1.9A / 1.2MHz Boost DC to DC Converter

DESCRIPTION
The TS1935B is a current mode step up converter intended for small, low power applications. The converter input voltage ranging from 2.6V to 5.5V. The output voltage can be set up to 27V. The frequency is 1.2MHz allows the use of small external inductors and capacitors and provides fast transient response. Internal soft start results in small inrush current and extends battery life. Internal power MOSFET with very low RDS (ON) provides high efficiency. The TS1935B automatically transits from PWM to PFM during light load condition further increasing efficiency. The converter also provides protection functions such as under-voltage lockout, current limit and thermal shutdown.

FEATURES
● 2.6V to 5.5 V operating input voltage range
● Adjustable output voltage range up to 27V
● 1.2MHz Fixed Switching Frequency
● Internal soft-start function
● Current limit and Thermal shutdown protection
● Under voltage Lockout
● ≤1µA Shutdown Current
● Compliant to RoHS Directive 2011/65/EU and in accordance to WEEE 2002/96/EC.
● Halogen-Free according to IEC 61249-2-21

APPLICATION
● White LED current source
● Portable electronics
● Local Boost Regulator

SOT-25
Pin Definition:
1. SW
2. Ground
3. FB
4. EN
5. VCC

Notes: MSL 3 (Moisture Sensitivity Level) per J-STD-020

TYPICAL APPLICATION CIRCUIT

<table>
<thead>
<tr>
<th>V&lt;sub&gt;IN&lt;/sub&gt;</th>
<th>V&lt;sub&gt;OUT&lt;/sub&gt;</th>
<th>R3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6~3.6V</td>
<td>5V</td>
<td>120kΩ</td>
</tr>
<tr>
<td>2.6~5.3V</td>
<td>7V</td>
<td>82kΩ</td>
</tr>
<tr>
<td>2.6~5.5V</td>
<td>7.5~27V</td>
<td>0Ω</td>
</tr>
</tbody>
</table>

\[ V_{OUT} = 1.238V \times \left(1 + \frac{R2}{R1}\right) \]

R<sub>2</sub> Suggest 350Ω~820K
### ABSOLUTE MAXIMUM RATINGS (TA = 25°C unless otherwise specified) *(Note 1)*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>LIMIT</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>VIN</td>
<td>GND - 0.3 to GND + 6.5</td>
<td>V</td>
</tr>
<tr>
<td>EN, VEN, VFB Voltage</td>
<td>VEN, VFB</td>
<td>GND - 0.3 to VCC + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>SW Voltage</td>
<td>VSW</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>Internal Power Dissipation</td>
<td>PD</td>
<td>(TJ - TA)/RJA</td>
<td>mW</td>
</tr>
<tr>
<td>Lead Solder Temperature (260°C)</td>
<td>TA</td>
<td>5</td>
<td>S</td>
</tr>
<tr>
<td>Ambient Temperature Range</td>
<td>TAMB</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Junction Temperature Range</td>
<td>TJ</td>
<td>-40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>TSTG</td>
<td>-40 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Note:** Stress above the listed absolute maximum rating may cause permanent damage to the device.

### THERMAL PERFORMANCE *(Note 3)*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>LIMIT</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Resistance - Junction to Case</td>
<td>RJC</td>
<td>110</td>
<td>°C/W</td>
</tr>
<tr>
<td>Thermal Resistance - Junction to Ambient</td>
<td>RJA</td>
<td>250</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**Note:** RJA is measured with the PCB copper area of approximately 1 in² (Multi-layer).

### RECOMMENDED OPERATING CONDITION (TA = 25°C unless otherwise specified) *(Note 4)*

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>LIMIT</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply pin</td>
<td>VCC</td>
<td>38</td>
<td>V</td>
</tr>
<tr>
<td>DMG voltage to GND</td>
<td>VDMG</td>
<td>-0.3 to 38</td>
<td>V</td>
</tr>
<tr>
<td>OUT voltage to GND</td>
<td>VOUT</td>
<td>-0.3 to 38</td>
<td>V</td>
</tr>
<tr>
<td>CS voltage to GND</td>
<td>VCS</td>
<td>-0.3 to 5</td>
<td>V</td>
</tr>
<tr>
<td>COM voltage to GND</td>
<td>VCROM</td>
<td>-0.3 to VCC</td>
<td>V</td>
</tr>
<tr>
<td>Operating Junction Temperature Range</td>
<td>TJ</td>
<td>-40 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Ambient Temperature Range</td>
<td>TOPA</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
</tbody>
</table>

### ELECTRICAL SPECIFICATIONS (TA = 25°C unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITION</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage range</td>
<td>VCC</td>
<td>CONDITION</td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
<td>UNIT</td>
</tr>
<tr>
<td>Under Voltage Lockout</td>
<td>UVLO</td>
<td>Rising</td>
<td>2.6</td>
<td>--</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>UVLO Hysteresis</td>
<td></td>
<td></td>
<td>--</td>
<td>2.35</td>
<td>2.60</td>
<td>V</td>
</tr>
<tr>
<td>Step-Up Voltage Adjust Range</td>
<td>VOUT</td>
<td></td>
<td>--</td>
<td>-130</td>
<td>--</td>
<td>mV</td>
</tr>
<tr>
<td>Operating quiescent current</td>
<td>ICCQ</td>
<td>IOUT = 0mA, VFB =1.5V</td>
<td>--</td>
<td>150</td>
<td>250</td>
<td>μA</td>
</tr>
<tr>
<td>Shutdown current</td>
<td>ISD</td>
<td>VEN=0V</td>
<td>--</td>
<td>0.1</td>
<td>1</td>
<td>μA</td>
</tr>
<tr>
<td>Feedback Voltage</td>
<td>VFB</td>
<td></td>
<td>1.213</td>
<td>1.238</td>
<td>1.263</td>
<td>V</td>
</tr>
<tr>
<td>FB Input Leakage Current</td>
<td>IFB-LKG</td>
<td>VFB = 1.3V</td>
<td>-100</td>
<td>0.01</td>
<td>+100</td>
<td>nA</td>
</tr>
<tr>
<td>Line Regulation</td>
<td></td>
<td>VOUT = 2.5 to 5.5V</td>
<td>--</td>
<td>0.2</td>
<td>--</td>
<td>%</td>
</tr>
<tr>
<td>Load Regulation</td>
<td></td>
<td>IOUT = 20mA</td>
<td>--</td>
<td>0.2</td>
<td>--</td>
<td>%</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>FOSC</td>
<td></td>
<td>900</td>
<td>1200</td>
<td>1500</td>
<td>kHz</td>
</tr>
<tr>
<td>Maximum Duty</td>
<td>DMAX</td>
<td></td>
<td>82</td>
<td>87</td>
<td>--</td>
<td>%</td>
</tr>
</tbody>
</table>
### ELECTRICAL SPECIFICATIONS \((T_A = 25°C\) unless otherwise specified)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITION</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-channel MOSFET current limit</td>
<td>(I_{\text{LIM}})</td>
<td>Duty=50%</td>
<td>--</td>
<td>1.9</td>
<td>--</td>
<td>A</td>
</tr>
<tr>
<td>MOSFET on-resistance (^{(Note)})</td>
<td>(R_{\text{DS(on)}})</td>
<td>(V_{\text{CC}}=3\text{V}, I_{\text{SW}}=1\text{A})</td>
<td>--</td>
<td>650</td>
<td>--</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{\text{CC}}=5\text{V}, I_{\text{SW}}=1\text{A})</td>
<td>--</td>
<td>500</td>
<td>--</td>
<td>mΩ</td>
</tr>
<tr>
<td>SW Leakage Current</td>
<td>(I_{\text{SWL}})</td>
<td>(V_{\text{LX}} = 27\text{V}, V_{\text{FB}} = 1.5\text{V})</td>
<td>--</td>
<td>--</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>EN high-level input voltage</td>
<td>(V_{\text{IH}})</td>
<td></td>
<td>1.0</td>
<td>--</td>
<td>--</td>
<td>V</td>
</tr>
<tr>
<td>EN low-level input voltage</td>
<td>(V_{\text{IL}})</td>
<td></td>
<td>--</td>
<td>--</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>EN Hysteresis</td>
<td>(h_{\text{ys}})</td>
<td></td>
<td>--</td>
<td>200</td>
<td>--</td>
<td>mV</td>
</tr>
<tr>
<td>EN input leakage current</td>
<td>(I_{\text{EN-LKG}})</td>
<td>(V_{\text{EN}}=\text{GND or VCC})</td>
<td>--</td>
<td>0.01</td>
<td>0.1</td>
<td>µA</td>
</tr>
<tr>
<td>Thermal Shutdown</td>
<td>(T_{\text{DS}})</td>
<td></td>
<td>--</td>
<td>150</td>
<td>--</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal Shutdown Hysteresis</td>
<td>(T_{\text{SH}})</td>
<td></td>
<td>--</td>
<td>35</td>
<td>--</td>
<td>°C</td>
</tr>
</tbody>
</table>

**Note:** Guaranteed by design

### ORDERING INFORMATION

<table>
<thead>
<tr>
<th>ORDERING CODE</th>
<th>PACKAGE</th>
<th>PACKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS1935BCX5 RFG</td>
<td>SOT-25</td>
<td>3,000pcs / 7&quot;Reel</td>
</tr>
</tbody>
</table>
FUNCTION BLOCK

PIN DESCRIPTION

<table>
<thead>
<tr>
<th>PIN NO.</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SW</td>
<td>Power Switch Output. SW is the drain of the internal MOSFET switch. Connect the power inductor and output rectifier to SW. SW can swing between GND and 27V.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground. Tie directly to ground plan.</td>
</tr>
<tr>
<td>3</td>
<td>FB</td>
<td>Feedback Input. FB voltage is 1.238V. Connect a resistor divider to FB.</td>
</tr>
<tr>
<td>4</td>
<td>EN</td>
<td>Regulator On/Off Control Input. A high input at EN turns on the converter, and a low input turns it off. When not used, connect EN to the input source for automatic startup. The EN pin cannot be left floating.</td>
</tr>
<tr>
<td>5</td>
<td>VCC</td>
<td>Input Supply Pin. Must be locally bypassed.</td>
</tr>
</tbody>
</table>
APPLICATION INFORMATION

Setting the Output Voltage
Application circuit item shows the basic application circuit with TS1935BCX5 adjustable output version. The external resistor sets the output voltage according to the following equation:

$$V_{OUT} = 1.238V \times \left(1 + \frac{R2}{R1}\right)$$

For most applications, R2 is suggested a value by 390k~820kΩ. Place the resistor-divider as close to the IC as possible to reduce the noise sensitivity.

Under Voltage Lockout (UVLO)
To avoid mis-operation of the device at low input voltages an under voltage lockout is included that disables the device, if the input voltage falls below (2.35V-130mV).

Input Capacitor Selection
The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used. Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 10µF ceramic capacitor for most applications is sufficient. For a lower output power requirement application, this value can be decreased.

Output Capacitor Selection
The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current. A 4.7uF ceramic capacitors works for most of the applications. Higher capacitor values can be used to improve the load transient response.

Layout Guide
ELECTRICAL CHARACTERISTICS CURVE

Figure 1. Quiescent Current vs. Input Voltage

Figure 2. Frequency vs. Input Voltage

Figure 3. FB Voltage vs. Input Voltage

Figure 4. FB Voltage vs. Output Current

Figure 5. FB Voltage vs. Temperature

Figure 6. Frequency vs. Temperature
ELECTRICAL CHARACTERISTICS CURVE (CONTINUE)

Figure 7. Threshold Voltage vs. Temperature

Figure 8. Max. Duty vs. Temperature

Figure 9. UVLO vs. Temperature

Figure 10. Duty vs. Current Limit

Figure 11. Efficiency vs. Output Current

Figure 12. Efficiency vs. Output Current
PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

SOT-25

SUGGESTED PAD LAYOUT (Unit: Millimeters)

MARKING DIAGRAM

BA = Device Code
Y = Year Code (3=2013, 4=2014……)
W = Week Code
WW: 01~26 (A~Z)
27~52 (a~z)
X = Internal ID Code
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