General Description

The FP7152 is a continuous current mode inductive step down converter. It can drive single or multiple series connected LEDs. The FP7152 includes the output switch and a high-side output current sensing circuit, which use an external resistor to set the average output current. Output current can also be adjusted by applying an external signal to the ‘ADJ’ pin. The ADJ pin accept either a DC voltage or a PWM dimming waveform. The PWM dimming filter components are contained within the chip. Applying a voltage under 0.2V to the ADJ pin will turn off the output.

The FP7152 is available in the SOT89-5L package. Its space-saving footprint occupies small PCB area for miscellaneous application fields.

Features

- 1A Output Current
- Internal 0.5Ω 26V Power MOSFET Switch
- Wide 7 to 26V Operating Input Range
- 20μA Shutdown Mode Current
- Typical 4% Output Current Accuracy
- Signal pin ON / OFF and Brightness Control
- Adjustable Soft-Start
- Up to 95% Efficiency
- Up to 1MHz Switching Frequency
- Internal Dimming Filter
- Package: SOT89-5L

Applications

- Low Voltage Halogen replacement LEDs
- LED back-up lighting

Typical Application Circuit

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Website: http://www.feeling-tech.com.tw

Rev. 0.63

2/14
Marking Information

SOT89-5L

Halogen Free: Halogen free product indicator
Lot Number: Wafer lot number’s last two digits
   For Example: 132386TB \rightarrow 86
Internal ID: Internal Identification Code
Per-Half Month: Production period indicated in half month time unit
   For Example: A \rightarrow First Half Month of January
   B \rightarrow Last Half Month of January
   C \rightarrow First Half Month of February
   D \rightarrow Last Half Month of February
Year: Production year’s last digit
Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Operating Temperature</th>
<th>Package</th>
<th>MOQ</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>FP7152AR-G1</td>
<td>-40°C ~ 85°C</td>
<td>SOT89-5L</td>
<td>1000EA</td>
<td>Tape &amp; Reel</td>
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Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
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<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>$V_{IN}$</td>
<td></td>
<td>-0.3</td>
<td>26</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{SENSE}$ Voltage</td>
<td>$V_{SENSE}$</td>
<td>Measured with Respect to $V_{IN}$</td>
<td>+0.3</td>
<td>-5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>LX Input Voltage</td>
<td>$V_{LX}$</td>
<td></td>
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<td>26</td>
<td></td>
<td>V</td>
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<tr>
<td>Adjust Pin Input Voltage</td>
<td>$V_{ADJ}$</td>
<td></td>
<td>-0.3</td>
<td>6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>$P_D$</td>
<td>SOT89-5L @ $T_A=25°C$</td>
<td></td>
<td></td>
<td>800</td>
<td>mW</td>
</tr>
<tr>
<td>Thermal Resistance (Note1)</td>
<td>$\theta_{JA}$</td>
<td>SOT89-5L</td>
<td></td>
<td>+156</td>
<td></td>
<td>°C/W</td>
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<tr>
<td>Junction Temperature</td>
<td>$T_J$</td>
<td></td>
<td></td>
<td>+150</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>$T_{OP}$</td>
<td></td>
<td>-40</td>
<td>+85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>$T_{ST}$</td>
<td></td>
<td>-65</td>
<td>+150</td>
<td></td>
<td>°C</td>
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<tr>
<td>Lead Temperature (soldering, 10 sec)</td>
<td></td>
<td></td>
<td></td>
<td>+260</td>
<td></td>
<td>°C</td>
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</table>

Note1: $\theta_{JA}$ is measured in the natural convection at $T_A=25°C$ on a low effective thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

IR Re-flow Soldering Curve
### DC Electrical Characteristics \( V_{IN}=12V, T_A=25^\circ C \) (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage</td>
<td>( V_{IN} )</td>
<td></td>
<td>7</td>
<td>26</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Internal Regulator Start-up Threshold</td>
<td>( V_{SU} )</td>
<td>( V_{IN} ) Rising</td>
<td>4.8</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Quiescent Supply Current with Output off</td>
<td>( I_{INQoff} )</td>
<td>ADJ pin Grounded</td>
<td>15</td>
<td>20</td>
<td></td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Quiescent Supply Current with Output Swi</td>
<td>( I_{INQon} )</td>
<td>ADJ pin Floating, f=250kHz</td>
<td>400</td>
<td>800</td>
<td></td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Mean Current Sense Threshold Voltage</td>
<td>( V_{SENSE} )</td>
<td>Measured on ( I_{SENSE} ) pin with respect to ( V_{IN} ) ( V_{ADJ} =1.25V )</td>
<td>95</td>
<td>100</td>
<td>105</td>
<td>mV</td>
</tr>
<tr>
<td>Sense Threshold Hysteresis</td>
<td>( V_{SENSEHYS} )</td>
<td></td>
<td>±15</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>ISENSE Pin Input Current</td>
<td>( I_{SENSE} )</td>
<td>( V_{SENSE} =V_{IN} -0.1 )</td>
<td>3</td>
<td>10</td>
<td></td>
<td>( \mu A )</td>
</tr>
<tr>
<td>Internal Reference Voltage</td>
<td>( V_{REF} )</td>
<td>Measured on ADJ pin with pin Floating</td>
<td>1.21</td>
<td>1.25</td>
<td>1.29</td>
<td>V</td>
</tr>
<tr>
<td>Temperature Coefficient of ( V_{REF} )</td>
<td>( \Delta V_{REF} / \Delta T )</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
<td>ppm/(^\circ C)</td>
</tr>
<tr>
<td>External Control Voltage Range on ADJ Pin for DC Brightness Control</td>
<td>( V_{ADJ} )</td>
<td></td>
<td>0.3</td>
<td>2.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>ADJ Pin Enable High Voltage</td>
<td>( V_{ADJ_ON} )</td>
<td>( V_{ADJ} ) Rising</td>
<td>0.2</td>
<td>0.25</td>
<td>0.3</td>
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<tr>
<td>ADJ Pin Enable Hysteresis</td>
<td>( V_{ADJ_HYS} )</td>
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<td>20</td>
<td>50</td>
<td>80</td>
<td>mV</td>
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<tr>
<td>Resistance Between ADJ Pin and ( V_{REF} )</td>
<td>( R_{ADJ} )</td>
<td></td>
<td>135</td>
<td></td>
<td>250</td>
<td>k( \Omega )</td>
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<tr>
<td>Continuous LX Switch Current</td>
<td>( I_{LX_mean} )</td>
<td></td>
<td>1.0</td>
<td>1.2</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>LX Switch 'On' Resistance</td>
<td>( R_{LX} )</td>
<td></td>
<td>0.5</td>
<td>0.7</td>
<td></td>
<td>( \Omega )</td>
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<tr>
<td>LX Switch Leakage Current</td>
<td>( I_{LX_leak} )</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>( \mu A )</td>
</tr>
</tbody>
</table>
### DC Electrical Characteristics (Cont.) \( V_{\text{IN}}=12V, \ T_{\text{A}}=25^\circ C \) (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>Duty Cycle Range of PWM Signal Applied to ADJ Pin During Low Frequency PWM Dimming Mode</td>
<td>DPWM (LF)</td>
<td>PWM Frequency &lt;500Hz PWM Amplitude= ( V_{\text{REF}} ) Measured on ADJ pin</td>
<td>0.01</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brightness Control Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100:1</td>
<td></td>
</tr>
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<td>DPWM (HF)</td>
<td>PWM Frequency &gt;10kHz PWM Amplitude= ( V_{\text{REF}} ) Measured on ADJ Pin</td>
<td>0.16</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brightness Control Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5:1</td>
<td></td>
</tr>
<tr>
<td>Soft Start Time</td>
<td>( T_{\text{SS}} )</td>
<td>Time Taken for Output Current to Reach 90% of Final Value after Voltage on ADJ pin Has Risen Above 0.3V</td>
<td></td>
<td>500</td>
<td></td>
<td>( \mu \text{s} )</td>
</tr>
<tr>
<td>Operating Frequency</td>
<td>( f_{\text{LX}} )</td>
<td>ADJ Pin Floating ( L=100\mu \text{H} \ (0.82\Omega) ) ( I_{\text{OUT}}=700\text{mA} \ @ \ V_{\text{LED}}=3.4V ) Driving 1 LED</td>
<td></td>
<td>250</td>
<td></td>
<td>( \text{KHz} )</td>
</tr>
<tr>
<td>Minimum Switch ‘ON’ Time</td>
<td>( T_{\text{ONmin}} )</td>
<td>LX switch ‘ON’</td>
<td></td>
<td>200</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>Minimum Switch ‘OFF’ Time</td>
<td>( T_{\text{OFFmin}} )</td>
<td>LX switch ‘OFF’</td>
<td></td>
<td>200</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>Recommended Maximum Operating Frequency</td>
<td>( f_{\text{LXmax}} )</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>Recommended Duty Cycle Range of Output Switch at ( f_{\text{LXmax}} )</td>
<td>( D_{\text{LX}} )</td>
<td></td>
<td></td>
<td>0.3</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Internal Comparator Propagation Delay</td>
<td>( T_{\text{PD}} )</td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>ns</td>
</tr>
</tbody>
</table>

**Notes:**

1. 100% brightness corresponds to \( V_{\text{ADJ}} = V_{\text{ADJ (nom)}} = V_{\text{REF}} \). Driving the ADJ pin above \( V_{\text{REF}} \) will increase the \( V_{\text{SENSE}} \) threshold and output current proportionally.
Typical Operating Characteristics

(Vcc=12V, Single LED, Ta= 25°C, L=100uH, unless otherwise noted)

- **Input Voltage vs. Vsense Voltage**

- **Input Voltage vs. ILED**

- **Temperature vs. ILED**

- **Vadj vs. ILED**

  - L=47uH, Rs=0.22ohm

  - L=100uH, Rs=0.22ohm

- **Vadj vs. Vsense ERR**

  - Suggestion: 0.3V≤Vadj≤2.5V

- **Rs vs. ILED**
Function Description

Operation

The FP7152 is a continuous mode inductive step-down converter that is easy to be configured in varies applications ranging from 7V~26V input. The converter employs a high side current sensing resistor RS to detect and regulate the LED current. The voltage across the current sensing resistor is kept measured and regulated in 100mV±15mV range.

The internal 1.25V reference voltage is utilized to provide a 0.25V reference for enabling the part and a 1.25V pulling-up voltage as current reference voltage. When $V_{ADJ}>0.25V$ the output of the comparator becomes high and the other blocks are enabled.

When input voltage $V_{IN}$ is first applied, the initial current in $L1$ and RS is zero and there is no output from the current sense circuit. Under this condition, the output of comparator is high. This turns on an internal switch and switches the SW pin low, causing current to flow from $V_{IN}$ to ground, via RS, $L1$ and the LED(s). The current rises at a rate determined by $V_{IN}$ and $L1$ to produce a voltage ramp across RS. When $(V_{IN} - V_{SENSE}) > 115mV$, the output of the comparator switches low and turns the LX pin output to high impedance state. Then the current flowing on the RS decreases at another rate. When $(V_{IN} - V_{SENSE}) < 85mV$, the LX switch turns on again and the mean current on the LED is $100mV/RS$.

Adjusting output current

The device contains a low pass filter between the ADJ pin and the threshold comparator. An internal current limiting resistor (250k nom.) is placed between ADJ and the internal reference voltage. This allows the ADJ pin to be overdriven with either DC or pulse signals to change the $V_{SENSE}$ switching threshold and adjust the output current.

Output Shutdown

The output of the low pass filter drives the shutdown circuit. When the input voltage to this circuit falls below the threshold (0.2V nom.), the internal regulator and the output switch are turned off. The voltage reference remains powered during shutdown to provide the bias current for the shutdown circuit. Quiescent supply current during shutdown is nominally 15uA and switch leakage is below 1uA.
Dimming Control

The FP7152 provides two dimming methods: PWM dimming and DC analog dimming. To use PWM dimming, apply a square wave to the EN/DIM pin. To used analog dimming, apply a 0.3V~2.5V DC voltage to this pin.
Application Information

Setting the LED Current

The LED current is identical and set by the current setting resistor between the \( V_{\text{IN}} \) pin and \( I_{\text{SENSE}} \) pin. To set the LED current according to the following equation:

\[
I_{\text{LED}} = \frac{0.1}{RS}
\]

For \( RS=0.33\Omega \), the LED current is set to 300mA

Shutdown Mode

Taking the ADJ pin to a voltage below 0.2V will turn off the output and the supply current will fall to a low standby level of 15\( \mu \)A nominal.

Soft Start

The voltage on the ADJ pin is the inductor current reference. An external capacitor connected between the ADJ pin and ground provides a soft-start delay. When \( V_{\text{IN}} \) starts, internal voltage source charges the capacitor from 0V to 1.25V to fulfill soft-start function.

Capacitor selection

A low ESR capacitor should be used for input decoupling. The ESR of this capacitor appears in series with the supply source impedance and lowers overall efficiency. This capacitor has to supply the relatively high peak current to the coil and smooth the current ripple on the input supply. A minimum value of 4.7\( \mu \)F is acceptable if the input source is close to the device, but higher values will improve performance at lower input voltages, especially when the source impedance is high. The input capacitor should be placed as close to the IC as possible.

For maximum stability over temperature and voltage, capacitors with X7R, X5R, or better dielectric are recommended. Capacitors with Y5V dielectric are not suitable for decoupling in this application and should not be used.

Reducing output ripple

Peak to peak ripple current in the LED(s) can be reduced, if required, by shunting a capacitor \( C_{\text{LED}} \) across the LED(s)

Inductor selection

Recommended inductor values for the FP7152 are in the range of 47\( \mu \)H to 100\( \mu \)H. Higher
inductance value is recommended at higher supply voltages in order to minimize errors due to switching delays, which result in increased ripple and lower efficiency. Higher values of inductance also result in a smaller change in output current over the supply voltage range. The inductor should be mounted as close to the device as possible with low resistance connections to the LX and VIN pins. The chosen coil should have a saturation current higher than the peak output current and a continuous current rating above the required mean output current.

**DC Dimming**

\[ I_{\text{OUTDC}} = 0.08 \times \frac{V_{\text{ADJ}}}{R_S} \quad (\text{for } 0.3 < V_{\text{ADJ}} < 2.5 \text{V}) \]

The ADJ pin can be driven by an external DC voltage \( V_{\text{ADJ}} \) to adjust the output current to a value below the nominal average value defined by \( R_S \). The LED current decreases linearly with the \( V_{\text{ADJ}} \) when \( 0.3 \text{V} \leq V_{\text{ADJ}} \leq 2.5 \text{V} \), \( R_S \) must be increased in proportion to prevent \( I_{\text{OUTDC}} \) exceeding 700mA maximum. When the \( V_{\text{ADJ}} \) falls below the threshold, 0.2V, the output switch is turned off which allows PWM dimming.

**PWM Dimming**

A Pulse Width Modulated (PWM) signal with duty cycle \( D_{\text{PWM}} \) can be applied to the ADJ pin. The PWM signal is recommended above 50kHz. As shown below, to adjust the output current to a value above or below the nominal average value set by resistor \( R_S \):
PC Board Layout Checklist

1. the capacitor C1 has to be placed to V\textsubscript{IN} as close as possible
2. The sense resistor RS has to be placed as close as possible to V\textsubscript{IN} and I\textsubscript{SENSE}
3. The D1 anode, the LX pin and the inductor L1 have to be placed as close as possible to avoid ringing
Typical Application

DC Input
LED Application Circuit

AC Input
LED Application Circuit
Package Outline

SOT89-5L

**Symbols** | **Min. (mm)** | **Max. (mm)**
---|---|---
A | 1.400 | 1.600
B | 0.400 | 0.520
c | 0.350 | 0.410
D | 4.400 | 4.600
D1 | 1.500 | 1.700
D2 | 1.300 | 1.500
E | 2.400 | 2.600
E1 | 2.200 REF | 2.200 REF
E2 | 0.520 REF | 0.520 REF
e | 1.500 REF | 1.500 REF
e1 | 3.000 REF | 3.000 REF
F | 5° REF | 5° REF
H | 4.050 | 4.250
L | 0.800 | 0.800

UNIT: mm