Kingbor Technology Co.,Ltd
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Power LED Driver

2MHz High-Brightness LED Drivers with High-Side Current Sense and 5000:1 Dimming

FEATURES

- 5.5V to 40V Input Voltage Range
- High-Side Current Sense
- 20kHz Maximum Dimming Frequency
- Hysteretic Control: No Compensation
- 200mV Low Reference Voltage(5%)
- Dedicated Dimming Control Input
- Up to 2MHz Switching Frequency
- Adjustable Constant LED Current
- Up to 5A Constant Current Output
- 5V, 10mA On-Board Regulator
- -40℃to +125℃Operating Temperature Range
- SOT23-6 package

APPLICATIONS

- MR16 and Other LED Bulbs
- Power Led driver
- Constant Current Source

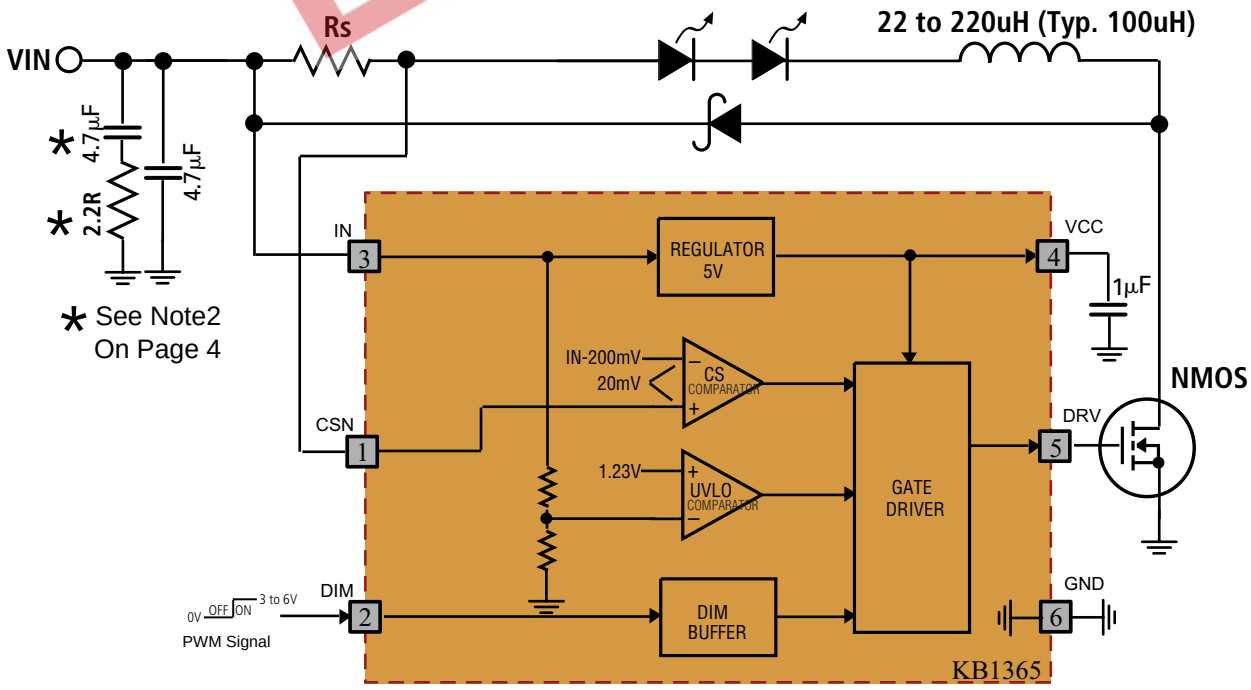
DESCRIPTION

The KB1365, step-down constant-current high-brightness LED (HB LED) drivers provide a cost-effective solution for automotive interior/exterior lighting,architectural and ambient lighting, LED bulbs such as MR16 and other LED illumination applications.

The KB1365 operate from a 5.5V to 40V input voltage range and feature a 5V/10mA on-board regulator. A high-side current-sense resistor adjusts the output current and a dedicated PWM input (DIM) enables a wide range of pulsed dimming.

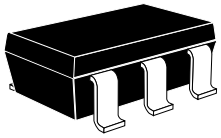
The KB1365 is well suited for applications requiring a wide input voltage range. The high-side current-sensing and an integrated current-setting circuitry minimize the number of external components while delivering an LED current with +/-5% accuracy. A hysteretic control algorithm ensures excellent input-supply rejection and fast response during load transients and PWM dimming. The KB1365 features a 20% inductor current ripple. These devices operate up to 2MHz switching frequency, thus allowing for small component size.

SIMPLIFIED BLOCk DIAGRAM

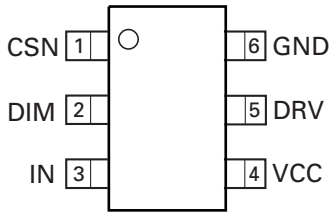


PIN CONFIGURATION

SOT23-6



SOT23-6
(TOP VIEW)



ORDER INFORMATION

Part number	Package	Marking
KB1365GRE	SOT23-6,Green	xxxx,Date Code with one bottom line

PIN DESCRIPTION

PIN	NAME	FUNCTION
1	IN	Positive Supply Voltage Input. Bypass with a 1µF or higher value capacitor to GND.
2	CSN	Current-Sense Input
3	DIM	Logic-Level Dimming Input. Drive DIM low to turn off the current regulator. Drive DIM high to enable the current regulator.
4	GND	Ground
5	DRV	Gate Drive Output. Connect to the gate of an external n-channel MOSFET.
6	V_{CC}	Voltage Regulator Output. Connect a 1µF capacitor from V_{CC} to GND.
SOT23-6		

ABSOLUTE MAXIMUM RATINGS

IN, CSN, DIM to GND .....-0.3V to +40V
V_{CC}, DRV to GND .....-0.3V to +6V
CSN to IN.....-0.3V to +0.3V
Maximum Current into Any Pin
(except IN, V_{CC}, and DRV).....±20mA
Continuous Power Dissipation (T_A = +70°C)
6-Pin SOT.....350mW

Operating Temperature Range .....-40°C to +125°C
Junction Temperature.....+150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C
Pin-to-Pin ESD Ratings (HB Model).....2.5kV
*As per JEDEC51 Standard (Single-Layer Board).

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATION CONDITIONS

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Power supply voltage	V_{IN}	5.5	—	40	V
Operating temperature	Top	-40	+25	+125	℃

ELECTRICAL CHARACTERISTICS

(V_{IN} = 12V, V_{DIM} = V_{CC}, C_{VCC} = 1μF, R_{SENSE} = 0.5Ω, T_A = T_J = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage Range	V_{IN}		5.5		40.0	V
Maximum Current Regulator Switching Frequency	f_{SW}				2	MHz
Ground Current	I_{GND}	DRV open			1.5	mA
Supply Current	I_{IN}	V_{DIM} < 0.6V			425	μA
Undervoltage Lockout	UVLO	V_{IN} = V_{CSN} = V_{DIM}, V_{IN} rising from 4V until V_{DRV} > V_{CC} - 0.5V		4.7	5.0	V
		V_{IN} = V_{CSN} = V_{DIM}, V_{IN} falling from 6V, V_{DRV} < 0.5V			4.5	
Undervoltage Lockout Hysteresis				0.5		V
SENSE COMPARATOR						
Sense Voltage Threshold High	V_{SNSHI}	(V_{IN} - V_{CSN}) rising from 0V until V_{DRV} < 0.5V (25℃)	215	220	225	mV
		(V_{IN} - V_{CSN}) rising from 0V until V_{DRV} < 0.5V (-40℃to +125℃)	210	220	230	
Sense Voltage Threshold Low	V_{SNSLO}	(V_{IN} - V_{CSN}) falling from 0.26V until V_{DRV} > (V_{CC} - 0.5V) (25℃)	175	180	185	mV
		(V_{IN} - V_{CSN}) falling from 0.26V until V_{DRV} > (V_{CC} - 0.5V) (-40℃to +125℃)	170	180	190	
Propagation Delay to Output High	t_{DPDH}	Falling edge of (V_{IN} - V_{CSN}) from 0.26V to 0V to DRV high, C_{DRV} = 1nF		82		ns
Propagation Delay to Output Low	t_{DPDL}	Rising edge of (V_{IN} - V_{CSN}) from 0V to 0.26V to DRV low, C_{DRV} = 1nF		82		ns
Current-Sense Input Current	I_{CSN}	(V_{IN} - V_{CSN}) = 200mV			1	μA
Current-Sense Threshold Hysteresis	CS_{HYS}	0.5V (25℃)		40	50	mV
		0.5V (-40℃to +125℃)		40	60	mV

ELECTRICAL CHARACTERISTICS

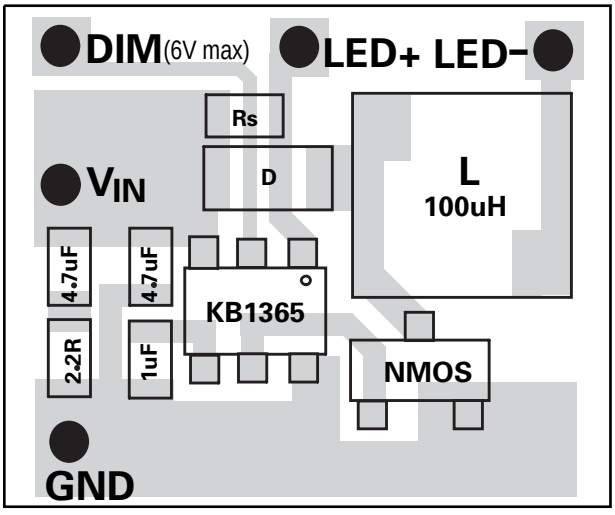
(V_{IN} = 12V, V_{DIM} = V_{CC}, C_{VCC} = 1μF, R_{SENSE} = 0.5Ω, T_A = T_J = -40°C to +125°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
GATE DRIVER						
Gate Driver Source Current		V_{CSN} = V_{IN}, V_{DRV} = 0.5 x V_{CC}		0.5		A
Gate Driver Sink Current		V_{CSN} = V_{IN} - 250mV, V_{DRV} = 0.5 x V_{CC}		1		A
Gate Driver Output-Voltage High	V_{OH}	I_{DRV} = 10mA	V_{CC} - 0.5			V
Gate Driver Output-Voltage Low	V_{OL}	I_{DRV} = -10mA			0.5	V
DIM INPUT						
Maximum DIM Frequency	f_{DIM}				20	kHz
DIM Input-Voltage High	V_{IH}	V_{CSN} = V_{IN}, increase DIM until V_{DRV} > (V_{CC} - 0.5V)	2.8		6.0	V
DIM Input-Voltage Low	V_{IL}	V_{CSN} = V_{IN}, decrease DIM until V_{DRV} < 0.5V			0.6	V
DIM Hysteresis	DIM_{HYS}			200		mV
DIM Turn-On Time	t_{DIMON}	DIM rising edge to V_{DRV} = 0.5 x V_{CC}, C_{DRV} = 1nF		100		ns
DIM Turn-Off Time	t_{DIMOFF}	DIM falling edge to V_{DRV} = 0.5 x V_{CC}, C_{DRV} = 1nF		100		ns
DIM Input Leakage High		V_{DIM} = V_{IN}			10	μA
DIM Input Leakage Low		V_{DIM} = 0V	-1		+1	μA
V_{CC} REGULATOR						
Regulator Output Voltage	V_{CC}	I_{VCC} = 0.1mA to 10mA, V_{IN} = 5.5V to 40V	4.5		5.5	V
		I_{VCC} = 0.1mA to 10mA, V_{IN} = 5.5V to 40V	4.0		5.5	V
Load Regulation		I_{VCC} = 0.1mA to 10mA, V_{IN} = 12V		4		Ω
Line Regulation		V_{IN} = 6V to 40V, I_{VCC} = 10mA		11		mV
Power-Supply Rejection Ratio	PSRR	V_{IN} = 12V, I_{VCC} = 5mA, f_{IN} = 10kHz		-35		dB
Current Limit	I_{LIM}	V_{IN} = 5.5V, V_{CC} = 0V		45		mA
		V_{IN} = 5.5V, V_{CC} = 4V		18		mA
Regulator Startup Time	t_{STRAT}	V_{CC} = 0 to 5.5V		350		us

Note 1: All devices are 100% production tested at T_J = +25°C and +125°C. Limits to -40°C are guaranteed by design.

Note 2: Vin Bypass Capacitor

Many types of capacitors can be used for input bypassing, however, caution must be exercised when using multi-layer ceramic capacitors. Because of the self-resonant and high Q characteristics of some types of ceramic capacitors, high voltage transients can be generated under some start-up conditions, such as connecting the charger input to a live power source. Adding a 2.2Ω resistor in series with an X5R ceramic capacitor will minimize start-up voltage transients.

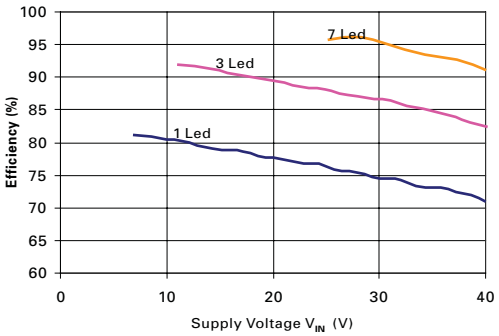


Layout suggestion

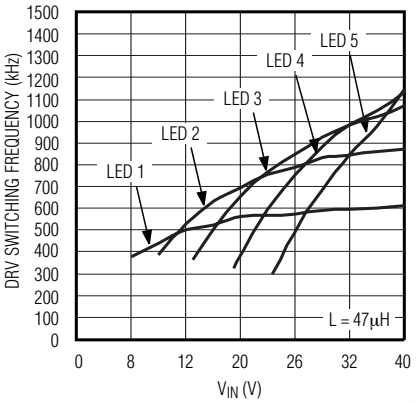
TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = V_{DIM} = 12V, C_{VCC} = 1μF, R_{SENSE} = 0.5Ω connected between IN and CSN. Typical values at T_A = +25°C, unless otherwise noted.)

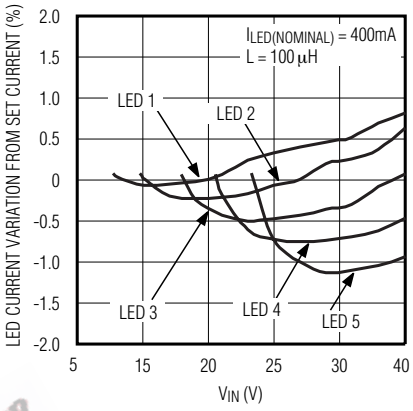
EFFICIENCY vs. VIN
1,3 and 7 LEDs
L = 100μH



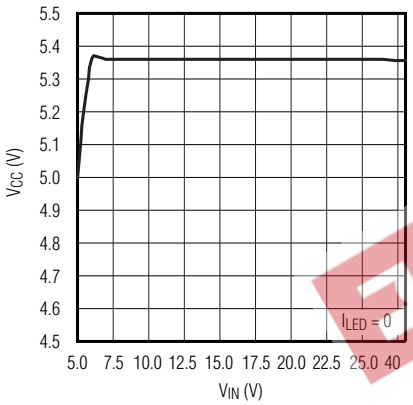
DRV SWITCHING FREQUENCY vs. VIN



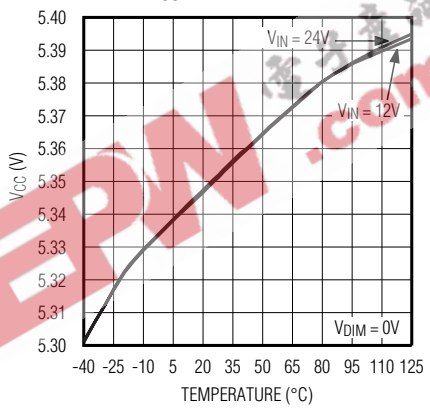
LED CURRENT VARIATION vs. VIN



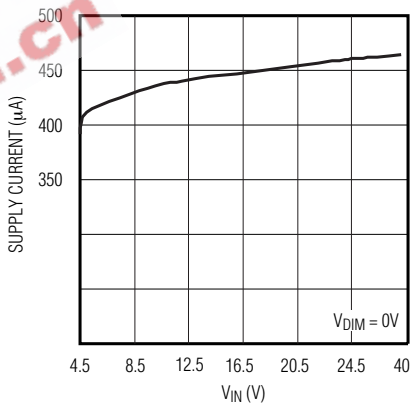
VCC vs. VIN



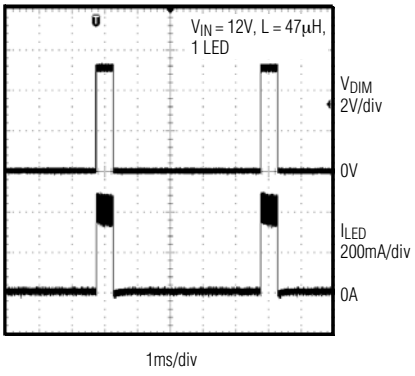
VCC vs. TEMPERATURE



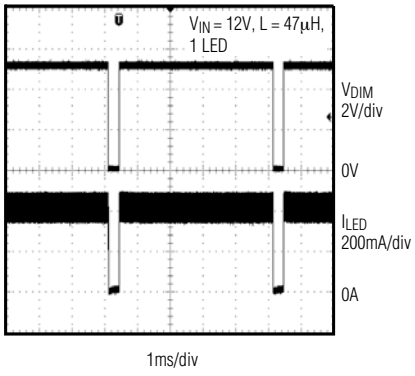
SUPPLY CURRENT vs. VIN



PWM DIMMING AT 200Hz
(10% DUTY CYCLE)



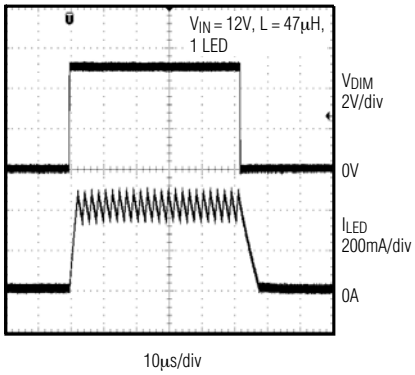
PWM DIMMING AT 200Hz
(90% DUTY CYCLE)



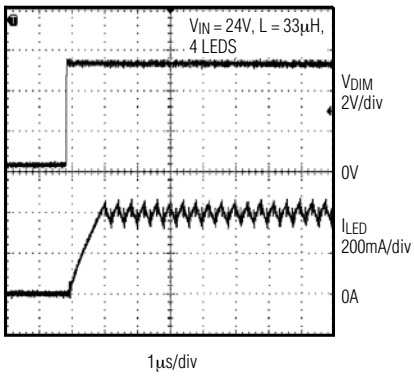
TYPICAL PERFORMANCE CHARACTERISTICS

(V_{IN} = V_{DIM} = 12V, C_{VCC} = 1µF, R_{SENSE} = 0.5Ω connected between IN and CSN. Typical values at T_A = +25°C, unless otherwise noted.)

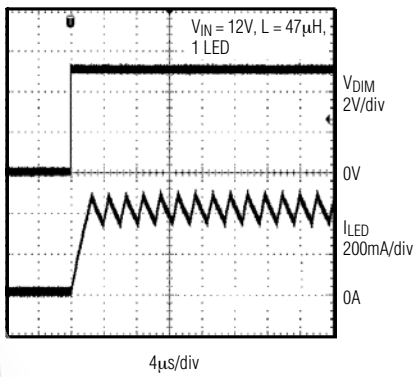
PWM DIMMING AT 200Hz (1% DUTY CYCLE)



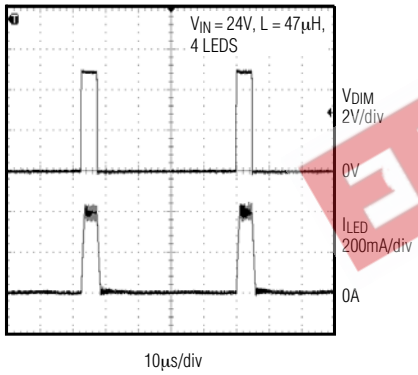
PWM DIMMING EXPANDED (50% DUTY CYCLE)



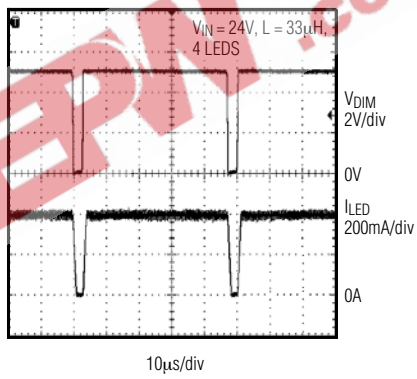
PWM DIMMING EXPANDED (50% DUTY CYCLE)



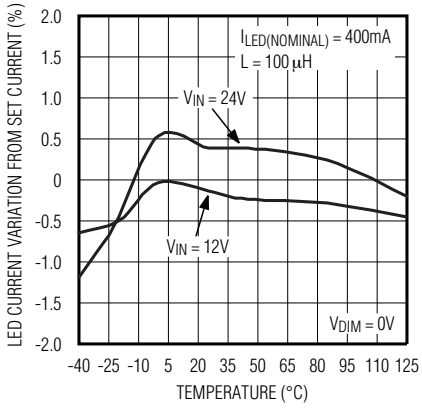
PWM DIMMING AT 20kHz (10% DUTY CYCLE)



PWM DIMMING AT 20kHz (90% DUTY CYCLE)



I_{LED} VARIATION vs. TEMPERATURE



Detailed Description

The KB1365 are step-down, constant-current, high-brightness LED (HB LED) drivers. These devices operate from a 5.5V to 40V input voltage range and provide up to 0.5A of source and 1A of sink drive capability to the gate of an external MOSFET. A high-side current-sense resistor sets the output current and a dedicated PWM dimming input (DIM) allows for a wide range of independent pulsed dimming.

The high-side current-sensing scheme and on-board current-setting circuitry minimize the number of external components while delivering LED current with a ±5% accuracy, using a 1% sense resistor. See the *Functional Diagram*.

Undervoltage Lockout (UVLO)

The KB1365 include a 5.0V undervoltage lockout (UVLO) with 500mV hysteresis. When V_{IN} falls below 4.5V, DRV goes low, turning off the external n-channel MOSFET. DRV goes high once V_{IN} is 5V or higher.

5V Regulator

V_{CC} is the output of a 5V regulator capable of sourcing 10mA. Bypass V_{CC} to GND with a 1µF capacitor.

DIM Input

The KB1365 allow dimming with a PWM signal at the DIM input. A logic level below 0.6V at DIM forces the KB1365's DRV output low, turning off the LED current. To turn the LED current on, the logic level at DIM must be at least 2.8V.

For the values of V_{SNSHI} and V_{SNSLO}, see the *Electrical Characteristics*.

Current Regulator Operation

The KB1365 regulate the LED output current using an input comparator with hysteresis (Figure 1). As the current through the inductor ramps up and the voltage across the sense resistor reaches the upper threshold, the voltage at DRV goes low, turning off the external MOSFET. The MOSFET turns on again when the inductor current ramps down through the freewheeling diode until the voltage across the sense resistor equals the lower threshold. Use the following equation to determine the operating frequency:

$$f_{SW} = \frac{(V_{IN} - n \times V_{LED}) \times n \times V_{LED} \times R_{SENSE}}{V_{IN} \times \Delta V \times L}$$

where n = number of LEDs, V_{LED} = forward voltage drop of one LED, and $\Delta V = (V_{SNSHI} - V_{SNSLO})$.

Applications Information

Setting nominal average output current with external resistor RS

The nominal average output current in the LED(s) is determined by the value of the external current sense resistor (R_S) connected between V_{IN} and CSN and is given by:

$$I_{OUTnom} = 0.2/R_S$$

The table below gives values of nominal average output current for several preferred values of current setting resistor (R_S) in the typical application circuit shown on page 1:

R_S (Ω)	Nominal average output current (mA)	Rs Power (w)
0.1	2000	0.4
0.2	1000	0.2
0.57	350	0.07

Inductor selection

Recommended inductor values for the KB1365 are in the range 22µH to 220µH(100µH Typ.).

APPLICATION CIRCUIT

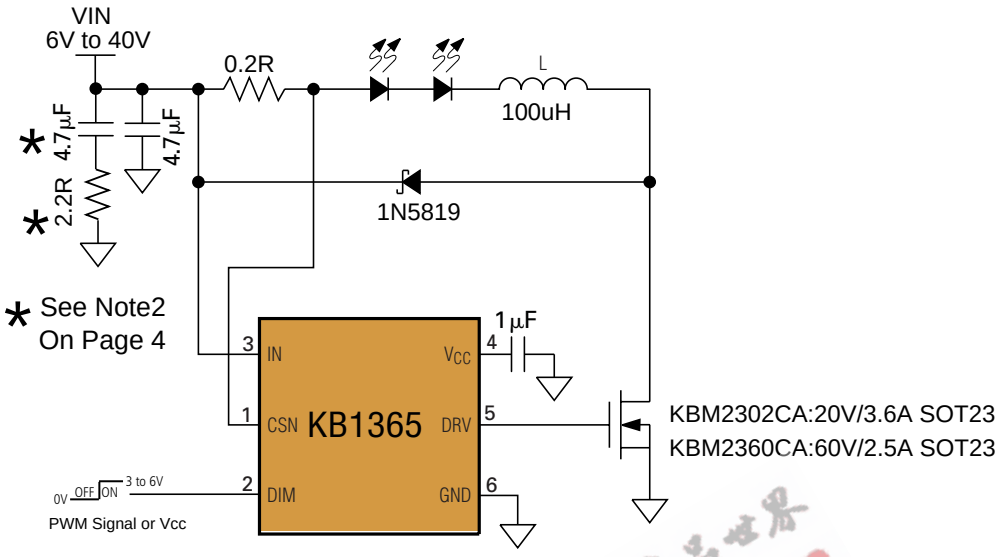


Figure 1a.KB1365 Typical Application Circuit with 1A Output .

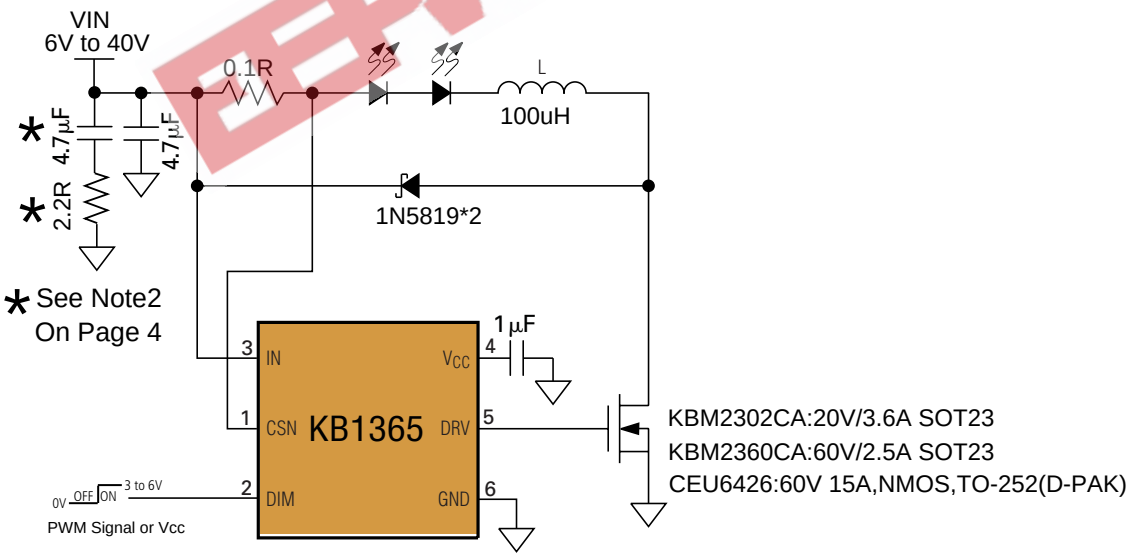
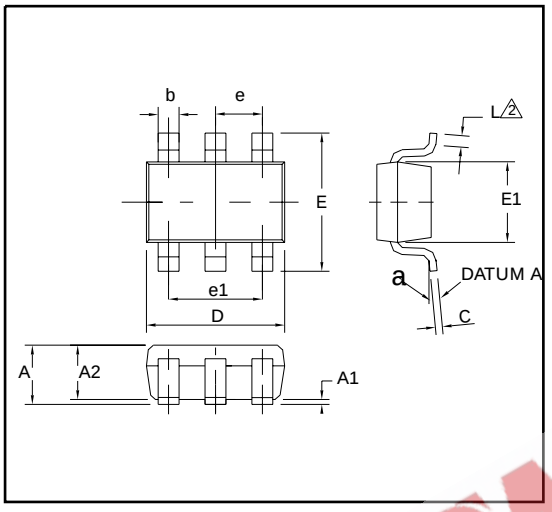


Figure 1a.KB1365 Typical Application Circuit with 2A Output .

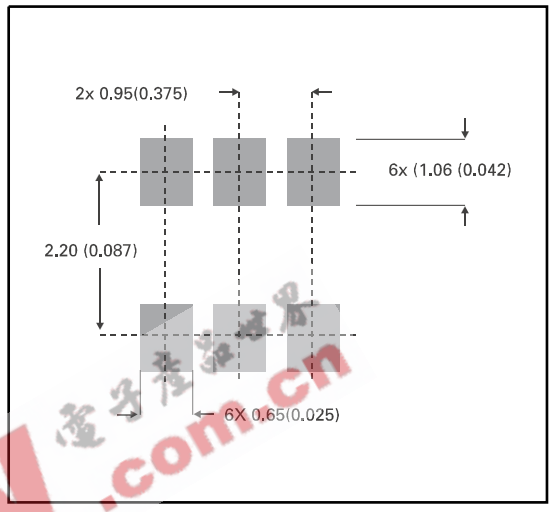
PACAGE DESCRIPTION

Small Outline SOT23-6

PACKAGE OUTLINE



PAD LAYOUT DETAILS



CONTROLLING DIMENSIONS IN MILLIMETRES APPROX CONVERSIONS INCHES.

PACKAGE DIMENSIONS

DIM	Millimetres		Inches		DIM	Millimetres		Inches	
	Min	Max	Min	Max		Min	Max	Min	Max
A	0.90	1.45	0.35	0.057	E	2.60	3.00	0.102	0.118
A1	0.00	0.15	0	0.006	E1	1.50	1.75	0.059	0.069
A2	0.90	1.30	0.035	0.051	L	0.10	0.60	0.004	0.002
b	0.35	0.50	0.014	0.019	e	0.95 REF		0.037 REF	
C	0.09	0.20	0.0035	0.008	e1	1.90 REF		0.074 REF	
D	2.80	3.00	0.110	0.118	L	0°	10°	0°	10°