Description

This application note is a document for introduction of connection conversion board which can be used when new product TPD420*F series (package: SSOP30) is evaluated as the successor for conventional TPD41**K series (package: DIP26), which are applied for brushless DC motors.
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0. Introduction

This application note is a document for introduction of connection conversion board which can be used when new product TPD420*F series (package: SSOP30) is evaluated as the successor for conventional TPD41**K series (package: DIP26), which are applied for brushless DC motors. TPD420*F series is motor driver IC which includes FET drivers with built-in level shift in the input stage, MOFETs in the output stage and various protective functions. In addition, a compact surface mount-type packaging SSOP30 is applied reduce the size of the control board. The brushless DC motor has a square wave drive (120-degree conduction) and a sine wave drive (180-degree conduction), and the high-voltage intelligent power device introduced in this application note supports sine wave drive and realizes low noise and low vibration of the motor by combining with our motor controller IC and microcomputer.

1. Product List

<table>
<thead>
<tr>
<th>Product name (Note 1)</th>
<th>Rating</th>
<th>Package</th>
<th>Output stage</th>
<th>Configura-</th>
<th>SD (Shutdown) Function</th>
<th>Overcurrent Protection</th>
<th>Thermal Shutdown</th>
<th>Under voltage Protection</th>
<th>Conduction Mode (Note 2)</th>
<th>Assumed motor Output (Note 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TPD4123K</td>
<td>500V/1A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>30W</td>
</tr>
<tr>
<td>TPD4123AK</td>
<td>500V/1A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>30W</td>
</tr>
<tr>
<td>TPD4144K</td>
<td>500V/2A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>40W</td>
</tr>
<tr>
<td>TPD4144AK</td>
<td>500V/2A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>40W</td>
</tr>
<tr>
<td>TPD4135K</td>
<td>500V/3A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>60W</td>
</tr>
<tr>
<td>TPD4135AK</td>
<td>500V/3A</td>
<td>DIP26</td>
<td>IGBT</td>
<td>1 Chip</td>
<td>Y</td>
<td>-</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>60W</td>
</tr>
<tr>
<td>TPD4204F</td>
<td>600V/2.5A</td>
<td>SSOP30</td>
<td>MOSFET</td>
<td>Module</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>40W</td>
</tr>
<tr>
<td>TPD4206F</td>
<td>500V/2.5A</td>
<td>SSOP30</td>
<td>MOSFET</td>
<td>Module</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>40W</td>
</tr>
<tr>
<td>TPD4207F</td>
<td>600V/5A</td>
<td>SSOP30</td>
<td>MOSFET</td>
<td>Module</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>180 degrees</td>
<td>80W</td>
</tr>
</tbody>
</table>

Note 1: DIP26 products including (Note 1) are scheduled to discontinue the production.
Note 2: Control is possible using a combination microcomputer or controller IC (Table 1-2 and Table 1-3).
Note 3: Motor output is for reference only and varies depending on drive and heat dissipation conditions.

TPD41**K series (DIP26) is a one-chip IGBT configuration (Figure 1-1), and TPD420*F series (SSOP30) is a MOSFET module configuration (Figure 1-2).

Figure 1-1 Internal Structural Diagram: DIP26
Figure 1-2 Internal Structural Diagram: SSOP30
Sine wave drive (180-degree conduction) type
The K type of TPD41** series has only overcurrent protection to turn off the input signal to the output transistor when the RS pin voltage exceeds 0.5V, and the AK type has only a shutdown function to turn off the input signal to the output transistor by inputting the "L" signal to the SD pin by an external circuit. However, TPD420*F series has a built-in overcurrent protection function and shutdown function, which can be used together.

**TPD4123K/TPD4144K/TPD4135K**
Built-in overcurrent protection function.

**TPD4123AK/TPD4144AK/TPD4135AK**
The overcurrent protection function has been deleted and the SD (shutdown) function has been added.

**TPD4204F/TPD4206F/TPD4207F**
Both the overcurrent protection function and the SD (shutdown) function are built-in.
In combination with our motor controller ICs and microcomputers (see Table 1-2 and Table 1-3 Recommended Products), sine wave drive (180-degree conduction) is possible, which realizes low noise and low vibration of the motor.

### Table 1-2 Controller IC List Sine Wave Drive Type (Example of Products)

<table>
<thead>
<tr>
<th>Product name</th>
<th>PKG</th>
<th>Vcc / Io</th>
<th>Position detection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB6551FAG</td>
<td>SSOP24</td>
<td>12V/2mA</td>
<td>Hall effect IC</td>
<td>Automatic lead angle Control</td>
</tr>
<tr>
<td>TB6556FG</td>
<td>SSOP30</td>
<td>12V/2mA</td>
<td>Hall effect IC</td>
<td>Y</td>
</tr>
<tr>
<td>TB6584FNG/AFNG</td>
<td>SSOP30</td>
<td>18V/2mA</td>
<td>Hall element or Hall effect IC</td>
<td>Y</td>
</tr>
<tr>
<td>TB6634FNG</td>
<td>SSOP30</td>
<td>18V/2mA</td>
<td>Hall element or Hall effect IC</td>
<td>Y</td>
</tr>
<tr>
<td>TB6631FNG</td>
<td>SSOP30</td>
<td>18V/2mA</td>
<td>Hall element or Hall effect IC</td>
<td>Y</td>
</tr>
<tr>
<td>TC78B041FNG</td>
<td>SSOP30</td>
<td>18V/2mA</td>
<td>Hall element or Hall effect IC</td>
<td>Y</td>
</tr>
<tr>
<td>TC78B042FTG</td>
<td>QFN32</td>
<td>18V/2mA</td>
<td>Hall element or Hall effect IC</td>
<td>Y</td>
</tr>
</tbody>
</table>

Note 1: Specifications such as modulation generation method and automatic advance angle mode differ. Refer to the data sheet of each product for details.

Note 2: Internal auto lead angle control function based on FG signal frequency.

Note 3: Intelligent Phase Control, Our unique automatic phase adjustment function.

### Table 1-3 Microcomputer List Sine Wave Drive Type (Example of Products)

<table>
<thead>
<tr>
<th>Product name</th>
<th>Package</th>
<th>ROM Size (Bytes)</th>
<th>RAM Size (Bytes)</th>
<th>Maximum operation Frequency (MHz)</th>
<th>Working voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM375FSDMG</td>
<td>SSOP30</td>
<td>64K</td>
<td>4K</td>
<td>40(Note 1)</td>
<td>4.5 5.5</td>
</tr>
<tr>
<td>TMPM372FWUG</td>
<td>LQFP64</td>
<td>128K</td>
<td>6K</td>
<td>80(Note 2) 32(Note 1)</td>
<td>4.5 5.5</td>
</tr>
<tr>
<td>TMPM373FWDUG</td>
<td>LQFP48</td>
<td>256K</td>
<td>10K</td>
<td>80(Note 2)</td>
<td>4.5 5.5</td>
</tr>
<tr>
<td>TMPM374FWUG</td>
<td>LQFP44</td>
<td>512K</td>
<td>32K</td>
<td>80(Note 2)</td>
<td>4.5 5.5</td>
</tr>
</tbody>
</table>

Note 1: Ambient temperature -40°C ~ 105°C

Note 2: Ambient temperature -40°C ~ 85°C
2. Packaging compared SSOP30 with conventional product DIP26

2.1 SSOP30 Packaging Features

Similar to DIP26, SSOP30 realizes easy wiring of the board by separating the high-voltage terminal and the control terminal on both sides of the packaging. It is also thinner and smaller than DIP26. In addition, SSOP30 is equipped with a MOSFET to reduce power dissipation.

2.2 Package Dimensions

Figure 2-1 DIP26 Dimensions

Figure 2-2 SSOP30 Dimensions

Figure 2-3 Comparing DIP26 and SSOP30

2.3 SSOP30 Marking

Figure 2-4 SSOP30 Marking

TPD4204F

Part No.

Lot Code (Ex) 930

Week of manufacture (01 for first week of year, continues up to 52 or 53)
Year of manufacture (The last digit of Christian year)

When Lot code is 『930』, it expressed that having been manufactured at the 30th week in 2019.
3. Introduction of “DIP26 to SSOP30 connection conversion board”

Package-size and pin assignment differ between DIP26 and SSOP30. Conversion board (four-layer boards with through-hole construction) is available to evaluate SSOP30 as the successor for DIP26.

3.1 Handling the Conversion Board

If there is a board designed for DIP26 at present, DIP26 can be removed from it, and the operation can be checked by inserting and soldering a conversion board which required components such as SSOP30, pins and others are assembled with. A bootstrap-capacitors are mounted on the conversion board, and BUS/BSV/BSW terminal on the conversion board to the board for DIP26 are not connected. In addition, there is no need to remove the bootstrap-capacitors mounted on SSOP30 can be evaluated by inserting and soldering a conversion board with a SSOP30 into an existing board designed for DIP26.

By using a conversion board, it is possible to evaluate SSOP30 with an existing board designed for DIP26.

3.2 Conversion Board Layout Diagram
4. DIP26 and SSOP30 comparisons

SSOP30 packages are smaller than conventional DIP26, but the power dissipation is reduced by changing the output device from IGBT to MOSFET, which reduces the effect of heat generation due to miniaturization.

In the following examples, when the motor is rotated at an input power of $P_{in}=30\text{W}$, the power loss is reduced approximately $1.25\text{W}$ when HVIPD is changed from TPD4144K(DIP26) to TPD4204F(SSOP30), and the surface temperature of the package is reduced approximately $55\degree$.

Evaluating condition, Controller IC : TB6551FAG, $V_{BE}=280\text{V}$, $V_{CC}=15\text{V}$, $f_s=16.5\text{kHz}$, $V_c=3\text{V}$ (Voltage command input terminal of TB6551FAG), $T_a=25\degree\text{C}$, heat sink less

![Figure 4-1 Loss-Input power Curve](image1)

![Figure 4-2 Package Surface Temperature-Input Power Curve](image2)
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