3 PHASE CONTROLLER
FOR DC BRUSHLESS MOTOR

Features:
- Up to 50 KHz PWM switching capability.
- No bootstrap capacitor.
- Trapezoidal 120° or 60° compatibility.
- Forward and reverse direction.
- Regeneration mode.
- Programmable over current shutdown.
- Programmable over temperature shutdown.
- E.S.D protection.
- Lead-free, RoHS compliant.

Description:
The IR3230 is a three-phase brushless DC motor controller/driver with many integrated features. They provide large flexibility in adapting the IR3230 to a specific system requirement and simplify the system design.

Typical connection:

Application:
- E-bike
- Fan and pump
- Actuators system
- Compressor

Package:
- SOIC-28L Wide Body

* Qualification standards can be found on IR’s web site www.irf.com
### Qualification Information

<table>
<thead>
<tr>
<th>Qualification Level</th>
<th>Industrial††</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments: This family of ICs has passed JEDEC industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture Sensitivity Level</th>
<th>SOIC28W</th>
<th>MSL3 260°C (per IPC/JEDEC J-STD-020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD</td>
<td>Machine Model</td>
<td>Class A (per JEDEC standard JESD22-A115)</td>
</tr>
<tr>
<td></td>
<td>Human Body Model</td>
<td>Class 1C (per JEDEC standard JESD22-A114)</td>
</tr>
<tr>
<td></td>
<td>Charged Device Model</td>
<td>Class IV (per JEDEC standard JESD22-C101)</td>
</tr>
<tr>
<td>IC Latch-Up Test</td>
<td>Class II, Level A (per JEDEC standard JESD78)</td>
<td></td>
</tr>
<tr>
<td>RoHS Compliant</td>
<td>Yes</td>
<td></td>
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</tbody>
</table>

† Qualification standards can be found at International Rectifier's web site [http://www.irf.com/](http://www.irf.com/)

†† Higher qualification ratings may be available should the user have such requirement. Please contact your International Rectifier sales representative for further information.
Absolute Maximum Ratings
Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. \((T_j=-40^\circ C..150^\circ C, V_{cc}=6..65V \text{ unless otherwise specified})\).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>V Gnd to Vcc</td>
<td>Maximum Gnd to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Gndpwr to Vcc</td>
<td>Maximum Gndpwr to Vcc voltage</td>
<td>-0.3</td>
<td>65</td>
<td>V</td>
</tr>
<tr>
<td>V Gnd to Gndpwr</td>
<td>Maximum Gnd to Gndpwr voltage</td>
<td>-40</td>
<td>40</td>
<td>V</td>
</tr>
<tr>
<td>V Latch test</td>
<td>Maximum power supply voltage to perform the latch test</td>
<td>—</td>
<td>50</td>
<td>V</td>
</tr>
<tr>
<td>V Dig in to Vcc</td>
<td>Maximum all digital input to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Flt to Vcc</td>
<td>Maximum Flt to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Vsx to Vcc</td>
<td>Maximum Vsx to Vcc voltage</td>
<td>-1.5</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Shftp to Vcc</td>
<td>Maximum Shftp to Vcc voltage</td>
<td>-0.3</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>V Shtm to Vcc</td>
<td>Maximum Shtm to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Out_supply to Vcc</td>
<td>Maximum Out_supply to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>V Tp to Vcc</td>
<td>Maximum Tp to Vcc voltage</td>
<td>-0.3</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td>I flt</td>
<td>Maximum continuous output current on the Flt pin</td>
<td>—</td>
<td>4</td>
<td>mA</td>
</tr>
<tr>
<td>Pd 3230s</td>
<td>Maximum power dissipation ((1) \quad Rth=80^\circ C/W)</td>
<td>—</td>
<td>1.5</td>
<td>W</td>
</tr>
<tr>
<td>Tj max.</td>
<td>Max. storage &amp; operating temperature junction temperature</td>
<td>-40</td>
<td>150</td>
<td>°C</td>
</tr>
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</table>

Thermal Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rth 3230s</td>
<td>Thermal resistance junction to ambient</td>
<td>80</td>
<td>—</td>
<td>°C/W</td>
</tr>
</tbody>
</table>
# Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc OPP</td>
<td>Power supply voltage</td>
<td>6</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>C PUMP</td>
<td>Charge pump capacitor</td>
<td>0.22</td>
<td>4.7</td>
<td>μF</td>
</tr>
<tr>
<td>MAX CONSUMPTION VSS</td>
<td>Maximum consumption on the Vss</td>
<td>100</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>CD</td>
<td>Recommended capacitor between Vcc and Vss</td>
<td>10</td>
<td>100</td>
<td>nF</td>
</tr>
<tr>
<td>R DIG IN</td>
<td>Recommended resistor in series with digital input pin</td>
<td>0</td>
<td>10</td>
<td>kΩ</td>
</tr>
<tr>
<td>R pd FLT</td>
<td>Recommended pull down resistor on the Flt pin (no internal pull down)</td>
<td>1.5</td>
<td>-</td>
<td>kΩ</td>
</tr>
<tr>
<td>RVsx</td>
<td>Recommended resistor in series with high side source (recommended RVsx = RLox)</td>
<td>5</td>
<td>100</td>
<td>Ω</td>
</tr>
<tr>
<td>RLox</td>
<td>Recommended resistor in series with low side gate</td>
<td>5</td>
<td>100</td>
<td>Ω</td>
</tr>
<tr>
<td>F_Hox max</td>
<td>Maximum recommended high side MOSFET frequency (Hox-Vsx) load = 2.2nF, C pump = 220nF</td>
<td>2</td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>F_Lox max</td>
<td>Maximum recommended low side MOSFET frequency Lox load = 2.2nF, C pump = 220nF</td>
<td>50</td>
<td></td>
<td>kHz</td>
</tr>
</tbody>
</table>

# Static Electrical Characteristics

Tj=25°C, Vcc=48V (unless otherwise specified), Dig in = All except Hox, Lox, Vsx, Flt, Pmp, Tp, Shtp, Shtm, Vcc, Gnd, Gndpwr, Out_supply.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Gnd Slp</td>
<td>Supply current in low consumption mode</td>
<td>0.3</td>
<td>1</td>
<td>2</td>
<td>mA</td>
<td>En = 0;</td>
</tr>
<tr>
<td>I Gnd On</td>
<td>Gnd current when the device is awake</td>
<td>1.2</td>
<td>2.5</td>
<td>4</td>
<td>mA</td>
<td>En = 1;</td>
</tr>
<tr>
<td>I Out supply</td>
<td>Out_supply output current</td>
<td>1</td>
<td>1.7</td>
<td>3.1</td>
<td>mA</td>
<td>Vout_Vcc &gt; 6V</td>
</tr>
<tr>
<td>I Flt</td>
<td>Flt pin output current</td>
<td>3</td>
<td>6.6</td>
<td>10</td>
<td>mA</td>
<td>Flt = Gnd when fault</td>
</tr>
<tr>
<td>V Flt</td>
<td>Flt pin output voltage</td>
<td>4.5</td>
<td>5</td>
<td>5.8</td>
<td>V</td>
<td>I Flt = 10μA</td>
</tr>
<tr>
<td>V dig in Off</td>
<td>All digital input Low threshold voltage</td>
<td>0.6</td>
<td>1</td>
<td>1.6</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V dig in On</td>
<td>All digital input High threshold voltage</td>
<td>1.9</td>
<td>2.8</td>
<td>3.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V dig in Hyst</td>
<td>All digital input hysteresis</td>
<td>1.3</td>
<td>1.8</td>
<td>2.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I dig in On</td>
<td>All digital input On state current</td>
<td>3.8</td>
<td>8</td>
<td>16</td>
<td>μA</td>
<td>Vdig_in = 5V</td>
</tr>
<tr>
<td>I sensor</td>
<td>All digital input On state current</td>
<td>8.8</td>
<td>18</td>
<td>36</td>
<td>μA</td>
<td>Vsensor = 0V</td>
</tr>
<tr>
<td>V Hox-Vsx</td>
<td>High side gate voltage</td>
<td>5.8</td>
<td>6.1</td>
<td>7</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V Lox</td>
<td>Low side gate voltage</td>
<td>5.8</td>
<td>6.5</td>
<td>11</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I Hox Out Gndpwr</td>
<td>High side gate output current Vsx &lt; Vcc</td>
<td>38</td>
<td>50</td>
<td>85</td>
<td>mA</td>
<td>Hox = Vsx</td>
</tr>
<tr>
<td>I Hox Out Vcc</td>
<td>High side gate output current Vsx &gt; Vcc</td>
<td>7</td>
<td>15</td>
<td>19</td>
<td>mA</td>
<td>Hox = Vcc</td>
</tr>
<tr>
<td>I Hox In</td>
<td>High side gate input current</td>
<td>70</td>
<td>110</td>
<td>250</td>
<td>mA</td>
<td>(Hox – Vsx) = 6V, Vsx = Vcc</td>
</tr>
<tr>
<td>I Lox Out</td>
<td>Low side gate output current</td>
<td>250</td>
<td>350</td>
<td>700</td>
<td>mA</td>
<td>Lox = Gndpwr</td>
</tr>
<tr>
<td>I Lox In</td>
<td>Low side gate input current</td>
<td>250</td>
<td>350</td>
<td>700</td>
<td>mA</td>
<td>Lox = 6V</td>
</tr>
</tbody>
</table>
### Switching Electrical Characteristics

**Vcc=48V, Tj=25°C (unless otherwise specified)**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cpump</td>
<td>Time to charge the pump capacitor</td>
<td>1.5</td>
<td>5</td>
<td>8</td>
<td>ms</td>
<td>Cpump = 220nF from EN = hi to (Vcpump-Vcc) = 5.3V</td>
</tr>
<tr>
<td>Tpwr_on_rst</td>
<td>Power on reset time</td>
<td>180</td>
<td>600</td>
<td>1200</td>
<td>μs</td>
<td>Cpump = 6V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tr1 Hox-Vsx</td>
<td>Rise time high side gate with Vsx = gndpwr</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 10% to 90%</td>
</tr>
<tr>
<td>Tr2 Hox-Vsx</td>
<td>Rise time high side gate with Vsx = Vcc</td>
<td>0.8</td>
<td>2.5</td>
<td>5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 10% to 90%</td>
</tr>
<tr>
<td>Tf1 Hox-Vsx</td>
<td>Fall time high side gate with Vsx = Gndpwr</td>
<td>0.05</td>
<td>0.15</td>
<td>0.25</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 90% to 10%</td>
</tr>
<tr>
<td>Tf2 Hox-Vsx</td>
<td>Fall time high side gate with Vsx = Vcc</td>
<td>0.15</td>
<td>0.7</td>
<td>1.4</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 90% to 10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Td1 MtoR Hox off</td>
<td>Motor to Regen mode High side turn-off delay time</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Reg/mot to 90% of (Hox – Vsx)</td>
</tr>
<tr>
<td>Td2 MtoR Hox off</td>
<td>Motor to Regen mode High side turn-off delay time</td>
<td>0.8</td>
<td>2.5</td>
<td>5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Reg/mot to 90% of (Hox – Vsx)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Td1 RtoM Hox on</td>
<td>Regen to Motor mode High side turn-on delay time</td>
<td>0.1</td>
<td>0.3</td>
<td>0.5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Reg/mot to 10% of (Hox – Vsx)</td>
</tr>
<tr>
<td>Td2 RtoM Hox on</td>
<td>Regen to Motor mode High side turn-on delay time</td>
<td>0.8</td>
<td>2.5</td>
<td>5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Reg/mot to 10% of (Hox – Vsx)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tr Lox</td>
<td>Low side rise time to turn on</td>
<td>0.04</td>
<td>0.1</td>
<td>0.3</td>
<td>µs</td>
<td>Lox load =2.2nF from 10% to 90%</td>
</tr>
<tr>
<td>Tf Lox</td>
<td>Low side fall time to turn off</td>
<td>0.04</td>
<td>0.1</td>
<td>0.3</td>
<td>µs</td>
<td>Lox load =2.2nF from 90% to 10%</td>
</tr>
<tr>
<td>Td MtoR Lox on</td>
<td>Motor to Regen mode low side turn-on delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Reg/mot to 10% of Lox</td>
</tr>
<tr>
<td>Td RtoM Lox off</td>
<td>Regen to Motor mode low side turn-off delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Reg/mot to 10% of Lox</td>
</tr>
</tbody>
</table>
## Regen mode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Td Pwm Lox on</td>
<td>Pwm to low side turn-on delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Pwm to 10% of Lox</td>
</tr>
<tr>
<td>Td Pwm Lox off</td>
<td>Pwm to low side turn-off delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Pwm to 90% of Lox</td>
</tr>
</tbody>
</table>

## Motor Mode

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
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<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>High side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Td1 Sensx Hox on</td>
<td>Sensor to high side turn-on delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Sensx to 10% of (Hox - Vsx)</td>
</tr>
<tr>
<td>Td2 Sensx Hox on</td>
<td>Sensor to high side turn-off delay time</td>
<td>0.8</td>
<td>2</td>
<td>5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Sensx to 90% of (Hox - Vsx)</td>
</tr>
<tr>
<td>Td1 Sensx Hox off</td>
<td>Sensor to high side turn-off delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Sensx to 90% of (Hox - Vsx)</td>
</tr>
<tr>
<td>Td2 Sensx Hox off</td>
<td>Sensor to high side turn-off delay time</td>
<td>0.8</td>
<td>2</td>
<td>5</td>
<td>µs</td>
<td>(Hox-Vsx) load =2.2nF from 50% of Sensx to 90% of (Hox - Vsx)</td>
</tr>
<tr>
<td>Low side</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Td Pwm Lox on</td>
<td>Pwm to low side turn-on delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Pwm to 10% of Lox</td>
</tr>
<tr>
<td>Td Pwm Lox off</td>
<td>Pwm to low side turn-off delay time</td>
<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Pwm to 90% of Lox</td>
</tr>
<tr>
<td>Td Sensx Lox on</td>
<td>Sensor to low side turn-off delay time</td>
<td>0.1</td>
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<td>µs</td>
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<td>Td Sensx Lox off</td>
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<td>0.1</td>
<td>0.25</td>
<td>0.5</td>
<td>µs</td>
<td>Lox load =2.2nF from 50% of Sensx to 90% of Lox</td>
</tr>
</tbody>
</table>

## Protection Characteristics

Vcc=48V, Tj=25°C (unless otherwise specified).

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
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<tr>
<td>Vth Isd</td>
<td>Maximum over current shutdown threshold between Shtp and Shtm</td>
<td>65</td>
<td>80</td>
<td>97</td>
<td>mV</td>
<td>Rshunt =5 mΩ → Imax =20A</td>
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<td>Vth Tsd</td>
<td>External over temperature threshold</td>
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<td>50</td>
<td>55</td>
<td>%</td>
<td>(Vtemp-VSht)/(Vss-VSht+)</td>
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<tr>
<td>Tsd int</td>
<td>Internal over temperature threshold</td>
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<td>165</td>
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<td>°C</td>
<td>Delay fault from Vth(Isd) = 200mV</td>
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<td>1</td>
<td>3</td>
<td>µs</td>
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<td>Dly Latch reset</td>
<td>Delay to reset the latch by Flt_rst pin</td>
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<td>25</td>
<td>60</td>
<td>µs</td>
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<td>Shtp – Pmp charge pump under voltage on</td>
<td>4.9</td>
<td>5.3</td>
<td>5.75</td>
<td>V</td>
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<tr>
<td>UV Pump off</td>
<td>Shtp – Pmp charge pump under voltage off</td>
<td>4.5</td>
<td>4.9</td>
<td>5.4</td>
<td>V</td>
<td></td>
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<tr>
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<td>Shtp – Pmp charge pump under voltage hysteresis</td>
<td>0.2</td>
<td>0.37</td>
<td>0.6</td>
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<td>Vcc (Shtp)- Vss under voltage</td>
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<td>4.8</td>
<td>5.7</td>
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<tr>
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<td>Vcc (Shtp)-Gnd under voltage</td>
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<td>5.4</td>
<td>6</td>
<td>V</td>
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<td>UV Vcc gndpwr</td>
<td>Vcc-Gndpwp under voltage</td>
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<td>5.4</td>
<td>6</td>
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**Lead Assignments 4.6**

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<td>2</td>
<td>Rev/Fwd</td>
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<tr>
<td>3</td>
<td>Mot/Regen</td>
</tr>
<tr>
<td>4</td>
<td>Pwm</td>
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<td>En</td>
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<td>Flt rst</td>
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<td>Gnd</td>
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<td>Tp</td>
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<td>Vss</td>
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<td>Lo1</td>
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<tr>
<td>15</td>
<td>Lo2</td>
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<td>Lo3</td>
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**IR3230SPbF**

SOIC-28L Wide Body
Typical Schematic:

High side source connection for high current application:
Functional Block Diagram

All values are typical
Simplified schematic:

Figure 1: Digital input

Figure 2: Fault output

Figure 3: Out_supply

Figure 4: Lo output

Figure 5: Hox output

Figure 6: Vss pin

Figure 7: Sht_in
### Decoder Table:

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<td>Diagnostic</td>
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<tr>
<td>120/60 =1 120° mode</td>
<td>Rev/Fwd</td>
<td>Mot/Regen</td>
</tr>
<tr>
<td>S1</td>
<td>S2</td>
<td>S3</td>
</tr>
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#### Regen mode

| x | x | x | x | x | x | 0 | 1 | 0 | 0 | 0 | Pwm | Pwm | Pwm | Buck converter | Generator |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 1 | x | x | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Hz | Hz | Hz |
| 0 | 1 | 0 | 0 | 0 | x | x | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | Hz | Hz | Hz |

#### Fault mode

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<td>0</td>
<td>0</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
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</table>

#### Keys

- **x**: Don't care
- **1**: Active
- **0**: Not active
- **Hz**: High impedance
- **Pwm**: Signal on the pwm input

### Fault Table:

#### Latched fault

- **Flt = 1**
  
  - If \([V(Sht+) - V(Sht-)] > 80\text{mv}\)
  
  or

  - If \([V(Vcc) - V(Tp)] > 50\% \text{ of } [V(Vcc)-V(Vss)]\)
  
  or

  - If the sensor code is wrong

#### Not latched fault

- **Flt = 1**
  
  - If \(\text{Flt\_rst} = 5\text{v}\)
  
  or

  - If one of all UV is activated
  
  or

  - If En is not activated
  
  or

  - If the Tpwr\_on\_rst is activated

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Logical equation:

1) 120° mode:
   ▶ Forward direction:
      - $Ho_1 = S_1 \cdot \overline{S_2}$
      - $Ho_2 = S_2 \cdot \overline{S_3}$
      - $Ho_3 = S_3 \cdot S_1$

       - $Lo_1 = \overline{S_1} \cdot S_2$
       - $Lo_2 = \overline{S_2} \cdot S_3$
       - $Lo_3 = S_3 \cdot S_1$

   ▶ Reverse direction:
      - $Ho_1 = \overline{S_1} \cdot S_2$
      - $Ho_2 = \overline{S_2} \cdot S_3$
      - $Ho_3 = S_3 \cdot S_1$

2) 60° mode:
   ▶ Forward direction:
      - $Ho_1 = \overline{S_2} \cdot \overline{S_3}$
      - $Ho_2 = S_1 \cdot S_2$
      - $Ho_3 = \overline{S_1} \cdot S_3$

       - $Lo_1 = S_2 \cdot S_3$
       - $Lo_2 = \overline{S_1} \cdot \overline{S_2}$
       - $Lo_3 = S_1 \cdot \overline{S_3}$

   ▶ Reverse direction:
      - $Ho_1 = S_2 \cdot S_3$
      - $Ho_2 = \overline{S_1} \cdot \overline{S_2}$
      - $Ho_3 = S_1 \cdot \overline{S_3}$

       - $Lo_1 = \overline{S_2} \cdot \overline{S_3}$
       - $Lo_2 = S_1 \cdot S_2$
       - $Lo_3 = S_1 \cdot S_3$
Shtp & Shtm, over Current protection:
The IR3230 has shunt interface input: Shtp & Shtm. This shunt measurement is referenced to the Vcc (measurement on the battery line). Thanks to the shunt value and an external divider resistor, the user can adjust the maximum current in the motor. The internal threshold is Vth Isd. This protection is latched so the Flt output is activated (High state) to provide a diagnostic to the µP. This protection can be reset by activating Flt_rst high for more than Trst time. This protection works only in the motor mode.

Tp & Vss, over temperature protection:
The IR3230 has CTN interface input: Tp, Vss. This CTN is referenced to the Vss. Thanks to an external resistor in series with the CTN resistor; the user can adjust the maximum temperature threshold. The internal threshold is Vth Tsd. This protection is latched so the Flt output is activated (high state) to provide a diagnostic to the µP. This protection can be reset by activating Flt_rst high for more than Trst time.

Mot/Regen:
This digital input allows selecting the motor mode or the regeneration mode (braking mode). The µP needs to implement a delay to switch from one to the other to avoid shoot through short circuit and activate the over current fault. This can be calculating by using the “Td xxx xx” parameters in the Switching electrical characteristics. Use the following parameters as a simple rule:
- Delay to go from the motor mode to the regen mode: use the maximum of the Td2 MtoR Hox off + the maximum of the Tt2_Hox-Vsx parameter.
- Delay to go from the regen mode to the motor mode: use the maximum of the Td1 RtoM Lox off + the maximum of theTf Lox parameter.

Pwm:
In motion mode, through the pwm input, the µP controls the speed of the motor. This input provides duty cycle and the frequency to the low side switches in order of the sensor table selected by logical sensor input.
In regen mode (buck converter operation), It provides the duty cycle and the frequency to the 3 low side switches in same time independently of the sensor input sequence. So the µP can controls the regeneration current level in the battery and breaking the motor.

En:
The input Pin enable allows switching off all output power Mosfets and the Charge pump. This reduces the consumption of the device. The Out_supply output stays active to power supply the µP even if the Enable is set at 0V. En pin high wake up the device. When the voltage of charge pump capacitor reaches the UV pump threshold, the device wait for the power reset (Pwr on rst) and then it is ready to operate.

120/60°:
This digital input selects the right sensor table in order to the sensor electrical position 120° or 60°.

Out_supply:
This output provides a 1.6mA regulated current. This output can be used as a biasing to create a power supply thanks to an external zener diode and a bipolar ballast transistor. The created voltage of this power supply is defined by the value of the zener diode implemented. This power supply could be used to supply all external circuitries (Sensor, µP…).

Rev/Fwd:
This digital input selects the right sensor table in order to choose the motor direction forward and reverse.
Fault:
A minimum pull down resistor to gnd must be used to limit the current on this output. Please refer to the Absolute maximum ratings table. There is no internal pull down: value is undefined when not in fault if no external pull down resistor is used.
Refer to Fault table to check which event will be latched or not.
Parameters curves:

**Figure 1:** High side gate current vs. temperature

**Figure 2:** Low side gate current vs. temperature

**Figure 3:** Output gate voltage vs. temperature

**Figure 4:** $V_{th\, Isd}$ Vs $T_j$
Package outline:

NOTES:
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS ARE ShOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-013AE.
5. DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.
6. DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS SHALL NOT EXCEED 0.15 [.006].

28 Lead SOIC (wide body)
CARRIER TAPE DIMENSION FOR 28SOICW

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Part Marking Information

Ordering Information

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Tel: (310) 252-7105

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21
## Revision History

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