                            |                    |

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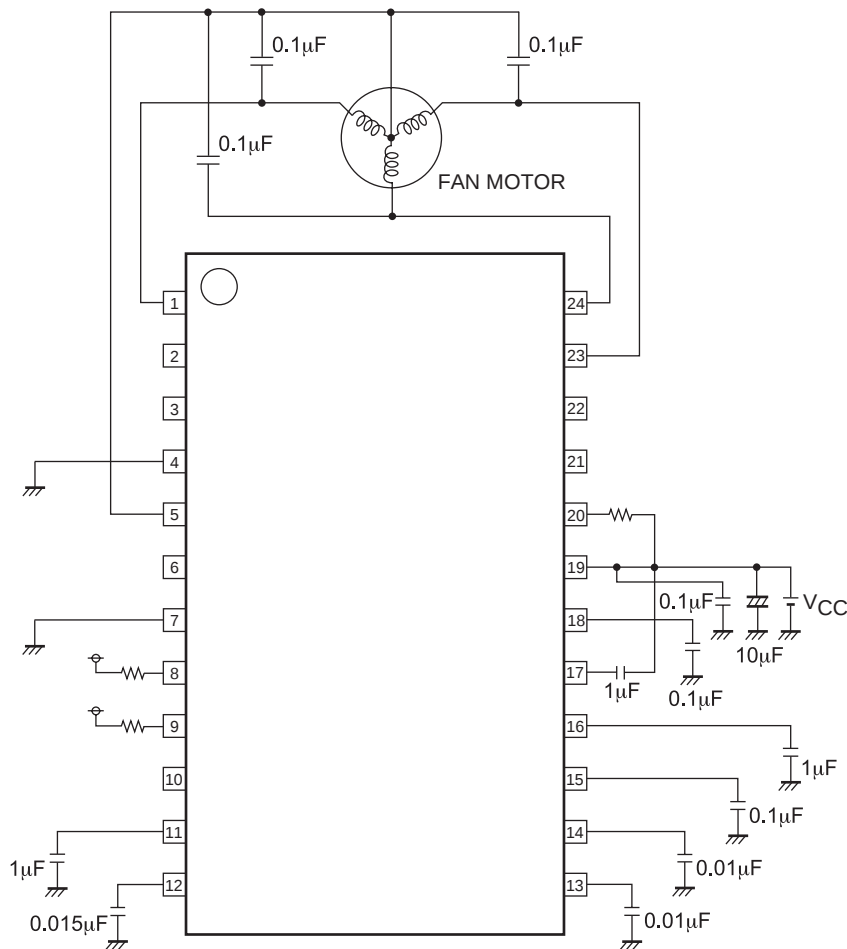
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| Pin No.  | Pin name | Function                                                                                                                                                                                 | Equivalent circuit                                                                   |
|----------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 13<br>14 | C1<br>C2 | Soft switching adjustment pin.<br>The triangular wave from is form formed by connecting a capacitor with this pin.<br>And, the switching of three-phase output is adjusted by the slope. |    |
| 15       | FC2      | Frequency characteristic correction pin 2.<br>To suppress the oscillation of control system closed loop of sink-side, connect a capacitor between this pin and GND.                      |    |
| 16       | FC1      | Frequency characteristic correction pin 1.<br>To suppress the oscillation of control system closed loop of source-side, connect a capacitor between this pin and GND.                    |   |
| 17       | VOH      | Three-phase output high level output pin.<br>To stabilize the output voltage of this pin, connect a capacitor between this pin and the VCC pin.                                          |  |
| 18       | VREG     | DC voltage (3.3V) output pin.<br>Connect a capacitor between this pin and GND for stabilization.                                                                                         |  |
| 19       | VCC      | Pin to supply power-supply voltage.<br>To curb the influence of ripple and noise. The voltage should be stabilized.                                                                      |                                                                                      |

## Application Circuit Example

\* Each fixed number in the following FIG, is the referential value.



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