The Analog Mixed Signal Company

Data Sheet

Rev. 1.00 / December 2011

ZLED7015

1.0MHz Boost Converter with Internal 35V Switch



ZLED7015

1.0MHz Boost Converter with Internal 35V Switch

The Analog Mixed Signal Company

Brief Description

The ZLED7015, one of our ZLED family of LED control ICs, is a constant current boost converter with an internal high-power 35V switch. It is optimal for driving multiple white LEDs connected in series so that the LED current is uniform for better brightness and color control. It can also drive devices that require a constant voltage and is capable of operating efficiently with voltage supplies ranging from 6VDC to 30VDC. It is ideal for diverse lighting applications requiring low supply voltages such as SELV applications. Typically, smaller, less expensive external components can be used since the ZLED7015 switches at 1.0MHz (typical).

The ZLED7015 output current is adjustable via an external current sense resistor R_S connected from the FB pin to ground.

The ZLED7015 improves efficiency and minimizes power losses in the current setting resistor R_S by use of an internal 0.3V feedback reference voltage.

Dimming can be controlled using a pulse-width modulation (PWM) waveform or a DC voltage applied to the FB pin.

The ZLED7015 provides a “soft-start” function to prevent excessive in-rush current on start-up and ensures a controlled rise of the output voltage.

Over-voltage protection is adjustable via external resistors R_1 and R_2.

Features

- Integrated 35V power switch
- Wide input range: 6VDC to 30VDC
- Over-temperature protection
- Over-voltage (open LED string) protection adjusted via external resistor divider
- Under-voltage lockout ensures reliable circuit operation
- Control of output current during start-up via internal “soft-start”
- Switching frequency: 1.0MHz
- Single pin on/off or brightness control via PWM, microcontroller, or DC voltage control signal input
- MSOP-10 package

Benefits

- High efficiency: up to 95% efficiency
- Few small, low-profile components needed for operation
- Small form-factor package

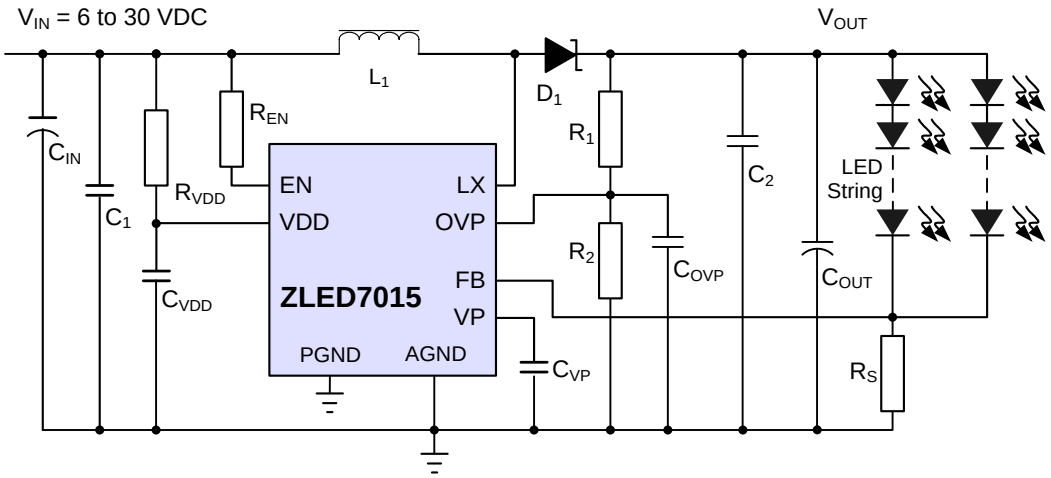
Available Support

- Evaluation Kit

Physical Characteristics

- Operating temperature: -40°C to 85°C
- RoHS-compliant

ZLED7015 Typical Application Circuit



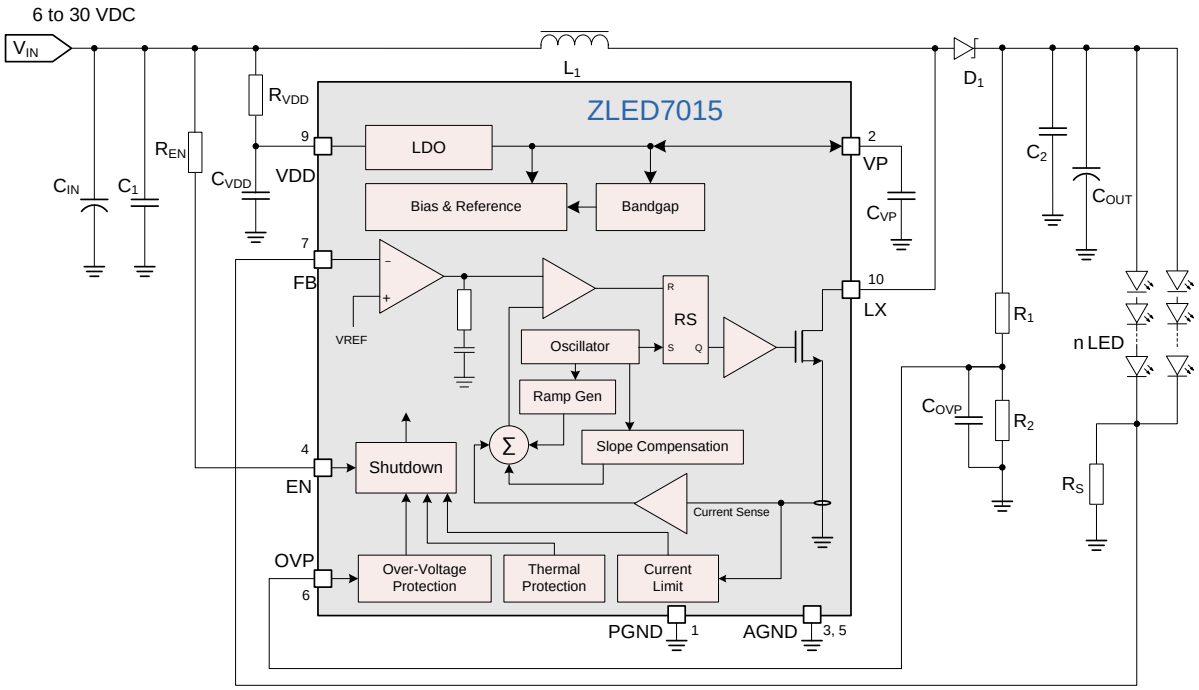
© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner.
The information furnished in this publication is subject to changes without notice.

ZLED7015

1.0MHz Boost Converter with Internal 35V Switch

The Analog Mixed Signal Company

ZLED7015 Block Diagram



Typical Applications

- *Low-Voltage Retro-fit Lighting*
- *MR16 Lights*
- *SELV Lighting*
- *Signage and Outdoor Lighting*
- *Architectural/Building Lighting*
- *Replacement Tubes*
- *LED Backlighting*
- *General Purpose Low-Voltage Industrial and Consumer Applications*

Ordering Information

Product Sales Code	Description	Package
ZLED7015-ZI1R	ZLED7015 – 1.0MHz Boost Converter with Internal 35V Switch	MSOP-10 (Tape & Reel)
ZLED7015KIT-E1	ZLED7015-E1 Evaluation Board, 1 ZLED-PCB10, and 5 ZLED7015 ICs	Kit

Sales and Further Information

www.zmdi.com LED_Drivers@zmdi.com

Zentrum Mikroelektronik Dresden AG
Grenzstrasse 28
01109 Dresden
Germany

Phone +49.351.8822.7.533
Fax +49.351.8822.8.7533

ZMD America, Inc.
275 South 5th Avenue
Pocatello, ID 83201
USA

Phone +1.208.478.7200
Fax +1.208.478.7200

Zentrum Mikroelektronik Dresden AG, Japan Office
2nd Floor, Shinbashi Tokyu Bldg.
4-21-3, Shinbashi, Minato-ku
Tokyo, 105-0004
Japan

Phone +81.3.6895.7410
Fax +81.3.6895.7301

ZMD FAR EAST, Ltd.
3F, No. 51, Sec. 2,
Keelung Road
11052 Taipei
Taiwan

Phone +886.2.2377.8189
Fax +886.2.2377.8199

Zentrum Mikroelektronik Dresden AG, Korean Office
POSCO Centre Building
West Tower, 11th Floor
892 Daechi, 4-Dong,
Kangnam-Gu
Seoul, 135-777
Korea

Phone +82.2.559.0660
Fax +82.2.559.0700

DISCLAIMER: This information applies to a product under development. Its characteristics and specifications are subject to change without notice. Zentrum Mikroelektronik Dresden AG (ZMD AG) assumes no obligation regarding future manufacture unless otherwise agreed to in writing. The information furnished hereby is believed to be true and accurate. However, under no circumstances shall ZMD AG be liable to any customer, licensee, or any other third party for any special, indirect, incidental, or consequential damages of any kind or nature whatsoever arising out of or in any way related to the furnishing, performance, or use of this technical data. ZMD AG hereby expressly disclaims any liability of ZMD AG to any customer, licensee or any other third party, and any such customer, licensee and any other third party hereby waives any liability of ZMD AG for any damages in connection with or arising out of the furnishing, performance or use of this technical data, whether based on contract, warranty, tort (including negligence), strict liability, or otherwise.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner.

Contents

1 IC Characteristics 6
1.1 Absolute Maximum Ratings 6
1.2 Operating Conditions 6
1.3 Electrical Parameters 7
1.4 Typical Operating Characteristics 8
1.5 Characteristic Waveforms 10
2 Circuit Description 12
2.1 EN Pin, VP Pin, and Soft-Start Function 12
2.2 Output Current Control 12
2.2.1 Output Current and R_S 12
2.2.2 Dimming via External DC Voltage Control 13
2.2.3 Dimming via PWM Control 14
2.2.4 Microcontroller LED Control 15
2.2.5 Constant Voltage Application 15
3 Application Circuit Design 17
3.1 External Component – R_S 17
3.2 External Component – Inductor L_1 17
3.3 External Components – Input Decoupling Capacitors C_1 and C_{IN} 17
3.4 External Component –Output Capacitors C_2 and C_{OUT} 17
3.5 External Component – Diode D_1 17
3.6 Additional External Components 17
4 Operating Conditions 18
4.1 Under-Voltage Lockout 18
4.2 Over-Voltage Threshold and Open-Circuit Protection 18
4.3 Over-Temperature Protection 18
5 ESD/Latch-Up-Protection 19
6 Pin Configuration and Package 19
7 Layout Requirements 21
7.1 General Considerations and Ground Traces 21
7.2 Layout Considerations for C_1, C_{IN}, C_2 and C_{OUT} 21
7.3 Layout Considerations for the EN Pin 21
7.4 Layout Considerations for the LX Pin, L_1 External Coil, and D_1 Diode 21
7.5 Layout Considerations for the External Current Sense Resistor (R_S) 21
7.6 Layout Considerations for C_{VP} and C_{VDD} 21
7.7 Layout Considerations for the Thermal Pad 21
8 Glossary of Terms 22
9 Ordering Information 22
10 Document Revision History 22

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

List of Figures

Figure 1.1 I_{OUT} vs. V_{IN} with R_S = 0.42Ω 8
Figure 1.2 I_{OUT} vs. V_{IN} with R_S = 0.88Ω 8
Figure 1.3 I_{OUT} vs. V_{OUT} with R_S = 0.42Ω 8
Figure 1.4 I_{OUT} vs. V_{OUT} with R_S = 0.88Ω 8
Figure 1.5 Efficiency vs. V_{IN} with R_S = 0.42Ω 8
Figure 1.6 Efficiency vs. V_{IN} with R_S = 0.88Ω 8
Figure 1.7 Efficiency vs. V_{OUT} with R_S = 0.42Ω 9
Figure 1.8 Efficiency vs. V_{OUT} with R_S = 0.88Ω 9
Figure 1.9 V_{FB} Reverence Voltage vs. V_{IN} 9
Figure 1.10 I_{OUT} vs. PWM Duty Cycle 9
Figure 1.11 V_{OUT}, V_{IN}, and I_{L1} during Soft Start 10
Figure 1.12 V_{OUT}, V_{LX}, and I_{OUT} during Typical Operation 10
Figure 1.13 V_{OUT}, V_{LX}, and I_{L1} when Over-Voltage Protection (OVP) Threshold is Exceeded 11
Figure 2.1 Typical Application Circuit 13
Figure 2.2 Example Circuit for Controlling Output Current via an External DC Control Voltage 13
Figure 2.3 Example Circuit for Controlling Output Current via a PWM Control Signal 14
Figure 2.4 Example Circuit for Constant Voltage Source Applications 16
Figure 6.1 ZLED7015 Pin Configuration—MSOP-10 Package 19
Figure 6.2 MSOP-10 Package Dimensions for the ZLED7015 20

List of Tables

Table 1.1 Absolute Maximum Ratings 6
Table 1.2 Operating Conditions 6
Table 1.3 Electrical Parameters 7
Table 6.1 Pin Description MSOP-10 19

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

1 IC Characteristics

Note: Exceeding the maximum ratings given in this section could cause operation failure and/or cause permanent damage to the ZLED7015. Exposure to these conditions for extended periods may affect device reliability.

1.1 Absolute Maximum Ratings

Table 1.1 Absolute Maximum Ratings

No.	PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
1.1.1	Supply voltage on VDD pin (also see specification 1.2.2)	V_{DD}		-0.3		40.0	V
1.1.2	LX pin output voltage	V_{LX}		-0.3		40.0	V
1.1.3	All other pins			-0.3		6.0	V
1.1.4	ESD Performance Human Body Model		High voltage pins: 1, 4, 5, 9, and 10			±2.5	kV
			Low voltage pins: 2, 3, 6, 7, and 8			±4	kV
1.1.5	Junction temperature	$T_{j\,MAX}$		-40		150	°C
1.1.6	Storage temperature	T_{ST}		-65		150	°C
1.1.7	Lead soldering temperature		10 seconds maximum			260	°C
1.1.8	Junction-to-ambient thermal resistance	$R_{\theta JA}$				60	°C/W

1.2 Operating Conditions

Table 1.2 Operating Conditions

No.	PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
1.2.1	Operating temperature	T_{OP}		-40		+85	°C
1.2.2	Supply voltage on VDD pin (also see absolute maximum specification 1.1.1)	V_{DD}		6		30	V

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

1.3 Electrical Parameters

Test conditions for the following specifications are T_{amb} = 25°C (typical) and V_{DD} = 12V, unless otherwise noted.

Production testing of the ZLED7015 is performed at 25°C unless otherwise stated. Functional operation of the ZLED7015 and specified parameters at other temperatures are guaranteed by design, characterization, and process control.

Table 1.3 Electrical Parameters

No.	PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
1.3.1	Supply current	I_{DD}	Continuous switching		2		mA
			Quiescent: no switching		1.1		mA
1.3.2	Shutdown current	I_{SD}	Shutdown: no switching; V_{EN}=0V		15		µA
1.3.3	LX switching frequency	f_{OCS}			1		MHz
1.3.4	Maximum duty cycle	D_{LX}			90		%
1.3.5	EN pin ON threshold voltage	V_{ENon}	Rising V_{EN}	1.4			V
1.3.6	EN pin OFF threshold voltage	V_{ENoff}	Falling V_{EN}			0.4	V
1.3.7	Internal feedback reference voltage	V_{FB}		0.285	0.3	0.315	V
1.3.8	Integrated switch ON resistance	R_{DSon}			0.8	1.2	Ω
1.3.9	Integrated switch current limit	$I_{SWlimit}$	Duty cycle = 90%	1.8	2.1	2.4	A
1.3.10	Integrated switch leakage current	I_{SWleak}	V_{LX} = 40V			1	µA
1.3.11	Internal regulator	V_P	6V<V_{DD}<30V, C_{VP}=10µF	4.5	5.0	5.5	V
1.3.12	Over-temperature protection (OTP) threshold	T_{OTP}			150		°C
1.3.13	OTP threshold hysteresis	T_{OTP_HYS}			50		°C
1.3.14	Under-voltage lock-out threshold (UVLO)	V_{UVLO}	Falling V_{DD}		2.9		V
1.3.15	UVLO hysteresis	V_{UVLO_HYS}			100		mV
1.3.16	Internal over-voltage threshold reference voltage	V_{OVP_TH}			0.9		V
1.3.17	Over-voltage protection threshold hysteresis	$V_{OVP_TH_HYS}$			10		mV

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

1.4 Typical Operating Characteristics

The curves are valid for the typical application circuit and T_{amb} = 25°C unless otherwise noted.

Figure 1.1 I_{OUT} vs. V_{IN} with R_S = 0.42Ω

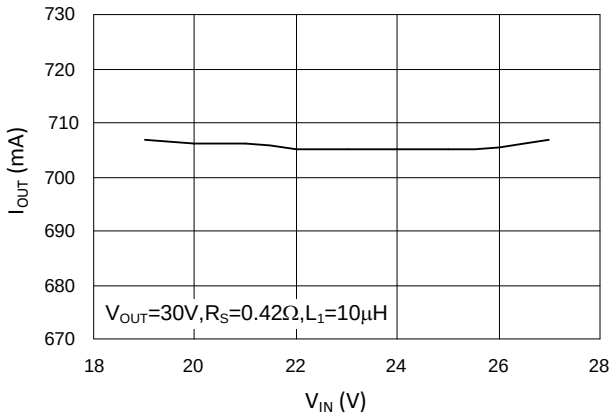


Figure 1.2 I_{OUT} vs. V_{IN} with R_S = 0.88Ω

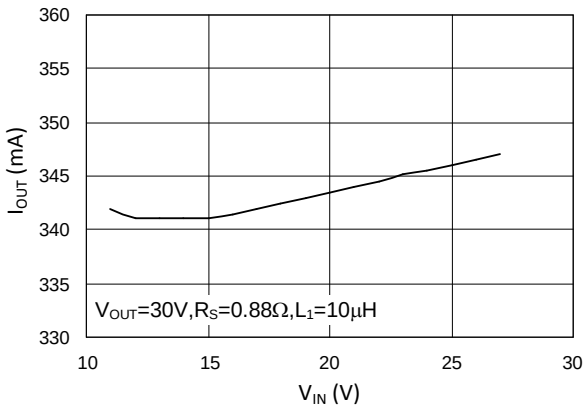


Figure 1.3 I_{OUT} vs. V_{OUT} with R_S = 0.42Ω

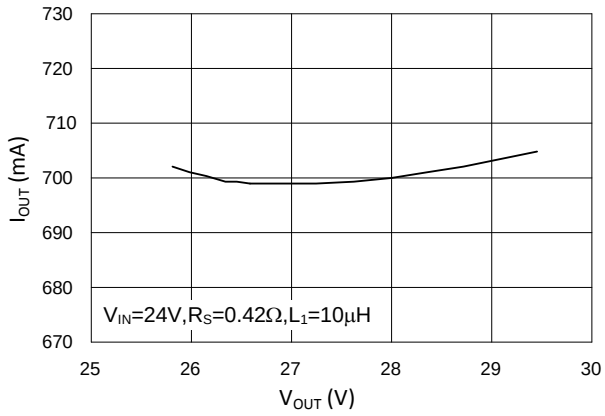


Figure 1.4 I_{OUT} vs. V_{OUT} with R_S = 0.88Ω

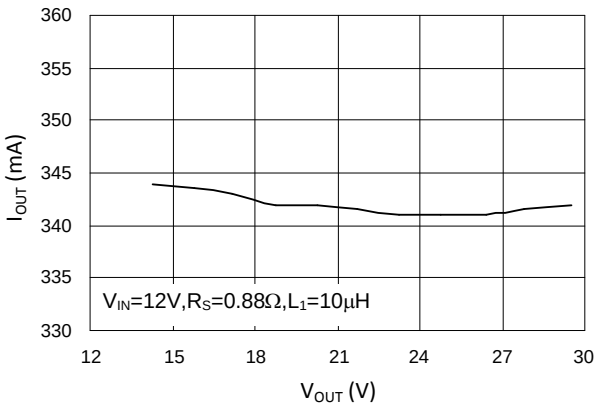


Figure 1.5 Efficiency vs. V_{IN} with R_S = 0.42Ω

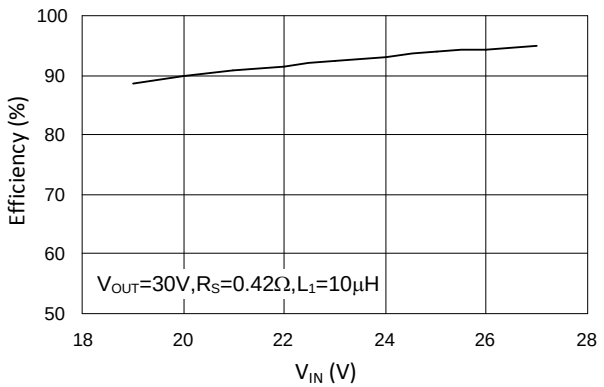
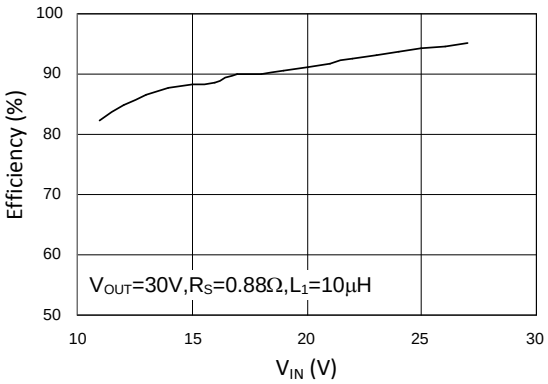


Figure 1.6 Efficiency vs. V_{IN} with R_S = 0.88Ω



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Figure 1.7 Efficiency vs. V_{OUT} with R_S = 0.42Ω

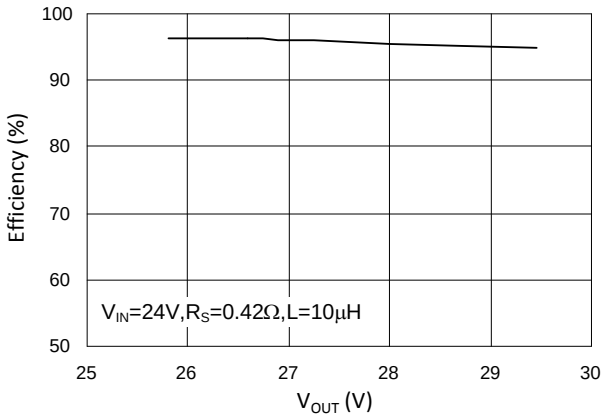


Figure 1.8 Efficiency vs. V_{OUT} with R_S = 0.88Ω

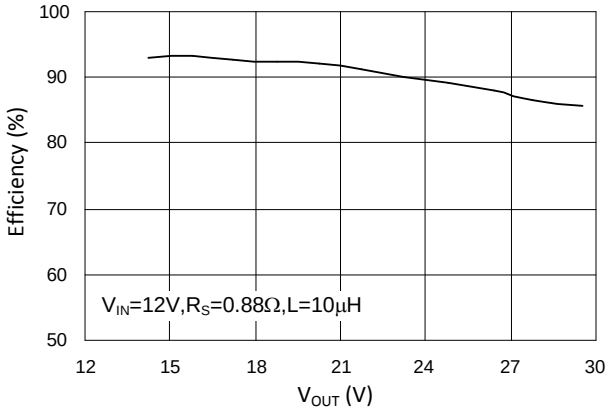


Figure 1.9 V_{FB} Reverence Voltage vs. V_{IN}

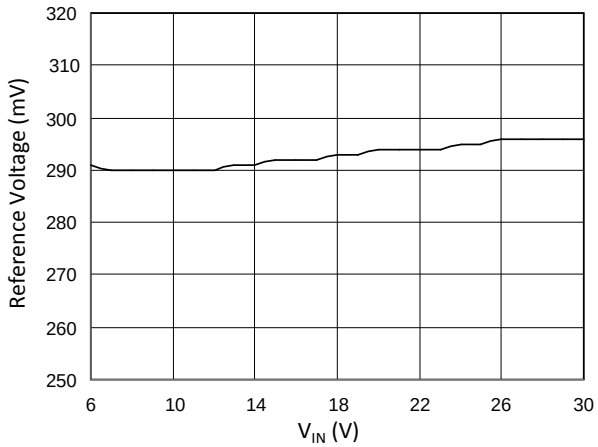
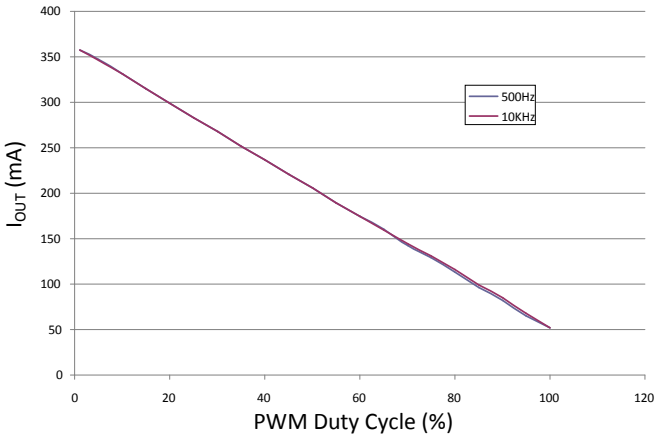


Figure 1.10 I_{OUT} vs. PWM Duty Cycle

(For details of PWM dimming, see section 2.2.3.)



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

1.5 Characteristic Waveforms

Figure 1.11 V_{OUT}, V_{IN}, and I_{L1} during Soft Start

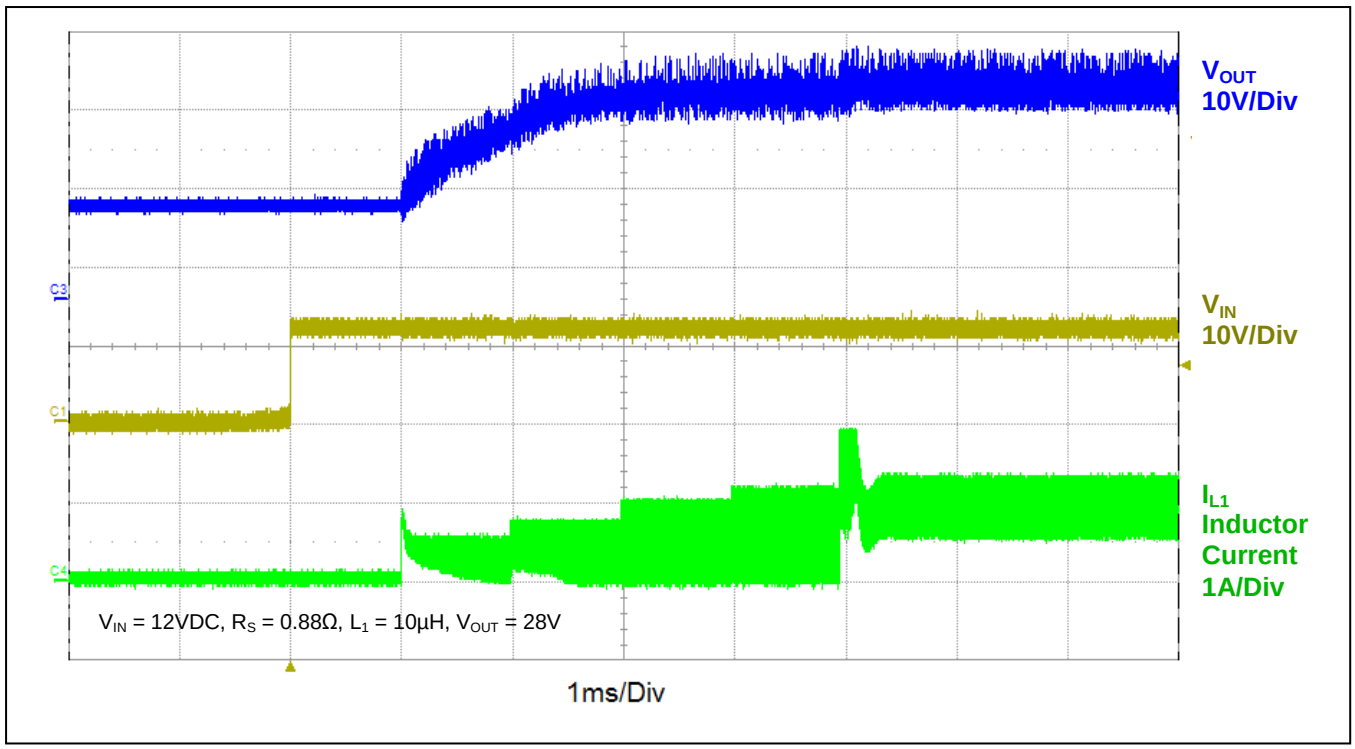
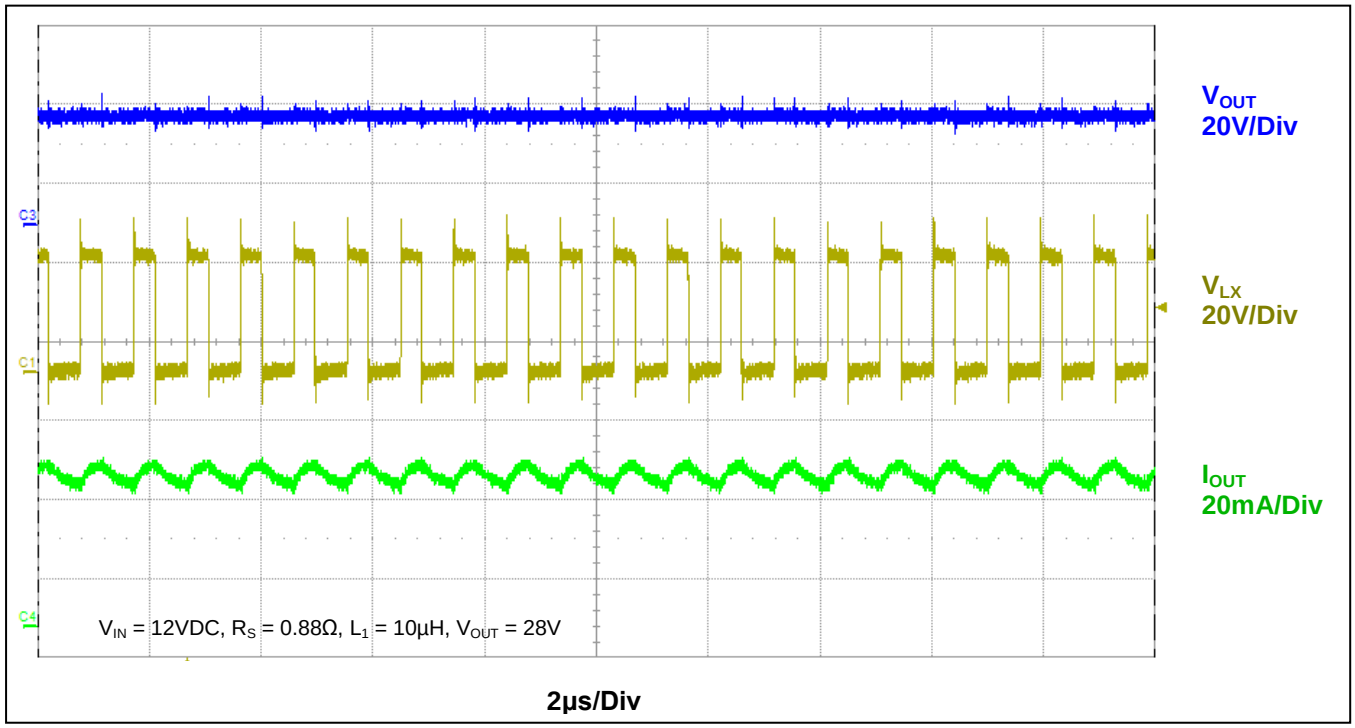
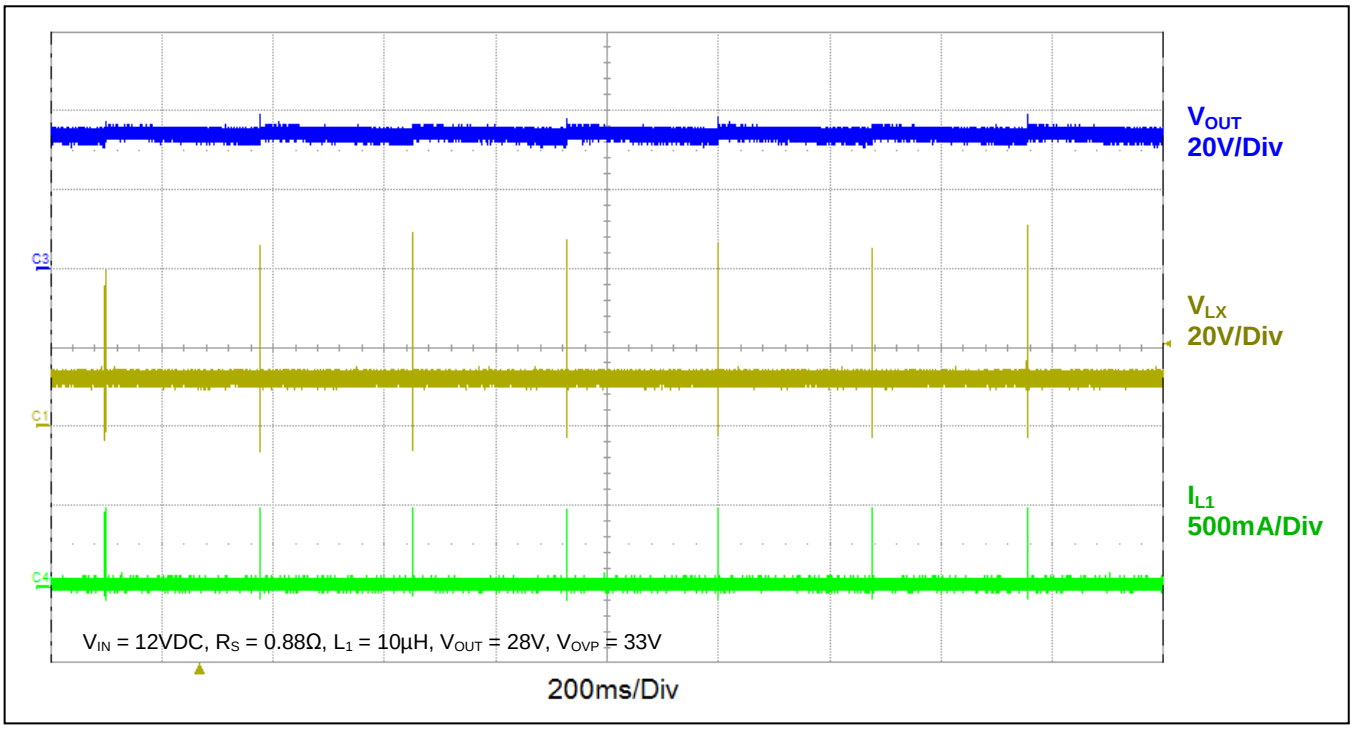


Figure 1.12 V_{OUT}, V_{LX}, and I_{OUT} during Typical Operation



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Figure 1.13 V_{OUT}, V_{LX}, and I_{L1} when Over-Voltage Protection (OVP) Threshold is Exceeded



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

2 Circuit Description

The ZLED7015 is a constant-current boost converter that can also function as a constant voltage driver for LED applications. The boost converter topology features an internal 35V power switch and feedback circuit to control the output to the LED string. Optimal performance is achieved by operating in continuous conduction mode within the application's load current range; i.e., the current through inductor L1 is always above 0A. The output current is set by an external resistor and the device supports DC linear or PWM dimming. Additional device features include selectable open-load/over-voltage protection, over-temperature protection, under-voltage lockout, and an automatic soft-start function to minimize the inrush current during startup.

2.1 EN Pin, VP Pin, and Soft-Start Function

The EN pin can be used to enable or disable the ZLED7015. When the voltage on the EN pin rises above the ON threshold voltage V_{ENon} specified in Table 1.3, the ZLED7015 begins its "soft-start." When the voltage at EN falls below the OFF threshold voltage V_{ENoff}, the ZLED7015 shuts down. There is a hysteresis between V_{ENon} and V_{ENoff} to prevent intermittent operation.

The ZLED7015's internal "soft-start" function ensures a smooth device start-up by preventing excessive in-rush current and providing a controlled rise in the output current. When the soft-start function is initiated, the internal circuitry clamps the internal switch current threshold to zero during a 1millisecond delay. The soft-start function then gradually increases the internal switch current threshold over a 4-5 msec period. See Figure 1.11 for an illustration of typical waveforms during start-up.

Important: The EN pin requires termination. If the EN pin is not used to control operation, connect it to the positive power supply through a 100kΩ resistor. Do not allow the EN pin to float.

The VP pin is connected to the ZLED7015's internal power regulator and requires an external bypass capacitor, C_{VP}, to ensure correct device operation.

2.2 Output Current Control

The LED current is determined by the voltage across the external sense resistor R_S, which is fed back to the input FB. Internally, this is compared with the internal feedback reference voltage, V_{FB} (see typical application shown on page 2), and the duty cycle of the internal power switch is adjusted to reduce or increase the output current I_{OUT}. Selection of R_S is discussed in section 2.2.1, and other external components are discussed in section 3. Dimming can be controlled by superimposing a DC or filtered pulse-width modulated (PWM) signal on the feedback voltage from R_S. Refer to sections 2.2.2 and 2.2.3, respectively, for more details.

2.2.1 Output Current and R_S

The ZLED7015 continually adjusts the output current, I_{OUT}, in order to maintain the voltage level at the FB pin equal to the internal feedback reference voltage, V_{FB}. Equation (1) shows the basic relationship between I_{OUT}, V_{FB}, and R_S for the basic application shown in Figure 2.1.

$$I_{OUT} = \frac{V_{FB}}{R_S} = \frac{0.3V}{R_S} \quad \textbf{(1)}$$

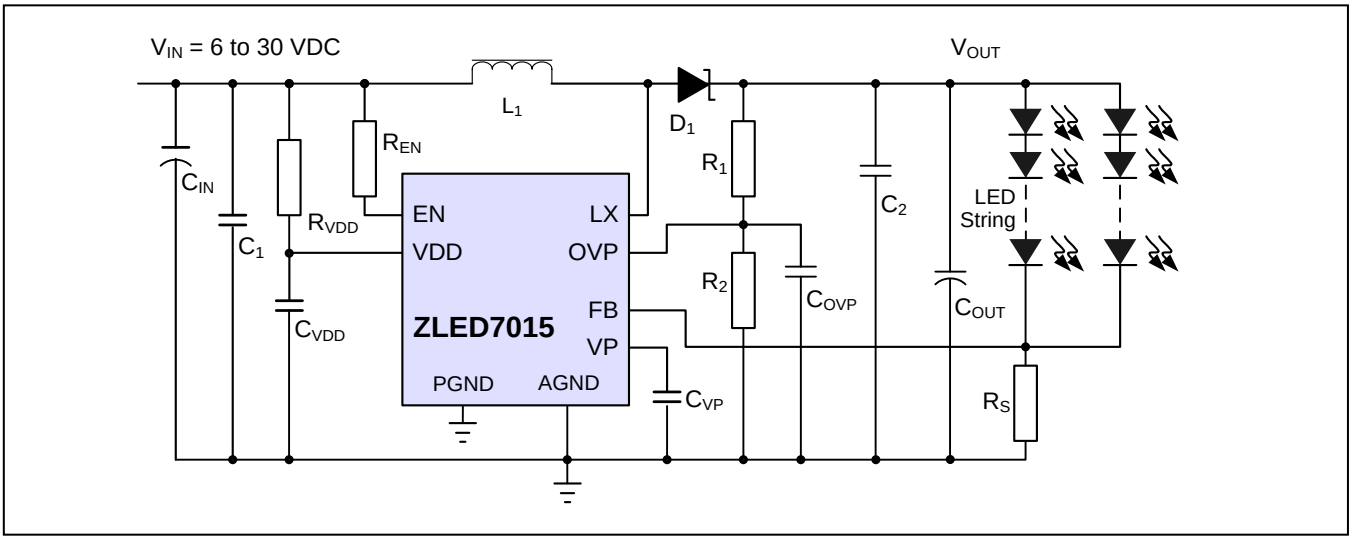
Where

I_{OUT} = Average output current through the LED(s) in amperes

V_{FB} = Internal feedback reference voltage (see Table 1.3, parameter 1.3.7)

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Figure 2.1 Typical Application Circuit

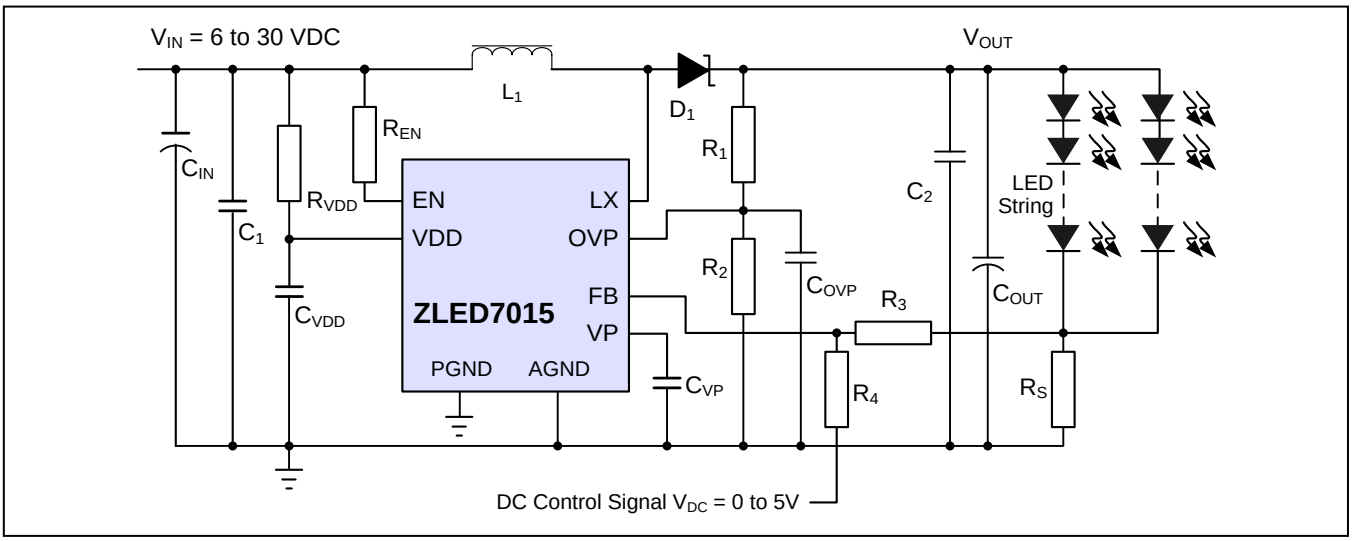


2.2.2 Dimming via External DC Voltage Control

The LED output current can be set below the nominal average value defined on section 2.2.1 by using an external DC voltage control signal superimposed on the FB pin as shown in the example circuit in Figure 2.2. As the DC control signal, V_{DC}, increases, the current through R_3 increases with a subsequent increase in the voltage at the FB pin. This causes the ZLED7015 to compensate by reducing the output current through the LED string. Consequently, the output current is inversely proportional to the DC control voltage.

Note: It is important to ensure that the LED output voltage V_{OUT} remains higher than the input voltage V_{IN} in dimming applications.

Figure 2.2 Example Circuit for Controlling Output Current via an External DC Control Voltage



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

The output current controlled by the DC voltage on FB can be calculated using equation (2):

$$I_{OUT} = \frac{V_{FB} - \left(\frac{R_3 \times (V_{DC} - V_{FB})}{R_4} \right)}{R_S} \quad \textbf{(2)}$$

Where

I_{OUT} = Output current through the LED(s) with a DC control voltage

V_{FB} = Internal feedback reference voltage (Table 1.3, parameter 1.3.7)

V_{DC} = External DC control voltage

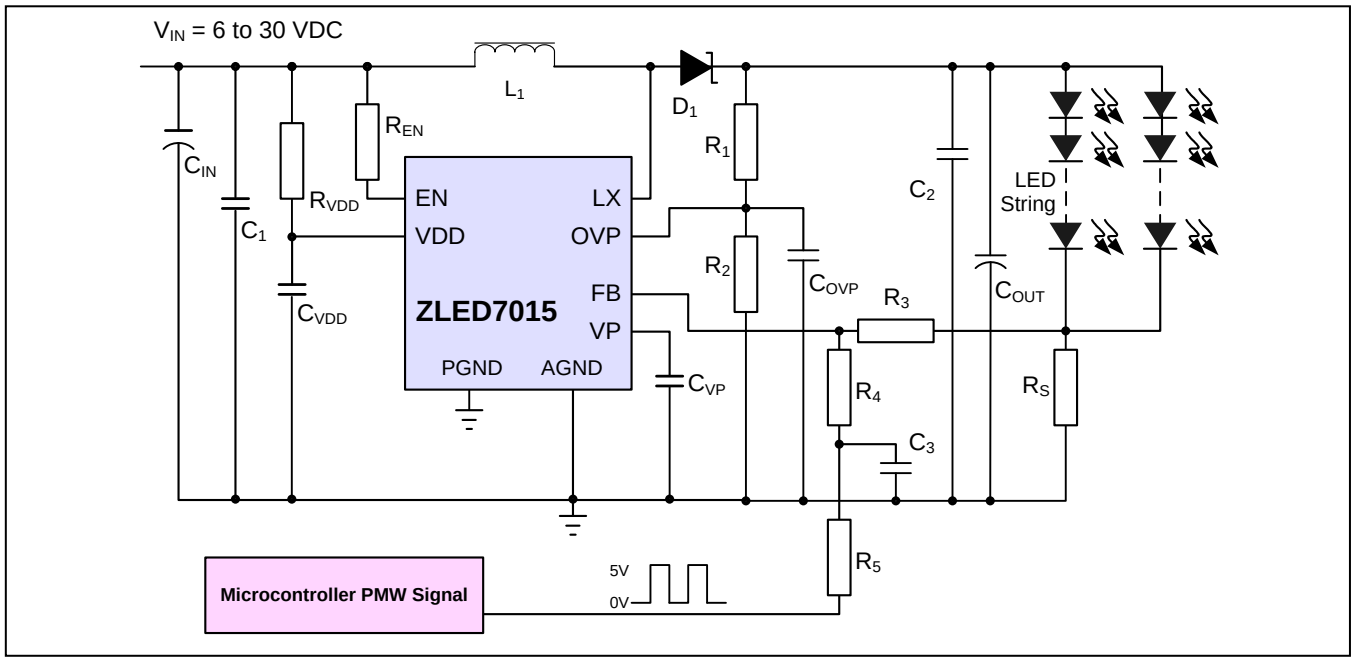
2.2.3 Dimming via PWM Control

An external pulse-width modulated (PWM) signal input can be used to control the LED output current by driving the output current to a value below the nominal average value defined in section 2.2.1. A microcontroller can be used to generate the PWM signal. See Figure 2.3 for an example circuit. The PWM signal is superimposed on the feedback voltage from R_S at the FB pin via the input filter R_5/C_3 and R_4, which produces a DC voltage with a ripple. This method of controlling dimming is similar to the external DC voltage control described in section 2.2.2. The duty cycle of the PWM signal regulates the filtered DC voltage level, which inversely controls the LED output current level. When the duty cycle is at 100%, the output current is at the minimum. With a 0% duty cycle, the output current is at the maximum.

Recommendation: With a PWM signal of 0 to 5V, use an R_3 value of 10kΩ and a PWM frequency of >2kHz to minimize the filtered PWM voltage ripple.

Note: It is important to ensure that the LED output voltage V_{OUT} remains higher than the input voltage V_{IN} in dimming applications.

Figure 2.3 Example Circuit for Controlling Output Current via a PWM Control Signal



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

The output current controlled by the PWM voltage on FB can be calculated using equation (3):

$$I_{OUT} = \frac{V_{FB} - \left(\frac{R_3 \times (V_{PWM} \times D_{PWM} - V_{FB})}{R_4 + R_5} \right)}{R_S} \quad \textbf{(3)}$$

Where

I_{OUT} = Output current through the LED(s) with a PWM control voltage

V_{FB} = Internal feedback reference voltage (see Table 1.3, parameter 1.3.7)

V_{PWM} = External PWM control voltage

D_{PWM} = Duty cycle of the PWM control signal

2.2.4 Microcontroller LED Control

A microcontroller can control the LED output current by providing a PWM control signal to the FB pin as described in section 2.2.3.

Depending on the application, the microcontroller can also be used to control the shutdown circuitry via the EN pin (see section 2.1) providing a fast and smooth transition to shutdown.

2.2.5 Constant Voltage Application

In addition to functioning as a constant-current boost converter for driving an LED string, the ZLED7015 can be configured as a constant-voltage boost converter for other applications. Figure 2.4 demonstrates a typical circuit for this application.

The output voltage controlled by the values of R_3 and R_S can be calculated using equation (4):

$$V_{OUT} = V_{FB} \times \frac{(R_3 + R_S)}{R_S} \quad \textbf{(4)}$$

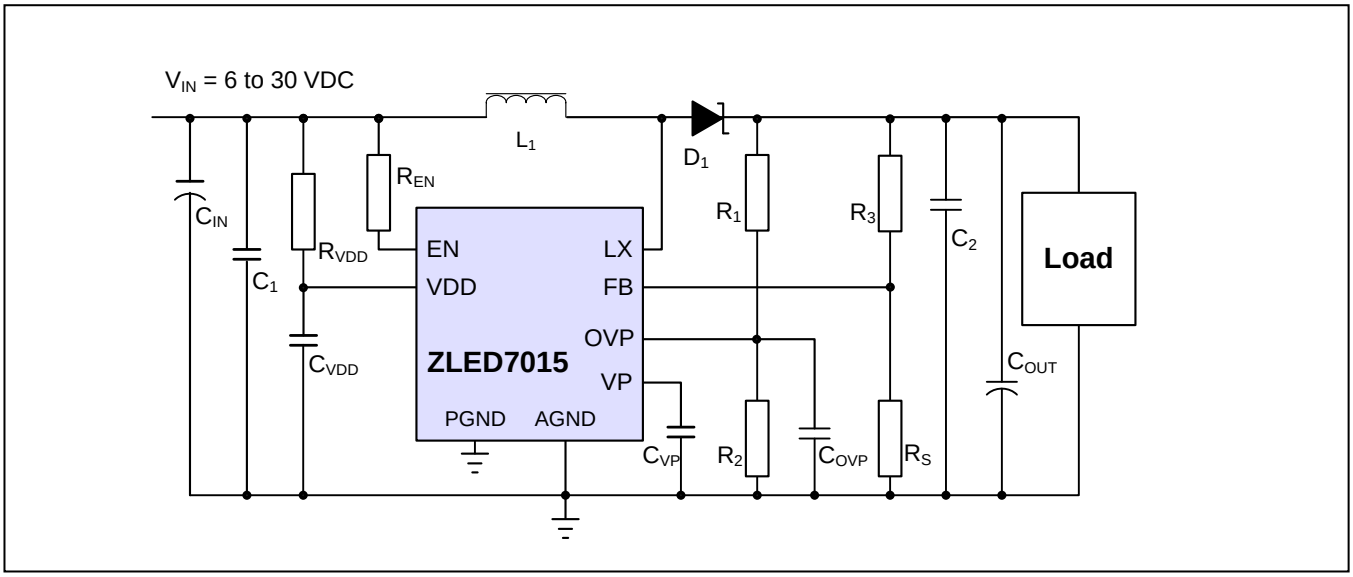
Where

V_{OUT} = Output voltage to the load

V_{FB} = Internal feedback reference voltage (Table 1.3, parameter 1.3.7)

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Figure 2.4 Example Circuit for Constant Voltage Source Applications



© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

3 Application Circuit Design

The following sections cover selection of the external components shown in the typical application on page 2.

3.1 External Component – R_S

Recommendation: Use precision resistors (±1% or better tolerance) for the R_S resistor to ensure accurate control of the LED current.

See section 2.2.1 for the equation for selecting the value of R_S, which sets the nominal current output.

3.2 External Component – Inductor L_1

Designing the circuit so that the current through inductor L_1 is always above 0V (i.e., continuous mode) typically gives the best performance due to improved load regulation and reduced output ripple. Select an inductor that has a saturation current and a current rating greater than the mean input current.

The inductor value selection requires trade-offs between unwanted ripple current and parasitic effects. A larger value inductor reduces inductor ripple current, resulting in less output ripple voltage; however, higher values also increase parasitic resistance, which can degrade performance. For most applications, a 10µH inductor with a saturation current >2.5A is adequate. See section 7.4 for layout restrictions.

3.3 External Components – Input Decoupling Capacitors C_1 and C_{IN}

The input capacitors C_1 and C_{IN} minimize the input voltage noise and ripple. Recommendation: use a 22µF or larger low-ESR electrolytic capacitor for C_{IN} in parallel with a 1µF ceramic capacitor rated at greater than the input voltage plus a safety margin for C_1.

3.4 External Component –Output Capacitors C_2 and C_{OUT}

The output capacitors C_2 and C_{OUT} minimize the output voltage ripple. Recommendation: use a 22µF or larger low-ESR electrolytic capacitor for C_{OUT} in parallel with a 1µF ceramic capacitor rated at greater than the output voltage plus a safety margin for C_2.

3.5 External Component – Diode D_1

For the diode D_1, select a high-speed, low-capacitance Schottky diode with low reverse leakage at the maximum operating voltage and temperature to ensure maximum efficiency and performance.

Important: Choose diodes with a continuous current rating higher than the maximum output load current and a peak current rating above the peak coil current. When operating above 85°C, the reverse leakage of the diode must be addressed because it can cause excessive power dissipation in the diode, especially when the output voltage is relatively high. Its reverse breakdown voltage must be greater than the over-voltage protection level V_{OVP} (see section 4.2).

Note: Silicon diodes have higher forward voltage and higher voltage overshoot before they start conducting, which can increase the peak voltage on the LX output. Ensure that the total voltage appearing on the LX pin, including supply ripple, is within the specified range (see Table 1.1).

3.6 Additional External Components

For the VDD input, connect resistor R_{VDD} to the positive power supply and connect ceramic capacitor C_{VDD} to ground. Recommendations: use 1µF for C_{VDD}; use 300Ω for R_{VDD} with input voltages ≥ 8V, use 50Ω for R_{VDD} with input voltages < 8V.

For the VP pin, connect a 10µF ceramic bypass capacitor to ground (C_{VP}).

If the EN pin is not used, connect a 100kΩ resistor to the positive power supply (R_{EN}). Do not allow the EN pin to float.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

4 Operating Conditions

4.1 Under-Voltage Lockout

The under-voltage lockout (UVLO) monitors the ZLED7015's internal regulator output voltage, VP, to ensure correct operation of the internal circuitry. When the VP voltage is lower than the UVLO threshold V_{UVLO}, the ZLED7015 disables the internal power switch. If the VP voltage reaches a level higher than the UVLO threshold plus UVLO hysteresis (V_{UVLO}+V_{UVLO_HYS}) the UVLO turns off and the internal power switch is re-enabled. See parameters 1.3.14 and 1.3.15 in section 1.3 for the UVLO threshold and hysteresis.

4.2 Over-Voltage Threshold and Open-Circuit Protection

If the LED string becomes open or the FB pin is shorted to ground, the ZLED7015 would normally continually boost the output voltage to potentially damaging levels. To prevent this, the ZLED7015 includes an integrated over-voltage protection (OVP) mechanism. If the output voltage reaches the ZLED7015's OVP threshold V_{OVP}, the protection circuitry is triggered and the device automatically turns off the internal switch, stopping the boost function and protecting the device. Once the output voltage falls below the OVP threshold minus OVP threshold hysteresis (V_{OVP_TH}-$V_{OVP_TH_HYS}$), the device will enter soft-start mode.

The OVP threshold V_{OVP} for the ZLED7015 is selectable via the R1 and R2 resistor values determined by equation (5):

$$V_{OVP} = V_{OVP_TH} \times \frac{(R_1 + R_2)}{R_2} \quad \textbf{(5)}$$

Where

V_{OVP} = Over-voltage protection threshold

V_{OVP_TH} = Internal over-voltage threshold reference voltage (see Table 1.3, parameter 1.3.16)

Important: Care must be taken to select proper R_1 and R_2 values to ensure proper functioning of the ZLED7015. See specification 1.3.16 in Table 1.3 for the over-voltage protection threshold voltage. Set V_{OVP} 3V higher than the normal operation output voltage.

Important: When setting V_{OVP}, care must be taken to ensure V_{OUT} cannot exceed 35V.

Minimize noise coupling on the OVP pin, which could interfere with proper protection, by connecting a 10nF ceramic capacitor to GND from OVP (C_{OVP}).

4.3 Over-Temperature Protection

The ZLED7015 features on-chip over-temperature protection. If its internal temperature exceeds the over-temperature protection (OTP) threshold, T_{OTP}, due to high power dissipation and improper heat sinking, the internal power switch is disabled. Once the internal temperature has fallen below the OTP threshold minus the OTP threshold hysteresis (T_{OTP} - T_{OTP_HYS}), the ZLED7015 enters the soft-start mode (see section 2.1).

Refer to Table 1.1 for the maximum package power dissipation specifications for the ZLED7015's MSOP-10 package.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

5 ESD/Latch-Up-Protection

All high voltage pins (1, 4, 5, 9, and 10) have an ESD protection of >± 2500V according to the Human Body Model (HBM). The ESD test follows the Human Body Model based on MIL 883-H, Method 3015.8

All low voltage pins (2, 3, 6, 7, and 8) have an ESD protection of >± 4000V according to the Human Body Model (HBM). The ESD test follows the Human Body Model based on MIL 883-H, Method 3015.8

All pins pass the latch-up test based on the JEDEC Standard No. 78B, December 2008.

6 Pin Configuration and Package

The ZLED7015 package is an MSOP-10, which has a thermal resistance (junction to ambient) of $R_{\theta JA} = 60°C/W$.

Figure 6.1 ZLED7015 Pin Configuration—MSOP-10 Package

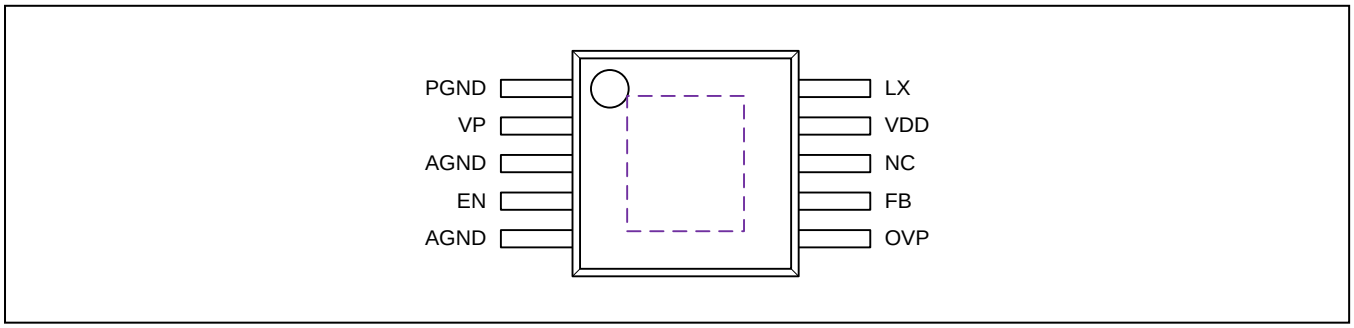
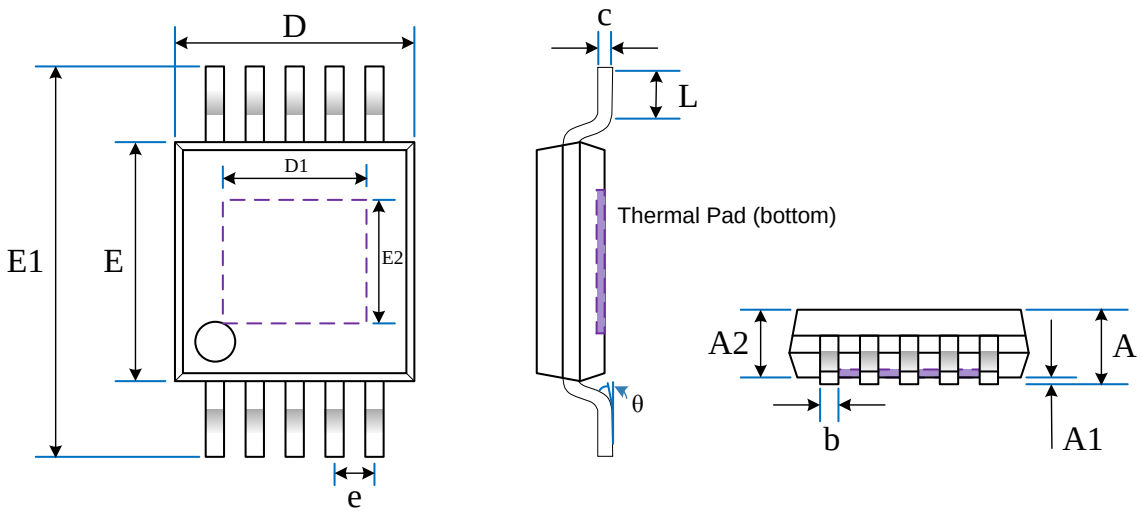


Table 6.1 Pin Description MSOP-10

Pin Name	No.	Description
PGND	1	Power ground
VP	2	Internal 5V linear regulator output. VP is the power supply for the internal switch gate driver and the internal control circuitry. Use a 10µF ceramic bypass capacitor between VP and ground.
AGND	3	Analog (signal) ground.
EN	4	Enable control input. Important: Do not allow this pin to float.
AGND	5	Analog (signal) ground.
OVP	6	Over-voltage protection control input.
FB	7	Feedback voltage input. The nominal average output current is set by the value of R_S connected from FB to GND – see section 2.2.1 for details. Important: Do not allow the FB pin to float.
n.c.	8	No connection
VDD	9	Supply voltage (6V to 30V)—see section 7 for layout considerations.
LX	10	Drain of the internal switch. Connect the power inductor between LX and the power supply. Connect the output rectifier D_1 between LX and the output circuit. See section1.1 for output range specifications.
Thermal Pad		Connect to ground.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Figure 6.2 MSOP-10 Package Dimensions for the ZLED7015



Symbol	Dimension (mm, except θ)		Symbol	Dimension (mm)	
	Min	Max		Min	Max
A	0.82	1.10	D	2.90	3.10
A1	0.02	0.15	D1	1.70	1.90
A2	0.75	0.95	e	0.50 BSC	
b	0.18	0.28	E	2.90	3.10
c	0.09	0.23	E1	4.75	5.05
			E2	1.45	1.65
θ	0°	6°	L	0.40	0.80

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

7 Layout Requirements

Follow these layout guidelines to avoid circuit instability and EMI vulnerability, especially with high current or high switching frequency applications.

Important: Route traces connecting the feedback network to the FB and OVP pin away from the L_1 inductor, the D_1 Schottky diode, and the LX pin. These traces should be as short as possible. Shield the FB pin and feedback network with a ground plane or trace to prevent noise coupling.

7.1 General Considerations and Ground Traces

Make the ground traces as wide and short as possible. To prevent a signal ground shift, keep traces for the signal ground (pin 5) separate from traces for the power ground (pin 1). Connect the signal and power ground traces together at either the large ground plane or the negative terminal of C_{IN}.

Connect the grounds for other components to the signal ground.

Use wide traces for connection of the high current loop.

7.2 Layout Considerations for C_1, C_{IN}, C_2 and C_{OUT}

Place C_1, C_2 and C_{OUT} as close as possible to the ZLED7015 to minimize ripple. The C_{IN} input decoupling capacitor must be placed as close as possible to the VDD pin to minimize power supply noise, which can reduce efficiency.

7.3 Layout Considerations for the EN Pin

Important: Do not allow the EN pin to float. It must be terminated if it is not used.

7.4 Layout Considerations for the LX Pin, L_1 External Coil, and D_1 Diode

Minimize the length of circuit board traces connected to the LX pin because it is a fast switching output.

Place L_1 and D_1 as close as possible to the LX pin using traces that are as short and wide as possible. Avoid routing other traces crossing or in parallel with this node to minimize the noise coupling into this circuit.

7.5 Layout Considerations for the External Current Sense Resistor (R_S)

Any trace resistance in series with R_S must be taken into consideration when selecting its value. For the most accurate LED current control, use a trace that is as wide and short as possible for the R_S connection to ground. Connect it to the signal ground (pin 5), not the power ground (pin 1).

7.6 Layout Considerations for C_{VP} and C_{VDD}

For good filtering, connect C_{VP} as close as possible to the VP pin and place C_{VDD} as close as possible to the VDD pin.

7.7 Layout Considerations for the Thermal Pad

To optimize heat dissipation, solder the thermal pad on the back of the MSOP-10 package to the large ground plan.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

8 Glossary of Terms

Term	Definition
LDO	Low Dropout Regulator
OTP	Over-Temperature Protection
OVP	Over-Voltage Protection
UVL	Under-Voltage Lockout

9 Ordering Information

Product Sales Code	Description	Package
ZLED7015-ZI1R	ZLED7015 – 1MHz Boost Converter with Internal 35V Switch	MSOP-10 (Tape & Reel)
ZLED7015KIT-E1	ZLED7015-E1 Evaluation Board, 1 ZLED-PCB10, and 5 ZLED7015 ICs	Kit

10 Document Revision History

Revision	Date	Description
1.00	December 20, 2011	First Issue.

Sales and Further Information www.zmdi.com LED_Drivers@zmdi.com

Zentrum Mikroelektronik Dresden AG
Grenzstrasse 28
01109 Dresden
Germany

Phone +49.351.8822.7.533
Fax +49.351.8822.8.7533

ZMD America, Inc.
275 South 5th Avenue
Pocatello, ID 83201
USA

Phone +1.208.478.7200
Fax +1.208.478.7200

Zentrum Mikroelektronik Dresden AG, Japan Office
2nd Floor, Shinbashi Tokyu Bldg.
4-21-3, Shinbashi, Minato-ku
Tokyo, 105-0004
Japan

Phone +81.3.6895.7410
Fax +81.3.6895.7301

ZMD FAR EAST, Ltd.
3F, No. 51, Sec. 2,
Keelung Road
11052 Taipei
Taiwan

Phone +886.2.2377.8189
Fax +886.2.2377.8199

Zentrum Mikroelektronik Dresden AG, Korean Office
POSCO Centre Building
West Tower, 11th Floor
892 Daechi, 4-Dong,
Kangnam-Gu
Seoul, 135-777
Korea

Phone +82.2.559.0660
Fax +82.2.559.0700

DISCLAIMER: This information applies to a product under development. Its characteristics and specifications are subject to change without notice. Zentrum Mikroelektronik Dresden AG (ZMD AG) assumes no obligation regarding future manufacture unless otherwise agreed to in writing. The information furnished hereby is believed to be true and accurate. However, under no circumstances shall ZMD AG be liable to any customer, licensee, or any other third party for any special, indirect, incidental, or consequential damages of any kind or nature whatsoever arising out of or in any way related to the furnishing, performance, or use of this technical data. ZMD AG hereby expressly disclaims any liability of ZMD AG to any customer, licensee or any other third party, and any such customer, licensee and any other third party hereby waives any liability of ZMD AG for any damages in connection with or arising out of the furnishing, performance or use of this technical data, whether based on contract, warranty, tort (including negligence), strict liability, or otherwise.

© 2011 Zentrum Mikroelektronik Dresden AG — Rev. 1.00
All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of the copyright owner. The information furnished in this publication is subject to changes without notice.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

ZMDI:
ZLED7015ZI1R